# ALPS

## Advanced Line Protection™ System

## Instruction Manual

Firmware Revision: V0004.04AA34 (Rev. A models)
V0005.02AA05 (Rev. B models)

Manual P/N: GEK-105555F

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**Note: All relays must be powered up at least once per year to avoid deterioration of electrolytic capacitors and subsequent relay failure.**

**ISO9000**
REGISTERED

Manufactured under an
ISO9002 Registered system.

**2. CALCULATION OF SETTINGS**

> **NOTE**
>
> **Before attempting to install or use this relay, it is imperative that all WARNINGS and CAUTIONS in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.**

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 Power Management 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 on pages 1–49 to 1–52 for the locations of the DC power inputs

Instructions on using the keypad to change settings and put the relay into test mode can be found in Section 4.1.7: SETTING CHANGES on page 4–3. Complete instructions on operating the keypad are found in Chapter 8: LOCAL USER INTERFACE.

**GE Power Management contact information:**

GE Power Management
215 Anderson Avenue
Markham, Ontario
Canada   L6E 1B3

| **Telephone**: | Toll Free North America: | (800) 547-8629 |
| | Europe | +34 94 485 88 54 |
| | Other Areas | (905) 294-6222 |
| | Emergency | (416) 414-4941 |
| **Fax**: | (905) 201-2098 | |
| **Email**: | info.pm@indsys.ge.com | |
| **Home Page**: | www.GEindustrial.com/pm | |

The ALPS requires passwords to change settings or 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.  Select the Password Privilege level to be changed.

5.  Press [ENT].

6.  Enter the factory password (for example: 789. for Master Password).

7.  Enter your password.

8.  Re-enter your password.

9.  Press [END], press [ENT], and then press [CLR].

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

**1**

### 1.1.3 REMOTE COMMUNICATIONS VIA LOCAL PC

To communicate with the relay through 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 are shown in the following:

- Figure 8–2: MODEM CABLE on page 8–23
- Figure 8–3: 25-PIN NULL MODEM CABLE on page 8–23
- Figure 8–4: 25-PIN NULL MODEM CABLE on page 8–27
- Figure 8–5: NULL MODEM CABLE FOR PORT PL1 on page 8–27

The communications software required to access the relay, ALPS-Link, is included on the enclosed Products CD. Follow instructions in Section 11.1.5 SOFTWARE INSTALLATION on page 11–3 to load ALPS-Link onto the PC.

### 1.1.4 ALPS-LINK 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 into the relay, the password can be changed under the ACTION menu by selecting CHANGE PASSWORD.**

The user must logout from the ALPS before changing another password. The remaining passwords can then be changed by logging into the ALPS using another default password. The communications passwords may be viewed, in an encoded format, via the [INF] (information) key.

To log into the relay, follow the instructions in Section 4.1.9: USING COMMUNICATIONS (OPTIONAL) on page 4–4. Any one of the factory passwords can be used to log on to the relay. The relay **UNITID** (General Setting 101) is factory set to "0".

**Table 1–1: ORDER CODES**

| | ALPS | * | * | * | * | * | * | * | * | * | * | * | * | * | – | * | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Base Unit** | ALPS | | | | | | | | | | | | | | | | Base Unit |
| **Distance Relay** | | D | | | | | | | | | | | | | | | Distance Relay |
| **Revision** | | | A | | | | | | | | | | | | | | ALPS Revision A |
| | | | B | | | | | | | | | | | | | | ALPS Revision B |
| **Tripping Logic** | | | | 1 | | | | | | | | | | | | | Single Phase Tripping Logic |
| | | | | 3 | | | | | | | | | | | | | Three Phase Tripping Logic |
| **Current Rating** | | | | | 1 | | | | | | | | | | | | 1 Ampere rated current |
| | | | | | 5 | | | | | | | | | | | | 5 Ampere rated current |
| **Series Capacitors** | | | | | | U | | | | | | | | | | | For applications without series capacitors |
| | | | | | | C | | | | | | | | | | | For Applications with series capacitors |
| **Battery Voltage** | | | | | | | 0 | | | | | | | | | | 48V DC battery voltage |
| | | | | | | | 1 | | | | | | | | | | 110/125 V DC battery voltage |
| | | | | | | | 2 | | | | | | | | | | 220/250 V DC battery voltage |
| **Trip Outputs** | | | | | | | | 1 | | | | | | | | | SCR trip outputs & contact channel interface |
| | | | | | | | | 2 | | | | | | | | | Contact trip outputs & contact channel interface |
| | | | | | | | | 3 | | | | | | | | | SCR trip outputs & 5V / 20mA channel interface |
| | | | | | | | | 4 | | | | | | | | | Contact trip outputs & 5V / 20 mA channel interface |
| **Comm Ports** | | | | | | | | | 2 | | | | | | | | Front RS232 port & 1 settable RS232/RS485 rear port (GEmodem/ASCII)[†] |
| | | | | | | | | | 3 | | | | | | | | Front RS232 port & 2 settable RS232/RS485 rear ports (GEmodem/ASCII) |
| **Mounting** | | | | | | | | | | H | | | | | | | Horizontal mounting |
| | | | | | | | | | | V | | | | | | | Vertical mounting |
| **Oscillography** | | | | | | | | | | | S | | | | | | Standard oscillography memory [†] |
| | | | | | | | | | | | E | | | | | | Extended oscillography memory |
| **OST / Positive Sequence Overvoltage** | | | | | | | | | | | | 0 | | | | | No out-of-step tripping or positive sequence overvoltage [†] |
| | | | | | | | | | | | | 1 | | | | | With out-of-step tripping [†] |
| | | | | | | | | | | | | 2 | | | | | With positive sequence overvoltage units [†] |
| | | | | | | | | | | | | 3 | | | | | With positive sequence overvoltage units & out-of-step tripping |
| **Recloser** | | | | | | | | | | | | | N | | | | No recloser |
| | | | | | | | | | | | | | R | | | | Recloser |
| | | | | | | | | | | | | | S | | | | Recloser with sync check |
| **Protocol** | | | | | | | | | | | | | | | | AC | Modbus RTU communication [†] |

**† These options are applicable to Revision A models only.**

**EXAMPLE:** ALPSDA35U122VE1N = ALPS Digital Line Protection Distance Relay; revision A; three phase tripping logic; 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 recloser.

**1**

The Advanced Line Protection System (ALPS) is a microprocessor-based digital relay system that uses waveform sampling with appropriate algorithms to provide three phase or single phase tripping schemes for transmission line protection, fault location, and related features. The models covered by this instruction book are intended for either three phase or single phase tripping applications. The relay samples the current and voltage inputs from the power system 64 times per cycle. Protection algorithms process this sampled data in sets of four, sixteen times per cycle. The ALPS 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 Inches) 19-inch rack mount case and is available for either horizontal or vertical mounting. The case outline and mounting dimensions are shown in Figure 3–2: FRONT AND REAR VIEW on page 3–2.

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

The 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, and includes logic for step distance and five standard pilot tripping schemes. The scheme logic is described in Section 1.8: PROTECTION SCHEMES on page 1–23. The external connections for the ALPS are shown in the elementary diagrams on pages 1–49 to 1–52.

The ALPS is available with either a 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.

The measurement functions are listed in Table 1–2: ALPS MEASUREMENT FUNCTIONS on page 1–5.

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. The ALPS also offers ground quadrilateral distance functions as Zone 1 ground 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 ALPS also offers Zone 2 ground quadrilateral characteristics. 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 ALPS also has the option for quadrilateral ground-distance functions.

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. The ALPS with three phase tripping also has the option to use Zone 4 ground quadrilateral distance functions 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. Time-overcurrent tripping (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.

**1**

**Table 1–2: ALPS MEASUREMENT FUNCTIONS**

| ZONE OR TYPE | FUNCTIONS |
|---|---|
| Zone 1 | • 3 Variable-Mho phase-distance functions |
| | • 3 Variable-Mho ground-distance functions |
| | • 3 Reactance ground-distance functions with "adaptive reach" Mho supervision **or** 3 Quadrilateral ground-distance functions (Revision B relays only). |
| Zone 2 (Pilot Zone) | • 3 Variable-Mho phase distance functions |
| | 3 Variable Mho ground-distance functions **and/or** Ground directional-overcurrent functions consisting of: IPT: Ground Trip overcurrent NT: Negative Sequence Directional Trip IPB: Ground Block overcurrent NB: Negative Sequence directional block **or** 3 Quadrilateral ground-distance functions (Revision B relays only) |
| Zone 3 | • 3 Variable-Mho phase-distance functions |
| | • 3 Variable-Mho ground-distance functions, **or** 3 Quadrilateral ground-distance functions (Revision B relays only) |
| Zone 4 | • 3 Reversible variable-Mho phase-distance functions |
| | • 3 Reversible variable-Mho ground-distance functions, **or** 3 Quadrilateral ground-distance functions (Revision B relays only) |
| 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 Detectors | • 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 |
| Out of Step Tripping (OST) | • 3 Variable-Mho positive sequence-distance functions |

### 1.2.4 GROUND DISTANCE QUADRILATERAL CHARACTERISTICS

The ALPS relay has been modified to include the option to use either quadrilateral characteristics or variable Mho characteristics for all zones of ground distance protection. The model numbers affected by this modification are: ALPSD-B*XXXXXXXXX* (where *X* may be any valid character) with firmware version V0005.00AA00 or higher. A new version of ALPS-Link may be required to access the new settings via remote communications (ALPS-Link must be version 3.5 or higher). If required, the updated version of ALPS-Link may be downloaded from the GE power Management website at www.GEindustrial.com/pm.

Many protective relay engineers prefer to use a quadrilateral (polygonal) characteristic for ground distance functions to provide more fault resistance coverage than the circular mho characteristic. A typical quadrilateral characteristic is shown in Figure 1–1: GROUND DISTANCE QUADRILATERAL CHARACTERISTIC. The characteristic is comprised of four straight lines; the trip zone is the inside area bounded by all four characteristics. The upper boundary, the reactance characteristic, may also be used with a variable mho function. The variable mho provides both directional supervision for reverse faults. and resistive limits to prevent operation on load.
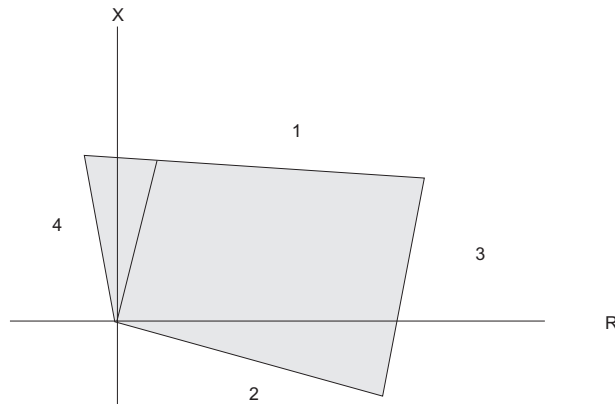
**Figure 1–1: GROUND DISTANCE QUADRILATERAL CHARACTERISTIC**

In the ALPS relay the four straight lines of the quadrilateral characteristic are developed by a combination of the following three characteristics:

1. Reactance characteristic (section 1). The tilt of the reactance characteristic is determined by the characteristic timer setting. The range of the setting is 80° to 155° in 1° steps.

2. Restricted directional characteristic (sections 2 and 4)

3. Right (positive) resistive blinder (section 3)

The following definitions pertain to all of the distance functions:

$I_A$ = phase A current at relay
$I_B$ = phase B current at relay
$I_C$ = phase C current at relay
$I_0$ = zero-sequence current at relay
$V_A$ = phase A to ground voltage at relay
$V_B$ = phase B to ground voltage at relay
$V_C$ = phase C to ground voltage at relay
$X_1$ = positive-sequence component of $X$
$X_2$ = negative-sequence component of $X$
$X_M$ = memory (pre-fault) value of $X$
$Zx_1$ = Zone $x$ positive-sequence reach setting: $ZxR \angle$ POSSEQANG
$Zx_0$ = Zone $x$ zero-sequence reach setting: $ZxR \angle$ ZERSEQANG
    Note: The magnitudes of $Zx_1$ and $Zx_0$ are identical - these quantities differ in phase angle only.
$K_01$ = Zone 1 zero-sequence compensation factor: Z1K0
$K_0$ = zero-sequence compensation factor

### a) REACTANCE CHARACTERSTIC

The reactance characteristic used for the ground quadrilateral is the similar as the existing negative / zero sequence phase angle comparator reactance characteristic. The function has been modified by the addition of a fourth comparator input (Pol. #3). The operate and polarizing signals used in this function are:

Operate:    $I\phi'Z - V\phi$
Pol.# 1:    $I_0Z_1$
Pol.# 2:    $I_2Z_1$
Pol.# 3:    $I_{1F}Z_1$

where:    $I\phi'Z$ is the compensated $IZ$ product
        $Z_1$ is the positive sequence replica impedance
        $V\phi$ is the phase to ground voltage
        $I_0$ is the zero sequence current component
        $I_2$ is the negative sequence current component, referenced to the proper phase.
        $I_{1F}$ is the fault component of the positive sequence current component, referenced to the proper phase.
            The pre-fault load current is removed from this quantity.

All zones of ground reactance characteristics will have a characteristic timer with a pickup range of 90 to 155° in steps of 1. The characteristic timer setting will be used to "tilt" the reactance characteristic (Tent) to prevent over-reach on non-homogeneous systems, as shown below. Note that the "tent" is not the same as tilting the reactance because it also tilts down to the left of the maximum reach balance point. By adjusting the angle of the phase angle comparator rather than the angle of "maximum torque", the transient over reach is not increased.
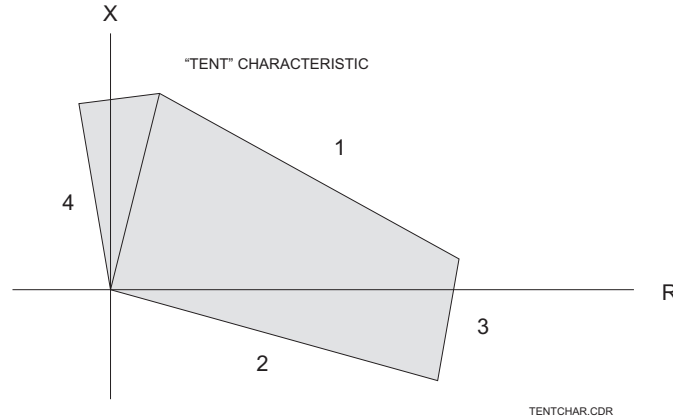


**Figure 1–2: TENT CHARACTERISTIC**

For the Zone 1 ground function, the signals are:

Phase A: $(I_A - I_0) \cdot Z1_1 + K_01 \cdot I_0 \cdot Z1_0 - V_A$
$I_{A2} \cdot Z1_1$
$I_0 \cdot Z1_1$
$I_{A1F} \cdot Z1_1$

Phase B: $(I_B - I_0) \cdot Z1_1 + K_01 \cdot I_0 \cdot Z1_0 - V_B$
$I_{B2} \cdot Z1_1$
$I_0 \cdot Z1_1$
$I_{B1F} \cdot Z1_1$

Phase C: $(I_C - I_0) \cdot Z1_1 + K_01 \cdot I_0 \cdot Z1_0 - V_C$
$I_{C2} \cdot Z1_1$
$I_0 \cdot Z1_1$
$I_{C1F} \cdot Z1_1$

**b) RESTRICTED DIRECTIONAL CHARACTERISTIC**

The restricted directional characteristic for the ground quadrilateral requires a separate directional unit for each phase. No settings are required for this characteristic. The input signals to the comparator are:

Phase A: $I_A \cdot ZD$
$V_A$

Phase B: $I_B \cdot ZD$
$V_B$

Phase C: $I_C \cdot ZD$
$V_C$

where *ZD* is the angle of "maximum torque" and is equal to 65°.

The characteristic timer angle will be fixed at 115°. That is, the function will operate when the input signals are within ±65° of each other.

If the faulted phase voltage magnitude is too low (as for a close-in Zone 1 fault), the phase directional function will not operate. This might also occur for a remote fault when the relay is located near a strong source. Therefore, if the phase voltage is less than the minimum threshold voltage, the positive-sequence memory voltage from the ground Mho functions is used in place of the phase voltage to polarize the directional function.

### c) RIGHT RESISTIVE BLINDER

The right resistive blinder is a two input phase angle comparator. The input signals for the comparator are:

Operate:      $I\phi' \cdot RB1 - V\phi$

Polarize:     $I\phi' \cdot RB1$

> where:
>
> > The magnitude of $RB1$ (**R**ight **B**linder for Zone **1**) is the point at which the characteristic intersects the R axis. The range of adjustment will be 0.1 to 500.0 ohms in 0.1 ohm steps.
> >
> > The angle of $RB1$ is be fixed based on the positive sequence line angle, the zero sequence line angle, and the $K0$ factor. The angle is:
> >
> > $$\frac{2 \cdot POSSEQANG + K0 \cdot ZERSEQANG}{2 + K0}$$
> >
> > $I\phi'$ is the compensated phase current, $(I_A - I_0) + K_01 \bullet I_0$

The characteristic timer angle will be fixed at 90°. For the Zone 1 ground function, the operate and polarizing signals are:

| | | |
|---|---|---|
| Phase A: | $I_A' \cdot RB1 - V_A$ <br> $I_A' \cdot RB1$ | where: |
| | | $I_A' = (I_A - I_0) + K_01 \cdot I_0$ |
| Phase B: | $I_B' \cdot RB1 - V_B$ <br> $I_B' \cdot RB1$ | $I_B' = (I_B - I_0) + K_01 \cdot I_0$ |
| | | $I_C' = (I_C - I_0) + K_01 \cdot I_0$ |
| Phase C: | $I_C' \cdot RB1 - V_C$ <br> $I_C' \cdot RB1$ | $K_01 = | K_01| - (ZERSEQANG - POSSEQANG)$ |

### 1.2.5 LINE PROTECTION SCHEMES

The ALPS provides four zones of distance protection with overcurrent backup functions. The ALPS is a highly flexible system: along with predefined protection schemes, it 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)
- Blocking
- Hybrid
- Phase Identified Channel

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

The ALPS offers a high degree of custom programmability. Custom programming of the ALPS is accomplished using Xpression Builder. Xpression Builder is a Windows based program that allows the user to design programmable logic and make I/O (Input/Output) assignments for the ALPS and other GE Power Management relays. Xpression Builder is included with ALPS software suite on the GE Power Management CD. A complete description of Xpression Builder is included in Chapter 13: XPRESSION BUILDER.

**1.3.2 PROGRAMMABLE LOGIC**

In addition to the pre-programmed line protection schemes and configurable I/O, 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 program-mable logic includes the following: 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.

**1.3.3 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 below and on the default elementary diagrams on pages 1–49 to 1–52.

⚠ **WARNING**   **Each configurable input can be assigned only one flag – assigning more than one flag to a configurable input may cause maloperation!**

**Table 1–3: ALPS DEFAULT CONTACT CONVERTER ASSIGNMENTS: SINGLE PHASE MODEL**

| INPUT | DESCRIPTION | MNEMONIC | INDEX # | 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 | BLPTRP | 11 | (Blocking Scheme Only) |
| CC5 | ENABLE THREE 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 1–4: ALPS DEFAULT CONTACT CONVERTER ASSIGNMENTS: THREE PHASE MODEL**

| INPUT | DESCRIPTION | MNEMONIC | INDEX # | 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 | BLPTRP | 11 | (Blocking Scheme Only) |
| CC5 | | | | |
| CC6 | | | | |
| CC7 | BKR 1 52B | 52B_1 | 1 | |
| CC8 | BKR 2 52B | 52B_2 | 4 | |

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. These are shown below and in Figure 1–28: ELEMENTARY DIAGRAM WITH DEFAULT I/O (THREE PHASE TRIPPING) on page 1–50 for the three phase model and Figure 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING) on page 1–49 for the single phase model.

**Table 1–5: ALPS DEFAULT OUTPUT CONTACT ASSIGNMENTS: SINGLE PHASE MODEL**

| RELAY | DESCRIPTION | MNEMONIC | INDEX NO. |
|---|---|---|---|
| T1 | TRIP BUS PHASE A | TRIPA | 33 |
| T2 | TRIP BUS PHASE A | TRIPA | 33 |
| T3 | TRIP BUS PHASE A | TRIPA | 33 |
| T4 | TRIP BUS PHASE A | TRIPA | 33 |
| T5 | TRIP BUS PHASE B | TRIPB | 34 |
| T6 | TRIP BUS PHASE C | TRIPC | 34 |
| A1 | MANUAL CLOSE BREAKER 1 | MNCLS1 | 58 |
| A2 | MANUAL CLOSE BREAKER 2 | MNCLS2 | 59 |
| A3 | TRIP BUS PHASE A | TRIPA | 33 |
| A4 | TRIP BUS PHASE A | TRIPA | 33 |
| A5 | THREE PHASE RECLOSE INITIATE | RI-3P | 37 |
| A6 | THREE PHASE RECLOSE INITIATE | RI-3P | 37 |
| A7 | RECLOSE CANCEL OUTPUT FROM SCHEME LOGIC | CANCL | 38 |
| A8 to A12 | UNASSIGNED | --- | --- |
| 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 START #2 | KEY2 | 40 |
| C1 | NON-CRITICAL ALARM | NCALM | 52 |
| C2 | PT FUSE FAILURE ALARM | FF | 115 |

**Table 1–6: ALPS DEFAULT OUTPUT CONTACT ASSIGNMENTS: THREE PHASE MODEL**

| RELAY | DESCRIPTION | MNEMONIC | INDEX NO. |
|---|---|---|---|
| T1 | TRIP CIRCUIT #1 | TRIPA | 33 |
| T2 | TRIP CIRCUIT #2 | TRIPA | 33 |
| T3 | TRIP CIRCUIT #3 | TRIPA | 33 |
| T4 | TRIP CIRCUIT #4 | TRIPA | 33 |
| A1 | MANUAL CLOSE CIRCUIT BREAKER #1 | MNCLS1 | 58 |
| A2 | MANUAL CLOSE CIRCUIT BREAKER #2 | MNCLS2 | 59 |
| A3 | BREAKER FAILURE INITIATE #1 | TRIPA | 33 |
| A4 | BREAKER FAILURE INITIATE #2 | TRIPA | 33 |
| A5 | RECLOSE INITIATE #1 | RI_3P | 37 |
| A6 | RECL OSE INITIATE #2 | R1_3P | 37 |
| A7 | RECLOSE CANCEL | CANCL | 38 |
| A8 | RECLOSE CANCEL | CANCL | 38 |
| 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 START #2 | KEY2 | 40 |
| C1 | NON-CRITICAL ALARM | NCALM | 52 |
| C2 | PT FUSE FAILURE ALARM | FF | 115 |

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. Rather, 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. The PTFF functional logic is shown below.

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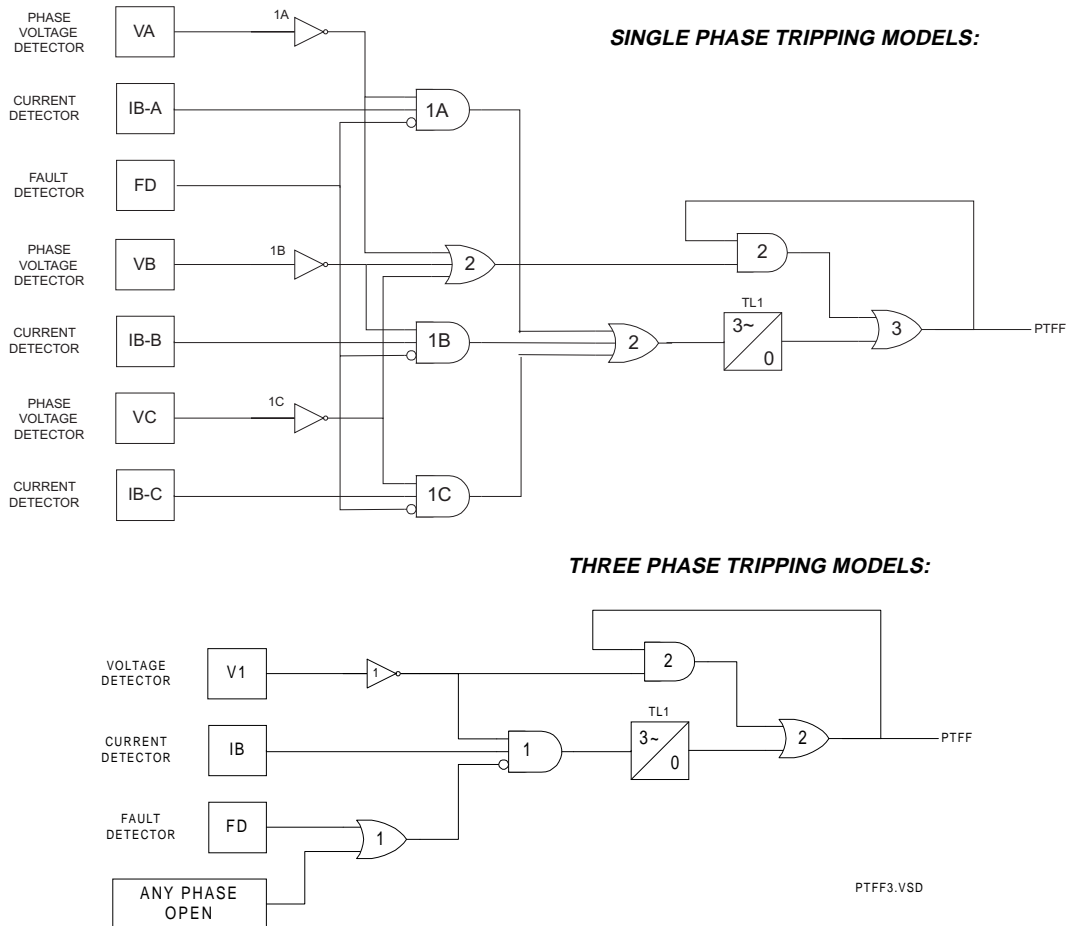


**Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS**

If AC potential is lost for any reason, including a blown fuse or fuses, and there is no disturbance on the power system that operates the fault detector, the AND1 output 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.

**1**

### a) THREE PHASE TRIPPING

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. The logic is shown below:
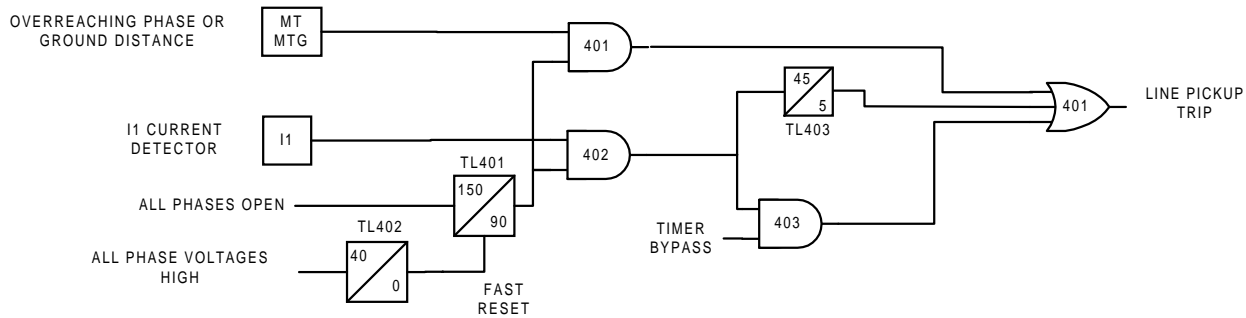


**Figure 1–4: LINE PICKUP LOGIC DIAGRAM (THREE PHASE TRIPPING)**

When the line is de-energized, the open breaker is detected by the All phases Open signal as shown in the above logic. 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 TL402 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.

### b) SINGLE PHASE TRIPPING

Logic is included to provide high speed tripping when a single phase reclose onto a permanent fault occurs. When a phase of the circuit breaker is open, the associated timer (TL404, TL405, and 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.
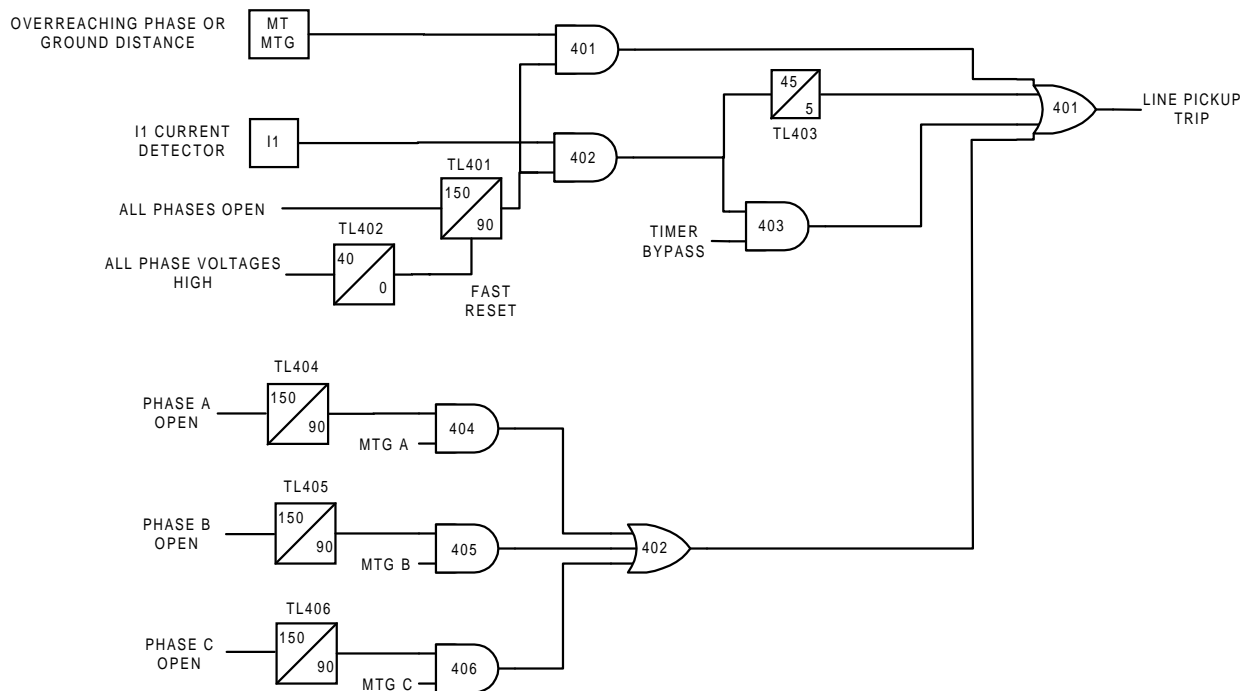
**Figure 1–5: LINE PICKUP LOGIC DIAGRAM (SINGLE PHASE TRIPPING)**

**1.4.3 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 1–6: REMOTE-OPEN DETECTOR LOGIC (ROD), the ROD output trips via OR2, AND1, OR2, AND2, OR3, and AND4. The Remote-Open Detector will not operate when a balanced three-phase fault is present.

ROD speeds 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 pilot schemes.

Figure 1–6: REMOTE-OPEN DETECTOR LOGIC (ROD) 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-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.

**1**
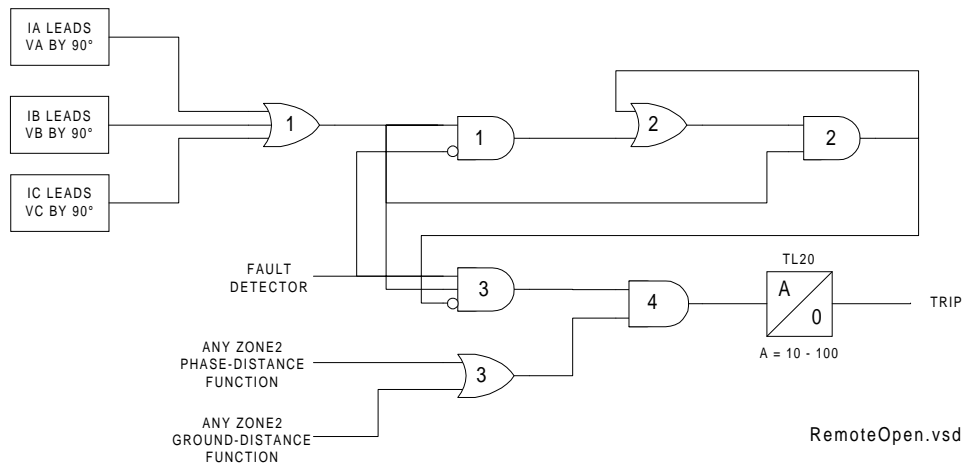


**Figure 1–6: REMOTE-OPEN DETECTOR LOGIC (ROD)**

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 mA or more (secondary phase current) to assure operation of ROD. If the fault is still present as indicated by an output from OR3, an ROD trip follows the expiration of the TL20 security time delay.

### 1.4.4 OUT-OF-STEP BLOCKING

Figures 1–7: OSB R-X DIAGRAM and 1–8: OSB LOGIC DIAGRAMS represent the functional logic diagrams for 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 the middle input to AND201. The top input is present from the NOT via OR202, since MT (A-B) has not operated yet. The bottom NOT 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 AND202 via OR202 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. OSB can be selected to block tripping of:

1.  All functions (Protection Setting 1603: **BLOCKWHAT** = BLKALL)

2.  All distance functions (Protection Setting 1603: **BLOCKWHAT** = BLKDIST)

3.  Only the phase distance functions (Protection Setting 1603: **BLOCKWHAT** = BLKPHAS)

4.  No functions (Protection Setting 1603: **BLOCKWHAT** = BLKNONE)

For selections 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 Protection Settings 1604 through 1607 (**BLOCKZ1**, **BLOCKZ2**, **BLOCKZ3**, and **BLOCKZ4**).

Timer TL1 has an adaptive pickup feature with an initial pickup setting of 30 ms for the first slip cycle; the pickup delay becomes progressively lower during successive slip cycles. This improves the capability to maintain the out-of-step output during the increasing slip frequencies typically encountered after the first slip cycle.
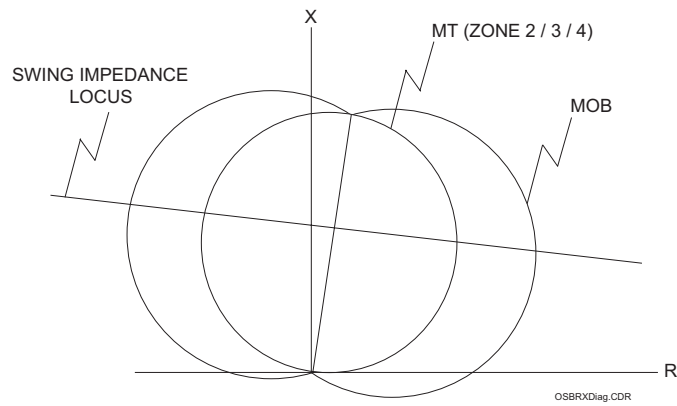
**Figure 1–7: OSB R-X DIAGRAM**

*ALPS WITH THREE-PHASE TRIPPING:*
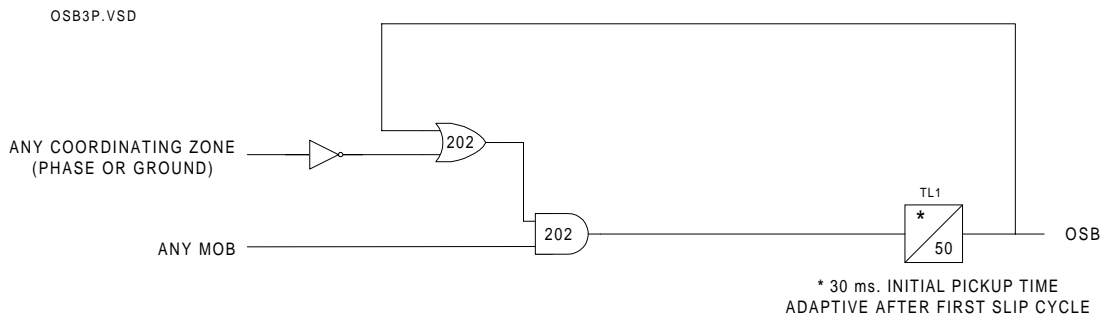


*ALPS WITH SINGLE-PHASE TRIPPING:*
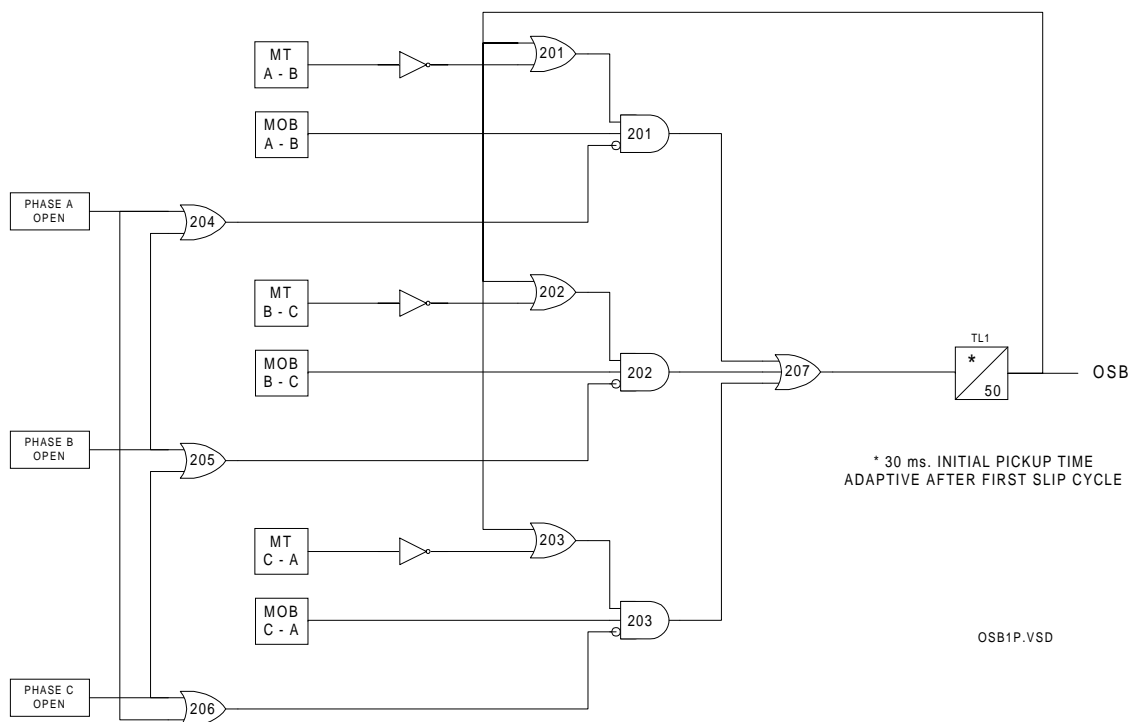


**Figure 1–8: OSB LOGIC DIAGRAMS**

**1**

### 1.5.1 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.

### 1.5.2 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.

### 1.5.3 CURRENT UNBALANCE DETECTION

If the Fault Detector 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.

### 1.5.4 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.

### 1.5.5 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 Section 8.2.3: REQUEST FAULT INFORMATION on page 8–17 for obtaining a fault report through the local user interface and Section 11.6: INFORMATION on page 11–14 for fault reports using ALPS-Link.

### 1.5.6 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. Protection 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: **NUM-FAULTS**. 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 an 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 information on reading oscillography with ALPS-Link is found in Section 11.6.5: OSCILLOGRAPHY REPORT on page 11–15. The ALPS does not store flags for functions that are disabled. For example, if Protection Setting 104: **Z1GROUND** = NO and a Z1 ground fault is applied, the Zone 1 ground flag will not operate or be stored.

### 1.5.7 PLAYBACK

The ALPS 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 Section 8.1.20: PLAYBACK on page 8–13 for a complete description of the Playback feature.

### 1.5.8 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 event list contained in Section 8.2.7: EVENT INFORMATION on page 8–19.

### 1.5.9 EQUIPMENT DUTY

When the ALPS is applied with a single breaker, it 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 Section 2.2.4: EQUIPMENT DUTY on page 2–6 for a complete description of the Equipment Duty feature.

### 1.5.10 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 Figure 1–9: SWITCH SELECTION OF ACTIVE SETTING GROUP below.

**NOTE**
**For this example, CC5 has been assigned to "CGST2" (Change Setting Group Input, Bit 1) and CC6 has been assigned to "CGST1" (Change Setting Group Input, Bit 0). Other contact converters may be assigned to these functions.**

**1**

```
                              TRUTH TABLE        CC5  CC6   SETTINGS
                                                            GROUP
                              CC5 --> bit 1       0    0      G1
                              CC6 --> bit 0       0    1      G2
                                                  1    0      G3
                                                  1    1      G4
```
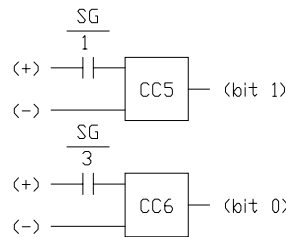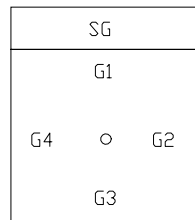


**Figure 1–9: SWITCH SELECTION OF ACTIVE SETTING GROUP**

**1.5.11 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.

**1.5.12 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 (that is, current and voltage at the relay) at that instant. A Trip Bus Check also occurs before a newly selected settings group is allowed to become the active settings group. If Trip Bus Check finds a picked-up trip function, protection is turned off and a critical alarm is issued.

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

**1.5.13 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 to 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.

**1**

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 General Setting 107: **NUM_MON**.

Operation of the Trip Circuit Monitor causes a noncritical alarm event. If one or more breaker poles 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 non-critical alarm for this condition, closure of the associated 52/b contact disables the Trip Circuit Monitor function for the involved pole.

### 1.5.14 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 a 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 overload alarm, may be added by the user via Xpression Builder.

### 1.5.15 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.

### 1.5.16 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 as shown in Figure 3–5: INPUT BOARD DIAGRAM on page 3–7. The ALPS is shipped from the factory with this jumper and Breaker Control enabled. Install the jumper to disable Remote Breaker Control.

A local user interface, incorporating a keypad and display, is provided to enter settings, display present values, view fault target information, and access stored data (see Chapter 8 for details). Passwords provide security for keypad access. Three separate 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 Section 8.1.21: CHANGE PASSWORD on page 8–14 for a description of the keypad password usage.

A DB-9 plug RS232 port (Port 1) on the front panel provides local serial communication via an IBM PC-compatible computer. One or two rear ports (RS232 or RS485) are provided for serial communications. Port 2 is standard on all models. When Port 2 is configured as RS232, connection is made using a DB25 plug; when Port 2 is configured as RS485, connection is made using a 4-pin Phoenix plug. Port 3 is optional (depending on the model) and uses a DB25 plug for either RS232 or RS485. The communications protocol for each port may be selected independently as either GE-Modem, ASCII, or DNP 3.0. Each port may be set independently for data communications from 300 to 9600 bps. In addition, Port 2 has the ability to accept a plug in communication module that can support the Modbus RTU communications protocols.

Four different passwords provide remote serial communications security. The levels of password protection for communications 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 GUIDE for a description of ALPS-Link and Chapter 12: ASCII COMMUNICATIONS for ASCII port password usage. The Modbus memory map and DNP 3.0 protocol information are contained in Appendices B and C, respectively.

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

Two settings are associated with the SCADA DTA Interface. **FLTLOCK** specifies a time 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. When either the ALPS date or time is changed the timers associated with **FLTLOCK** and **FLTRESET** are reset and the DTA logic is reset. Fault phase identification dry contacts for A, B, C, and N phases must be programmed by the user. Refer to Chapter 3 for details.

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: COMPONENTS TESTED DURING START-UP TESTS on page 9–2.

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 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 ALPS message is displayed and the ALPS begins acquiring and processing data.

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 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5. 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 Table 9–2: RUN-TIME BACKGROUND SELF-TESTS on page 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 not available for testing. The components tested in the foreground are listed in Table 9–3: RUN-TIME FOREGROUND SELF-TESTS. 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 Section 1.5.13: TRIP CIRCUIT MONITOR on page 1–18 of 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.

**1**

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 are found in Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PRO-GRAMMABLE LOGIC on page 2–52. The Index numbers used for the Continuous Monitor are as follows:

- 48: Trip Circuit alarm
- 49: ZONE flags on alarm
- 50: Overcurrent Alarm
- 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.

**1**

The six standard protection schemes are described in this section. Functional logic diagrams Figure 1–10: STEP DIS-TANCE LOGIC DIAGRAM through Figure 1–18: HYBRID LOGIC DIAGRAM show the scheme logic for the protection schemes using conventional AND/OR combinational logic. The elementary diagrams on pages 1–49 to 1–52 show 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 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIP-PING) on page 1–49 and Figure 1–28: ELEMENTARY DIAGRAM WITH DEFAULT I/O (THREE PHASE TRIPPING) on page 1–50. The programmability of the ALPS is discussed in Chapter 13: XPRESSION BUILDER. Figures 1–11: INTER-CONNECTION DIAGRAM FOR PUTT/POTT WITH NS40A through 1–17: INTERCONNECTION DIAGRAM FOR BLOCK-ING SCHEME WITH CS61C on pages 1–25 to 1–32 show typical interconnections between the ALPS and an appropriate carrier/tone equipment for three pilot schemes:

- BLOCKING with NS40A

- POTT with CS28A

- HYBRID with Unblocking CS61C

Figure 1–10: STEP DISTANCE LOGIC DIAGRAM on page 1–27 is the logic diagram for the Step Distance scheme for the ALPS single phase and three phase models, respectively. Since this non-pilot 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 for-ward-looking Zone 4.

The phase-distance functions can be placed in or out of service by specifying a separate setting for each protection zone. The same is true for the ground-distance functions. Zone 2, Zone 3, and Zone 4 each have two independently set zone tim-ers. One timer is associated with the phase functions, the other with the ground functions.
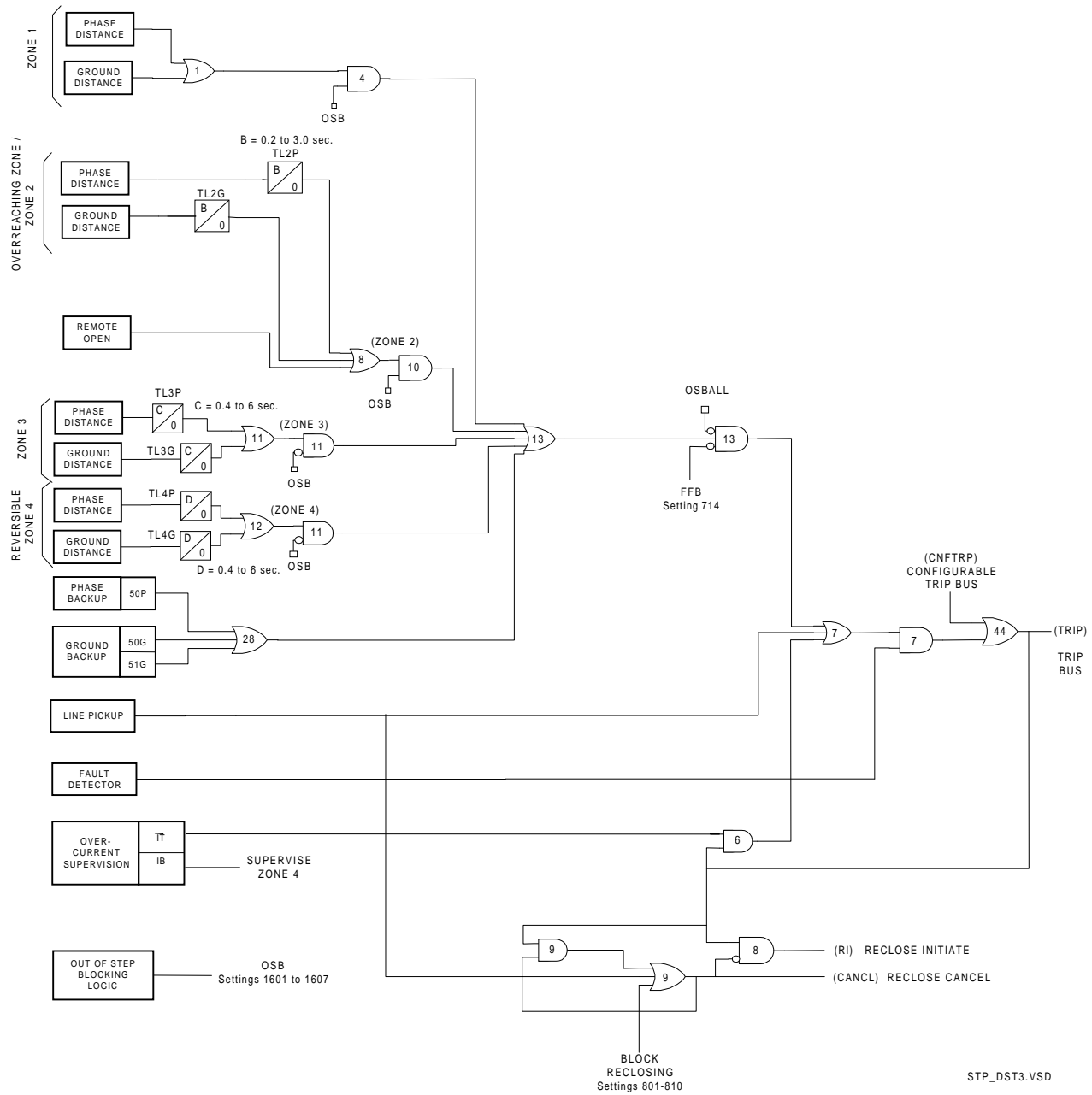
**Figure 1–10: STEP DISTANCE LOGIC DIAGRAM**

Figure 1–12: PUTT LOGIC DIAGRAM on page 1–29 is the logic diagram for the PUTT scheme. This scheme requires Zone 1 as well as overreaching zone functions. Zone 1 trips directly via OR1, AND4, OR25, OR3, OR4, AND3, OR13, AND13, OR7, and AND7 and keys the transmitter to the trip frequency via OR5. Tripping for internal faults not seen by the Zone 1 functions occurs when an overreaching function operates and the receiver(s) produce an output, satisfying the input conditions of the comparator, AND407.

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 POTT1 scheme. As with a POTT1 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 OR21, rather than ANDed together as with a POTT1 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 PICKSCHEME = 2 [PUTT] and NUMRCVR = 2 [2 RCVRS], as indicated in Figure 1–12: PUTT LOGIC DIAGRAM by the link between AND5 and OR5. 52/b contact keying of the transmitter should be used for a two-terminal PUTT application.
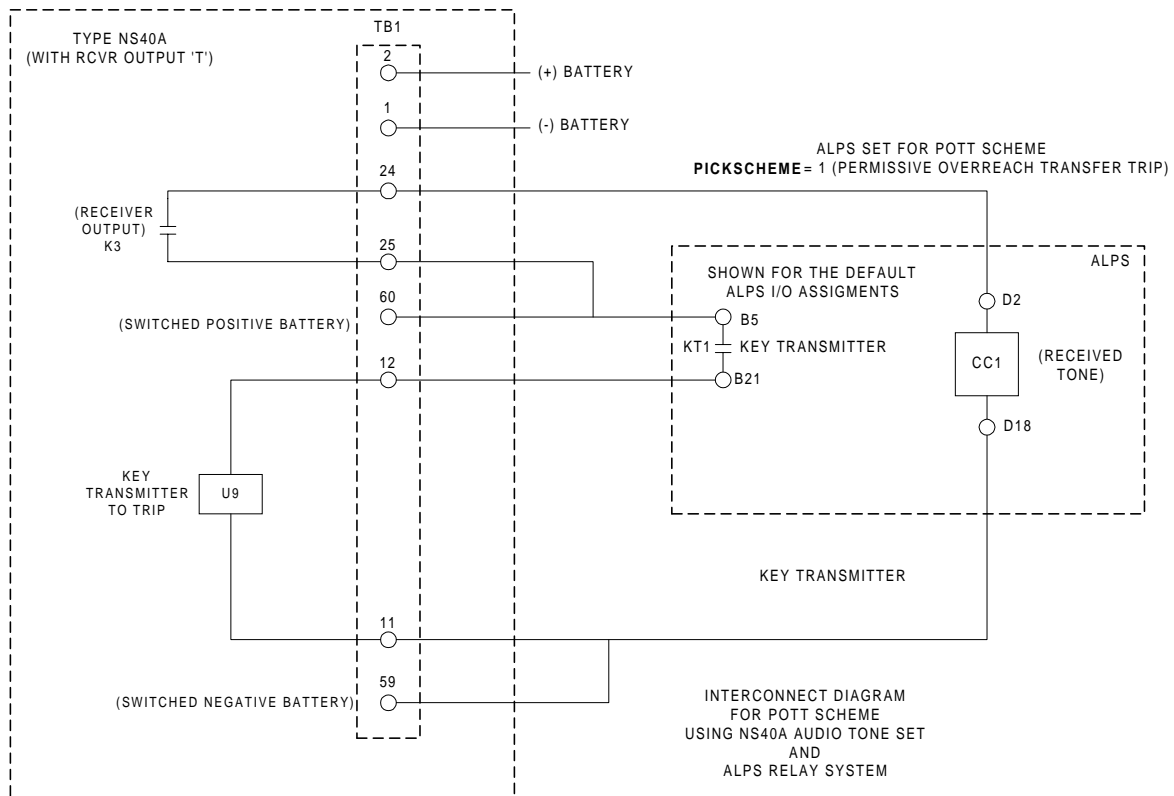


**Figure 1–11: INTERCONNECTION DIAGRAM FOR PUTT/POTT WITH NS40A**

**1**



**Figure 1–12: PUTT LOGIC DIAGRAM**

Figure 1–13: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1) on page 1–31 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 and applies one of the inputs to the comparator, AND407, 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 AND407 output results in a trip output via OR3, TL1, OR4, AND3, OR13, AND13, OR7, and AND7.

This same sequence 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 AND7, 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 AND21.

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 1–14: POTT WITH BLOCKING FUNCTIONS (POTT2) on page 1–32 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.
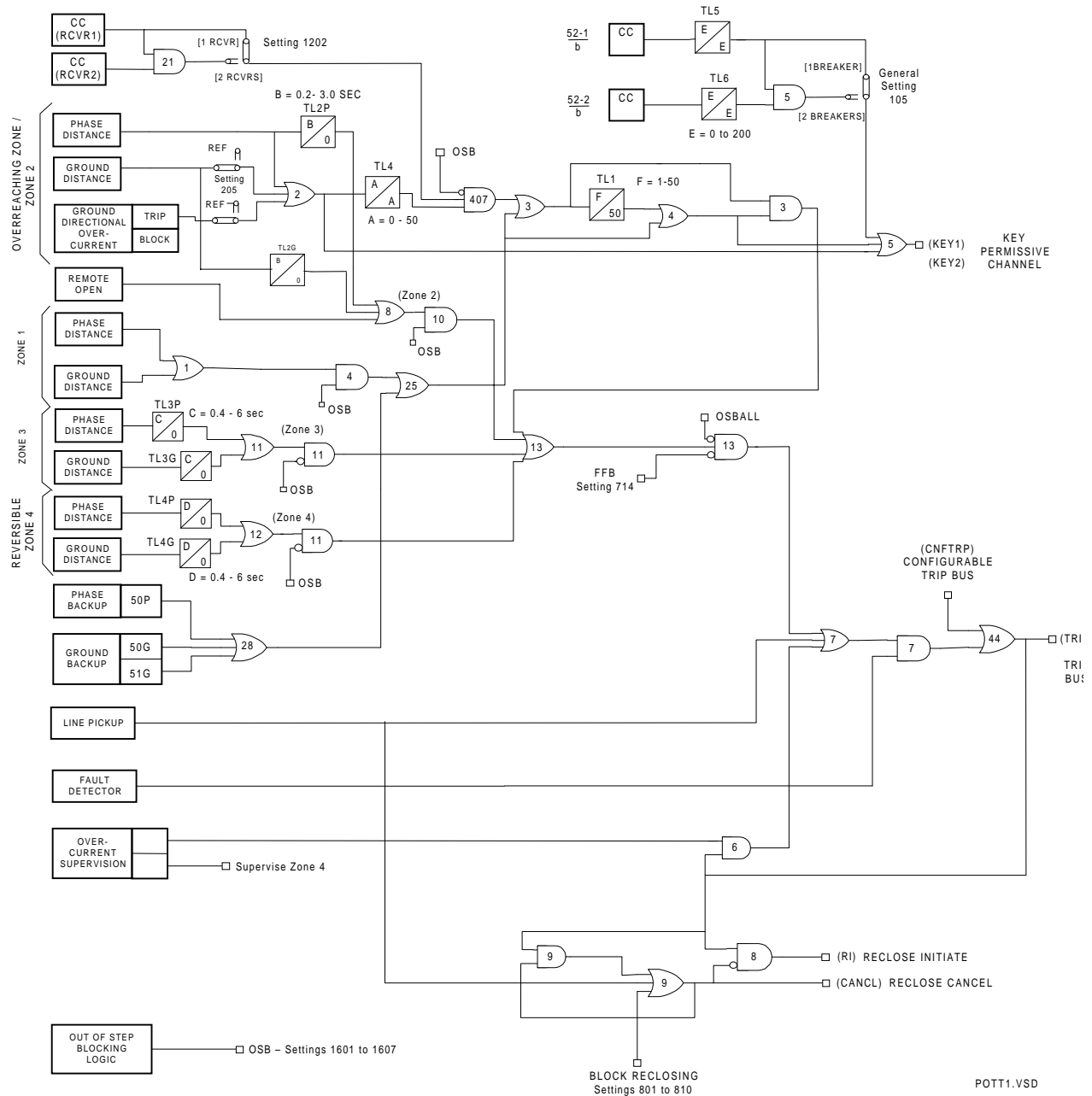
**1**



**Figure 1–13: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1)**

**Figure 1–14: POTT WITH BLOCKING FUNCTIONS (POTT2)**

**1**
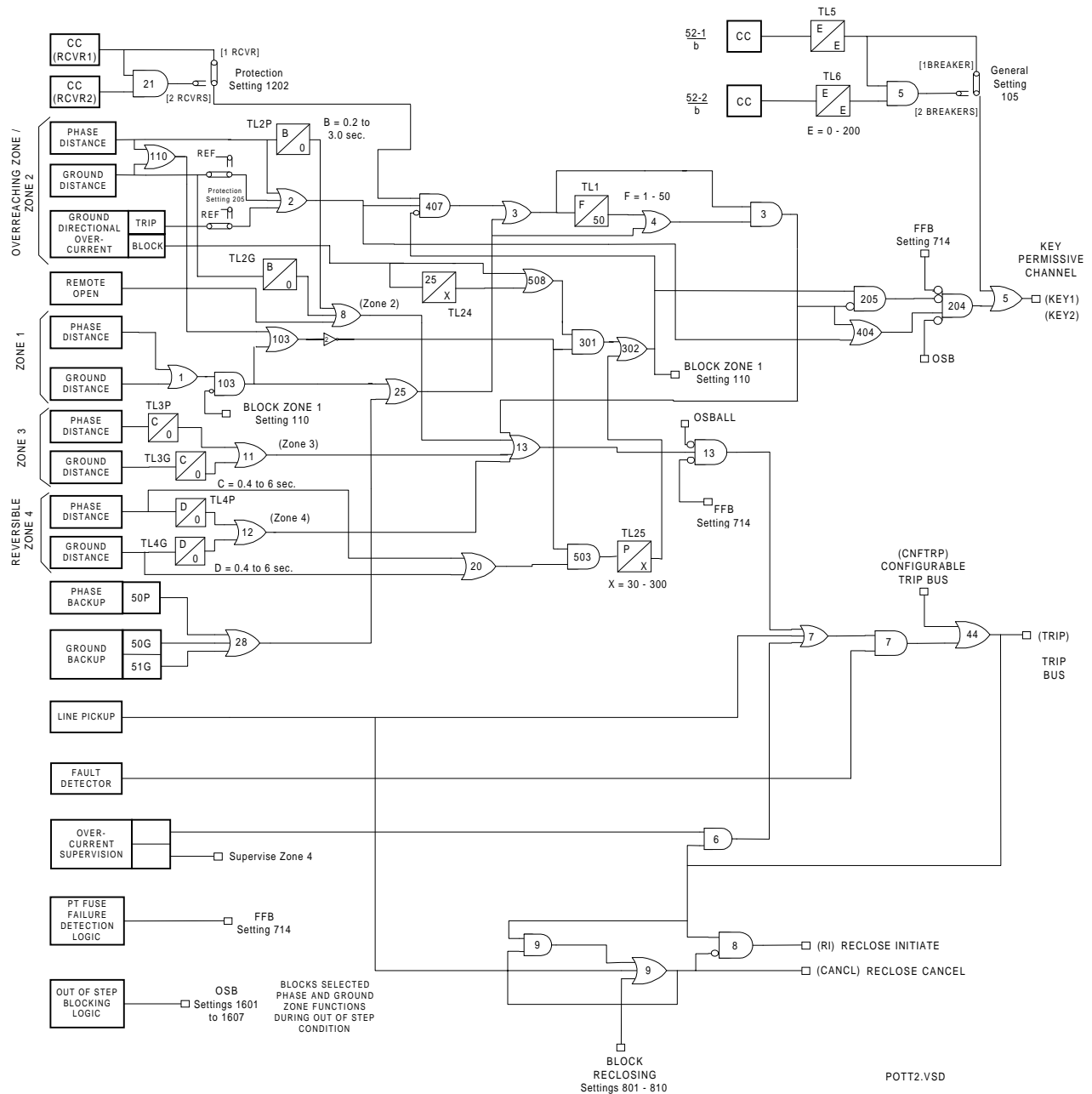
The logic for the Blocking scheme is shown in the following diagram. Since a reverse-looking blocking function is required in these schemes, the Zone 4 distance functions are automatically set for reversed reach when the Blocking scheme is selected. As for channel operation, a blocking scheme has the 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 carrier set. 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 Blocking scheme has provision for different logics to start the carrier for ground faults. The carrier starting option is determined by Protection Settings 1204: **CARRSTART** and 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. 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 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.

For any multiphase fault on the protected line, one or more of the overreaching zone variable-Mho functions operates at each end and apply 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 comparator 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 FD option uses the fault detector (FD) without NB supervision as a non-directional carrier start function. 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. Tripping, as in all the schemes, is supervised by the Fault Detector at AND7, thus confirming that a trip only occurs when a disturbance is present on the power system.

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 comparator. 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 comparator for at least 30 ms following the clearing of the external fault.

The ground-distance and phase-distance transient blocking logic consists of OR20, AND503, TL25, and OR302. It operates in a similar manner to the GDOC transient blocking logic. Thus, if any of the overreaching zone tripping functions 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 the logic diagram) 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 NS40A. 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.
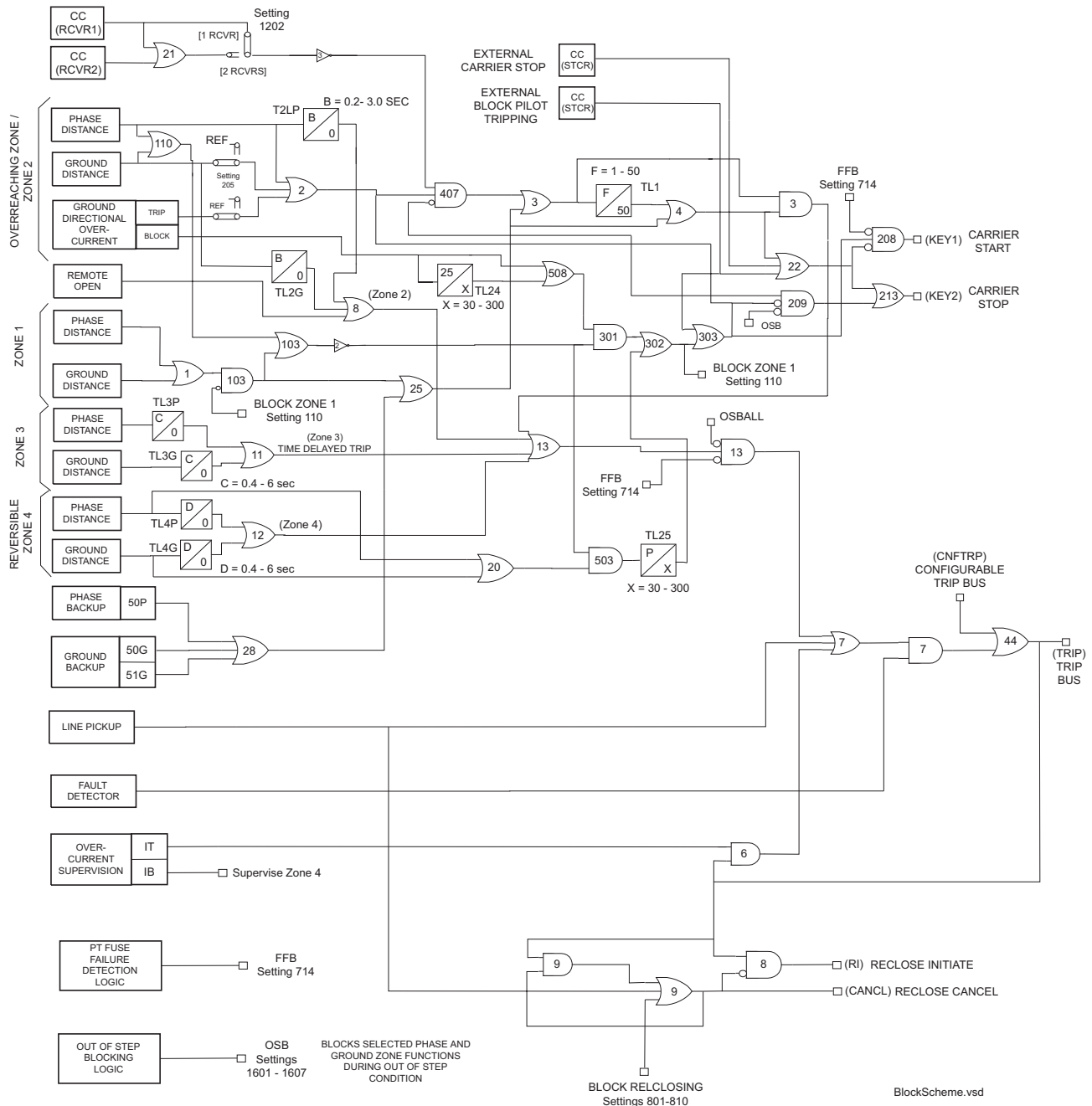


**Figure 1–15: BLOCKING SCHEME LOGIC DIAGRAM**

External contacts may be used to supervise the relay-channel interface. The EXTERNAL STOP CARRIER signal is assigned to 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.

**1**

The BLOCK PILOT TRIPPING signal is assigned to 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.
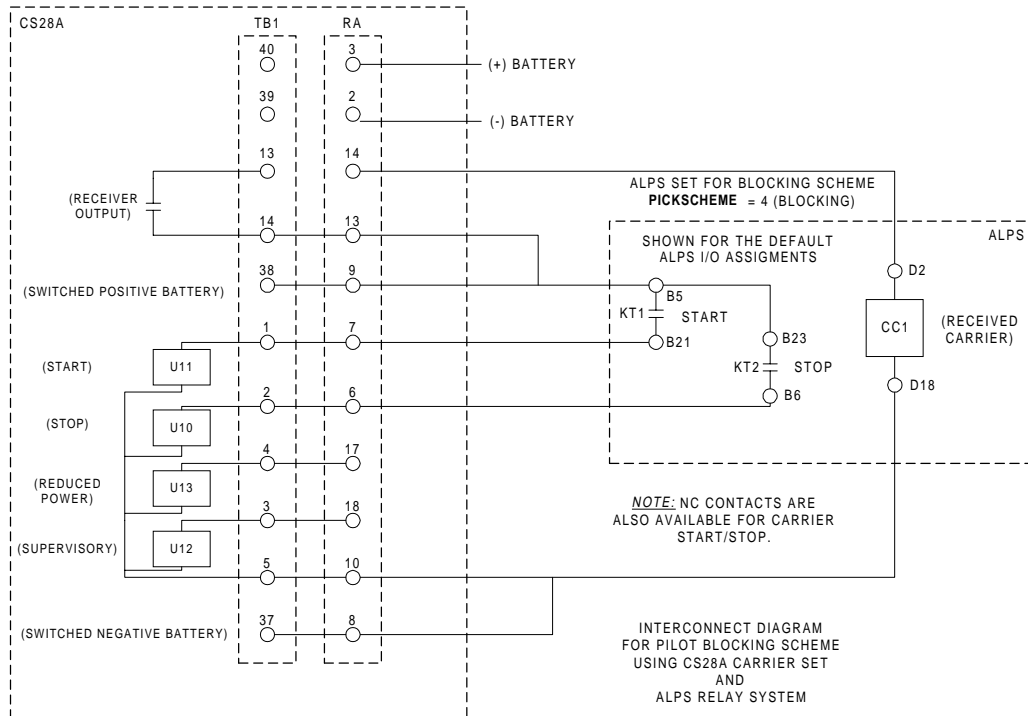


**Figure 1–16: INTERCONNECTION DIAGRAM FOR BLOCKING SCHEME WITH CS28A**
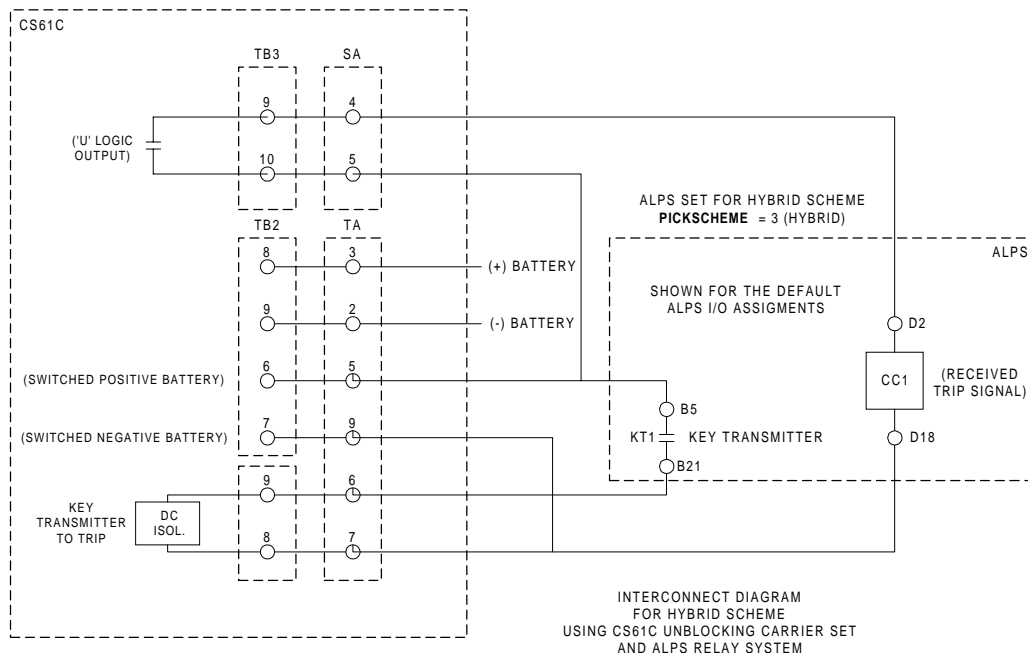


**Figure 1–17: INTERCONNECTION DIAGRAM FOR BLOCKING SCHEME WITH CS61C**

Figure 1–18: HYBRID LOGIC DIAGRAM on page 1–34 is the logic diagram for the Hybrid scheme. A Hybrid scheme combines aspects of a tripping scheme with aspects of a blocking scheme, but it is perhaps easiest to explain as an enhanced POTT scheme.

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

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

When an internal fault produces sufficient fault current to operate the tripping functions at each terminal of the line, the Hybrid scheme operates exactly like the 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. This is to maintain security when an external fault is cleared quickly. These changes occur automatically when Protection Setting 1202: NUMRCVR (number of receivers) is set at 2, provided that the select scheme Setting (Protection Setting 1201: PICKSCHEME) 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 a) FD has operated, or b) 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.

**1**



**Figure 1–18: HYBRID LOGIC DIAGRAM**

> **This section applies to the ALPS with single phase tripping model only.**
>
> **NOTE**

### a) PHASE SELECTION

When used in a single phase tripping application, the ALPS is designed so that 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. To accomplish this goal, the ALPS includes a faulted phase determination algorithm. This 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, determines which trip outputs are energized for each fault. The Trip Output logic for the ALPS is shown in below for all logic scheme except the Hybrid; the logic for the Hybrid scheme is shown in Figure 1–20: SINGLE PHASE TRIPPING LOGIC (HYBRID SCHEME) on page 1–40.
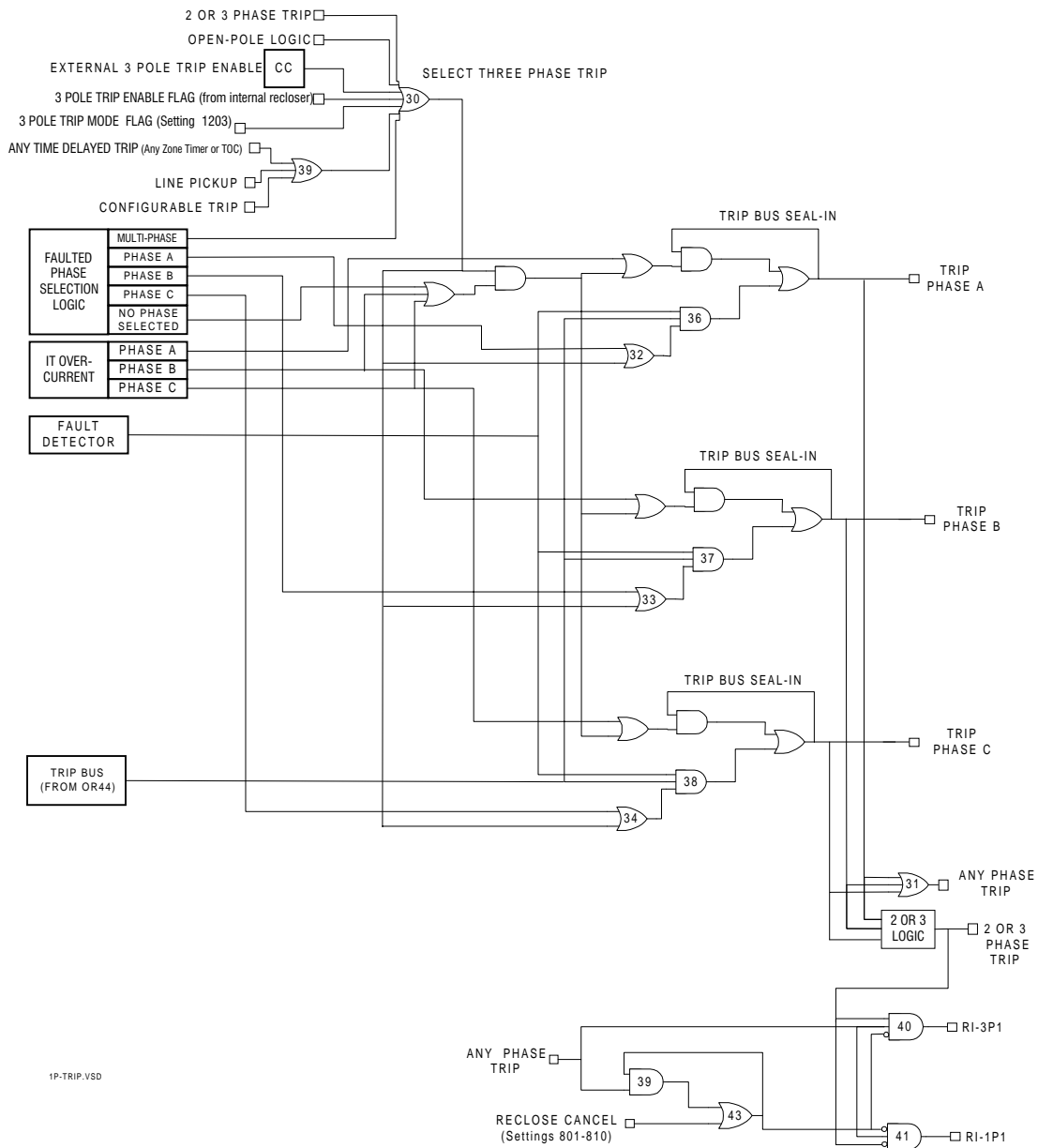


**Figure 1–19: SINGLE PHASE TRIPPING LOGIC (EXCEPT FOR HYBRID SCHEME)**
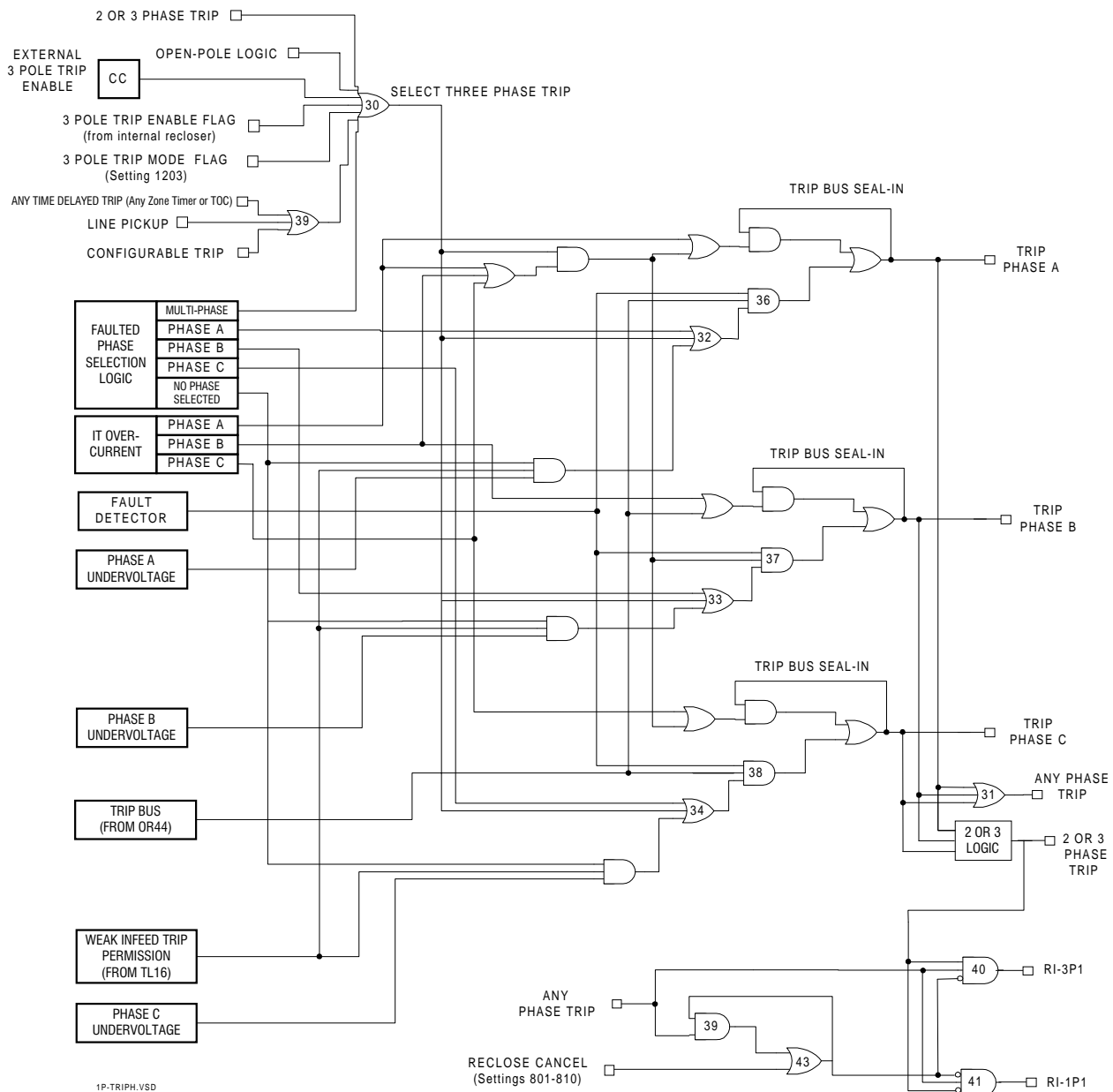
**Figure 1–20: SINGLE PHASE TRIPPING LOGIC (HYBRID SCHEME)**

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.

### b) 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 1–21: OPEN POLE DETECTION LOGIC on page 1–41. 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.

### c) OPEN POLE OPERATION

The functional logic diagrams in Figures 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS through 1–8: OSB LOGIC DIAGRAMS 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 $I_2$ and $I_0$, as well as the change in $I_1$, $I_2$, and $I_0$. When the OPENPOLE flag is set, FD operates on the change in the three sequence currents but does not operate on the magnitude of $I_2$ and $I_0$, since an open pole will produce some steady-state level of $I_2$ and $I_0$.

The Potential Transformer Fuse Failure Detection function is indicated as FFB on the logic diagrams. For a Hybrid scheme, the weak-infeed logic is modified as shown in Figure 1–8: OSB LOGIC DIAGRAMS on page 1–15 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.

> **NOTE** **A single-pole relay configured for three-pole tripping requires the use of three CC inputs: 52b_A, 52b_B, and 52b_C. This requirement is necessary for open-pole logic to function correctly.**
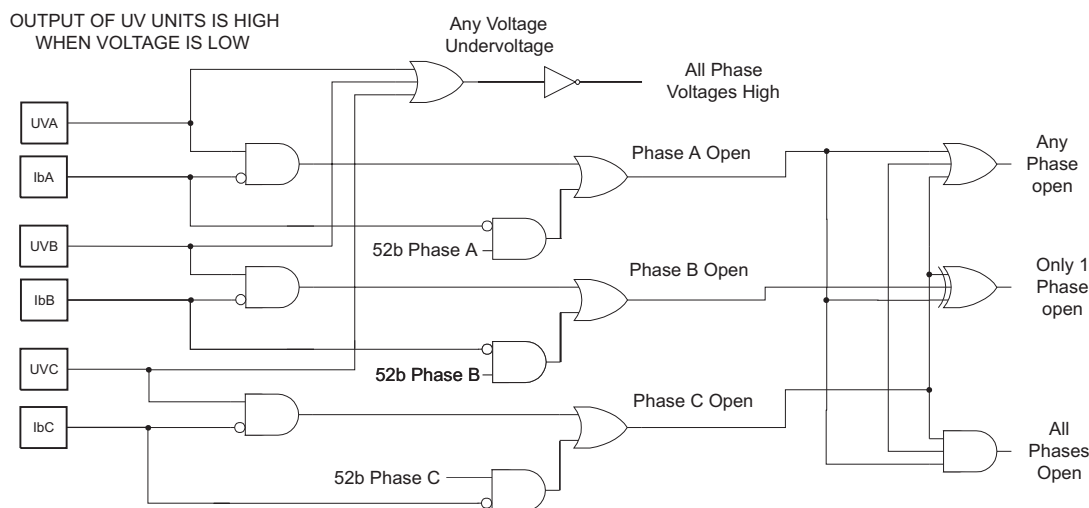


**Figure 1–21: OPEN POLE DETECTION LOGIC**

### d) RECLOSE CONTROL

The ALPS 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 1–23: OST MHO CHARACTERISTIC on page 1–42 and 1–24: OUT-OF-STEP TRIPPING LOGIC on page 1–42, 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.

**1**

> **NOTE**

**This feature applies to the ALPS with single phase tripping model only.**

The ALPS with Single Phase Tripping models on series-compensated lines include the ability to use multiple permissive channels in phase identified channel schemes to improve the phase selection capability of the protection. The model numbers that include this feature are: ALPSDA1*XXXXXXXX* and ALPSDB1*XXXXXXXX* (where *X* is any valid character) with firmware version V0004.03AA21 or higher. The use of phase identified channel schemes improves the performance of the protection scheme in single phase tripping applications where inter-circuit ("cross-country") faults are possible.

**1.9.2 INTER-CIRCUIT FAULTS**

The protection of double circuit transmission lines presents a challenging problem when single phase tripping is required. Consider the simple system shown in Figure 1–22: INTER-CIRCUIT FAULT EXAMPLE below.
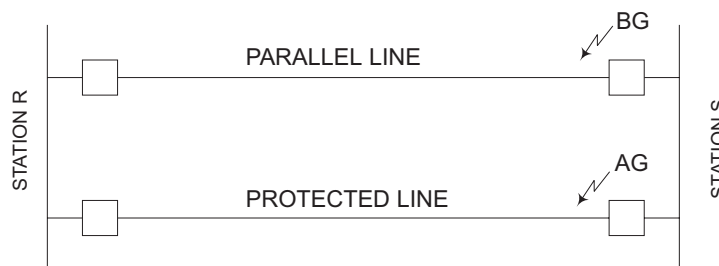


**Figure 1–22: INTER-CIRCUIT FAULT EXAMPLE**

For the fault condition shown, the protective relays on both lines at Station R will detect an AB to ground fault. At Station S, the relay on the protected line will detect an AG fault, while the relay on the parallel line will detect a BG fault. Note that as the fault location is moved away from the bus at station S, the relays at Station R will detect the correct single line to ground fault. If suitable precautions are not taken, the condition of Fig. A-1 will result in the tripping of all three phases of both line at Station R, and proper single pole tripping at Station S. The operation of the relays at Station R is due to the fact that they must rely on the local phase selection to determine the fault type and which phase or phases to trip. The solution to the problem is to use the fault type information from both the local and remote ends of the line to determine the proper tripping mode. This solution requires multiple communications channels to transmit the information between the substations. The ALPS relay offers two phase identified channel solutions to the problem. The first requires the use of two permissive channels with encoding; the second requires the use of four permissive channels. The operation of these schemes is described in the following section.

**1.9.3 TWO CHANNEL PHASE IDENTIFIED CHANNEL LOGIC**

**a) PILOT TRIPPING**

The local faulted phase determination uses the same algorithms as other ALPS relays. The permissive keying is supervised by the fault detecting functions (phase and ground distance, GDOC) and the local fault type determination algorithm. The channel keying is based on the local fault type as shown in the following table.

**Table 1–7: CHANNEL KEYING FOR PILOT TRIPPING (TWO CHANNELS)**

| LOCAL FAULT TYPE | XMTR #1 | XMTR #2 |
|---|---|---|
| AG, BC, BCG | X | |
| BG, CA, CAG | | X |
| CG, AB, ABG, 3PH | X | X |

The receipt of either channel will be used as the permissive signal in the scheme logic. This allows the relay to determine that the fault is within the protected line. In addition to the permissive signal, the receiver inputs will be compared with the selected local fault type per the following table to determine which phase(s) to trip.

**1**

For the fault conditions shown in Figure 1–22: INTER-CIRCUIT FAULT EXAMPLE, the ALPS relay on the protected line at the S substation will sent detect an AG fault and send channel 1 to the remote terminal. The ALPS relay at Substation R will detect an ABG fault, and will send both channels 1 and 2 to the relay at S. The ALPS relay at Substation S will issue a single pole phase A trip via the operation of the Zone 1 ground distance function. The ALPS relay at the R substation will issue a single pole phase A trip per the logic of Table II (Local fault type is ABG, and only channel 1 is received).

**Table 1–8: SINGLE POLE PHASE A TRIP LOGIC**

| LOCAL FAULT TYPE | RECEIVER | PHASES TO TRIP |
|---|---|---|
| AG | RCVR #1·(!RCVR #2) | A |
| BG | (!RCVR #1)·RCVR #2 | B |
| CG | RCVR #1·RCVR #2 | C |
| AB, ABG, 3PH | RCVR #1·RCVR #2 | 3 Phase |
| AB, ABG, 3PH | RCVR #1·(!RCVR #2) | A |
| AB, ABG, 3PH | (!RCVR #1)·RCVR #2 | B |
| BC, BCG | RCVR #1·(!RCVR #2) | 3 Phase |
| BC, BCG | (!RCVR #1)·RCVR #2 | B |
| BC, BCG | RCVR #1·RCVR #2 | C |
| CA, CAG | (!RCVR #1)·RCVR #2 | 3 Phase |
| CA, CAG | RCVR #1·(!RCVR #2) | A |
| CA, CAG | RCVR #1·RCVR #2 | C |

· AND; + OR; ! NOT

> **NOTE**
>
> **Combination of Local Fault type and Receiver not listed above will not allow a permissive trip output.**

### b) ZONE 1 TRIPPING

Faulted phase determination for zone 1 tripping is the same as in the existing ALPS relay. This is to allow the Zone 1 elements to maintain their high speed operation and their independence from the channel.

### c) WEAK INFEED TRIPPING

The standard ALPS faulted phase determination algorithm has been supplemented by undervoltage units for Weak Infeed trips. The phase identified channel logic scheme will use the information in the received signal as well as the undervoltage units. If there is a local determination of the fault type, the previous table will be used to determine which phases to trip; if there is no local fault type determination, then the undervoltage functions will be used as in the existing ALPS Hybrid scheme.

### d) REPEAT (ECHO) KEYING

If no local tripping functions have operated, the repeat keying will be determined by the local fault type determination logic and the received channels as noted below. If any local trip functions have operated, the channel repeat logic will be blocked and the local fault type determination will control the keying outputs. If the fault type can not be determined locally, the received channel(s) will be repeated as received.

**Table 1–9: REPEAT KEYING LOGIC**

| LOCAL FAULT TYPE | RECEIVER | REPEAT KEYING |
|---|---|---|
| AG | RCVR #1 + RCVR #2 | XMTR #1 |
| BG | RCVR #1 + RCVR #2 | XMTR #2 |
| CG | RCVR #1 + RCVR #2 | XMTR #1·XMTR #2 |
| Any LL or LLG | ---- | Repeat as received |

**a) PILOT TRIPPING**

The local faulted phase determination uses the same algorithms as other ALPS relays. The permissive keying is supervised by the fault detecting functions (phase and ground distance, GDOC) and the local fault type determination algorithm.

**Table 1–10: CHANNEL KEYING FOR PILOT TRIPPING (FOUR CHANNELS)**

| LOCAL FAULT TYPE | XMTR #1 | XMTR #2 | XMTR #3 | XMTR #4 |
|---|---|---|---|---|
| AG | X | | | |
| BG | | X | | |
| CG | | | X | |
| Any interphase faults | | | | X |

In addition to providing the permissive signal, the receiver inputs will be compared with the selected local fault type per the following table to determine which phase(s) to trip.

**Table 1–11: PILOT KEYING (4 CHANNEL) LOGIC**

| LOCAL FAULT TYPE | RECEIVER | | | | PHASES TO TRIP |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| AG, AB, ABG, CA,CAG,3PH | X | | | | A |
| BG, AB, ABG, BC,BCG,3PH | | X | | | B |
| CG, BC, BCG, CA,CAG,3PH | | | X | | C |
| Any interphase fault | | | | X | A, B, & C |
| AG | | | | X | A |
| BG | | | | X | B |
| CG | | | | X | C |

For the fault conditions shown in Figure 1–22: INTER-CIRCUIT FAULT EXAMPLE, the ALPS on the protected line at the S substation detects an AG fault and sends channel 1 to the remote terminal. The ALPS at Substation R detects an ABG fault and sends channel 4 to the relay at S. The ALPS at Substation S issues a single pole phase A trip via the operation of the Zone 1 ground distance function. The ALPS at Substation R issues a single pole phase A trip per the logic above (Local fault type is ABG, and only channel 1 is received).

**b) ZONE 1 TRIPPING**

Faulted phase determination for Zone 1 tripping is the same as in the existing ALPS. This is to allow the Zone 1 elements to maintain their high speed operation and their independence from the channel.

**c) WEAK INFEED TRIPPING**

The standard ALPS faulted phase determination algorithm has been supplemented by undervoltage units for Weak Infeed trips. The phase identified channel logic scheme will use the information in the received signal as well as the undervoltage units. If there is a local determination of the fault type, the previous table will be used to determine which phases to trip. If there is no local fault type determination, then the undervoltage functions will be used as in the existing ALPS Hybrid scheme. If there is no local fault type determination and no undervoltage functions have operated, then the received fault type will be used to select the trip type.

**d) REPEAT (ECHO) KEYING**

If no local tripping functions have operated, the repeat keying will be determined by the local fault type determination logic and the received channels as noted below. If any local trip functions have operated, the channel repeat logic will be blocked and the local fault type determination will control the keying outputs. If the fault type can not be determined locally, the received channel(s) will be repeated as received.

| LOCAL FAULT TYPE | RECEIVER | REPEAT KEYING |
|---|---|---|
| AG | Any receivers | XMTR #1 |
| BG | Any receivers | XMTR #2 |
| CG | Any receivers | XMTR #3 |
| Any LL or LLG or 3PH | Any receivers | Repeat as received |

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 Protection Setting 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 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 (Protection 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 (Protection 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.

The shape of the offset Mho characteristic may be expanded or restricted by changing the characteristic timer setting. The three Mho characteristics used in the OST function are shown below. 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, Protection Setting 1401: **POSSEQANG**.

The dotted line in the figure below, SWING LOCUS, represents one possible path that would be followed by 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.

Discrimination between a fault condition and a system swing is accomplished by checking the time taken 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 at a much slower rate for a swing.

**1**
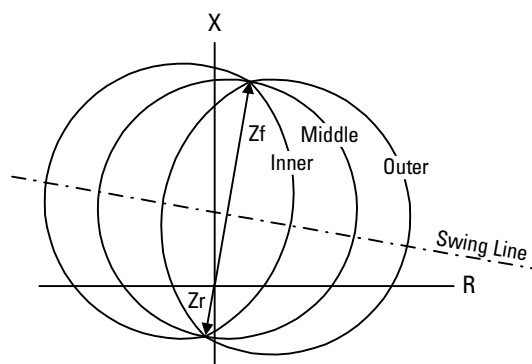


Figure 1–23: OST MHO CHARACTERISTIC
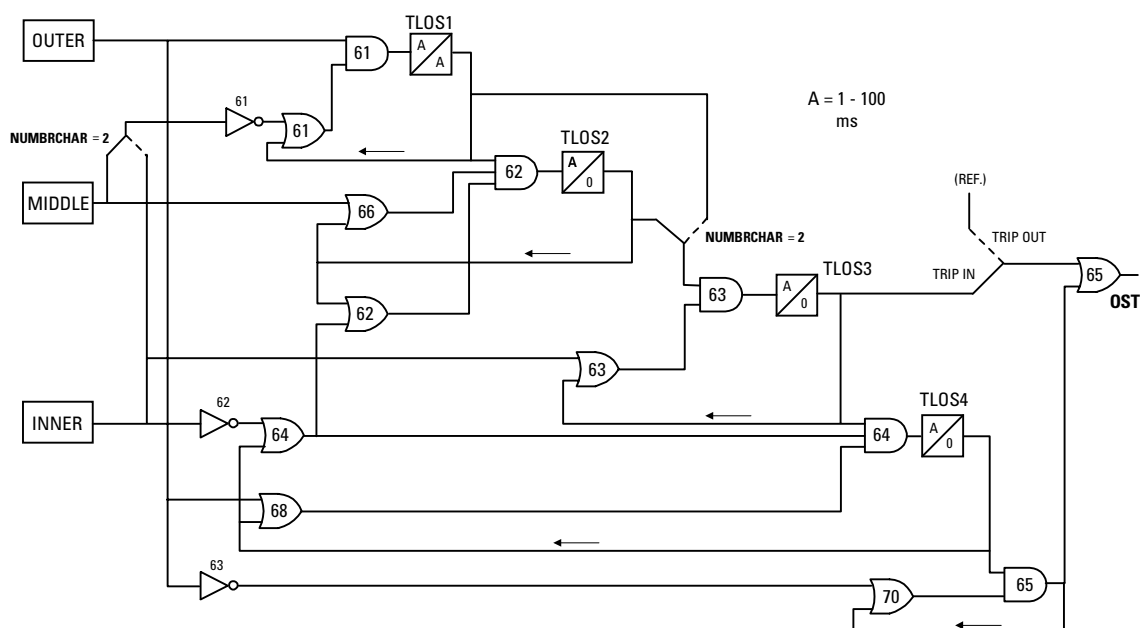


Figure 1–24: OUT-OF-STEP TRIPPING LOGIC

### 1.10.3 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 1–24: OUT-OF-STEP TRIPPING LOGIC on page 1–47.

The operation of the logic diagram in is explained below; this discussion assumes that Protection Setting 1702: **NUMBRCHAR** = 3 and all three OST Mho characteristics are used.

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.

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.

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 Protection Setting 1703: **TRIPIN_OUT** = IN.

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, TL64 operates and seals in. The output of TLOS4 also provides one input of AND65.

5.  If Protection Setting 1703: **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 Hz) after the OUTER resets, which is the dropout time of TLOS1.

### 1.10.4 TWO-CHARACTERISTIC OPERATION

Operation with two characteristics instead of three (Protection Setting 1702: **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.

### 1.10.5 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) 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.

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.

**PHASOR DIAGRAM**

VA1: POSITIVE SEQUENCE VOLTAGE AT RELAY
IC1: POSITIVE SEQUENCE CHARGING CURRENT
ZR: FUNCTION REACH SETTING (=LINE IMPEDANCE)
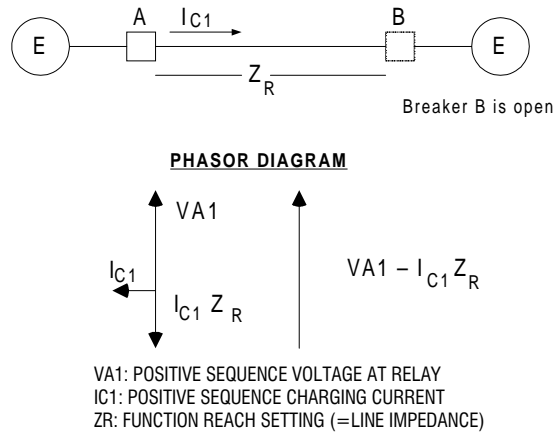
**Figure 1–25: COMPENSATED POSITIVE-SEQUENCE OVERVOLTAGE**

The compensated positive-sequence overvoltage function is intended to provide tripping of transmission lines when the line voltage is high enough to endanger system operation. The series-compensated overvoltage function provides instantaneous and time-delayed tripping 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 is intended to measure the voltage at the relay location, while the compensated positive-sequence voltage 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 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 detect:

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

    2. The open line, creating the bus high voltage and providing 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 to half 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 at the near and remote line ends ($V_N$ and $V_R$) resulting from an open breaker are known. In this case, the desired reach setting would be:

$$Z_R = \frac{(V_R - V_N)}{I_C}$$

**1**

The optional recloser can be used with the ALPS alone, separately with an external relay system, or it can be used simultaneously with the ALPS and an external relay system. It can be used in single phase or three phase tripping applications to provide up to 4 reclose attempts. When used in single phase 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 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.

**1.12.2 RECLOSING MODE**

The recloser can be set to operate in one of the following modes (Protection Setting 1801: **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 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 will be ignored.

4.    BOTH – Reclosing will be controlled by signals from the ALPS as well as external inputs (other relays / systems).

5.    OFF – No reclosing, either by internal or external control, is allowed. The three phase trip enable output will be set up at this time. This mode should be selected when automatic reclosing is disabled.

**1.12.3 RECLOSING PROGRAMS**

When reclosing is selected, the recloser can be set to operate in one of the following modes (Protection Setting 1802: **RECLTYPE**):

1.    1POLE – 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, 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 must be programmed for single phase tripping (Protection Setting 1203: **TRIPMODE** = 1POL or 1POLZ2).

2.    3POLE – 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 indicating that three-pole tripping was initiated. In this mode, the three-pole trip enable signal is 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, 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 mode, the ALPS must be programmed for three phase tripping (Protection Setting 1203: **TRIPMODE** = 3POL).

3.    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.

**1**

**NOTE**

The recloser settings (Protection Setting 1802: **RECLTYPE**) and the relay settings (Protection Setting 1203: **TRIP-MODE**) must be compatible. If the ALPS 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 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.

One to four reclose attempts may be selected for each of the reclosing modes. For 1POLE3POLE, 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**) establishes the time that the recloser will wait before going to reset following:

- *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.

- *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 (Protection Setting 1814: **DWELLTIME**; range: 0.1 to 2.0 s) establishes the time that the close contacts will remain closed when a reclose is called for by the recloser.

**1.12.4 RECLOSER INPUTS**

**a) BREAKER STATUS**

The recloser requires breaker "b" auxiliary switches to determine whether the breaker is in the open or closed position. Because all ALPS inputs are programmable, the correct number of contact converter(s) must 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.

**b) SINGLE POLE RECLOSE INITIATE (1PRI)**

The 1PRI input starts the single-pole reclosing mode. The ALPS provides 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.

**c) THREE POLE RECLOSE INITIATE (3PRI)**

The 3PRI input starts the three-pole reclosing mode of operation. The ALPS 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.

**d) HOLD**

The hold input controls the reclose output when the hold feature is selected (Protection Setting 1815: **HOLD** = YES). This feature allows an external contact to supervise the close output of the ALPS recloser. When the Hold feature is selected, the recloser waits a preset time for a hold input (Protection Setting 1816: **HOLDTIME**, range 1 to 1000 s) at the end of a programmed reclose time. If the hold input is applied during this delay, the reclose contacts initiate closing of the breaker. If the hold input is not applied during the hold time delay, the recloser goes to lockout when the hold time ends. The hold input can be programmed to accept either a normally closed or 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.

**e) RECLOSE CANCEL**

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

- In Reset, the recloser disregards any reclose initiate while Reclose Cancel is ON and stays in Reset.
- During a reclose cycle, Reclose Cancel sends the recloser to Lockout.
- Reclose Cancel waits until the dwell time has elapsed and the close relay has reset before sending the recloser to Lockout.
- In Lockout, the Reclose Cancel signal has no effect.

To use this feature, one of the contact converters must be programmed to accept the reclose cancel input.

**f) 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.

To use this feature, one of the contact converters must be programmed to accept the lockout input.

**g) 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. To use this feature, one of the contact converters must be programmed to accept the reset input.

**1.12.5 RECLOSER OUTPUTS**

All of the recloser outputs are programmable. To use any of these outputs externally, insure that an appropriate output relay is assigned to each of the used outputs. Assignment can be made through ALPS-Link, Xpression Builder, or the keyboard. The following outputs are provided:

**a) CLOSE**

The close output controls reclosing of the breaker. The dwell time setting (Protection Setting 1814: **DWELLTIME**) controls the time that the output contacts remain closed following a close command from the recloser.

**b) THREE POLE TRIP ENABLE**

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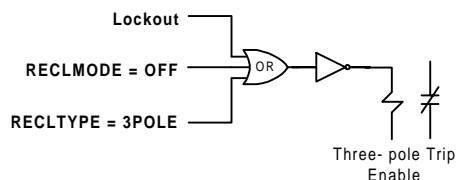


**Figure 1–26: THREE-POLE TRIP ENABLE OUTPUT**

The three-pole trip enable output is also produced when Protection Setting 1802: **RECLTYPE** = 3POLE or when the recloser is turned off (Protection Setting 1801: **RECLMODE** = OFF). This output is internally routed to the ALPS and insures 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 above) 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.

**1**

### c) RECLOSE IN PROGRESS (RIP) & LOCKOUT

This reclose in progress (RIP) 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. The lockout output is be produced whenever the recloser is in the lockout state.

#### 1.12.6 SYNCHRONISM CHECK (OPTIONAL)

An optional synchronism check function is available for use with the recloser. The synchronism check provides synchronism check and/or voltage supervision of any or all three-pole reclosures. Protection Setting 1818: **SYNCCHECK** (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 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. Setting 1821: **BUSLINE** (range: BUS or LINE) tells the recloser where the three-phase voltage used by the relay system is located, bus or line. Setting 1822: **SYNCPHASE** (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 Protection Settings (1832: **VBUSLIVE**, 1833: **VBUSDEAD**, 1834: **VLINELIVE**, and 1835: **VLINEDEAD**) are required for the synchronism check to establish live and dead voltage levels for the bus and line potential. Each of these levels has a range from 0.1 to 130 V. 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. Protection Setting 1819: **CLOSEANG** setting 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 Protection Setting 1820: **SLIPFREQ** and both criteria must be satisfied within the time specified by Protection Setting 1823: **SYNCHOLD** (range: 1 to 100 s). 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, Protection Setting 1840: **DELTAVBLK** is set to YES. Protection Setting 1839: **DELTAV** 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 synchMho 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 either through ALPS-Link, Xpression Builder, or the keypad.

#### 1.12.7 ALPS RECLOSING PROGRAM SUMMARY

| TRIPMODE (SETTING 1203) | RECLTYPE (SETTING 1802) | INITIAL TRIP TYPE | PROGRAM |
|---|---|---|---|
| 1POL/1POLZ2 | 1POLE | Single phase | Up to 4 reclose attempts using 1P delays |
|  |  | Three phase | Lockout |
| 3 POL | 1POLE | Any trip | Lockout |
| 3POL | 3POLE | Any trip | Up to 4 reclose attempts using 3P delays |
| 1POL/IPOLZ2 | 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 |

**Figure 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING)**

**Figure 1–28: ELEMENTARY DIAGRAM WITH DEFAULT I/O (THREE PHASE TRIPPING)**

**1**



**Figure 1–29: ELEMENTARY DIAGRAM (SINGLE PHASE TRIPPING)**

**1**



**Figure 1–30: ELEMENTARY DIAGRAM (THREE PHASE TRIPPING)**
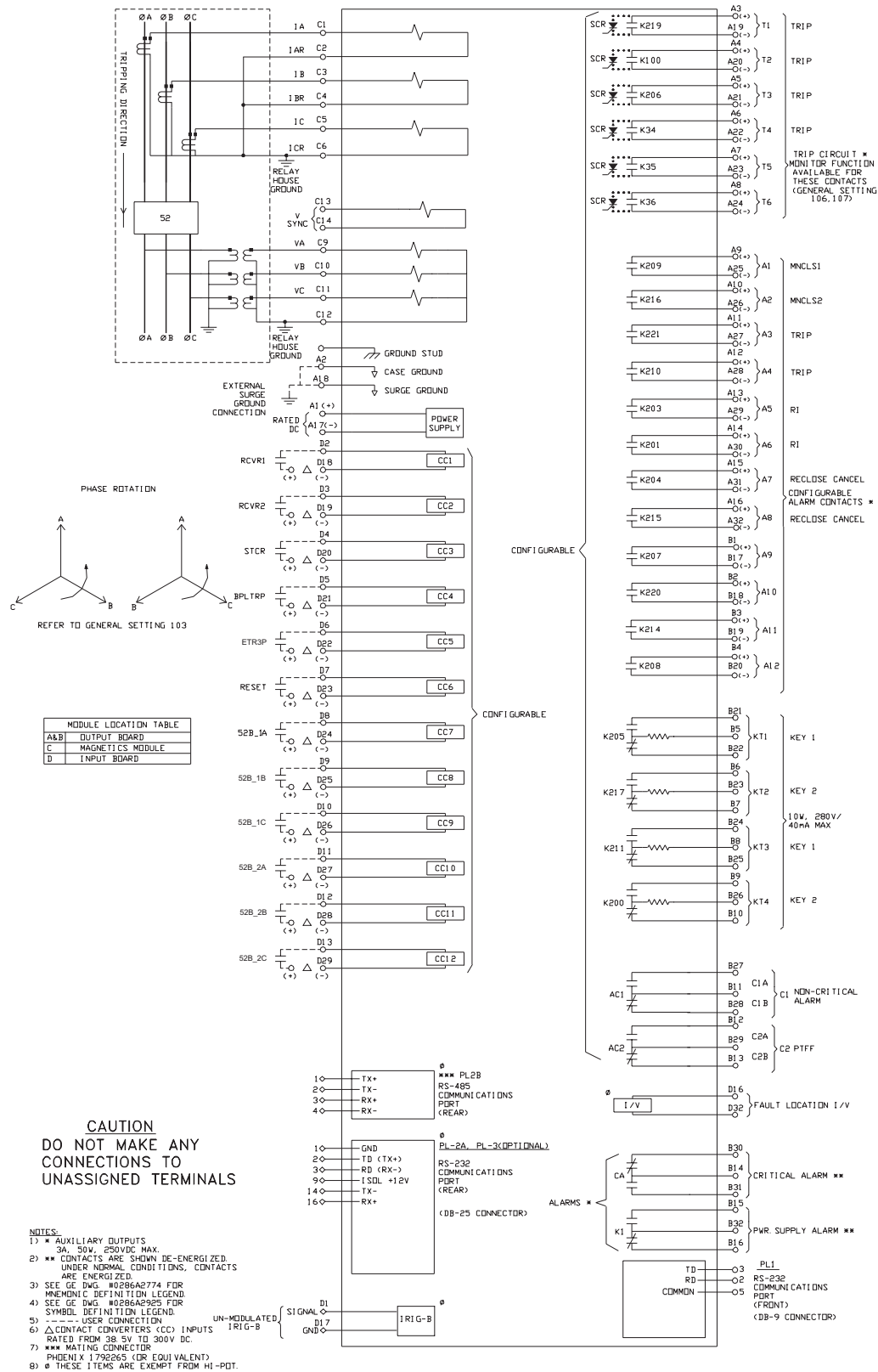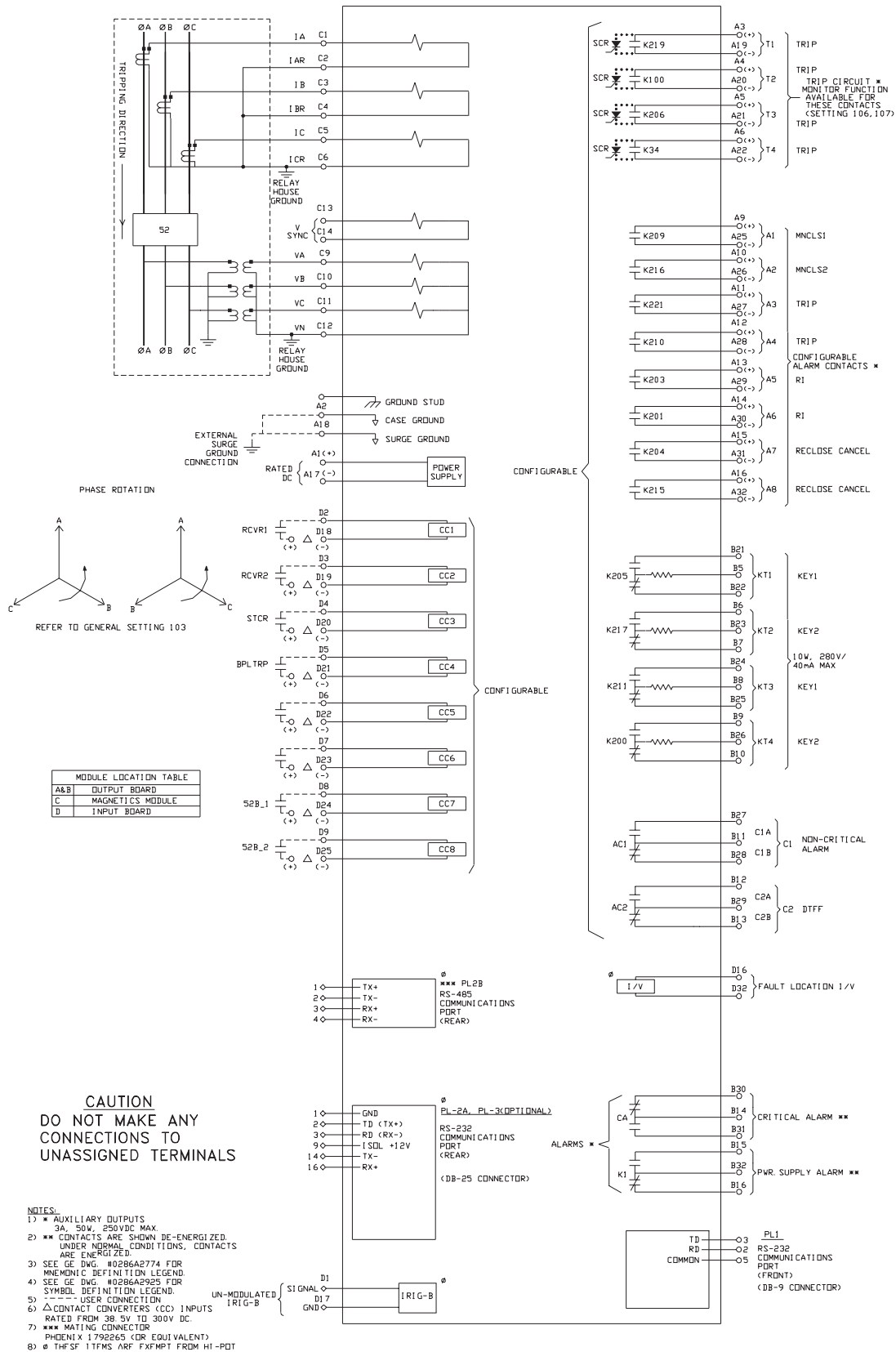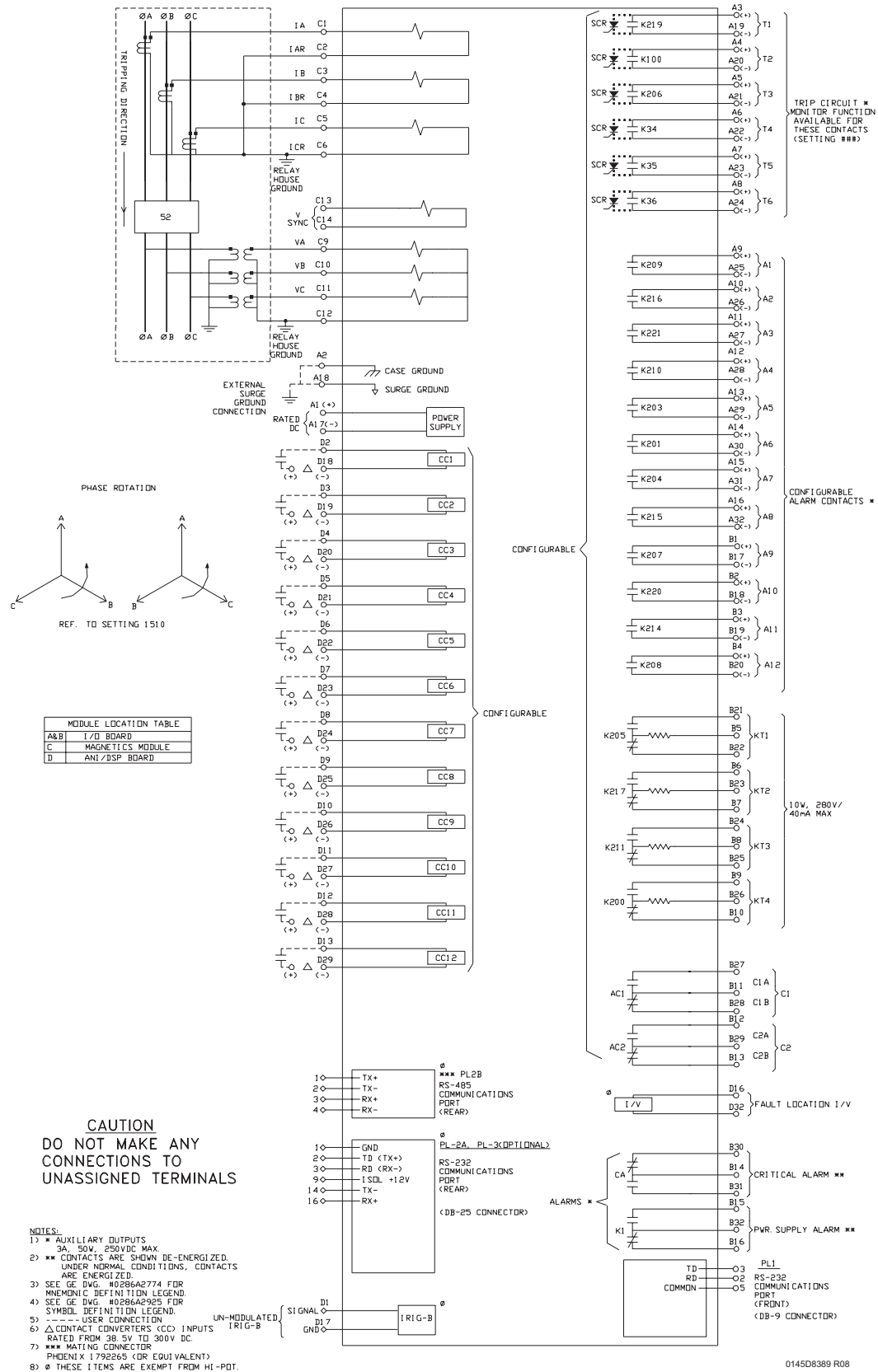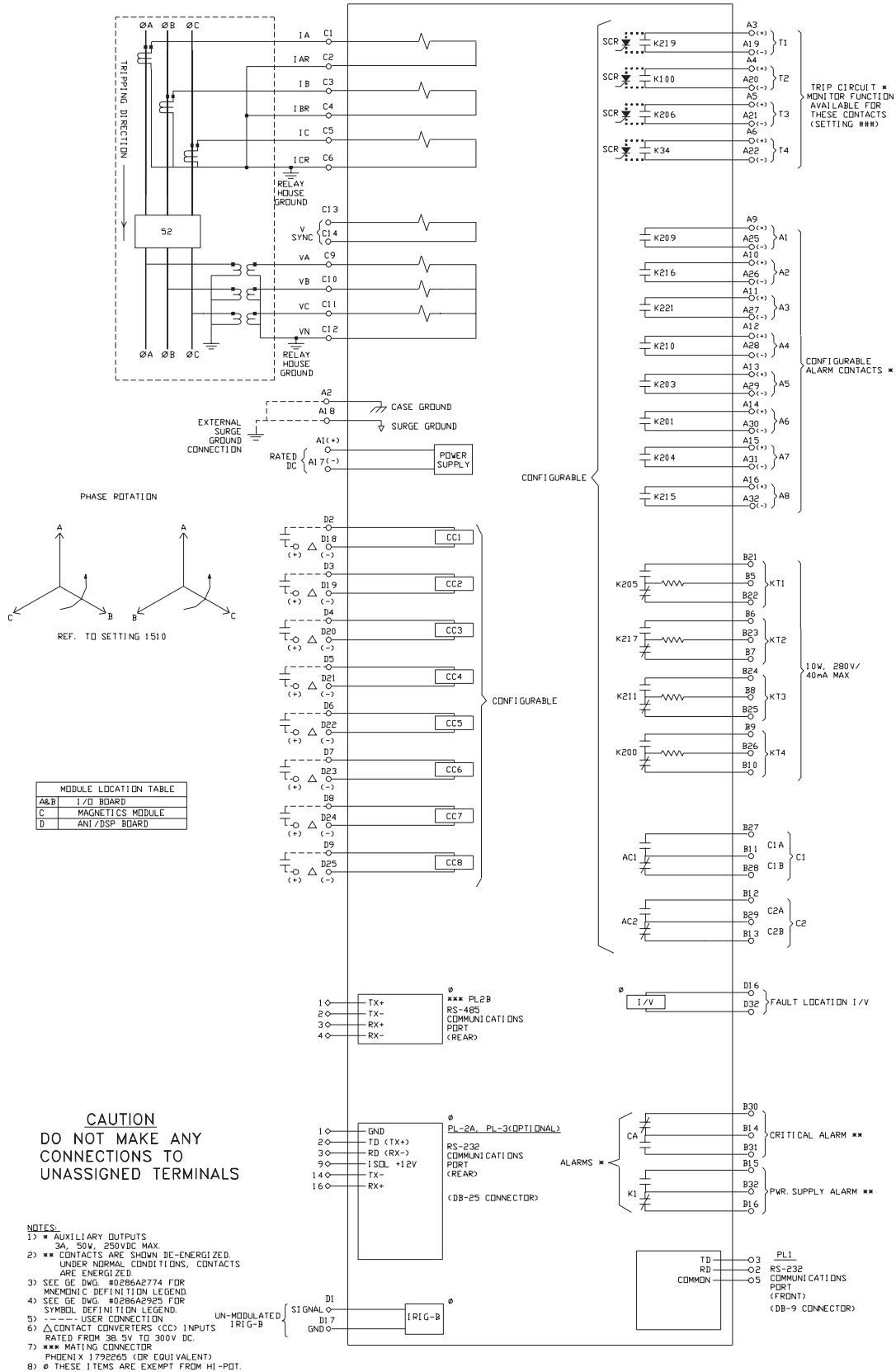
There are a number of settings that must be made in the ALPS relaying system. These settings are divided into two categories, with each category divided into the sub-groups shown below:

**a) GENERAL SETTINGS CATEGORIES**

- CONFIGURATION
- COMMUNICATIONS
- OSCILLOGRAPHY

- EQUIPMENT DUTY
- PROGRAMMABLE INPUTS

**b) PROTECTION SETTINGS CATEGORIES**

- Z1DISTANCE
- Z2DISTANCE
- Z3DISTANCE
- Z4DISTANCE
- CURSUPVISN
- OVERCURRNT
- VOLTAGE
- BLK RECLOS
- LINEPICKUP
- REMOTEOPEN

- LINEOVERLD
- SCHEME
- SCHMTIMERS
- LINE INFO
- SCADA_DTA
- OS BLOCKING
- OS TRIPPING
- RECLOSER
- NONCRIT_AL
- OUTPUTS

The sub-categories (defined by their mnemonic) are given in the order that they appear when scrolled in the display provided on the front of the ALPS. Up to four separate and distinct **Protection Settings** Groups can be programmed and stored in the ALPS. 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. 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 are listed in Table 2–11: PROTECTION SETTINGS GUIDE on page 2–57. and Table 2–12: GENERAL SETTINGS GUIDE on page 2–64. These tables show setting ranges for both 5 A and 1 A 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 ALPS-Link communications program.

> **NOTE**
> **All settings must be entered in secondary values (ohms, amperes, volts) unless per unit (p.u.) 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. Work through this section, setting-by-setting, and manually record each setting in the blank forms provided (see Section 2.5.4: PROTECTION SETTINGS DATA SHEETS on page 2–66 and Section 2.5.5: GENERAL SETTINGS DATA SHEETS on page 2–73). Once the form is completed, enter the settings individually via the keypad located on the front of the ALPS or through the ASCII communications port (a long and laborious process and not recommended). Alternatively, use the ALPS-Link 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 ALPS-SET program (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 via ALPS-Link. This file will then be available for future modification if required.

### 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 ALPS-Link communications program.

### 102: SYSFREQ - System Frequency

**SYSFREQ** establishes the operating frequency of the ALPS. It can be set to either 50 Hz or 60 Hz. When this setting is changed it will only be implemented after turning the DC power off and then on.

### 103: PHASRROTATE - Phase Rotation

**PHASRROTATE** can be set to either ABC or ACB to match the positive-sequence phase rotation for the power system where the ALPS is installed. This setting permits proper reporting of the faulted phase or phase pair.

### 104: TIMESYNCH - Select Time Synchronization

TIMESYNCH determines the method of synchronizing the ALPS internal clock. 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.

### 106: NUM_TC - Number of Trip Circuits

The number of trip outputs is dependent on whether the three phase or single phase tripping model is used. Assignment of the trip outputs is made via the **NUM_TC** setting and is directly coupled to the **NUM_BKR** setting.

With the Single Phase Tripping model, six outputs (T1 to T6) are available and assigned per the **NUM_TC** setting as shown in Table 2–1: NUM_TC SETTING (SINGLE PHASE MODELS). In this case, outputs T4 to T6 are available for assignment with Xpression Builder only when one breaker with one set of trip coils is being controlled (**NUM_TC** = 1).

With the Three Phase Tripping model, four outputs (T1 to T4) are available for tripping and assigned per the **NUM_TC** setting as shown in Table 2–2: NUM_TC SETTING (THREE PHASE MODELS). If one breaker with a single trip circuit is being used (**NUM_TC** = 1), then outputs T2 to T4 are available for assignment to different tasks through Xpression Builder. Outputs T3 and T4 are used only if two breakers are being controlled and if each of the breakers has two independent trip circuits (**NUM_TC** = 2). If independent trip coils are not being used, then the T3 and T4 contacts can be re-assigned with Xpression Builder.

The ALPS has the capability (when enabled) to trip the breaker(s) locally through the keypad or remotely via the ALPS-Link program or ASCII commands. In order for the ALPS to recognize which breaker should be tripped, the **NUM_TC** setting must be made as given in Table 2–1: NUM_TC SETTING (SINGLE PHASE MODELS) or Table 2–2: NUM_TC SETTING (THREE PHASE MODELS) and the trip outputs must be connected to the appropriate trip coils as assigned in the tables. 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 number 1 and the output T2 must be connected to the trip coil TC-1 of breaker number 2.

**Table 2–1: NUM_TC SETTING (SINGLE PHASE MODELS)**

| NUMBER OF BREAKERS NUM_BKR | NUMBER OF TRIP CIRCUITS NUM_TC | BREAKER NO. 1 | | | | | | BREAKER NO. 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 |

where: TC1, TC2 = Trip Coils; T1 to T6 = ALPS Trip Outputs

**Table 2–2: NUM_TC SETTING (THREE PHASE MODELS)**

| NUMBER OF BREAKERS NUM_BKR | NUMBER OF TRIP CIRCUITS NUM_TC | BREAKER NO. 1 | | BREAKER NO. 2 | |
|---|---|---|---|---|---|
| | | TRIP CIRCUIT 1 TC-1 | TRIP CIRCUIT 2 TC-2 | TRIP CIRCUIT 1 TC-1 | TRIP CIRCUIT 2 TC-2 |
| 1 | 1 | T1 | - | - | - |
| 1 | 2 | T1 | T2 | - | - |
| 2 | 1 | T1 | - | T2 | - |
| 2 | 2 | T1 | T2 | T3 | T4 |

where: TC1, TC2 = Trip Coils; T1 to T4 = ALPS Trip Outputs

### 107: NUM_MON - Trip Outputs To Be Monitored

Trip circuit monitoring can check the integrity of the trip circuit to which the selected trip output is connected. It does this by sensing the voltage across the trip output as shown in Figure 2–1: TRIP CIRCUIT MONITOR. 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.
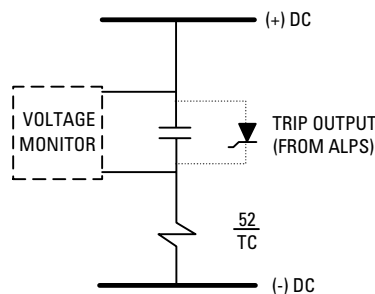


**Figure 2–1: TRIP CIRCUIT MONITOR**

The trip contacts are also monitored when a trip is initiated by the ALPS. If the voltage across the contacts does not drop when the trip is initiated, 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, the trip circuit is considered to have been activated and no alarm is issued.

Any or all of the outputs (T1 to T4 for Three Phase Tripping models; T1 to T6 for Single Phase Tripping models) can be monitored regardless of whether or not they are used in a trip circuit.

For single phase tripping models, the setting format for **NUM_MON** is *abcdef*, where any position can be a zero (0) or a one (1) as shown below. For three phase tripping models, the setting format for **NUM_MON** is *abcd*, where any position can be a zero (0) or a one (1) as shown in Table 2–4: SETTING FORMAT FOR NUM_MON (THREE PHASE TRIPPING MODELS). This setting is calculated in binary, but must be converted to a decimal value when entered from the keypad (see example below).

**2**

**Table 2–3: SETTING FORMAT FOR NUM_MON (SINGLE PHASE TRIPPING MODELS)**

| 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 |

**Table 2–4: SETTING FORMAT FOR NUM_MON (THREE PHASE TRIPPING MODELS)**

| POSITION | A | B | C | D |
|----------|---|---|---|---|
| Output | T4 | T3 | T2 | T1 |
| ON | 1 | 1 | 1 | 1 |
| OFF | 0 | 0 | 0 | 0 |

As an example, if you are using an ALPS with three phase tripping, and if outputs T1 and T3 are to be monitored and T2 and T4 are not, the following setting would be used: **NUM_MON** = 0101 This setting is entered in to the relay from the LUI in decimal format (that is, **NUM_MON** = 5).

### 108: DISPLAYVAL - Present Value Display Mode

This setting determines the mode in which 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.

### 110: SYSTEM INPUTS - Virtual Inputs

Four virtual inputs are available: SYSIN1 to SYSIN4. Virtual inputs are memory locations within the relay that can be assigned values via communications or the local user interface. If the value stored in virtual memory is a 1 (or YES), the virtual input is ON; likewise, if the value is 0 (or NO), the virtual input is OFF. The virtual input states are written to like settings: these values are non-volatile and are available in the memory map.

Each virtual input has two settings in ALPS-Link: YES for asserted 1, NO for non-asserted 0. From the front keypad, the virtual inputs can be set by following the path SET \ Edit Gen Settings \ Configure \ SYSIN1-4. The setting range is 0 to 15 (decimal) or 0000 to 1111 (binary), where the least-significant digit represents SYSIN1 and the most-significant digit represents SYSIN4. This value must be entered in decimal format.

The System Inputs can be incorporated into the relay logic with Xpression Builder, allowing for greater control of the overall logic. They can be treated like any digital input or flag. For example, System Inputs can provide supervisory functions for dedicated logic segments by disabling or enabling these segments. As such, Xpression Builder is mandatory for the successful implementation of System Inputs in the relay logic.

**2.2.2 COMMUNICATIONS**

### 201: COMPORT1 - Communications Port 1

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

| Baud Rate | = **xx** | = 03, 12, 24, 48, 96 (x 10) |
|---|---|---|
| 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. 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. ALPS-Link 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. ALPS-Link 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, 9600, or 19200 must be set to match the baud rate of the modem or serial device connected to the ALPS. The parity and stop bits must match those set 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. ALPS-Link can set the baud rate, parity, and stop bits.

### 204: PROTOCOL1 - Communication Port No. 1 Protocol

Two settings are possible:

1. GE-MODEM. Use this setting to communicate with the ALPS system via the ALPS-Link communications program as described in Chapter 11: ALPS-LINK USER GUIDE.

2. ASCII. Use this setting to communication with the ALPS system via the ASCII commands provided in Chapter 12: ASCII COMMUNICATIONS.

3. DNP 3.0. Use this setting to communicate via the DNP 3.0 protocol. See Appendix C for additional detail.

### 205: PROTOCOL2 - Communication Port No. 2 Protocol

Three settings are possible:

1. GE-MODEM. Use this setting to communicate via the ALPS-Link communications program.

2. ASCII. Use this setting to communicate via the ASCII commands provided in Chapter 12.

3. DNP 3.0. Use this setting to communicate via the DNP 3.0 protocol. See Appendix C for additional detail.

### 206: PROTOCOL3 - Communication Port No. 3 Protocol

Three settings are possible:

1. GE-MODEM. Use this setting to communicate with the ALPS via the ALPS-Link communications program.

2. ASCII. Use this setting to communication with the ALPS via the ASCII commands provided in Chapter 12.

3. DNP 3.0. Use this setting to communicate via the DNP 3.0 protocol. See Appendix C for additional detail.

### 301: NUMFAULTS - Number Of Faults To Be Captured

**NUMFAULTS** selects the maximum number of oscillography "storage events" (faults) that are stored in memory. When the maximum number of events are reached, 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. Table 2–5: OSCILLOGRAPHY CYCLES PER STORAGE EVENT shows the total number of oscillography cycles allowed per storage event as a function of the **NUMFAULTS** setting.

**Table 2–5: OSCILLOGRAPHY CYCLES PER STORAGE EVENT**

| STANDARD MEMORY | | EXPANDED MEMORY | |
|:---:|:---:|:---:|:---:|
| NUMFAULTS | STORAGE CYCLES | NUMFAULTS | STORAGE CYCLES |
| 2 | 72 | 6 | 72 |
| 4 | 36 | 12 | 36 |
| 8 | 18 | 24 | 18 |
| 12 | 12 | 36 | 12 |

### 302: PREFAULT - Number Of Pre-Fault Cycles To Capture

**PREFAULT** selects the number of pre-fault 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 pre-fault cycles.

### 303: SPLITREC - Split Oscillography Record For Long Duration Faults

The ALPS allows a pre-defined number of oscillography 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 pre-fault cycles that are captured as determined by the **PREFAULT** setting. **SPLITREC** applies only the fault record exclusive of the pre-fault cycles. **SPLITREC** is set as a percentage with a range of 0 to 100%, 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 (100 – **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 pre-fault data and 32 cycles of fault data. The ALPS samples at 64 times per cycle, therefore, 2048 samples (64 x 32) of fault data will be captured. Further assume that **SPLITREC** is set to 30%. If the fault lasts longer than 32 cycles (2048 samples), then the oscillography 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).

**2.2.4 EQUIPMENT DUTY**

The ALPS will count the total number of breaker operations as well as 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 defined exponent

The number of operations and accumulated duty will be compared to set values (entered by user). 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 to use as a starting point. The following settings need to be made.

**2**

### 401: EXPONENT - Exponent *x* to use in $I^x t$ Calculation

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

### 402: MAX_OP - Maximum Number Of Breaker Operations Permitted

This number can be set from 0 to 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 to 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 to 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 to 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 to 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).

### 407: NUM_OP - Present Number Of Breaker Operations

(Three Phase Tripping models only)

**NUM_OP** can be set over the range of 0 to 9999 with a step of 1. If the number of operations to that point in time is know, enter that value, otherwise, enter an estimated value or use the default value of zero (0). Index Flag 138: Number of Breaker Operations Alarm (BRMNOP) is set when the Breaker duty equals the set value. This flag may be directly assigned to an output contact, or used in configurable logic.

### 408: NUM_OP_A - Present Number of Breaker Operations for Phase A

### 409: NUM_OP_B - Present Number of Breaker Operations for Phase B

### 410: NUM_OP_C - Present Number of Breaker Operations for Phase C

(Single Phase Tripping Models Only)

**NUM_OP_1**, **NUM_OP_2**, and **NUM_OP_3** can be set over the range of 0 to 9999 with a step of 1. If the number of operations to that point in time is know, enter that value, otherwise enter an estimated value or use the default value of zero (0).

**2**

There are eight contact converters provided in three phase tripping models and twelve contact converters provided in single phase tripping models. These contact converters are used to convert contact inputs into logic signals for use within the scheme logic. Each of the contact converters can be assigned to any of the signals defined by the first 32 Index Numbers given in Table 2–9 on page 2–51.

**501: CC1 - Contact Converter 1**         **502: CC2 - Contact Converter 2**
**503: CC3 - Contact Converter 3**         **504: CC4 - Contact Converter 4**
**505: CC5 - Contact Converter 5**         **506: CC6 - Contact Converter 6**
**507: CC7 - Contact Converter 7**         **508: CC8 - Contact Converter 8**

Assign any of the 32 signals given in Table 2–9 on page 2–51 to define these contact converter functions.

The following contact converter input assignments are recommended when the phase identified channel logic (HYBRIDP) is used. Note that CC3 and CC4 only need to be assigned when using the four channel scheme.

**Table 2–6: CONTACT CONVERTER ASSIGNMENT FOR PHASE IDENTIFIED CHANNEL SCHEME**

| CONTACT CONVERTER ASSIGNMENT | DESCRIPTION | INDEX # | MNEMONIC |
|---|---|---|---|
| 501: **CC1** - Contact Converter 1 | RCVR #1 Input | 12 | RCVR1 |
| 502: **CC2** - Contact Converter 2 | RCVR #2 Input | 13 | RCVR2 |
| 503: **CC3** - Contact Converter 3 | RCVR #3 Input | 10 | STCR * |
| 504: **CC4** - Contact Converter 4 | RCVR #4 Input | 11 | BPLTRP * |

*Note that Index items 10 (STCR) and 11 (BPLTRP) use mnemonics that refer to their use in the BLOCKING scheme. When they are used in four channel HYBRIDP scheme logic, they function as the receiver input for the third and fourth channels.

**509: CC9 - Contact Converter 9**
**510: CC10 - Contact Converter 10**
**511: CC11 - Contact Converter 11**
**512: CC12 - Contact Converter 12**

(Single Phase Tripping models only)

Use any of the 32 signals given in Table 2–9 on page 2–51 to define the function of these contact converters.

**2**

### 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 Function

- **Uncompensated Systems**: If potential transformers (PTs) are used, use a reach setting that is no greater than 90% of the positive sequence impedance of the line to be protected. If capacitor voltage transformers are used, refer to the figure below to determine if additional reduction of the Zone 1 reach is required.

- **Compensated Systems**: If series compensation is included in the protected line, or in lines adjacent to the protected line, the Zone 1 settings need to be modified. If the **Z1PLEVDET** setting is required, then **Z1PREACH** should be set equal to 100% of the positive sequence impedance of the line to be protected. If it is determined that the **Z1PLEVDET** setting is not required, then **Z1PREACH** should be set as for an uncompensated system.
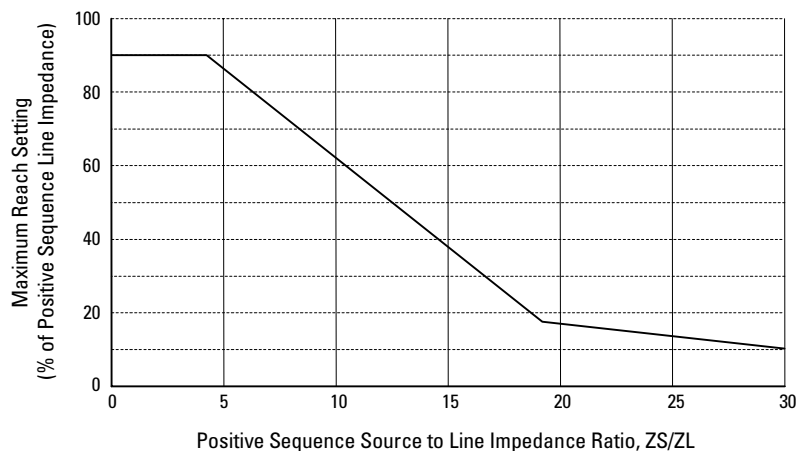


**Figure 2–2: ALLOWABLE ZONE 1 REACH (WHEN USED WITH CVTs)**

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

The distance functions are measured by comparing the phase relationship of an operate signal ($I \cdot Z - V$) to a polarizing signal ($V$); where $Z$ is the set 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 the figure above and assume that the potential source for the ALPS 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 ($Zline - Xc3$). It might then be assumed that a Zone 1 function could be set to reach 90% 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 MOVs. To overcome this limitation, the operating signal ($I \cdot Z - V$) in the ALPS Zone 1 functions 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.
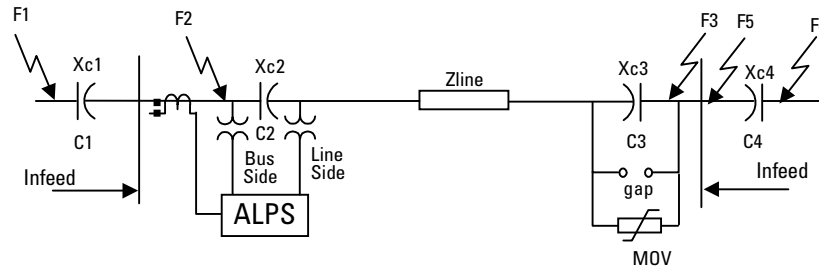
**Figure 2–3: POWER SYSTEM ONE LINE DIAGRAM WITH SERIES CAPACITORS**

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 MOVs 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:

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

If gap flashing does not occur, or if there is not significant conduction in the MOV, then the operate signal, $I \cdot Z - V$, is equal to $I \times X_C$, the voltage drop across the capacitor. If the gaps flash, the operate signal will be very small, or if the MOVs 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 F2 directly in front of the Zone 1 functions. For this fault, $V = 0$, and the operate signal, $I \cdot Z - V$, will therefore equal $I \cdot Z$. 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: POWER SYSTEM ONE LINE DIAGRAM WITH SERIES CAPACITORS above.

1.   Capacitors C3 and C4 need only be considered if line side potential is used.

2.   If bus side potential is used then capacitors 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 F4 (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 MOVs**: If the MOVs are protected with gaps, and if the minimum fault current (including infeed) for a fault at F4 is above the gap flashing level, then exclude C4 from the calculation. If there are no gaps around the MOVs or if the gaps do not flash, then use the protective level of the MOVs when making calculations.

Note that only one capacitor is shown in location C4 where in actuality there may be more than one 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 deciding which capacitors are involved, the protective levels of those capacitors are defined as follows:

$$PL_t = \frac{1}{95}\sum_{1}^{n} PL_n$$

where:   $n$ = number of capacitors involved
$PL_n$ = the gap flashing level in peak volts if gaps are used to protect the capacitors, *or*
$PL_n$ = the protective level in peak volts if MOVs are used to protect the capacitors.

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

**ZIPLEVDET** = $\sqrt{0.15 + 1.3 PL_t^2}$

### 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

- **Uncompensated Systems**: If potential transformers (PTs) are used, use a reach setting that is no greater than 90% of the positive sequence impedance of the line to be protected. If capacitor voltage transformers (CVTs) are used, refer to Figure 2–2: ALLOWABLE ZONE 1 REACH (WHEN USED WITH CVTs) on page 2–9 to determine if additional reduction of the Zone1 reach is required.

    If single phase tripping is employed, and if the application involves a parallel line (bussed at both ends) where single phase tripping is also employed, the Zone 1 ground distance functions should not be set greater than 80% of the line impedance or greater than 80% of the setting determined using the ALLOW ZONE 1 REACH figure.

- **Compensated Systems**: If series compensation is included in the protected line or in lines adjacent to the protected line, the Zone 1 settings need to be modified. If the Z1GLEVDET setting is required, then Z1GRDREACH should be set to 100% of the positive-sequence impedance of the line to be protected. If it is determined that the Z1GLEVDET setting is not required, then Z1GRDREACH should be set as for an uncompensated system.

### 106: Z1GRDCHAR - Zone 1 Ground Characteristic

**Z1GRDCHAR** can be set to either MHO, REACT or QUAD. This setting determines the type of measuring unit used for the Zone 1 ground distance functions, either a Mho function, a Reactance function, or a Quadrilateral 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 or Quadrilateral 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

This setting is relevant only when the Zone 1 ground distance functions have been set to be reactance functions (see 106: **Z1GRDCHAR** above). Since the reactance function is nondirectional, it must be supervised by a Mho function, as shown in Figure 2–5: MAXIMUM ALLOWABLE REACH on page 2–13. 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 is easily calculated if the maximum load flow across the line is known. The criterion used for establishing the minimum reach is based on maintaining a 40° angular margin between angles A and B as shown in Figure 2–5: MAXIMUM ALLOWABLE REACH on page 2–13. Angle 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 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 - Z1GROUND 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 to the following:

**Z1GROUNDK0** $= 0.95 \times (Z_{0L} / Z_{1L})$

where: $Z_{0L}$ = zero-sequence impedance of line and $Z_{1L}$ = positive sequence impedance of line

**109: Z1GLEVDET - Zone 1 Ground Level Detector**

(Series Capacitor Model Only)

Use the total protective level $PL_t$ determined with the **Z1PLEVDET** setting to calculate **Z1GLEVDET**:

$$\textbf{Z1GLEVDET} = \sqrt{0.15 + PL_t^2}$$

**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: POWER SYSTEM ONE LINE DIAGRAM WITH SERIES CAPACITORS on page 2–10. 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 there are series capacitors located behind the ALPS system as shown in Figure 2–3: POWER SYSTEM ONE LINE DIAGRAM WITH SERIES CAPACITORS on page 2–10.

**111: Z1GCHARANG - Zone 1 Ground Characteristic Timer Angle**

(Revision B models only)

**Z1GCHARANG** can be set from 80° to 155° in increments of 1°. This setting determines the "tilt" of the reactance portion of the quadrilateral ground distance characteristic.

A ground distance function employing a reactance/quadrilateral characteristic provides excellent protection on a homogeneous system where the fault current at the relay location is essentially in phase with the total fault current for a single line to ground fault at the remote end of the line; or if the fault current at the relay location is more lagging than the total fault current for a single line to ground fault at the remote end of the line. On a non-homogeneous system where the fault current at the relay location is more leading than the total fault current for a single line to ground fault at the remote end of the line, a conventional reactance/quadrilateral characteristic will tend to overreach, especially when fault resistance is present. In this situation, the "tent" characteristic shown below should be used.
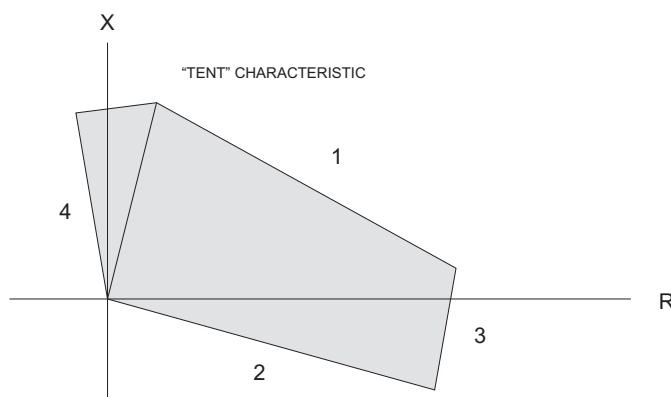


**Figure 2–4: TENT CHARACTERISTIC**

**112: Z1RGREACH - Zone 1 Resistive Ground Reach**

(Revision B models only)

**Z1RGREACH** can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. If Zone 2 is also set to Quad mode, this setting should be calculated as 0.8 or less of the Zone 2 Resistive Ground Reach (Protection Setting 211: **Z2RGREACH**). If Zone 2 is not set to Quad mode, the setting should be calculated at 0.8 (if "tent" characteristics are used) or less (0.6 to 0.7 if "tent" characteristics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 105: **Z1GRDREACH**) for this zone.

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 the following:

1.  Shape of the characteristic – circle or lens,

2.  Angle of maximum reach, and

3.  Maximum amount of load flow transferred across the transmission line.



MR = Maximum Allowable Reach
ZL = Load Impedance
D = Angle of Maximum Reach
B = Characteristic Angle; < 90 = Lens
C = Load Impedance Angle
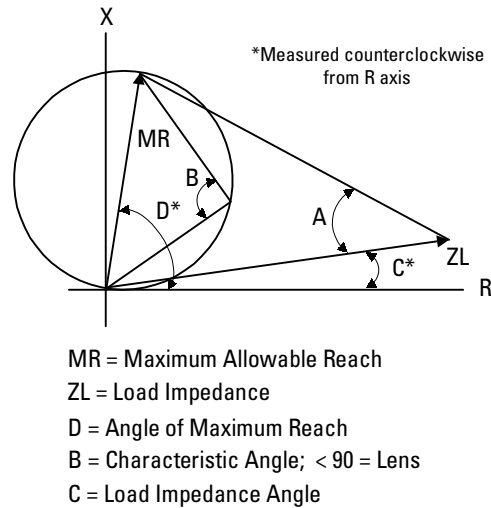
**Figure 2–5: MAXIMUM ALLOWABLE REACH**

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

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

where    $Z_L$ = minimum load impedance (ohms)
         $B$ = Characteristic angle (degrees) = 90° for a circle; > 90° for a 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 angles B and A shown in the figure above. A circular Mho characteristic (*B* = 90°) should be used when possible. However, for larger load flows (smaller load impedances) and for longer reaches, it may be necessary to resort to a lenticular characteristic (*B* > 90°) 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 applied as blocking functions in available schemes. In those applications, it is permissible to set the characteristic angle for Zone 4 to a minimum of 80°.

For each application, a desired reach should be determined 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.

**201: Z2PHASE - Zone 2 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 - Zone 2 Phase Distance Reach**

- **Step 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 to 150% of the positive sequence impedance of the protected line. **Z2PHREACH** should never be set so large as to:

    1. Exceed the maximum allowable reach (*MR*), or,

    2. 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.
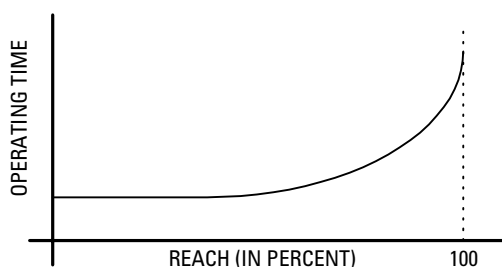


**Figure 2–6: OPERATING TIME CHARACTERISTIC**

- **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% 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 above in the diagram above.

    For example, if the reach of the Zone 2 functions is set to 125% of 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% 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 since coordination with Zone 2 functions in adjoining lines is not achieved. 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% 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 - Zone 2 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 2–5: MAXIMUM ALLOWABLE REACH on page 2–13.

### 204: Z2GROUND - Zone 2 Ground Distance Function

The choice of settings is YES or NO. Set **Z2GROUND** = YES if the Zone 2 ground distance functions are to be used, otherwise set **Z2GROUND** = NO.

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

**Z2GRDCHAR** can be set to either MHO**,** GDOC**,** MHOGDOC**,** MHO2GDOC (single phase models only) or QUAD. This setting determines the type of measuring unit used for the Zone 2 ground distance functions and the pilot tripping zone. The distance function may be set as an Mho (MHO, MHOGDOC, and MHO2GDOC) or as a quadrilateral (QUAD). The following ground directional overcurrent functions are placed in service whenever Z2GRDCHAR is set to MHO, MHOGDOC, MHO2GDOC, GDOC, or QUAD:

1.  NT: forward looking negative-sequence directional function

2.  IPT: zero-sequence overcurrent tripping function (with or without positive-sequence current restraint, depending on the protection scheme)

3.  NB: reverse looking negative-sequence directional function

4.  IPB: zero-sequence overcurrent blocking function (with or without positive-sequence current restraint)

Instead of using a distance function, the pilot zone may be applied in a ground directional overcurrent scheme (GDOC); it is also possible to use both the mho ground distance function and the ground directional overcurrent pilot schemes simultaneously (MHOGDOC). When **Z2GRDCHAR** is set to MHO2GDOC, the IPT and IPB functions are modified to include a negative-sequence current operating quantity in addition to the zero-sequence quantity used with the GDOC and MHOGDOC settings. The addition of the negative-sequence operating current allows the Directional Overcurrent function to detect phase-to-phase faults which do not include zero-sequence current. With this new option, MHO2GDOC, the Directional Overcurrent logic will operate for phase to phase faults, as well as for faults that involve ground. This modification allows the Directional Overcurrent logic to detect all unbalanced faults that may occur on the protected line, even if they occur during a power swing (out-of-step) condition. The MHO2GDOC logic is shown below.

**NOTE** The MHO2GDOC setting option is only available on the ALPS with single phase tripping.
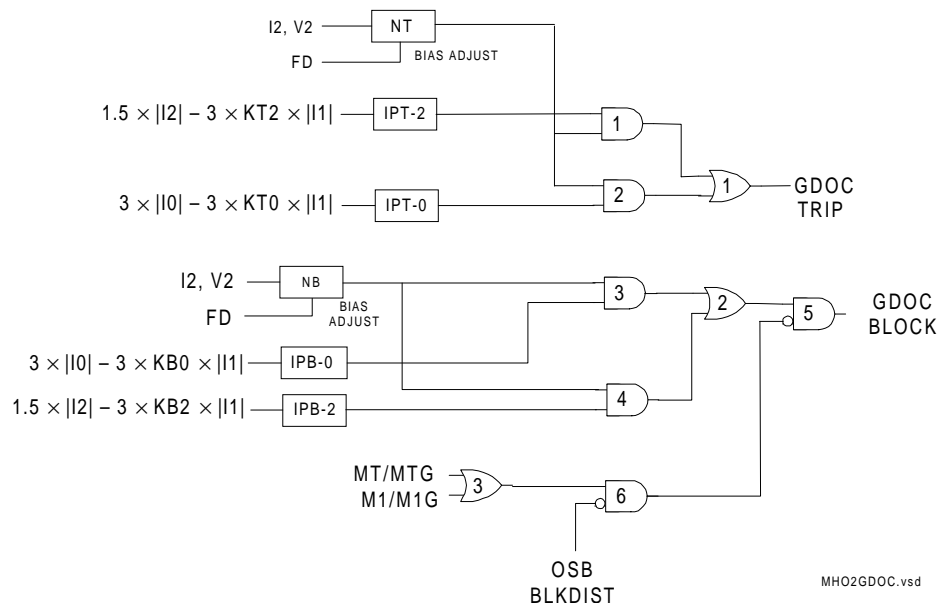


**Figure 2–7: MODIFIED GDOC LOGIC, MHO2GDOC**

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

**2**

- **PUTT Scheme**: Operation of this scheme is dependent on the Zone 1 ground distance functions keying the transmitter for ground faults. As such, 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: Z2GRDREACH - Z2 Ground Distance Function Reach

See the **Z2PHREACH** phase distance function reach setting (Protection Setting 202); the same philosophy applies.

### 207: Z2GCHARANG - Z2 Ground Distance Function Characteristic Angle

**Z2GCHARANG** is adjustable from 80° to 155° 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 to 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 used to provide Zone 3 tripping as described 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.

### 210: Z2G_TIME - Z2 Ground Timer (Revision B models only)

**Z2G_TIME** can be set over the range of 0.1 to 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.

### 211: Z2RGREACH - Zone 2 Resistive Ground Reach (Revision B models only)

**Z2RGREACH** can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. If Zone 3 is also set to Quad mode, this setting should be calculated at 0.8 or less of the Zone 3 Resistive Ground Reach (Protection Setting 310: **Z3RGREACH**). If Zone 3 is not set to Quad mode, the setting should be calculated as 0.8 (if "tent" characteristics are used) or less (0.6 to 0.7 if "tent" characteristics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 206: **Z2GRDREACH**) for this zone.

**2.3.4 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.

**2**

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

1.  Exceed the maximum allowable reach (*MR*), or,

2.  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 2–5: MAXIMUM ALLOWABLE REACH on page 2–13.

### 304: Z3GROUND - Select Zone 3 Ground

**Z3GROUND** 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 **Z3GROUND** = YES. If Zone 3 is not used required, set **Z3GROUND** = 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 multiphase fault at the end of the longest adjoining line section out of the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. **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 80 to 155° 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 2–5: MAXIMUM ALLOWABLE REACH.

### 307: Z3P_TIME - Z3 Phase Timer

**Z3P_TIME** can be set from 0.10 to 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 Ground Timer

**Z3G_TIME** can be set from 0.10 to 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.

**2**

### 309: Z3GRDCHAR - Zone 3 Ground Characteristic (Revision B models only)

**Z3GRDCHAR** can be set to MHO or QUAD. This setting determines the measuring unit used for the Zone 3 ground distance functions. The distance function may be set as an Mho (MHO) or as a quadrilateral (QUAD).

### 310: Z3RGREACH - Zone 3 Resistive Ground Reach (Revision B models only)

**Z3RGREACH** can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. If Zone 4 is also set to Quad mode looking forward, this setting should be calculated at 0.8 or less of the Zone 4 Resistive Ground Reach (Protection Setting 413: **Z4RGREACH**). If Zone 3 is not set to Quad mode, the setting should be calculated as 0.8 (if "tent" characteristics are used) or less (0.6 to 0.7 if "tent" characteristics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 305: **Z3GRDREACH**) for this zone.

**2.3.5 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 (see below). The reverse direction is required in certain applications and/or schemes as described below.
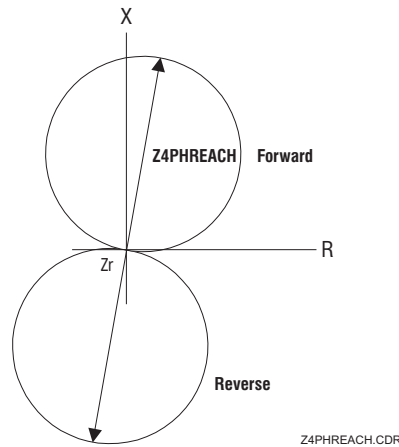


**Figure 2–8: GROUND DISTANCE FUNCTION CHARACTERISTIC**

Historically, Zone 4 distance functions have been provided with offset to include the origin of the R-X diagram within their characteristics (see below). 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.
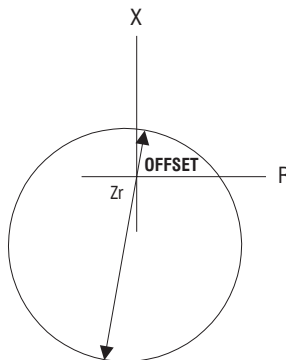


**Figure 2–9: R-X DIAGRAM FOR ZONE 4 DISTANCE FUNCTIONS**

For example, consider the fault at F1 shown below 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.



**Figure 2–10: ZONE 4 FAULT EXAMPLE**

The ALPS Zone 4 phase distance functions are not provided with offset since 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% 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% 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 Zone 4 phase distance functions are 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

- **Step 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.

### 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 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 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:

    1. 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 x Z2PHREACH$_R$

    2. 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 x (Z2PHREACH$_R$ - $Z_{1L}$)

    where: **Z2PHREACH$_R$** = reach of phase Zone 2 functions at remote line terminal
    $Z_{1L}$ = 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 setting is used, the reach should be checked per the maximum allowable reach procedure given under Section 2.3.2: ZONE 2, ZONE 3, AND ZONE 4 DISTANCE FUNCTIONS on page 2–13. See Figure 2–5: MAXIMUM ALLOWABLE REACH on page 2–13.

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 phase distance functions with a reach that is equal to or greater than the reach of the phase distance pilot tripping functions (normally Zone 2) at the remote end of the transmission line. For example:

**Z4PHREACH ≥ Z2PHREACH$_R$**

where **Z2PHREACH$_R$** is the reach of the pilot tripping functions (Zone 2 in this example) at the remote end of the line.

- **Step Distance and POTT2 Schemes**: In all other schemes, the Zone 4 phase distance functions can provide an additional zone of time delayed backup protection. They can be used to provide a fourth zone of protection in a straight step distance scheme, or they can be reversed in direction to provide the so-called reversed third zone of protection.

  The Zone 4 functions should be set with a reach commensurate with the application, considering underreach caused by intermediate fault current sources. **Z4PHREACH** should never be set so large as to:

  1. Exceed the maximum allowable reach (*MR*), or,

  2. To cause loss of selectivity with phase 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 **Z4P_TIME** with additional time delay.

### 403: Z4PCHARANG - Z4 Phase Characteristic Angle

- **Blocking, Hybrid and POTT2 Schemes**: Set the Zone 4 characteristic angle setting to 10° less than the characteristic angle setting (**Z2PCHARANG$_R$**) of the Zone 2 functions at the remote terminal of the line; that is:

  Z4PCHARANG = Z2PCHARANG$_R$ – 10°

- **Step Distance and POTT1 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; values lower than 90° should not be used except in blocking, hybrid and POTT2 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 **Z4PHREACH** and **Z4PCHARANG** may be evaluated by using the formula associated with the method of Figure 2–5: MAXIMUM ALLOWABLE REACH on page 2–13.

### 405: 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 **Z4GRND** = YES

- **Step 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.

### 406: 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 2–10: ZONE 4 FAULT EXAMPLE on page 2–19).

  In a hybrid scheme, the Zone 4 functions prevent keying of the transmitter to block echoing of the trip signal 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 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:

1. 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:

   Z4GRDREACH = 0.85 x Z2GRDREACH$_R$

2. 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:

   Z4GRDREACH = 1.7 x Z2GRDREACH$_R$ − $Z_{1L}$

   where **Z2GRDREACH$_R$** = reach of phase Zone 2 functions at remote line terminal
       $Z_{1L}$= 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 setting is used, then the reach should be checked per the maximum allowable reach procedure given in Section 2.3.2: ZONE 2, ZONE 3, AND ZONE 4 DISTANCE FUNCTIONS on page 2–13.

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:

  Z4GRDREACH ≥ 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.

- **Step 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 provide a fourth zone of protection in a straight step 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 to 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. 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.

### 407: Z4GCHARANG - Z4 Ground Characteristic Angle

- **Blocking and Hybrid Schemes**: Set the Zone 4 characteristic angle setting to 10° less than the characteristic angle setting (**Z2GCHARANG$_R$**) of the Zone 2 functions at the remote terminal of the line; that is:

    Z4CHARANG = Z2CHARANG$_R$ − 10°

- **Step 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 155° in 5° steps. A 90° setting is recommended; values lower than 90° should not be used except in blocking, hybrid and POTT2 schemes. If the desired reach, **Z4GRDREACH**, 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 **Z4GRDREACH** and **Z4GCHARANG** may be evaluated by using the formula associated with the method of Figure 2–5: MAXIMUM ALLOWABLE REACH on page 2–13.

### 408: 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

**409: 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.

**410: 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.

**411: 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.

**412: Z4GRDCHAR - Zone 4 Ground Characteristic (Revision B models only)**

**Z4GRDCHAR** can be set to either MHO or QUAD. This setting determines the measuring unit used for Zone 4 ground distance functions. The distance function may be set as an Mho (MHO) or as a quadrilateral (QUAD).

**413: Z4RGREACH - Zone 4 Resistive Ground Reach (Revision B models only)**

**Z4RGREACH** can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. This setting should be a balance between desired fault resistance coverage and load encroachment. It should be calculated as 0.8 (if "tent" characteristics are used) or less (0.6 to 0.7 if "tent" characteristics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 406: **Z4GRDREACH**) for this zone.

**2.3.6 CURSUPVISN**

**501: IT_PICKUP - Trip Supervision Current**
**502: IB_PICKUP - Block Supervision Current**

- **Step 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 x **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 MHO, 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.

**2**

- **Step 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 step 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 ANDed with the forward looking negative sequence directional function, NT, to form the pilot tripping. The IPT operating quantity is:

$$IPT_{op} = 3 \cdot I_0$$

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 ANDed with the forward looking negative sequence directional function, NT, to form the pilot tripping. The IPT operating quantity is:

$$IPT_{op} = \quad 3I_0 - 0.3I_1$$

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

$$IPT_{op} = 3 \cdot I_0 - \textbf{IPBKFACTOR} \times 3 \cdot I_1$$

The **IPBKFACTOR** controls the amount of positive sequence current restraint that is used with the *IPB* function. **IPBK-FACTOR** can be set equal to 0 or 0.066. A setting of 0.066 is proposed for these schemes. Positive sequence current restraint is used in both the tripping and blocking functions to provide increased security for any current unbalance that may occur during load flow or external fault conditions.

IPT and IPB must be set so as to provide proper coordination. This is done by setting the IPB function more sensitively than the IPT function. The following settings are proposed:

**IPB_PICKUP** = minimum
**IPT_PICKUP** = 1.3 x **IPB_PICKUP$_R$** + $I_{oc}$

where:　**IPB_PICKUP$_R$** = setting of IPB function at remote terminal of transmission line.
　　　　$I_{oc}$ = zero sequence line charging current (include effect of any non-switched shunt reactors)

- **Blocking Scheme**: IPT is logically ANDed with the forward looking negative sequence directional function, NT, to form the pilot tripping function. The IPT operating quantity is:

$$IPT_{op} = 3 \cdot I_0 - (0.3) \cdot I_1$$

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 ANDed 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 $IPT_{op} = 3 \cdot I_0 - \textbf{IPBKFACTOR} \times 3 \cdot I_1$

The **IPBKFACTOR** controls the amount of positive sequence current restraint that is used with the *IPB* function. **IPBK-FACTOR** 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 below in Table 2–7: PROPOSED SETTINGS FOR BLOCKING SCHEME.

**Table 2–7: PROPOSED SETTINGS FOR BLOCKING SCHEME**

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

**505: IPBKFACTOR - IPB I1 Restraint**

The IPB operating quantity is: $IPB_{op} = 3 \cdot I_0 -$ **IPBKFACTOR** x $3 \cdot I_1$

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 2–11: NT/NB FUNCTIONS. 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 (Zs/ZL), 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 (Zs/ZL 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 2–11: NT/NB FUNCTIONS on page 2–24, 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.

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.

**NT_OFFSET** is a per unit impedance setting. The base ohms for this setting is:

$$\frac{100}{I_n}$$ , where $I_n$ = Magnetics Module CT rating (1A or 5A)

Use the values determined as follows and make the next lowest available setting. For example, if the calculated value is 0.027, set **NT_OFFSET** = 0.02.

1.  Uncompensated Lines

    **NT_OFFSET** should be set to 0.05, or the value determined by the following if it is less than 0.05:
    **NT_OFFSET** = $(0.005) \cdot (Z_1) \cdot (I_n)$

    where $Z_1$ = positive sequence impedance of protected line (in secondary ohms)
    $I_n$ = Magnetics Module CT rating (1A or 5A)
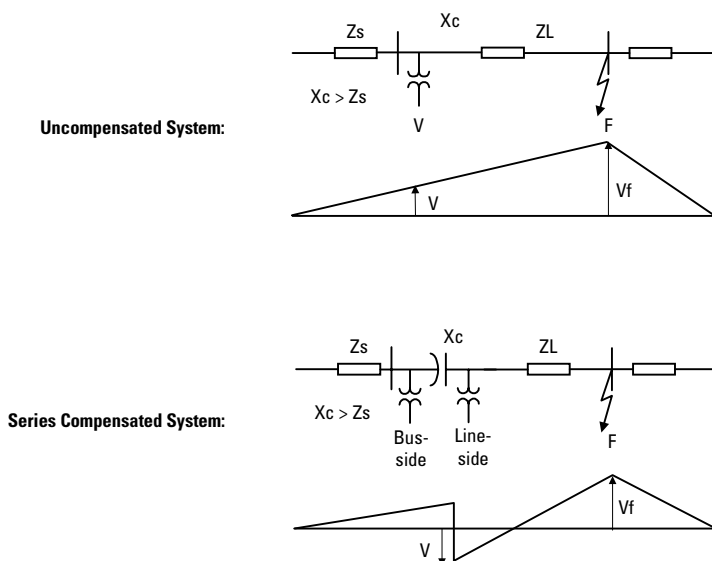


**Figure 2–11: NT/NB FUNCTIONS**

**2**

2.   Compensated Lines:

   a) Series compensated line, no capacitor at the relay end of the line.

   Set the NT_OFSET per the uncompensated line procedure.

   b) Series compensated line, Bus-side Potential

   **NT_OFFSET** = $(0.0055) \cdot (Z_1 - X_t) \cdot (I_n)$

   c) Series compensated line, Line-side Potential

   **NT_OFFSET** = $(0.022) \cdot (X_c) \cdot (I_n)$

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 ($X_c$ above in Figure 2–11: NT/NB FUNCTIONS).
         $I_n$ = 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:

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

Tripping will not be permitted unless there is a concurrent output from the fault detector, therefore an increase in security is obtained. The ALPS 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.

**2.3.7 OVERCURRNT**

### 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 Protection Settings 602 and 603 for further discussion on use of **50** function. Also, Protection Setting 201: **Z2PHASE** must be set to YES.

### 602: 50_DIRCNL - Directional Control Of 50

The **50** function can be set to directional or nondirectional. Directionality is obtained with the Zone 2 phase distance functions. Protection Setting 201 must be set to **Z2PHASE** = YES to make the **50** function directional.

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 multiphase faults, and it operates on the highest of the three delta currents, IA-IB, IB-IC, or IC-IA. This permits **50** to have the same response for all multiphase faults at the same location. If **50PICKUP** is non-directional, then it should be set at least 25% 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% 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 provide any protection. To overcome this drawback, a second setting (**50PICKUPFF**) provides some backup during a loss of potential. A **50PICKUPFF** setting must always be made and it must always be set at least 25% 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 Protection 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 nondirectional. 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 nondirectional or directionally controlled. If **50G** is nondirectional, 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:

$$\textbf{50G}_{op} = \ 3 \times |I_0| \ - \textbf{50GRESTNT} \ x \ \ 3 \times |I_1|$$

where **50GRESTNT** = 0 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 $3 \times I_0$ value from this same maximum operate signal.

$$\textbf{50GPICKUP} = \ 3 \times |I_0| \ - \textbf{50GRESTNT} \times \ 3 \times |I_1| \ + 0.25 \times \ 3 \times |I_0|$$

### 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 line.

### 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, $3 \times |I_0|$. 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

**51G** provides time delayed backup tripping for single-line-to-ground faults. Its operating quantity is:

$$3 \times |I_0|$$

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 directional and potential is lost to the relay, then directional control will be lost and the **51G** function will not provide any protection. To overcome this drawback, a second setting (**51GPCKUPFF**) provides some backup during a loss of potential. A **51GPCKUPFF** setting must always be set as given above and is based on the maximum operating quantity that can be obtained for a fault at either end of the line.

### 614: 51GCURVE - Select 51G Characteristic Curve

**51GCURVE** determines the characteristic curve shape for the **51G** function. The choices are inverse curve (INV**,** Figure 2–18: INVERSE CURVE on page 2–48), very inverse curve (V-INV, Figure 2–19: VERY INVERSE CURVE on page 2–49), extremely inverse curve (E-INV, Figure 2–20: EXTREMELY INVERSE CURVE on page 2–50), user-defined custom curve (CUSTOM), and definite time (DEFT).

### 615: 51GTIMDIAL - Ground Time Overcurrent Time Dial

**51GTIMDIAL** selects the 51G time dial setting. **51GTIMDIAL** can be set from 0.5 to 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 electromechanical device with a similar time curve. Select FAST for the fast reset or EM to emulate an electromechanical function.

**2.3.8 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 volts. Use a setting that is closest to the voltage that is applied to the ALPS.

### 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 to 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.

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> **NOTE** **The settings in this section apply to overvoltage models only**

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

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

    **V1OVER** = $V_1$

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:

    **V1COMP** = $V_1$ - ($I_1$ x $Z_{1C}$)

    where   $V_1$ = positive sequence voltage at the relay
            $I_1$ = positive sequence current at the relay
            $Z_{1C}$ = compensating positive sequence impedance

The uncompensated function responds to the positive-sequence voltage developed directly at the relay location. The compensated function responds to the positive-sequence voltage at some point ($Z_{1C}$ ohms) in front of the relay location. For example, if $Z_{1C}$ is set equal to the positive-sequence impedance of the protected line, then **V1COMP** measures the positive-sequence voltage developed at the end of the line remote from the relay.

### 705: V1OVER - Select Positive Sequence Overvoltage

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

### 706: V1OVINSTPU - Instantaneous Positive V1OVER Pickup

**V1OVINSTPU** establishes the pickup setting of the instantaneous **V1OVER** function and can be set from 1.0 to 1.4 per unit volts 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 volts 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 **V1OVTMDLY** 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 - V1COMP Impedance

**V1COMPRCH** establishes the point (in positive-*sequence* Ω) in front of the relay where the positive-sequence voltage will be measured. If **V1COMP** is selected, set **V1COMPRCH** to suit the particular application.

### 711: V1COMPINPU - V1COMP Instantaneous Pickup

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

### 712: V1COMPTDPU - V1COMP Function 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 volts based on the **RATEDVOLTS** setting. If **V1COMP** is selected, make a **V1COMPTDPU** setting that is suitable to the particular application.

### 713: V1COMPTDLY - V1COMP Overvoltage Function 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 directional, then they will not be allowed to trip. Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS on page 1–11 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 to the upper input of 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 has operated or 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 times-out TL1 and produces 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.

#### 2.3.10 BLK RECLOS

The following Protection Settings (801 to 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

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.

### 802: OUTOFSTEP - Block For Out Of Step

Set **OUTOFSTEP** = YES if reclosing is to 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.

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### 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: Z1PHASTRIP - 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.

**2.3.11 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 are left on the line following maintenance. Figure 1–4: LINE PICKUP LOGIC DIAGRAM (THREE PHASE TRIPPING) on page 1–12 and Figure 1–5: LINE PICKUP LOGIC DIAGRAM (SINGLE PHASE TRIP-PING) on page 1–13 show 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 where simultaneous high-speed reclosing is employed at both ends of the line, and where the I1 function must be set to pick up below the maximum load current that can occur at that time. TL3 then allows time for the voltage to return to normal and take Line Pickup out of service before it can trip on load current. If simultaneous high-speed reclosing is not used, timer TL3 can be permanently bypassed.

Line Pickup 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 pre-fault 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.

#### 2.3.12 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. A functional logic diagram of the ROD function is shown below. The sequence of events that results in an ROD output is as follows:
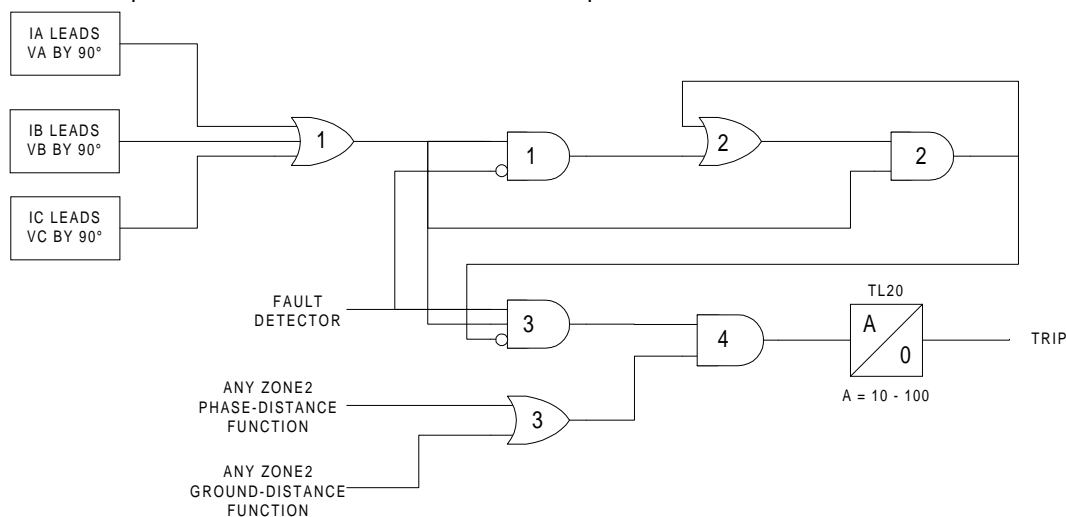


**Figure 2–12: ROD LOGIC DIAGRAM**

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.

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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 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.

**2.3.13 LINEOVRLD**

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 Protection Settings 1102 to 1105.

### 1102: LEVEL1PU - Level 1 Pickup Current

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

### 1103: LEVEL2PU - Level 2 Pickup Current

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

### 1104: LEVEL1TDLY - Level 1 Time Delay

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

### 1105: LEVEL2TDLY - Level 2 Time Delay

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

**2.3.14 SCHEME**

### 1201: PICKSCHEME - Select Scheme Logic

Any one of the following schemes can be selected:

1.   STEPDST - step distance
2.   PUTT - Permissive Underreaching Transfer Trip
3.   POTT1 - Permissive Overreaching Transfer Trip (uses traditional transient blocking for current reversals)
4.   POTT2 - Permissive Overreaching Transfer 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
7.   HYBRIDP - Hybrid scheme with Phase Identified channel logic (for both two and four channel schemes)

Set **PICKSCHEME** 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 (Single Phase Tripping model only)**

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 - Function 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.

**1205: WKINFTRIP - Select Weak Infeed Tripping in HYBRID Scheme**

This setting determines if the Weak Infeed Trip logic will be used when a HYBRID scheme is selected. One of the following can be selected:

1.  YES - with this selection, the Weak Infeed Tripping logic is enabled.

2.  NO - with this selection, the Weak Infeed Tripping logic is disabled, but the Channel Repeat (Echo) logic remains in service.

A Voltage Fault Detector (VFD) is used with the Current Fault Detector (FD) in the Hybrid scheme. The weak sides produce little or no fault current at the weak terminal and the current values may not be sufficient to pick up the FD flag. In such cases, the VFD is used to detect unbalance conditions or disturbances.

**2.3.15 SCHMTIMERS**

**1301: TL1PICKUP - Trip Integrator**

*   **Step Distance Scheme**: Timer TL1 is not used in a step distance scheme, therefore it is not necessary to make a setting because any setting that is made will be ignored.

*   **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:

    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: **TL1PICKUP** = 3 + channel time + propagation time, where channel time and propagation time are entered in milliseconds.

*   **PUTT, POTT1, POTT2 and HYBRID Schemes**: For 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.

*   **Phase Identified Channel Schemes**: For the HYBRIDP scheme, **TL1PICKUP** should be set to the larger of the following:

    **TL1PICKUP** = 10 – channel time – propagation time, or **TL1PICKUP** = 3

**1302: TL4PICKUP: POTT1 Coordination Timer Pickup**

- **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:

> **TL1PICKUP** = 4 ms
> **TL4PICKUP** = 13 ms + 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. As such, set **TL4PICKUP** to 0.

**1303: TL4DROPOUT - POTT1 Coordination Timer Dropout**

- **PUTT and POTT1 Schemes**: Set **TL4DROPOUT** to 0.

- **Step 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 Coordination Timer Pickup**

- **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 ANDed together when two breakers are used. The switch shown below in Figure 2–13: TL5PICKUP / TL6PICKUP REPRESENTATION is not a physical switch but rather a logical representation that is digitally controlled by General Setting 105: **NUM_BKR** as described in Section 2.2.1: CONFIGURATION on page 2–2.

  Figure 2–13: TL5PICKUP / TL6PICKUP REPRESENTATION on page 2–35 shows the connections for both three-phase and single-phase tripping schemes. For three-phase tripping, the 52/b contacts are wired from breaker 1 to CC5 and from breaker 2 to CC6. For single-phase tripping, the 52/b contacts are wired from breaker 1 to CC8 (phase A), CC9 (phase B), and CC10 (phase C). The outputs of TL5 and TL6 are also used by the ALPS 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 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 Figure 2–13: TL5PICKUP / TL6PICKUP REPRESENTATION on page 2–35. The setting requirements for TL5 and TL6 are the same as described above.

**1305: TL5DROPOUT - BKR1 b sw Coordination Timer Dropout**
**1306: TL6PICKUP - BKR2 b sw Coordination Timer Pickup**
**1307: TL6 DROPOUT - BKR2 b sw Coordination Timer Dropout**

See description for **TL5PICKUP** (Protection Setting 1304).

**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 (Protection 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 (Protection Setting 1205).

**Three Phase Tripping:**
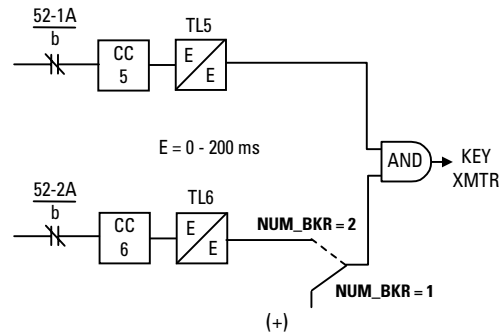
**Single Phase Tripping:**
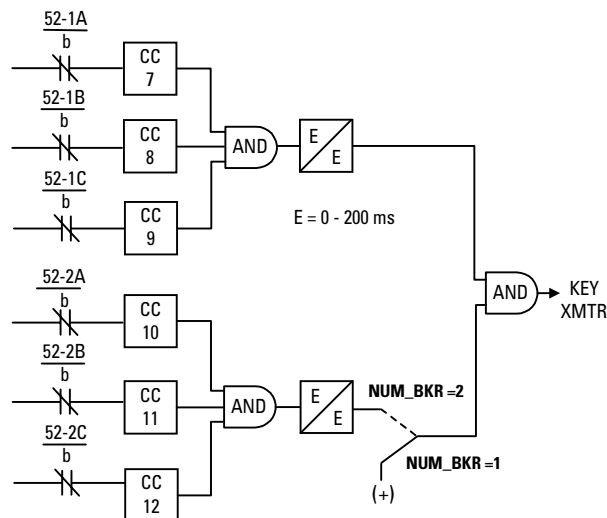
**Figure 2–13: TL5PICKUP / TL6PICKUP REPRESENTATION**

### 1309: TL24DRPOUT - GDOC Blocking Timer

- **Step Distance and POTT1 Schemes**: Timer TL24 is not used in these schemes. Therefore it is ignored and any setting 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, and

    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

- **Step Distance and POTT1 Schemes**: 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, and

3.  transients that can occur for external fault clearing.

The following settings are proposed:

1.  Uncompensated Lines,
    Single-pole tripping schemes: **TL25DRPOUT** = 30 ms
    Three-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 Timer

*   **Step Distance, Blocking, POTT1 and POTT2 Schemes**: Timer TL26 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** = $\left| Z_{Blocal} - Z_{Tremote} \right| + P + C$

where:   $\left| Z_{Blocal} - Z_{Tremote} \right|$ is the maximum difference in operating time between the blocking functions in the ALPS and the tripping functions in the system at the remote end of the line. If $Z_{Blocal} < Z_{Tremote}$, 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.

---

**2.3.16 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: ZEROSEQK0 - Zero Sequence Current Compensation

**ZEROSEQK0** 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:

**ZEROSEQK0** = $Z_{0L} / Z_{1L}$, where $Z_{0L}$ = zero-sequence impedance of line and $Z_{1L}$ = 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 Protection Setting 1406 below) relative to the relay location. Set **LINELENGTH** equal to the length of the line in terms of the units used in Protection Setting 1406.

**2**

### 1406: LINEUNIT - Unit Of Length

The ALPS 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 or PERCENT.

### 1407: CTRATIO - Current Transformer Ratio

The ALPS will report present values in terms of secondary values or primary values as set by General Setting 108: **DIS-PLAYVAL**. 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 will report present values in terms of secondary values or primary values as set by General Setting 108: **DIS-PLAYVAL**. 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.

---

**2.3.17 SCADA DTA**

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

**2**

Out-of-step blocking (OSB) is offered as a standard feature in the ALPS. Refer to Section 1.4.4: OUT-OF-STEP BLOCK-ING on page 1–14 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 2–13: TL5PICKUP / TL6PICKUP REPRESENTATION on page 2–35. For an out-of-step condition, the apparent impedance seen by the relay will follow a typical swing line as shown below. The ALPS 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 (Zone 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).
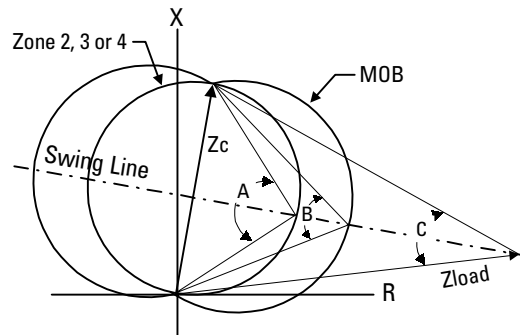


**Figure 2–14: OSB FUNCTION CHARACTERISTIC**

Angles A, B and C are determined as a function of the reach (Zc) of the coordinating zone, the maximum load flow (minimum Zload) and the fastest swing (first slip cycle). The angle A in the figure is selected via **ZxPHARANG** (**x** = 2, 3 or 4) and determines the shape of the coordinating zone characteristic. Angle B is selected via the **MOBCHARANG** setting and determines the shape of the MOB characteristic. Angle B should be set so 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 angles B and C is never less than 20°. Note that angle C is determined as a function of the minimum load impedance (Zload) and the reach (Zc) 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 Out-of-Step Tripping

**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.

**2.3.19 OS TRIPPING**

The ALPS can be supplied with optional out-of-step tripping in addition to out-of-step blocking. For a complete description of the out-of-step tripping logic see Section 1.10: OUT-OF-STEP TRIPPING (OPTIONAL) on page 1–41. Out-of-step tripping is implemented using positive sequence distance functions (separate from the regular ALPS distance functions) as shown in Figure 2–15: OST CHARACTERISTIC. Briefly, for an out-of-step condition, the apparent impedance seen by the relay will follow a typical swing line as shown. 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 directly related to the slip frequency of the power system during an out-of-step condition.
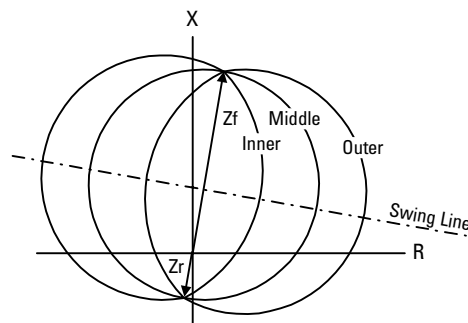


**Figure 2–15: OST CHARACTERISTIC**

The following settings must be made (refer to above and 2–16: OST REACH CHARACTERISTIC). 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 Entering Inner Or Leaving Outer**

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 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.
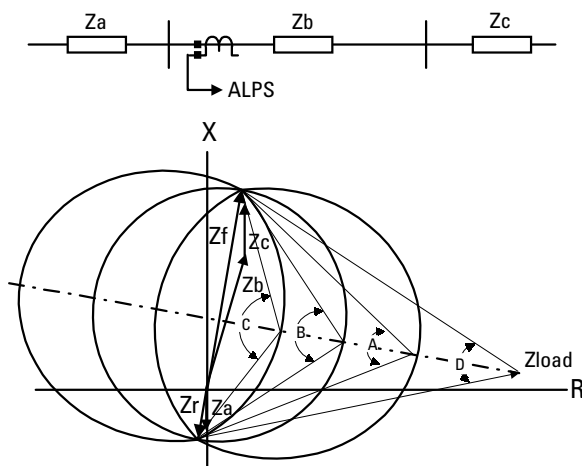


**Figure 2–16: OST REACH CHARACTERISTIC**

### 1704: FWDREACH - OST Forward Reach

For the simple system shown above in Figure 2–16: OST REACH CHARACTERISTIC, set the forward reach long enough to include the line plus the source at the remote end of the line; that is, **FWDREACH** > Zb + Zc

### 1705: REVREACH: - OST Reverse Reach

For the system shown above in Figure 2–16: OST REACH CHARACTERISTIC, set the reverse reach to include the source behind the ALPS; that is, **REVREACH** > Za

### 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; that is, the system becomes unstable.

The **OUTER** characteristic angle setting (angle A in Figure 2–16: OST REACH CHARACTERISTIC above) 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°. For example if angle D = 50°, set **OUTER** = 70°.

The INNER characteristic angle (angle C in figure above) 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**
**1711: TLOS2PU - Coordinating Timer 2 Pickup**
**1712: TLOS3PU - Coordinating Timer 3 Pickup**
**1713: TLOS4PU - Coordinating Timer 4 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. Refer to Figure 2–17: OUT OF STEP TRIPPING LOGIC below for the out-of-step tripping logic. 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 an out-of-step trip output will be produced. A minimum setting for **TLOS1DO** of 50 ms 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.
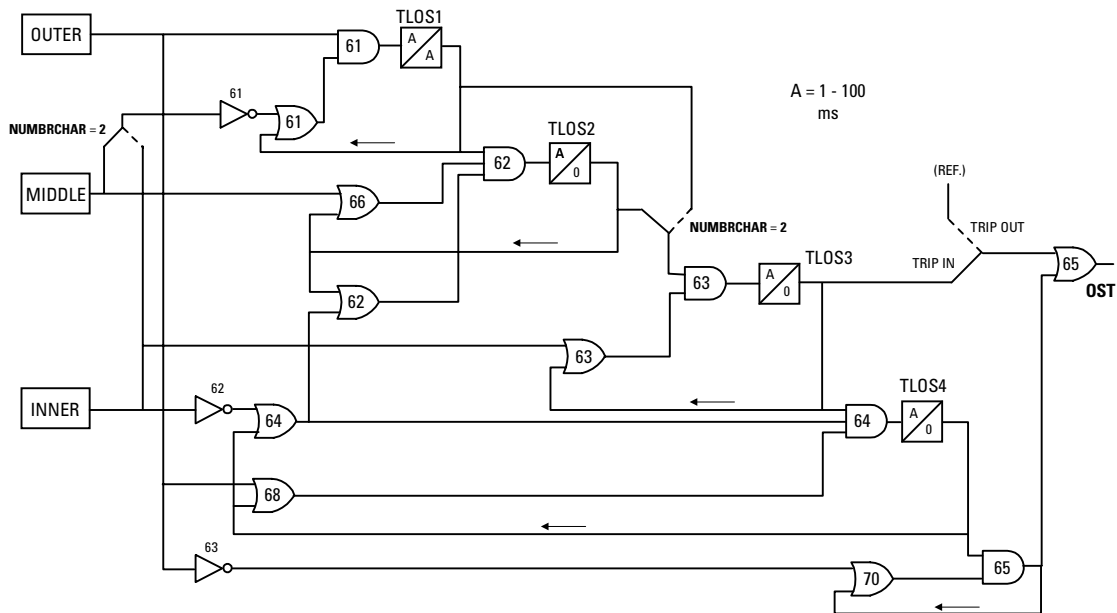


**Figure 2–17: OUT OF STEP TRIPPING LOGIC**

**2.3.20 RECLOSER**

The ALPS can be supplied with an optional recloser; see Section 1.12: RECLOSER (OPTIONAL) on page 1–45 for a complete description. If another relaying system is going to be used with or without the ALPS 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:

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

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

3.  INTERNAL - controlled by ALPS only.

4.  EXTERNAL - controlled by external relays only.

5.  BOTH - controlled by ALPS or external relays.

### 1802: RECLTYPE - Select Reclosing Type (Single Phase Tripping models only)

Set one of the following three reclosing types:

1.  1POLE - 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, the 3PRI signal will cause the recloser to go to lockout. When 1POLE reclosing is used, the three-pole trip enable signal 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 (Protection 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 here-after will be referred to as **1PDELAY1**, **1PDELAY2**, **1PDELAY3** and **1PDELAY4** (Protection Settings 1804 to 1807).

2.  3POLE - 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 (Protection 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** (Protection Settings 1809 to 1812).

3.  1POLE/3POLE - This mode of operation combines 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** (Protection Settings 1803 and 1808).

### 1803: NUM1P - Number of Attempts following Single-Pole Trip (Single Phase Tripping models only)

**NUM1P** establishes the number of reclosures attempted following a single-pole trip. It can be set as follows:

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 value suitable for the application.

### 1804: 1PDELAY1 - Single Pole First Reclose Delay (Single Phase Tripping models only)

**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 (Single Phase Tripping models only)

**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 (Single Phase Tripping models only)

**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.

**2**

### 1807: 1PDELAY4 - Single Pole Fourth Reclose Delay (Single Phase Tripping models only)

**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** sets the number of reclosure attempts following a three-pole trip. **NUM3P** can be set as follows:

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 value 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 HOLDTIME - Inhibit Hold Time

If **HOLD** is set to YES, then **HOLDTIME** establishes the time that the recloser will wait for hold input defined by Protection Setting 1817: **HOLDSENSE** to occur before sending the recloser to lockout. **HOLDTIME** 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 (Protection Setting 1816: **HOLDTIME**) 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 (Protection Setting 1816: **HOLDTIME**) 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: SYNCCHECK - Synch Check Supervision Select

**SYNCCHECK** 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 to 100 seconds. Make a setting that is suitable to the application.

### 1824: SP1PDELAY2 - Supervise Second Reclose (Single Phase Tripping models only)

**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 (Single Phase Tripping models only)

**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 (Single Phase Tripping models only)

**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 V.

### 1834: VLINELIVE - Live Line Voltage

**VLINELIVE** establishes the level which the line voltage must be greater than before the synchronism check function and functions requiring live line supervision operate. The voltage level can be set from 0.1 to 130.0 V.

### 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 V.

### 1836: LBUSDLINE - 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 **LBUSDLINE** = YES, otherwise set **LBUSDLINE** = 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 **DBUSDLINE** = 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 bus and line voltage magnitudes before a **DELTAVBLK** output (Protection Setting 1840) is produced. **DELTAV** can be set from 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 is allowed to operate. Set **DELTAVBLK** = YES to block the synchronism check function, otherwise set **DELTAVBLK** = NO.

**2.3.21 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 Number 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** | **1902: NCAIN2 - Non-Critical Alarm Input #2** |
| **1903: NCAIN3 - Non-Critical Alarm Input #3** | **1904: NCAIN4 - Non-Critical Alarm Input #4** |
| **1905: NCAIN5 - Non-Critical Alarm Input #5** | **1906: NCAIN6 - Non-Critical Alarm Input #6** |
| **1907: NCAIN7 - Non-Critical Alarm Input #7** | **1908: NCAIN8 - Non-Critical Alarm Input #8** |

Set these Protection Settings to one of the available Index numbers given in the Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC on page 2–52.

**2.3.22 OUTPUTS**

All 24 output contacts (Protection Settings 2001 to 2024) 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 (see Table 2–11: PROTECTION SETTINGS GUIDE on page 2–57). The default settings are established through an Xpression Builder file that is downloaded in the ALPS at the factory. The settings can be changed by modifying the logic via Xpression Builder, ALPS-Link, or through the keypad. Note that any index number settings changed through the keypad or ALPS-Link will be reflected in the configurable logic file, while any settings changed through the configurable logic will be reflected in the settings file.

| | | |
|---|---|---|
| **2001: T1 - T1 Contact** | **2002: T2 - T2 Contact** | **2003: T3 - T3 Contact** |
| **2004: T4 - T4 Contact** | **2005: T5 - T5 Contact** | **2006: T6 - T6 Contact** |
| **2007: A1 - A1 Contact** | **2008: A2 - A2 Contact** | **2009: A3 - A3 Contact** |
| **2010: A4 - A4 Contact** | **2011: A5 - A5 Contact** | **2012: A6 - A6 Contact** |
| **2013: A7 - A7 Contact** | **2014: A8 - A8 Contact** | **2015: A9 - A9 Contact** |
| **2016: A10 - A10Contact** | **2017: A11- A11 Contact** | **2018: A12 - A12 Contact** |
| **2019: C1 - C1 Contact** | **2020: C2 - C2 Contact** | **2021: KT1 - KT1 Contact** |
| **2022: KT2 - KT2 Contact** | **2023: KT3 - KT3 Contact** | **2024: KT4 - KT4 Contact** |

Note: Settings 2005, 2006, and 2015 to 2018 are for Single Phase Tripping models only.

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.

The following contact output assignments are recommended when the phase identified channel scheme (HYBRIDP) is used. Note that **KT3** and **KT4** only need to be assigned for the four channel scheme.

**Table 2–8: OUTPUT ASSIGNMENT FOR HYBRIDP SCHEME**

| CONTACT OUTPUT ASSIGNMENT | DESCRIPTION | INDEX # | MNEMONIC |
|---|---|---|---|
| 2021: **KT1** - KT1 Contact | Key Channel 1 | 39 | KEY1 |
| 2022: **KT2** - KT2 Contact | Key Channel 2 | 40 | KEY2 |
| 2023: **KT3** - KT3 Contact | Key Channel 3 | 53 | KEY3 |
| 2024: **KT4** - KT4 Contact | Key Channel 4 | 54 | KEY4 |

### 2025: CONFTRIP - Initiate Three Pole Trip

The **CONFTRIP** setting allows tripping to be initiated through the trip output contacts that are used by the scheme logic. **CONFTRIP** 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 on pages 2–51 to 2–52, or separate logic can be designed using the Xpression Builder program.

**2**
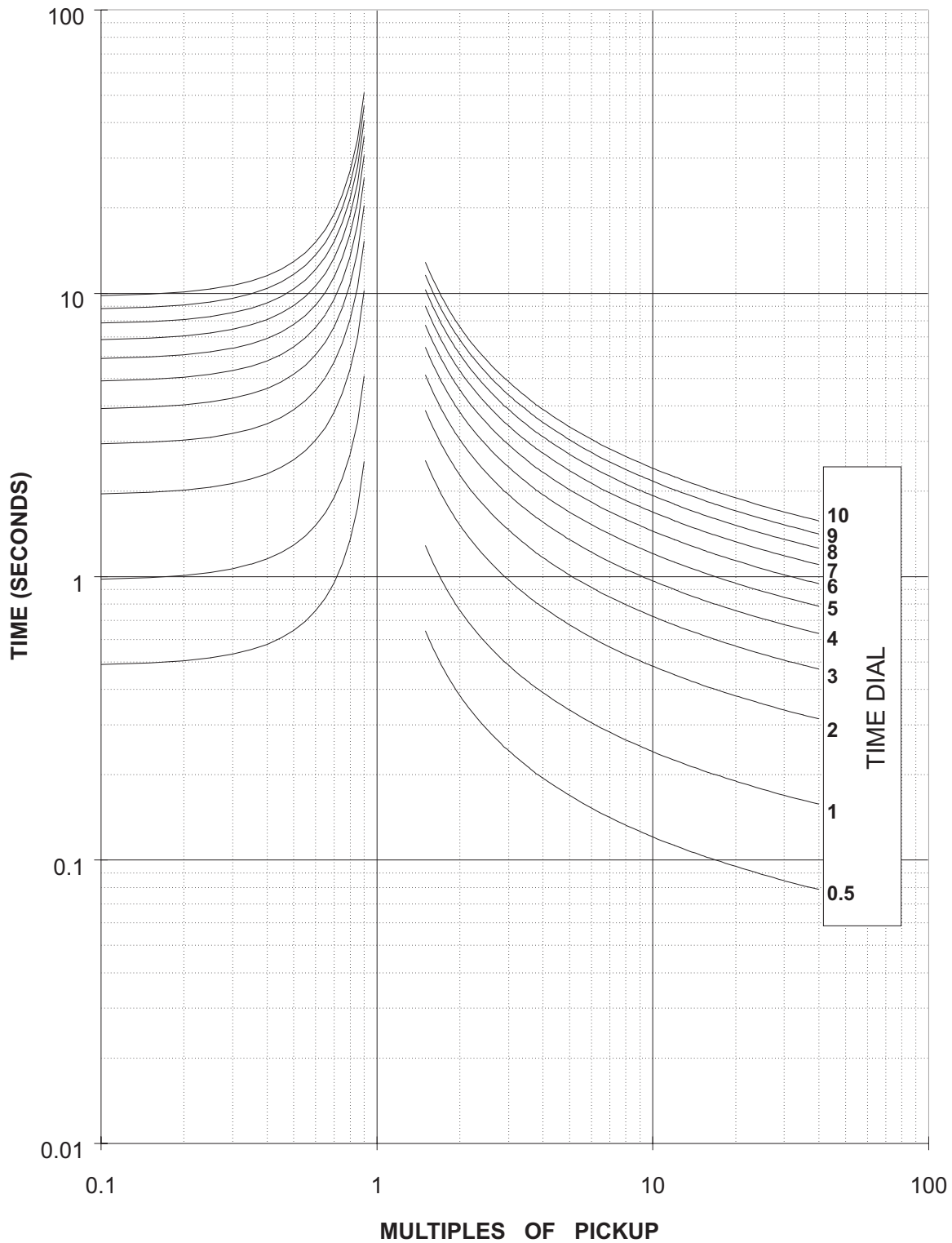
$$t(RESET) = TD\left[\frac{0.97}{1-M^2}\right] \qquad t(PU) = TD\left[\frac{0.0103}{M^{0.02}-1} + 0.0228\right]$$

**Figure 2–18: INVERSE CURVE**
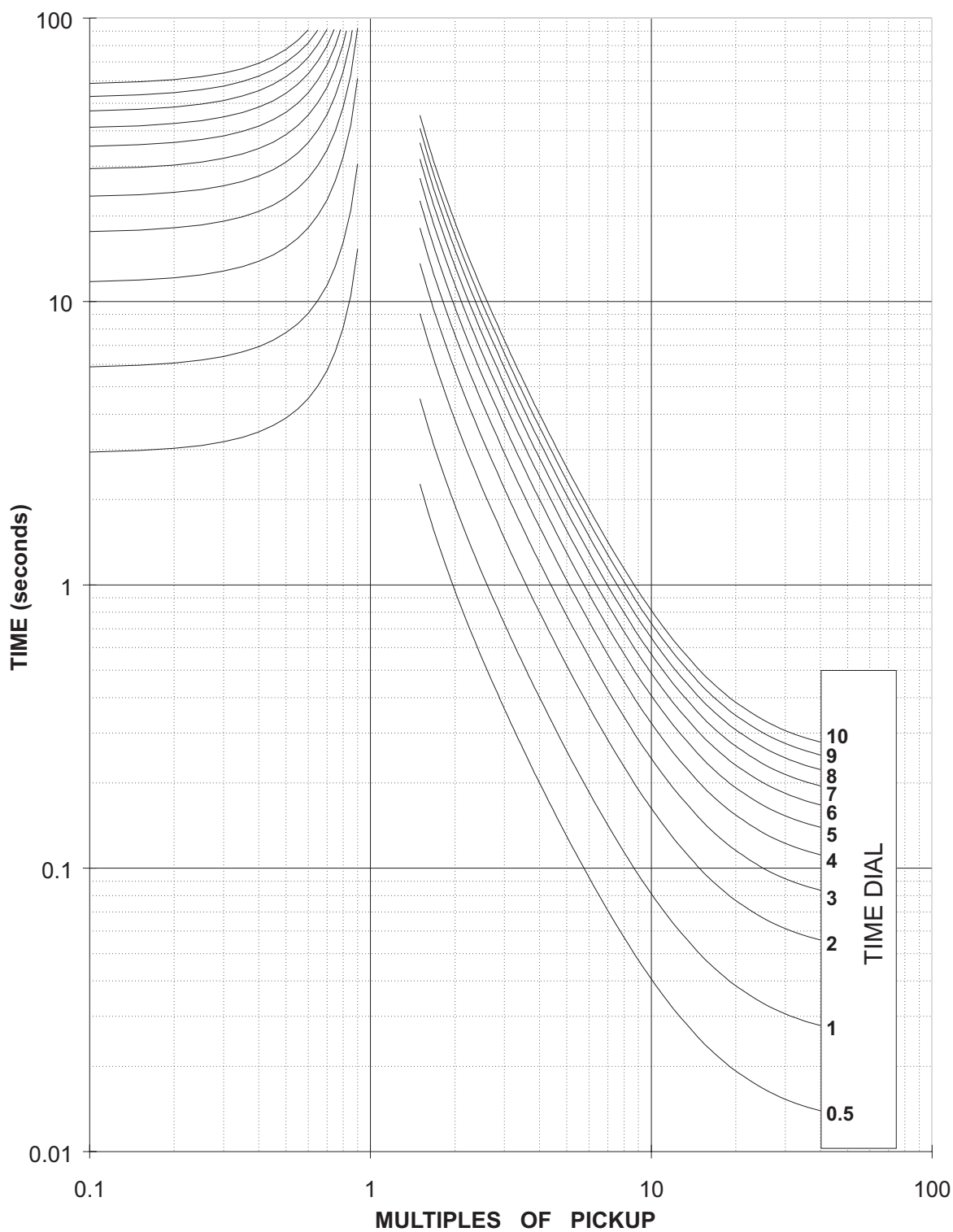
$$t(RESET) = TD\left[\frac{4.32}{1-M^2}\right] \qquad t(PU) = TD\left[\frac{3.922}{M^2-1} + 0.0982\right]$$

**Figure 2–19: VERY INVERSE CURVE**
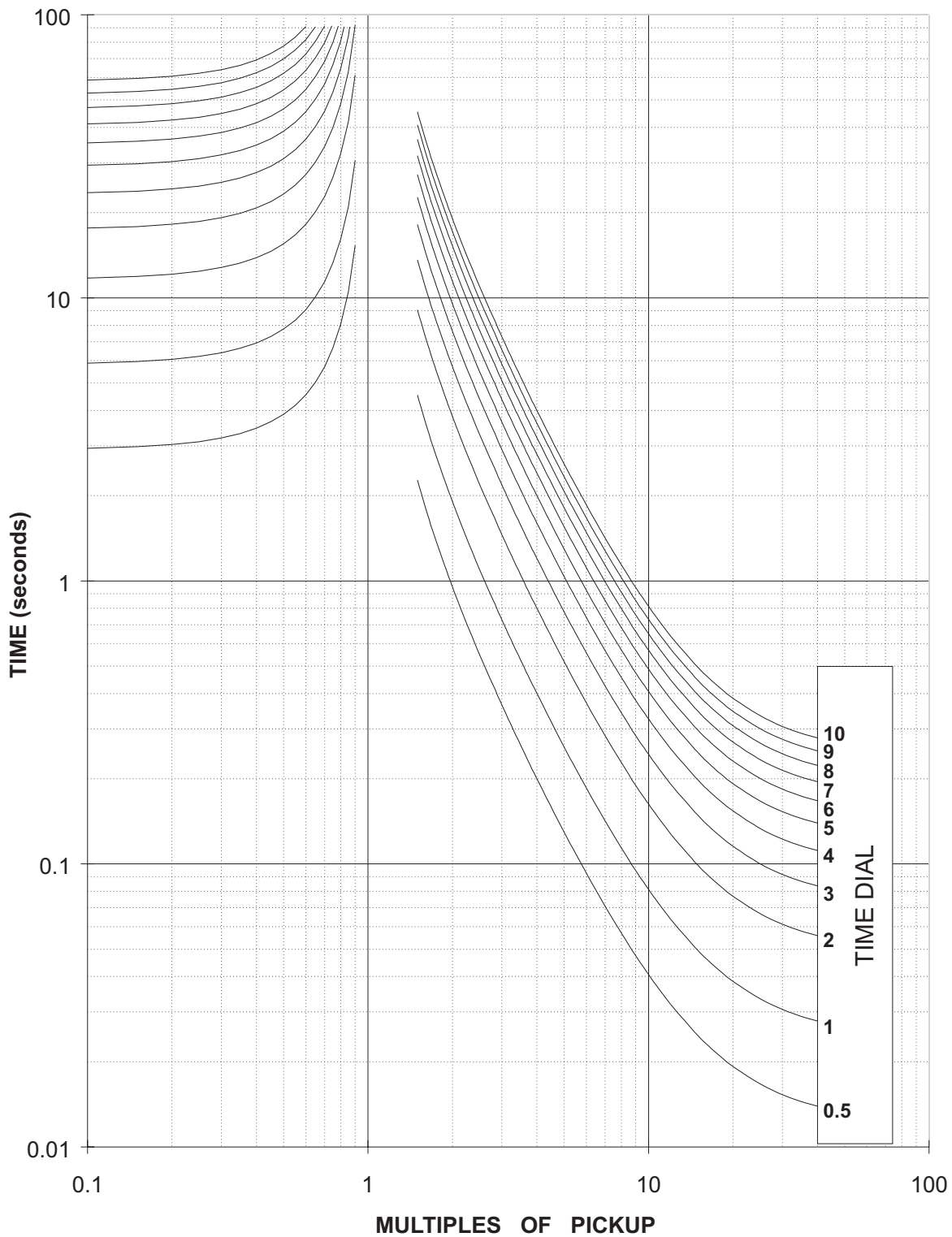
$$t(RESET) = TD\left[\frac{5.82}{1-M^2}\right] \qquad t(PU) = TD\left[\frac{5.64}{M^2-1} + 0.02434\right]$$

**Figure 2–20: EXTREMELY INVERSE CURVE**

**Table 2–9: INDEX NUMBERS – CONTACT CONVERTER INPUT ASSIGNMENT**

| ALPS with Single Phase Tripping | | | ALPS with Three Phase Tripping | | |
|---|---|---|---|---|---|
| Index | Description | Mnemonic | Index | Description | Mnemonic |
| 1 | Breaker #1 52b Contact Input Phase A | 52B_1A | 1 | Breaker #1 52b Contact Input | 52B_1 |
| 2 | Breaker #1 52b Contact Input Phase B | 52B_1B | 2 | Spare | |
| 3 | Breaker #1 52b Contact Input Phase C | 52B_1C | 3 | Spare | |
| 4 | Breaker #2 52b Contact Input Phase A | 52B_2A | 4 | Breaker #2 52b Contact Input | 52B_2 |
| 5 | Breaker #2 52b Contact Input Phase B | 52B_2B | 5 | Spare | |
| 6 | Breaker #2 52b Contact Input Phase C | 52B_2C | 6 | Spare | |
| 7 | Enable Three Phase Tripping | EXTRP3P | 7 | Spare | |
| 8 | Change Setting Group Input (BIT0) | CGST1 | 8 | Change Setting Group Input (BIT0) | CGST1 |
| 9 | Change Setting Group Input (BIT1) | CGST2 | 9 | Change Setting Group Input (BIT1) | CGST2 |
| 10 | External Contact Input to Stop Carrier * | STCR | 10 | External Contact Input to Stop Carrier * | STCR |
| 11 | External Contact Input to Block Pilot Tripping * | BPLTRP | 11 | External Contact Input to Block Pilot Tripping* | BLPTRP |
| 12 | Receiver 1 Input | RCVR1 | 12 | Receiver 1 Input | RCVR1 |
| 13 | Receiver 2 Input | RCVR2 | 13 | Receiver 2 Input | RCVR2 |
| 14 | External Reclose Initiate 1 Pole | EXRI1P | 14 | Spare | |
| 15 | External Reclose Initiate 3 Pole | EXRI3P | 15 | External Reclose Initiate 3 Pole | EXRI3P |
| 16 | External Reclose Inhibit | EXRINH | 16 | External Reclose Inhibit | EXRINH |
| 17 | External Reclose Cancel | EXRCNL | 17 | External Reclose Cancel | EXRCNL |
| 18 | Reclose Reset | RCLRST | 18 | Reclose Reset | RCLRST |
| 19 | External Phase 3 Reclose | CLOS3P | 19 | Spare | |
| 20 | External Contact Input to Reset ALPS Trip Target Display | RESET | 20 | Spare | |
| 21 | Spare | | 21 | Spare | |
| 22 | External Contact Input to Disable Outputs | DISOUT | 22 | External Contact Input to Disable Outputs | DISOUT |
| 23 | External Contact Input to Trigger Oscillography Capture | OSCTRG | 23 | External Contact Input to Trigger Oscillography Capture | OSCTRG |
| 24 | Manual Lockout | MANLKT | 24 | Manual Lockout | MANLLT |
| 25 | CONFIGURABLE INPUT1 | CNFDI1 | 25 | CONFIGURABLE INPUT1 | CNFDI1 |
| 26 | CONFIGURABLE INPUT2 | CNFDI2 | 26 | CONFIGURABLE INPUT2 | CNFDI2 |
| 27 | CONFIGURABLE INPUT3 | CNFDI3 | 27 | CONFIGURABLE INPUT3 | CNFDI3 |
| 28 | CONFIGURABLE INPUT4 | CNFDI4 | 28 | CONFIGURABLE INPUT4 | CNFDI4 |
| 29 | CONFIGURABLE INPUT5 | CNFDI5 | 29 | CONFIGURABLE INPUT5 | CNFDI5 |
| 30 | CONFIGURABLE INPUT6 | CNFDI6 | 30 | CONFIGURABLE INPUT6 | CNFDI6 |
| 31 | CONFIGURABLE INPUT7 | CNFDI7 | 31 | CONFIGURABLE INPUT7 | CNFDI7 |
| 32 | CONFIGURABLE INPUT8 | CNFDI8 | 32 | CONFIGURABLE INPUT8 | CNFDI8 |

**NOTE**:　　Any of the above signals (1 to 32) may be assigned to the 8 available ALPS Contact Converter Inputs (CC1 to 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.

**NOTE:**　　Contacts are normally open; add 1000 to number to close contact under normal conditions.

* Applies to Blocking Scheme Only

**2**

**Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 1 of 5)**

| ALPS with Single Phase Tripping | | | ALPS with Three Phase Tripping | | |
|---|---|---|---|---|---|
| Index | Description | Mnemonic | Index | Description | Mnemonic |
| 33 | Trip Bus Phase A | TRIPA | 33 | Trip Bus | TRIP |
| 34 | Trip Bus Phase B | TRIPB | 34 | Spare | |
| 35 | Trip Bus Phase C | TRIPC | 35 | Spare | |
| 36 | 1P Reclose Initiate | RI-1P | 36 | Spare | |
| 37 | 3P Reclose Initiate | RI-3P | 37 | 3P Reclose Initiate | RI |
| 38 | Reclose Cancel Output from Scheme Logic | CANCL | 38 | Reclose Cancel Output from Scheme Logic | CANCL |
| 39 | KEY XMTR1/CARR START Output from Scheme Logic | KEY1 | 39 | KEY XMTR1/CARR START Output from Scheme Logic | KEY1 |
| 40 | KEY XMTR2/CARR STOP Output from Scheme Logic | KEY2 | 40 | KEY XMTR2/CARR STOP Output from Scheme Logic | KEY2 |
| 41 | 3 Phase Trip Enable | TRIP3P | 41 | Spare | |
| 42 | Spare | | 42 | Spare | |
| 43 | Spare | | 43 | Warm Restart | WARMST |
| 44 | Reclose in Progress | RIP | 44 | Reclose in Progress | RIP |
| 45 | Line Over Load Alarm Output | LNOVLD | 45 | Line Over Load Alarm Output | LNOVLD |
| 46 | Critical Alarm Output | CRTALM | 46 | Critical Alarm Output | CRTALM |
| 47 | Recloser Lockout Alarm | LORCL | 47 | Recloser Lockout Alarm | LORCL |
| 48 | Trip Circuit Alarm | TCMALM | 48 | Trip Circuit Alarm | TCMALM |
| 49 | Zone Flags On Alarm | ZNALM | 49 | Zone Flags On Alarm | ZNALM |
| 50 | Overcurrent Alarm | OVRALM | 50 | Overcurrent Alarm | OVRALM |
| 51 | Unbalanced Current Detector Alarm Output | UNBAL | 51 | Unbalanced Current Detector Alarm Output | UNBAL |
| 52 | Non-Critical Alarm Output | NCALM | 52 | Non-Critical Alarm Output | NCALM |
| 53 | Spare | | 53 | Key 3 | |
| 54 | Spare | | 54 | Key 4 | |
| 55 | Spare | | 55 | Spare | |
| 56 | MANUAL OPEN BRK1 | MNOPN1 | 56 | MANUAL OPEN BRK1 | MNOPN1 |
| 57 | MANUAL OPEN BRK2 | MNOPN2 | 57 | MANUAL OPEN BRK2 | MNOPN2 |
| 58 | MANUAL CLOSE BRK1 | MNCLS1 | 58 | MANUAL CLOSE BRK1 | MNCLS1 |
| 59 | MANUAL CLOSE BRK2 | MNCLS2 | 59 | MANUAL CLOSE BRK2 | MNCLS2 |
| 60 | Fault ID: Phase A Involved | DAFLTA | 60 | Fault ID: Phase A Involved | DAFLTA |
| 61 | Fault ID: Phase B Involved | DAFLTB | 61 | Fault ID: Phase B Involved | DAFLTB |
| 62 | Fault ID: Phase C Involved | DAFLTC | 62 | Fault ID: Phase C Involved | DAFLTC |
| 63 | Fault ID: Neutral Involved | DAFLTN | 63 | Fault ID: Neutral Involved | DAFLTN |
| 64 | DMA Overrun | DMAOVR | 64 | DMA Overrun | DMAOVR |
| 65 | Zone 1 AB Distance Function | Z1AB | 65 | Zone 1 AB Distance Function | Z1AB |
| 66 | Zone 1 BC Distance Function | Z1BC | 66 | Zone 1 BC Distance Function | Z1BC |
| 67 | Zone 1 CA Distance Function | Z1CA | 67 | Zone 1 CA Distance Function | Z1CA |
| 68 | Zone 2 AB Distance Function | Z2AB | 68 | Zone 2 AB Distance Function | Z2AB |
| 69 | Zone 2 BC Distance Function | Z2BC | 69 | Zone 2 BC Distance Function | Z2BC |
| 70 | Zone 2 CA Distance Function | Z2CA | 70 | Zone 2 CA Distance Function | Z2CA |
| 71 | Zone 3 AB Distance Function | Z3AB | 71 | Zone 3 AB Distance Function | Z3AB |
| 72 | Zone 3 BC Distance Function | Z3BC | 72 | Zone 3 BC Distance Function | Z3BC |
| 73 | Zone 3 CA Distance Function | Z3CA | 73 | Zone 3 CA Distance Function | Z3CA |
| 74 | Zone 4 AB Distance Function | Z4AB | 74 | Zone 4 AB Distance Function | Z4AB |
| 75 | Zone 4 BC Distance Function | Z4BC | 75 | Zone 4 BC Distance Function | Z4BC |

**Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 2 of 5)**

| ALPS with Single Phase Tripping | | | ALPS with Three Phase Tripping | | |
|---|---|---|---|---|---|
| Index | Description | Mnemonic | Index | Description | Mnemonic |
| 76 | Zone 4 CA Distance Function | Z4CA | 76 | Zone 4 CA Distance Function | Z4CA |
| 77 | Any Z1 Phase Distance Function | Z1PH | 77 | Any Z1 Phase Distance Function | Z1PH |
| 78 | Any Z2 Phase Distance Function | Z2PH | 78 | Any Z2 Phase Distance Function | Z2PH |
| 79 | Any Z3 Phase Distance Function | Z3PH | 79 | Any Z3 Phase Distance Function | Z3PH |
| 80 | Any Z4 Phase Distance Function | Z4PH | 80 | Any Z4 Phase Distance Function | Z4PH |
| 81 | Zone 1 AG Distance Function | Z1AG | 81 | Zone 1 AG Distance Function | Z1AG |
| 82 | Zone 1 BG Distance Function | Z1BG | 82 | Zone 1 BG Distance Function | Z1BG |
| 83 | Zone 1 CG Distance Function | Z1CG | 83 | Zone 1 CG Distance Function | Z1CG |
| 84 | Zone 2 AG Distance Function | Z2AG | 84 | Zone 2 AG Distance Function | Z2AG |
| 85 | Zone 2 BG Distance Function | Z2BG | 85 | Zone 2 BG Distance Function | Z2BG |
| 86 | Zone 2 CG Distance Function | Z2CG | 86 | Zone 2 CG Distance Function | Z2CG |
| 87 | Zone 3 AG Distance Function | Z3AG | 87 | Zone 3 AG Distance Function | Z3AG |
| 88 | Zone 3 BG Distance Function | Z3BG | 88 | Zone 3 BG Distance Function | Z3BG |
| 89 | Zone 3 CG Distance Function | Z3CG | 89 | Zone 3 CG Distance Function | Z3CG |
| 90 | Zone 4 AG Distance Function | Z3AG | 90 | Zone 4 AG Distance Function | Z3AG |
| 91 | Zone 4 BG Distance Function | Z4BG | 91 | Zone 4 BG Distance Function | Z4BG |
| 92 | Zone 4 CG Distance Function | Z4CG | 92 | Zone 4 CG Distance Function | Z4CG |
| 93 | Any Z1 Ground Distance Function | Z1GRD | 93 | Any Z1 Ground Distance Function | Z1GRD |
| 94 | Any Z2 Ground Distance Function | Z2GRD | 94 | Any Z2 Ground Distance Function | Z2GRD |
| 95 | Any Z3 Ground Distance Function | Z3GRD | 95 | Any Z3 Ground Distance Function | Z3GRD |
| 96 | Any Z4 Ground Distance Function | Z4GRD | 96 | Any Z4 Ground Distance Function | Z4GRD |
| 97 | Phase A Open | AOPEN | 97 | Spare | |
| 98 | Phase B Open | BOPEN | 98 | Spare | |
| 99 | Phase C Open | COPEN | 99 | Spare | |
| 100 | All Phases Open | 3OPEN | 100 | All Phases Open | 3OPEN |
| 101 | Any Phases Open | ANYOPN | 101 | Any Phases Open | ANYOPN |
| 102 | 1 Pole Open | 1OPEN | 102 | Spare | |
| 103 | Any Phase Undervoltage | ANYUVT | 103 | Any Phase Undervoltage | ANYUVT |
| 104 | All Voltages High (No Phase Undervoltage) | ALLVLT | 104 | All Voltages High (No Phase Undervoltage) | ALLVLT |
| 105 | Fault Detector (FD) | FLTDET | 105 | Fault Detector (FD) | FLTDET |
| 106 | TL1 Timer Output | TL1 | 106 | TL1 Timer Output | TL1 |
| 107 | IT Detector | IT | 107 | IT Detector | IT |
| 108 | IB Detector | IB | 108 | IB Detector | IB |
| 109 | IPT Detector | IPT | 109 | IPT Detector | IPT |
| 110 | IPB Detector | IPB | 110 | IPB Detector | IPB |
| 111 | Remote Breaker Open Detector | REMOPN | 111 | Remote Breaker Open Detector | REMOPN |
| 112 | Ground Directional Trip (NT·IPT) | GRDTRP | 112 | Ground Directional Trip (NT·IPT) | GRDTRP |
| 113 | Ground Directional Block (NB·IPB) | GRDBLK | 113 | Ground Directional Block (NB·IPB) | GRDBLK |
| 114 | Line Pickup | LPU | 114 | Line Pickup | LPU |
| 115 | Fuse Failure Alarm | FF | 115 | Fuse Failure Alarm | FF |
| 116 | Instantaneous Phase O/C (50P/PH4) | 50 | 116 | Instantaneous Phase O/C (50P/PH4) | 50 |
| 117 | Instantaneous Ground O/C (50G/IDT) | 50G | 117 | Instantaneous Ground O/C (50g/IDT) | 50G |
| 118 | Ground Time Overcurrent Pick Up | TOCACT | 118 | Ground Time Overcurrent Pick Up | TOCACT |
| 119 | Ground Time Overcurrent Trip (51G/TOC) | TOCTRP | 119 | Ground Time Overcurrent Trip (51G/TOC) | TOCTRP |
| 120 | Out of Step Blocking | OSB | 120 | Out of Step Blocking | OSB |
| 121 | Out of Step Trip | OST | 121 | Out of Step Trip | OST |

**2**

**Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 3 of 5)**

| ALPS with Single Phase Tripping | | | ALPS with Three Phase Tripping | | |
|---|---|---|---|---|---|
| Index | Description | Mnemonic | Index | Description | Mnemonic |
| 122 | Configurable Trip Bus Input | CNFTRP | 122 | Configurable Trip Bus Input | CNFTRP |
| 123 | Configurable Oscillography Trigger | CNFOSC | 123 | Configurable Oscillography Trigger | CNFOSC |
| 124 | TL16 Timer Output | TL16 | 124 | TL16 Timer Output | TL16 |
| 125 | TL24 Timer Output | TL24 | 125 | TL24 Timer Output | TL24 |
| 126 | Ground Forward Flag (NT) | GRDFWD | 126 | Ground Forward Flag (NT) | GRDFWD |
| 127 | Ground Reverse Flag (NB) | GRDREV | 127 | Ground Reverse Flag (NB) | GRDREV |
| 128 | TL25 Timer Output | TL25 | 128 | TL25 Timer Output | TL25 |
| 129 | Z2 Ground Timer | Z2GTMR | 129 | Z2 Ground Timer | Z2GTMR |
| 130 | Z3 Ground Timer | Z3GTMR | 130 | Z3 Ground Timer | Z3GTMR |
| 131 | Z4 Ground Timer | Z4GTMR | 131 | Z4 Ground Timer | Z4GTMR |
| 132 | Z2 Phase Timer | Z2PTMR | 132 | Z2 Phase Timer | Z2PTMR |
| 133 | Z3 Phase Timer | Z3PTMR | 133 | Z3 Phase Timer | Z3PTMR |
| 134 | Z4 Phase Timer | Z4PTMR | 134 | Z4 Phase Timer | Z4PTMR |
| 135 | Any Trip Bus | TRPBUS | 135 | Any Trip Bus | TRPBUS |
| 136 | Week Infeed Trip | WITRIP | 136 | Week Infeed Trip | WITRIP |
| 137 | Sync Check | SYNC | 137 | Sync Check | SYNC |
| 138 | Number of Breaker Operation Alarm | BRMNOP | 138 | Number of Breaker Operation Alarm | BRMNOP |
| 139 | Breaker Equipment Duty Alarm | BRMNDT | 139 | Breaker Equipment Duty Alarm | BRMNDT |
| 140 | Any Phase Over Voltage Pickup | OVRVPU | 140 | Any Phase Over Voltage Pickup | OVRVPU |
| 141 | Positive Sequence Over Voltage Pickup | V1TPU | 141 | Positive Sequence Over Voltage Pickup | V1TPU |
| 142 | Compensated Positive Sequence OV Pkp | V1CPU | 142 | Compensated Positive Sequence OV Pkp | V1CPU |
| 143 | I1 Line Pickup | I1PU | 143 | I1 Line Pickup | I1PU |
| 144 | Block Reclose Initiate | BLK_RI | 144 | Block Reclose Initiate | BLK_RI |
| 145 | Inhibit Reclose Initiate | INH_RI | 145 | Manual Close in Progress | CLS_IP |
| 146 | Breaker Close | BKRCLS | 146 | Breaker Close | BKRCLS |
| 147 | Trip Circuit #1 Voltage Monitor Status | T1TC | 147 | Trip Circuit #1 Voltage Monitor Status | T1TC |
| 148 | Trip Circuit #2 Voltage Monitor Status | T2TC | 148 | Trip Circuit #2 Voltage Monitor Status | T2TC |
| 149 | Trip Circuit #3 Voltage Monitor Status | T3TC | 149 | Trip Circuit #3 Voltage Monitor Status | T3TC |
| 150 | Trip Circuit #4 Voltage Monitor Status | T4TC | 150 | Trip Circuit #4 Voltage Monitor Status | T4TC |
| 151 | Trip Circuit #5 Voltage Monitor Status | T5TC | 151 | Spare | |
| 152 | Trip Circuit #6 Voltage Monitor Status | T6TC | 152 | Spare | |
| 153 | PHASE A OVERVOLTAGE | AVOVR | 153 | PHASE A OVERVOLTAGE | AVOVR |
| 154 | PHASE B OVERVOLTAGE | BVOVR | 154 | PHASE B OVERVOLTAGE | BVOVR |
| 155 | PHASE C OVERVOLTAGE | CVOVR | 155 | PHASE C OVERVOLTAGE | CVOVR |
| 156 | Instantaneous Positive Sequence OV | V1IOVR | 156 | Instantaneous Positive Sequence OV | V1IOVR |
| 157 | Time Delayed Positive Sequence OV | V1TOVR | 157 | Time Delayed Positive Sequence OV | V1TOVR |
| 158 | Instantaneous Compensated Positive Sequence Overvoltage | V1COVR | 158 | Instantaneous Compensated Positive Sequence Overvoltage | V1COVR |
| 159 | Time Delayed Compensated Positive Sequence Overvoltage | V1CTOV | 159 | Time Delayed Compensated Positive Sequence Overvoltage | V1CTOV |
| 160 | Any Phase Overvoltage | OVRVLT | 160 | Any Phase Overvoltage | OVRVLT |
| 161 | Programmable Logic Gate #1 Output | G1 | 161 | Programmable Logic Gate #1 Output | G1 |
| 162 | Programmable Logic Gate #2 Output | G2 | 162 | Programmable Logic Gate #2 Output | G2 |
| 163 | Programmable Logic Gate #3 Output | G3 | 163 | Programmable Logic Gate #3 Output | G3 |
| 164 | Programmable Logic Gate #4 Output | G4 | 164 | Programmable Logic Gate #4 Output | G4 |
| 165 | Programmable Logic Gate #5 Output | G5 | 165 | Programmable Logic Gate #5 Output | G5 |
| 166 | Programmable Logic Gate #6 Output | G6 | 166 | Programmable Logic Gate #6 Output | G6 |

**Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 4 of 5)**

| ALPS with Single Phase Tripping | | | ALPS with Three Phase Tripping | | |

| Index | Description | Mnemonic | Index | Description | Mnemonic |
|---|---|---|---|---|---|
| 167 | Programmable Logic Gate #7 Output | G7 | 167 | Programmable Logic Gate #7 Output | G7 |
| 168 | Programmable Logic Gate #8 Output | G8 | 168 | Programmable Logic Gate #8 Output | G8 |
| 169 | Programmable Logic Gate #9 Output | G9 | 169 | Programmable Logic Gate #9 Output | G9 |
| 170 | Programmable Logic Gate #10 Output | G10 | 170 | Programmable Logic Gate #10 Output | G10 |
| 171 | Programmable Logic Gate #11 Output | G11 | 171 | Programmable Logic Gate #11 Output | G11 |
| 172 | Programmable Logic Gate #12 Output | G12 | 172 | Programmable Logic Gate #12 Output | G12 |
| 173 | Programmable Logic Gate #13 Output | G13 | 173 | Programmable Logic Gate #13 Output | G13 |
| 174 | Programmable Logic Gate #14 Output | G14 | 174 | Programmable Logic Gate #14 Output | G14 |
| 175 | Programmable Logic Gate #15 Output | G15 | 175 | Programmable Logic Gate #15 Output | G15 |
| 176 | Programmable Logic Gate #16 Output | G16 | 176 | Programmable Logic Gate #16 Output | G16 |
| 177 | Programmable Logic Gate #17 Output | G17 | 177 | Programmable Logic Gate #17 Output | G17 |
| 178 | Programmable Logic Gate #18 Output | G18 | 178 | Programmable Logic Gate #18 Output | G18 |
| 179 | Programmable Logic Gate #19 Output | G19 | 179 | Programmable Logic Gate #19 Output | G19 |
| 180 | Programmable Logic Gate #20 Output | G20 | 180 | Programmable Logic Gate #20 Output | G20 |
| 181 | Programmable Logic Gate #21 Output | G21 | 181 | Programmable Logic Gate #21 Output | G21 |
| 182 | Programmable Logic Gate #22 Output | G22 | 182 | Programmable Logic Gate #22 Output | G22 |
| 183 | Programmable Logic Gate #23 Output | G23 | 183 | Programmable Logic Gate #23 Output | G23 |
| 184 | Programmable Logic Gate #24 Output | G24 | 184 | Programmable Logic Gate #24 Output | G24 |
| 185 | Programmable Logic Gate #25 Output | G25 | 185 | Programmable Logic Gate #25 Output | G25 |
| 186 | Programmable Logic Gate #26 Output | G26 | 186 | Programmable Logic Gate #26 Output | G26 |
| 187 | Programmable Logic Gate #27 Output | G27 | 187 | Programmable Logic Gate #27 Output | G27 |
| 188 | Programmable Logic Gate #28 Output | G28 | 188 | Programmable Logic Gate #28 Output | G28 |
| 189 | Programmable Logic Gate #29 Output | G29 | 189 | Programmable Logic Gate #29 Output | G29 |
| 190 | Programmable Logic Gate #30 Output | G30 | 190 | Programmable Logic Gate #30 Output | G30 |
| 191 | Programmable Logic Gate #31 Output | G31 | 191 | Programmable Logic Gate #31 Output | G31 |
| 192 | Programmable Logic Gate #32 Output | G32 | 192 | Programmable Logic Gate #32 Output | G32 |
| 193 | Programmable Logic Gate #33 Output | G33 | 193 | Programmable Logic Gate #33 Output | G33 |
| 194 | Programmable Logic Gate #34 Output | G34 | 194 | Programmable Logic Gate #34 Output | G34 |
| 195 | Programmable Logic Gate #35 Output | G35 | 195 | Programmable Logic Gate #35 Output | G35 |
| 196 | Programmable Logic Gate #36 Output | G36 | 196 | Programmable Logic Gate #36 Output | G36 |
| 197 | Programmable Logic Gate #37 Output | G37 | 197 | Programmable Logic Gate #37 Output | G37 |
| 198 | Programmable Logic Gate #38 Output | G38 | 198 | Programmable Logic Gate #38 Output | G38 |
| 199 | Programmable Logic Gate #39 Output | G39 | 199 | Programmable Logic Gate #39 Output | G39 |
| 200 | Programmable Logic Gate #40 Output | G40 | 200 | Programmable Logic Gate #40 Output | G40 |
| 201 to 224 | Spare | | 201 to 224 | Spare | |
| 225 | Programmable Logic Timer 1 Output | TM1 | 225 | Programmable Logic Timer 1 Output | TM1 |
| 226 | Programmable Logic Timer 1 RESET | TM1RST | 226 | Programmable Logic Timer 1 RESET | TM1RST |
| 227 | Programmable Logic Timer 2 Output | TM2 | 227 | Programmable Logic Timer 2 Output | TM2 |
| 228 | Programmable Logic Timer 2 RESET | TM2RST | 228 | Programmable Logic Timer 2 RESET | TM2RST |
| 229 | Programmable Logic Timer 3 Output | TM3 | 229 | Programmable Logic Timer 3 Output | TM3 |
| 230 | Programmable Logic Timer 3 RESET | TM3RST | 230 | Programmable Logic Timer 3 RESET | TM3RST |
| 231 | Programmable Logic Timer 4 Output | TM4 | 231 | Programmable Logic Timer 4 Output | TM4 |
| 232 | Programmable Logic Timer 4 RESET | TM4RST | 232 | Programmable Logic Timer 4 RESET | TM4RST |
| 233 | Programmable Logic Timer 5 Output | TM5 | 233 | Programmable Logic Timer 5 Output | TM5 |
| 234 | Programmable Logic Timer 5 RESET | TM5RST | 234 | Programmable Logic Timer 5 RESET | TM5RST |
| 235 | Programmable Logic Timer 6 Output | TM6 | 235 | Programmable Logic Timer 6 Output | TM6 |

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**Table 2–10: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 5 of 5)**

| ALPS with Single Phase Tripping | | | ALPS with Three Phase Tripping | | |
|---|---|---|---|---|---|
| Index | Description | Mnemonic | Index | Description | Mnemonic |
| 236 | Programmable Logic Timer 6 RESET | TM6RST | 236 | Programmable Logic Timer 6 RESET | TM6RST |
| 237 | Programmable Logic Timer 7 Output | TM7 | 237 | Programmable Logic Timer 7 Output | TM7 |
| 238 | Programmable Logic Timer 7 RESET | TM7RST | 238 | Programmable Logic Timer 7 RESET | TM7RST |
| 239 | Programmable Logic Timer 8 Output | TM8 | 239 | Programmable Logic Timer 8 Output | TM8 |
| 240 | Programmable Logic Timer 8 RESET | TM8RST | 240 | Programmable Logic Timer 8 RESET | TM8RST |
| 241 | Programmable Logic Counter 1 | CNTR1 | 241 | Programmable Logic Counter 1 | CNTR1 |
| 242 | Programmable Logic Counter 2 | CNTR2 | 242 | Programmable Logic Counter 2 | CNTR2 |
| 243 | Programmable Logic Counter 3 | CNTR3 | 243 | Programmable Logic Counter 3 | CNTR3 |
| 244 | Programmable Logic Counter 4 | CNTR4 | 244 | Programmable Logic Counter 4 | CNTR4 |
| 245 | Programmable Logic Counter 5 | CNTR5 | 245 | Programmable Logic Counter 5 | CNTR5 |
| 246 | Programmable Logic Counter 6 | CNTR6 | 246 | Programmable Logic Counter 6 | CNTR6 |
| 247 | Programmable Logic Counter 7 | CNTR7 | 247 | Programmable Logic Counter 7 | CNTR7 |
| 248 | Programmable Logic Counter 8 | CNTR8 | 248 | Programmable Logic Counter 8 | CNTR8 |
| 249 | Programmable Logic LATCH 1 | LATCH1 | 249 | Programmable Logic LATCH 1 | LATCH1 |
| 250 | Programmable Logic LATCH 2 | LATCH2 | 250 | Programmable Logic LATCH 2 | LATCH2 |
| 251 | Programmable Logic LATCH 3 | LATCH3 | 251 | Programmable Logic LATCH 3 | LATCH3 |
| 252 | Programmable Logic LATCH 4 | LATCH4 | 252 | Programmable Logic LATCH 4 | LATCH4 |
| 253 | Programmable Logic LATCH 5 | LATCH5 | 253 | Programmable Logic LATCH 5 | LATCH5 |
| 254 | Programmable Logic LATCH 6 | LATCH6 | 254 | Programmable Logic LATCH 6 | LATCH6 |
| 255 | Programmable Logic LATCH 7 | LATCH7 | 255 | Programmable Logic LATCH 7 | LATCH7 |
| 256 | Programmable Logic LATCH 8 | LATCH8 | 256 | Programmable Logic LATCH 8 | LATCH8 |

**Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 1 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|-----|----------|-------------|------------|------------|---------|
| Z1 DISTANCE | | | | | |
| 101 | Z1PHASE | Z1 Phase Distance | NO, YES | | YES |
| 102 | Z1PHREACH | Z1 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 5.40Ω at 5A 27.0Ω at 1A |
| 103 | Z1PLEVDET | Z1 Phase Level Detector (Series Capacitor Model Only) | 0.0 to 9.9 p.u. volts step 0.1 | | 0 |
| 104 | Z1GROUND | Z1 Ground Distance | NO, YES | | YES |
| 105 | Z1GRDREACH | Z1 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 5.40Ω at 5A 27.0Ω at 1A |
| 106 | Z1GRDCHAR | Z1 Ground Characteristic | MHO, REACT, QUAD [†] | | MHO |
| 107 | Z1SUREACH | Z1 Ground Reaction Mho Supervision Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250 ohms step 0.05 | 20.0Ω at 5A 100Ω at 1A |
| 108 | Z1GROUNDK0 | Z1 Ground K0 | 1.0 to 7.0 step 0.01 | | 2.7 |
| 109 | Z1GLEVDET | Z1 Ground Level Detector (Series Capacitor Model Only) | 0.0 to 9.9 p.u. volts step 0.1 | | 0 V |
| 110 | Z1BLOCK | Blocking Supervision of Z1 | NO, YES | | NO |
| 111 [‡] | Z1GCHARANG | Z1 Ground Characteristic Timer Angle | 80° to 155° step 1 | | 90° |
| 112 [‡] | Z1RGREACH | Z1 Resistive Ground Reach | 0.01 to 100.00 Ω step 0.01 | 0.05 to 500 Ω step 0.01 | 8.1 Ω at 5A 40.5 Ω at 1A |
| Z2DISTANCE | | | | | |
| 201 | Z2PHASE | Z2 Phase Distance | NO, YES | | YES |
| 202 | Z2PHREACH | Z2 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 9.00Ω at 5A 45.0Ω at 1A |
| 203 | Z2PCHARANG | Z2 Phase Characteristic Angle | 90 to 120° step 5 | | 90 deg. |
| 204 | Z2GROUND | Z2 Ground Distance | NO, YES | | YES |
| 205 | Z2GRDCHAR | Z2 Ground Characteristic | MHO, GDOC, MHOGDOC, MHO2GDOC, QUAD [†] | | MHO |
| 206 | Z2GRDREACH | Z2 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 9.00Ω at 5A 45.0Ω at 1A |
| 207 | Z2GCHARANG | Z2 Ground Characteristic Angle | 80 to 155 deg. step 5 | | 90 deg. |
| 208 | Z2TIMERS | Z2 Timers | NO, YES | | YES |
| 209 | Z2P_TIME | Z2 Phase Timer | 0.10 to 3.0 sec. step 0.01 | | 1.0 sec. |
| 210 | Z2G_TIME | Z2 Ground Timer | 0.10 to 3.0 sec. step 0.01 | | 1.0 sec. |
| 211 [‡] | Z2RGREACH | Zone 2 Resistive Ground Reach | 0.01 to 100.00 Ω step 0.01 | 0.05 to 500 Ω step 0.01 | 13.5Ω at 5A 67.5Ω at 1A |
| Z3DISTANCE | | | | | |
| 301 | Z3PHASE | Z3 Phase Distance | NO, YES | | YES |
| 302 | Z3PHREACH | Z3 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 12.0Ω at 5A 60.0Ω at 1A |
| 303 | Z3PCHARANG | Z3 Phase Characteristic Angle | 90 to 120 deg. step 5 | | 90 deg. |
| 304 | Z3GROUND | Z3 Ground Distance | NO, YES | | YES |
| 305 | Z3GRDREACH | Z3 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 12.0Ω at 5A 60.0Ω at 1A |
| 306 | Z3GCHARANG | Z3 Ground Characteristic Angle | 80 to 155 deg. step 5 | | 90 deg. |
| 307 | Z3P_TIME | Z3 Phase Timer | 0.10 to 10.0 sec. step 0.01 | | 2.0 sec. |
| 308 | Z3G_TIME | Z3 Ground Timer | 0.10 to 10.0 sec. step 0.01 | | 2.0 sec. |
| 309 [‡] | Z3GRDCHAR | Z3 Ground Characteristic | MHO, QUAD | | MHO |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

**Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 2 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|---|---|---|---|---|---|
| 310 ‡ | Z3RGREACH | Z3 Resistive Ground Reach | 0.01 to 100 ohms step 0.01 | 0.05 to 500 ohms step 0.05 | 18Ω at 5A 90Ω at 1A |
| Z4DISTANCE | | | | | |
| 401 | Z4PHASE | Z4 Phase Distance | NO, YES | | YES |
| 402 | Z4PHREACH | Z4 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 18.0Ω at 5A 90.0Ω at 1A |
| 403 | Z4PCHARANG | Z4 Phase Characteristic Angle | 80 to 120 deg. step 5 | | 90 deg. |
| 404 | Not Used | | | | |
| 405 | Z4GRND | Z4 Ground Distance | NO, YES | | YES |
| 406 | Z4GRDREACH | Z4 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.01 to 250.0 ohms step 0.05 | 18.0Ω at 5A 90.0Ω at 1A |
| 407 | Z4GCHARANG | Z4 Ground Characteristic Angle | 80 to 155 deg., step 5 | | 90 deg. |
| 408 | Z4DIRECTN | Z4 Direction | FORWRD, REVERS | | FORWRD |
| 409 | Z4_TIMERS | Z4 Timers | NO, YES | | YES |
| 410 | Z4P_TIME | Z4 Phase Timer | 0.10 to 10.0 sec. step 0.01 | | 3.0 sec. |
| 411 | Z4G_TIME | Z4 Ground Timer | 0.10 to 10.0 sec. step 0.01 | | 3.0 sec. |
| 412 ‡ | Z4GRDCHAR | Z4 Ground Characteristic | MHO, QUAD | | MHO |
| 413 ‡ | Z4RGREACH | Z4 Resistive Ground Reach | 0.01 to 100 ohms step 0.01 | 0.05 to 500 ohms step 0.05 | 135Ω at 1A 27Ω at 5A |
| CURVSUPVISN | | | | | |
| 501 | IT_PICKUP | Trip Supervision Current | 0.20 to 4.0 amps step 0.01 | 0.04 to 0.8 amps step 0.01 | 0.20 A at 5A 0.04 A at 1A |
| 502 | IB_PICKUP | Block Supervision Current | 0.20 to 4.0 amps step 0.01 | 0.04 to 0.8 amps step 0.01 | 0.20 A at 5A 0.04 A at 1A |
| 503 | IPT_PICKUP | GDOC Trip Current | 0.50 to 5.0 amps step 0.01 | 0.10 to 1.0 amps step 0.01 | 0.75 A at 5A 0.15 A at 1A |
| 504 | IPB_PICKUP | GDOC Block Current | 0.25 to 3.75 amps step 0.01 | 0.05 to 0.75 amps step 0.01 | 0.25 A at 5A 0.05 A at 1A |
| 505 | IPBKFACTOR | IPB I1 Restraint | 0.0, 0.066 | | 0.066 |
| 506 | NT_OFFSET | NT/NB Offset | 0.0 to 20.0 ohms step 0.01 | 0.0 to 100 ohms step 0.01 | 0.05Ω at 5A 0.25Ω at 1A |
| 507 | UNBALALARM | Unbalanced Current Alarm | NO, YES | | YES |
| OVERCURRNT | | | | | |
| 601 | 50 | Phase Instantaneous Overcurrent | NO, YES | | NO |
| 602 | 50_DIRCNL | Directional Control of 50 | NO, YES | | YES |
| 603 | 50PICKUP | 50 Pickup Setting | 2.0 to 160.0 amps step 0.1 | 0.4 to 32.0 amps step 0.1 | 20.0 A at 5A 4.0A at 1A |
| 604 | 50PICKUPFF | 50 Pickup during fuse failure | 2.0 to 160.0 amps step 0.1 | 0.4 to 32.0 amps step 0.1 | 30.0 A at 5A 6.0 A at 1A |
| 605 | 50G | Ground Instantaneous Overcurrent | NO, YES | | YES |
| 606 | 50G_DIRCNL | Directional Control of 50G | NO, YES | | YES |
| 607 | 50GPICKUP | 50G Pickup Setting | 0.5 to 80.0 amps step 0.1 | 0.1 to 16.0 amps step 0.1 | 10.0 A at 5A 2.0 A at 1A |
| 608 | 50GPCKPFF | 50G Pickup during fuse failure | 0.5 to 80.0 amps step 0.1 | 0.1 to 16.0 amps step 0.1 | 15.0 A at 5A 3.0A at 1A |
| 609 | 50GRESTNT | 50G Restraint Setting | 0.0, 0.3 | | 0.3 |
| 610 | 51G | Ground Time Overcurrent | NO, YES | | YES |
| 611 | 51G_DIRCNL | Directional Control of 51G | NO, YES | | YES |
| 612 | 51GPICKUP | 51G Pickup Setting | 0.20 to 15.0 amps step 0.01 | 0.04 to 3.0 amps step 0.01 | 1.0 A at 5A 0.2 A at 1A |

† Setting value QUAD applies to Revision B models only.
‡ Setting applicable to Revision B models only.
^ Setting applicable to Single Phase Tripping models only.

**Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 3 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|-----|----------|-------------|------------|------------|---------|
| 613 | 51GPCKUPFF | 51G Pickup during fuse failure | 0.20 to 15.0 amps step 0.01 | 0.04 to 3.0 amps step 0.01 | 2.0 A at 5A 0.4 A at 1A |
| 614 | 51GCURVE | 51G Curve | INV, V-INV, E-INV, CUSTOM, DEFT | | V-INV |
| 615 | 51GTIMDIAL | 51G Time Dial | 0.5 to 10.0 step 0.1 | | 5 |
| 616 | DEFTIMDELY | Definite Time Delay | 0.5 to 30.0 sec. step 0.1 | | 1.0 sec. |
| 617 | 51G_RESET | 51G Reset Characteristic | FAST, EM | | FAST |
| VOLTAGE | | | | | |
| 701 | RATEDVOLTS | Rated Per Unit Voltage | 100, 105,110,115, 120 volts | | 115 volts |
| 702 | PHASEOVER | Select Phase Overvoltage | NO, YES | | NO |
| 703 | PHOVPICKUP | Phase Overvoltage Pickup | 0.0 to 1.4 p.u. volts step 0.01 | | 1.4 V |
| 704 | PHOVTMDLY | Phase Overvoltage Time Delay | 0.0 to 10.0 sec. step 0.01 | | 0.50 sec. |
| 705 | V1OVER | Select Positive Sequence Overvoltage (Overvoltage Model Only) | NO, YES | | NO |
| 706 | V1OVINSTPU | Instantaneous Positive Sequence Overvoltage Pickup (Overvoltage Model Only) | 1.0 to 1.4 p.u. volts step 0.01 | | 1.25 p.u. V |
| 707 | V1OVTIMPU | TOV Positive Sequence Overvoltage Pickup (Overvoltage Model Only) | 1.0 to 1.4 p.u. volts step 0.01 | | 1.25 p.u. V |
| 708 | V1OVTIMDLY | Positive Sequence Overvoltage Time Delay (Overvoltage Model Only) | 0.0 to 10.0 sec. step 0.01 sec. | | 0.25 sec. |
| 709 | V1COMP | Compensated Positive Sequence Overvoltage (Overvoltage Model Only) | NO, YES | | NO |
| 710 | V1COMPRCH | Compensated Positive Sequence Overvoltage Impedance (Overvoltage Model Only) | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 6.0Ω at 5A 30.0Ω at 1A |
| 711 | V1COMPINPU | INST Compensated Positive Sequence OV Pickup (Overvoltage Model Only) | 0.0 to 1.4 p.u. volts step 0.01 | | 1.4 p.u. V |
| 712 | V1COMPTDPU | TOV Compensated Positive Sequence OV Pickup (Overvoltage Model Only) | 0.0 to 1.4 p.u. volts step 0.01 | | 1.4 p.u. V |
| 713 | V1COMPTDLY | Compensated Positive Sequence OV Time Delay (Overvoltage Model Only) | 0.0 to 10.0 sec. step 0.01 | | 0.3 s at 5A 1.5 s at 1A |
| 714 | FUSEFAIL | Potential Fuse Failure Blocking | NO, YES | | YES |
| BLK RECLOS | | | | | |
| 801 | ALL_BELOW | Block reclosing for any function | NO, YES | | NO |
| 802 | OUTOFSTEP | Block for Out of Step | NO, YES | | NO |
| 803 | ALL_3_Z2PH | Block for 3 phase faults | NO, YES | | NO |
| 804 | 50G_BLOCK | Block for 50G trip | NO, YES | | NO |
| 805 | Z2TIMETRIP | Block for Z2 Time Delayed Trip | NO, YES | | NO |
| 806 | Z3TIMETRIP | Block for Z3 Time Delayed Trip | NO, YES | | NO |
| 807 | Z4TIMETRIP | Block for Z4 Time Delayed Trip | NO, YES | | NO |
| 808 | Z1PHASTRIP | Block for any Z1 Phase Fault | NO, YES | | NO |
| 809 | ANYZ2PHASE | Block for any Z2 Phase Fault | NO, YES | | NO |
| 810 | CONFGTRIP | Block For Configurable Trip Logic | NO, YES | | NO |
| LINEPICKUP | | | | | |
| 901 | LINEPICKUP | Select Line Pickup | NO, YES | | NO |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

**2**

### Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 4 of 7)

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|-----|----------|-------------|------------|------------|---------|
| 902 | BYPASSTL3 | Bypass Line Pickup Time Delay | NO, YES | | NO |
| 903 | I1PICKUP | I1 Pickup | 1.0 to 15.0 amps step 0.1 | 0.2 to 3.0 amps step 0.1 | 3.0 A at 5A 0.6 A at 1A |
| REMOTEOPEN (THREE-PHASE SYSTEMS ONLY) | | | | | |
| 1001 | REMOTEOPEN | Select Remote Open Detector | NO, YES | | NO |
| 1002 | TL20PICKUP | Remote Open Detector Time Delay | 10 to 100 msec. step 1 | | 100 msec. |
| LINEOVERLD | | | | | |
| 1101 | LINEOVERLD | Select Line Overload Protection | NO, YES | | NO |
| 1102 | LEVEL1PU | Level 1 pickup current | 2.5 to 20 amps step 0.1 | 0.5 to 4.0 amps step 0.1 | 10 A at 5A 2 A at 1A |
| 1103 | LEVEL2PU | Level 2 pickup current | 5.0 to 40.0 amps step 0.1 | 1.0 to 8.0 amps step 0.1 | 20 A at 5A 4 A at 1A |
| 1104 | LEVEL1TDLY | Level 1 time delay | 10 to 200 sec. step 1 | | 50 sec. |
| 1105 | LEVEL2TDLY | Level 2 time delay | 10 to 99 sec. step 1 | | 25 sec. |
| SCHEME | | | | | |
| 1201 | PICKSCHEME | Select a scheme logic | STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK, HYBRIDP | | STEPDST |
| 1202 | NUMRCVR | Select a number of receivers | 0, 1, 2, 4 | | 0 |
| 1203ˆ | TRIPMODE | 1-phase / 3-phase Trip Mode | 3POLE, 1POLE, 1POLEZ2 | | 3POLE |
| 1204 | CARRSTART | Select Function to use to Start Carrier in BLOCKing scheme | DIR, IPB, FD | | IPB |
| 1205 | WKINFTRIP | Select Weak Infeed Tripping for HYBRID scheme | NO, YES | | NO |
| SCHMTIMERS | | | | | |
| 1301 | TL1PICKUP | Trip Integrator | 1 to 200 msec. step 1 | | 5 msec. |
| 1302 | TL4PICKUP | POTT Coord Timer PU | 0 to 50 msec. step 1 | | 0 msec. |
| 1303 | TL4DROPOUT | POTT Coord Timer DO | 0 to 50 msec. step 1 | | 0 msec. |
| 1304 | TL5PICKUP | BKR1 b sw Coord Timer PU | 0 to 200 msec. step 1 | | 50 msec. |
| 1305 | TL5DROPOUT | BKR1 b sw Coord Timer DO | 0 to 200 msec. step 1 | | 50 msec. |
| 1306 | TL6PICKUP | BKR2 b sw Coord Timer PU | 0 to 200 msec. step 1 | | 50 msec. |
| 1307 | TL6DROPOUT | BKR2 b sw Coord Timer DO | 0 to 200 msec. step 1 | | 50 msec. |
| 1308 | TL16PICKUP | Weak Infeed Trip Timer | 8 to 99 msec. step 1 | | 8 msec. |
| 1309 | TL24DRPPOUT | GDOC Blocking Timer | 30 to 500 msec. step 1 | | 30 msec. |
| 1310 | TL25DRPOUT | Distance Blocking Timer | 30 to 500 msec. step 1 | | 30 msec. |
| 1311 | TL26PICKUP | Repeat Delay Timer | 0 to 50 msec. step 1 | | 0 msec. |
| LINE INFO | | | | | |
| 1401 | POSSEQANG | Positive Sequence Impedance Angle | 25 to 90 deg. step 1 | | 85 deg. |
| 1402 | ZERSEQANG | Zero Sequence Impedance Angle | 25 to 90 deg. step 1 | | 75 deg. |
| 1403 | ZLINE | Positive Sequence Line Impedance in sec.ohms | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | 6Ω at 5A 30Ω at 1A |
| 1404 | ZEROSEQK0 | Z0/Z1 Ratio | 1.0 to 7.0 step 0.01 | | 3.0 |
| 1405 | LINELENGTH | Line Length | 0.0 to 500.0 step 0.1 | | 100.0 |
| 1406 | LINEUNIT | Units of Length | MILES, KM, PERCENT | | MILES |
| 1407 | CTRATIO | CT Ratio | 1 to 5000 step 1 | | 400 for 5A 2000 for 1A |
| 1408 | PTRATIO | PT Ratio | 1 to 7000 step 1 | | 3000 |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**ˆ** Setting applicable to Single Phase Tripping models only.

**Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 5 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|---|---|---|---|---|---|
| SCADA_DTA | | | | | |
| 1501 | FLTLOCK | Hold Time | 0 to 99.9 sec. step 0.1 | | 0 sec. |
| 1502 | FLTRESET | Fault Location Reset Time | 0 to 999 minutes step 1 | | 0 minutes |
| OS BLOCKING | | | | | |
| 1601 | MOBZONE | Coordinating Zone | ZONE2, ZONE3, ZONE4 | | ZONE3 |
| 1602 | MOBCHARANG | MOB Characteristic Angle | 30 to 130 deg. step 1 | | 70 deg. |
| 1603 | BLOCKWHAT | Block during OS | BLKALL, BLKDIST, BLKPHAS, BLKNONE | | BLKALL |
| 1604 | BLOCKZ1 | Block all Zone 1 Functions | NO, YES | | YES |
| 1605 | BLOCKZ2 | Block all Zone 2 Functions | NO, YES | | YES |
| 1606 | BLOCKZ3 | Block all Zone 3 Functions | NO, YES | | YES |
| 1607 | BLOCKZ4 | Block all Zone 4 Functions | NO, YES | | YES |
| OS TRIPPING (OUT-OF-STEP TRIPPING MODELS ONLY) | | | | | |
| 1701 | USE_OST | Select OST | NO, YES | | NO |
| 1702 | NUMBRCHAR | Select Number of Characteristics | 2, 3 | | 3 |
| 1703 | TRIPIN_OUT | Trip Entering or Leaving Inner | IN, OUT | | OUT |
| 1704 | FWDREACH | OST Forward Reach | 0.1 to 75.0 ohms step 0.1 | 0.5 to 375.0 ohms step 0.5 | 15.0Ω at 5A 75.0Ω at 1A |
| 1705 | REVREACH | OST Reverse Reach | 0.1 to 75.0 ohms step 0.1 | 0.1 to 375.0 ohms step 0.5 | 5.0Ω at 5A 25.0Ω at 1A |
| 1706 | OUTER | Outer Characteristic Angle | 40 to 165 deg. step 1 | | 90 deg. |
| 1707 | MIDDLE | Middle Characteristic Angle | 40 to 165 deg. step 1 | | 105 deg. |
| 1708 | INNER | Inner Characteristic Angle | 40 to 165 deg. step 1 | | 120 deg. |
| 1709 | TLOS1PU | Coordinating Timer 1 Pickup | 1 to 100 msec. step 1 | | 40 msec. |
| 1710 | TLOS1DO | Coordinating Timer 1 Dropout | 1 to 100 msec. step 1 | | 40 msec. |
| 1711 | TLOS2PU | Coordinating Timer 2 Pickup | 1 to 100 msec. step 1 | | 40 msec. |
| 1712 | TLOS3PU | Coordinating Timer 3 Pickup | 1 to 100 msec. step 1 | | 40 msec. |
| 1713 | TLOS4PU | Coordinating Timer 4 Pickup | 1 to 100 msec. step 1 | | 40 msec. |
| RECLOSER | | | | | |
| 1801 | RECLMODE | Select Reclosing Option | OFF, NONE, INTERNAL, EXTERNAL, BOTH | | OFF |
| 1802 ^ | RECTYPE | Set Reclosing Type | 1POLE, 3POLE, 1POLE/3POLE | | 3POLE |
| 1803 ^ | NUM1P | Number of Attempts Following 1P Trip | 1 to 4 step 1 | | 1 |
| 1804 ^ | 1PDELAY1 | 1 Pole First Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1805 ^ | 1PDELAY2 | 1 Pole Second Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1806 ^ | 1PDELAY3 | 1 Pole Third Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1807 ^ | 1PDELAY4 | 1 Pole Fourth Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1808 | NUM3P | Number of Attempts Following 3P Trip | 1 to 4 step 1 | | 1 |
| 1809 | 3PDELAY1 | 3 Pole First Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1810 | 3PDELAY2 | 3 Pole Second Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1811 | 3PDELAY3 | 3 Pole Third Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1812 | 3PDELAY4 | 3 Pole Fourth Delay | 0.1 to 300 sec. step 0.1 | | 0.1 sec. |
| 1813 | RESETTIME | Reset Time | 0.1 to 300 sec. step 0.1 | | 1 sec. |
| 1814 | DWELLTIME | Contact Dwell Time | 0.1 to 2 sec. step 0.1 | | 0.1 sec. |
| 1815 | HOLD | Inhibit Hold Select | NO, YES | | NO |
| 1816 | HOLDTIME | Inhibit Hold Time | 1 to 1000 sec. step 1 | | 1 sec. |

† Setting value QUAD applies to Revision B models only.
‡ Setting applicable to Revision B models only.
^ Setting applicable to Single Phase Tripping models only.

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**Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 6 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|-----|----------|-------------|------------|------------|---------|
| 1817 | HOLDSENSE | Contact Input Status | CC, CO | | CC |
| 1818 | SYNCCHECK | Synch Check Supervision | NO, YES | | NO |
| 1819 | CLOSEANG | Closing Angle | 0 to 75 deg. step 1 | | 30 deg. |
| 1820 | SLIPFREQ | Slip Frequency | 0.1 to 5 Hz step 0.1 | | 1 Hz |
| 1821 | BUSLINE | Bus or Line Voltage | BUS, LINE | | LINE |
| 1822 | SYNCPHASE | Voltage used by SYNCCHECK | VA, VB, VC, VAB, VBC, VCA | | VA |
| 1823 | SYNCHOLD | SYNCCHECK Hold Time | 1 to 100 sec. step 1 | | 1 sec. |
| 1824 ^ | SP1DELAY2 | Supervise 2nd 3P Reclose after 1P Trip | NO, YES | | NO |
| 1825 ^ | SP1DELAY3 | Supervise 3rd 3P Reclose after 1P Trip | NO, YES | | NO |
| 1826 ^ | SP1DELAY4 | Supervise 4th 3P Reclose after 1P Trip | NO, YES | | NO |
| 1827 | SP3DELAY1 | Supervise 1st 3P Reclose after 3P Trip | NO, YES | | NO |
| 1828 | SP3DELAY2 | Supervise 2nd 3P Reclose after 3P Trip | NO, YES | | NO |
| 1829 | SP3DELAY3 | Supervise 3rd 3P Reclose after 3P Trip | NO, YES | | NO |
| 1830 | SP3DELAY4 | Supervise 4th 3P Reclose after 3P Trip | NO, YES | | NO |
| 1831 | SYNCMANCLS | Supervise Manual Close | NO, YES | | NO |
| 1832 | VBUSLIVE | Live Bus Voltage | 0.1 to 130 volts step 0.1 | | 50 V |
| 1833 | VBUSDEAD | Dead Bus Voltage | 0.1 to 130 volts step 0.1 | | 50 V |
| 1834 | VLINELIVE | Live Line Voltage | 0.1 to 130 volts step 0.1 | | 50 V |
| 1835 | VLINEDEAD | Dead Line Voltage | 0.1 to 130 volts step 0.1 | | 50 V |
| 1836 | LBUSDLINE | Live Bus Dead Line | NO, YES | | NO |
| 1837 | DBUSLLINE | Dead Bus Live Line | NO, YES | | NO |
| 1838 | DBUSDLINE | Dead Bus Dead Line | NO, YES | | NO |
| 1839 | DELTAV | Voltage Difference | 0.1 to 30 volts step 0.1 | | 10 V |
| 1840 | DELTAVBLK | Block Synch Check by DELTAV | NO, YES | | NO |
| NONCRIT_AL | | | | | |
| 1901 | NCAIN1 | Non-Critical Alarm Input #1 *These 8 inputs are ORed together and then outputted to the contact assigned to the Non-Critical Alarm* | 0 to 256 step 1 | | 48 |
| 1902 | NCAIN2 | Non-Critical Alarm Input #2 | 0 to 256 step 1 | | 49 |
| 1903 | NCAIN3 | Non-Critical Alarm Input #3 | 0 to 256 step 1 | | 50 |
| 1904 | NCAIN4 | Non-Critical Alarm Input #4 | 0 to 256 step 1 | | 51 |
| 1905 | NCAIN5 | Non-Critical Alarm Input #5 | 0 to 256 step 1 | | |
| 1906 | NCAIN6 | Non-Critical Alarm Input #6 | 0 to 256 step 1 | | |
| 1907 | NCAIN7 | Non-Critical Alarm Input #7 | 0 to 256 step 1 | | |
| 1908 | NCAIN8 | Non-Critical Alarm Input #8 | 0 to 256 step 1 | | |
| OUTPUTS | | | | | |
| 2001 | T1 | T1 Contract | 0 to 256 step 1 | | 33 |
| 2002 | T2 | T2 Contact | 0 to 256 step 1 | | 33 |
| 2003 | T3 | T3 Contact | 0 to 256 step 1 | | 33 |
| 2004 | T4 | T4 Contact | 0 to 256 step 1 | | 33 |
| 2005 ^ | T5 | T5 Contact | 0 to 256 step 1 | | 34 |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

**Table 2–11: PROTECTION SETTINGS GUIDE (Sheet 7 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | DEFAULT |
|---|---|---|---|---|---|
| 2006 ^ | T6 | T6 Contact | 0 to 256 step 1 | | 34 |
| 2007 | A1 | A1 Contact (configurable) | 0 to 256 step 1 | | 58 |
| 2008 | A2 | A2 Contact (configurable) | 0 to 256 step 1 | | 59 |
| 2009 | A3 | A3 Contact (configurable) | 0 to 256 step 1 | | 33 |
| 2010 | A4 | A4 Contact (configurable) | 0 to 256 step 1 | | 33 |
| 2011 | A5 | A5 Contact (configurable) | 0 to 256 step 1 | | 37 |
| 2012 | A6 | A6 Contact (configurable) | 0 to 256 step 1 | | 37 |
| 2013 | A7 | A7 Contact (configurable) | 0 to 256 step 1 | | 38 |
| 2014 | A8 | A8 Contact (configurable) | 0 to 256 step 1 | | 45 |
| 2015 ^ | A9 | A9 Contact (configurable) | 0 to 256 step 1 | | |
| 2016 ^ | A10 | A10 Contact (configurable) | 0 to 256 step 1 | | |
| 2017 ^ | A11 | A11 Contact (configurable) | 0 to 256 step 1 | | |
| 2018 ^ | A12 | A12 Contact (configurable) | 0 to 256 step 1 | | |
| 2019 | C1 | C1 Contact (configurable) | 0 to 256 step 1 | | 52 |
| 2020 | C2 | C2 Contact (configurable) | 0 to 256 step 1 | | 115 |
| 2021 | KT1 | KT1 Contact (configurable) | 0 to 256 step 1 | | 39 |
| 2022 | KT2 | KT2 Contact (configurable) | 0 to 256 step 1 | | 40 |
| 2023 | KT3 | KT3 Contact (configurable) | 0 to 256 step 1 | | 39 |
| 2024 | KT4 | KT4 Contact (configurable) | 0 to 256 step 1 | | 40 |
| 2025 | CONFTRIP | Initiate Three phase Trip with Input from Xpression Builder | 0 to 256 step 1 | | |
| 2026 | CONFOSC | Initiate Oscillography Capture with Xpression Builder Input | 0 to 256 step 1 | | |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

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**Table 2–12: GENERAL SETTINGS GUIDE (Sheet 1 of 2)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A & 1A) | STEP | DEFAULT |
|-----|----------|-------------|-----------------|------|---------|
| CONFIGURE | | | | | |
| 101 | UNITID | Unit ID | 0000 to 9999 | 1 | 0000 |
| 102 | SYSFREQ | System Frequency | 50 Hz, 60 Hz | N/A | 60Hz |
| 103 | PHASROTATE | Phase Rotation | ABC, ACB | N/A | ABC |
| 104 | TIMESYNCH | Time Synch Source | INTERNAL, IRIG-B | N/A | INTERNAL |
| 105 | NUM_BKR | Number of Breakers | 1, 2 | N/A | 1 |
| 106 | NUM_TC | Number of Trip Circuits | 1, 2 | N/A | 1 |
| 107 | NUM_MON | Number of Trip Circuit Monitors | for 1P tripping: format = abcdef; for 3P tripping: format = abcd | a-f = 0 (on) or 1(off) | 000111 (7) T1 to T3 off [†] 0000 (0) T1 to T4 off [‡] |
| 108 | DISPLAYVAL | Value Display Mode | PRI, SEC | N/A | SEC |
| 109 | LANGUAGE | Language Option | ENGLISH, SPANISH | N/A | ENGLISH |
| 110 | SYSIN1-4 | System Inputs 1 to 4 | 0000 to 1111 (binary) 0 to 15 (decimal) | 1 | 0000 |
| COMMPORTS | | | | | |
| 201 | COMPORT1 | Communications Port #1 Settings | Baud Rate (xx), Parity (y), Stop Bits (z) *format = xxyz* | xx = 03, 12, 24, 48, 96; y = 0 (none), 1 (odd), 2 (even); z = 1, 2 | 9601 |
| 202 | COMPORT2 | Communications Port #2 Settings | Interface (i), Baud Rate (xx), Parity (y), Stop Bits (z) *format = ixxyz* | i = 0 (RS232), 1 (RS485); xx = 03, 12, 24, 48, 96; y = 0 (none), 1 (odd), 2 (even); z = 1, 2 | 09601 |
| 203 | COMPORT3 | Communications Port #3 Settings | Interface (i), Baud Rate (xx), Parity (y), Stop bits (z) format = ixxyz | i = 0 (RS232), 1 (RS485); xx = 03, 12, 24, 48, 96; y = 0 (none), 1 (odd), 2 (even); z = 1, 2 | 09601 |
| 204 | PROTOCOL1 | Communications Port #1 Protocol | GE-MODEM, ASCII, DNP 3.0 | N/A | GE-MODEM |
| 205 | PROTOCOL2 | Communications Port #2 Protocol | GE-MODEM, ASCII, DNP 3.0 | N/A | ASCII |
| 206 | PROTOCOL3 | Communications Port #3 Protocol | GE-MODEM, ASCII, DNP 3.0 | N/A | GE-MODEM |
| OSC_GRAPHY | | | | | |
| 301 | NUMFAULTS | Number of Fault Records | 2,4,8,12 (std. mem.) 6,12,24,36 (exp mem)[†] | N/A | 12 |
| 302 | PREFAULT | Number of Pre-fault Cycles | 1 to 8 | 1 | 5 |
| 303 | SPLITREC | Splits Fault Record and captures this percentage at end, with 1-SPLITREC captured at beginning | 0 to 100% | 1 | 0 |
| BRKR DUTY | | | | | |
| 401 | EXPONENT | Exponent in $I^x t$ calculation | 1.0 to 2.0 | 0.1 | 2.0 |
| 402 | MAX_OP | Maximum Number of Breaker Operations for a Breaker | 0 to 9999 | 1 | 0 |

† Applicable to the Single Phase Tripping model only.
‡ Applicable to the Three Phase Tripping model only.
* Contact converter output normally appears as a Logic 1 with normally open contact connected; to invert output to Logic 0, add 1000 to the number.

**Table 2–12: GENERAL SETTINGS GUIDE (Sheet 2 of 2)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A & 1A) | STEP | DEFAULT |
|---|---|---|---|---|---|
| 403 | MAX_IXT | Maximum Breaker Duty for a Breaker | 0 to 9999999 $A^x$sec. | 100 | 0 |
| 404 | IXTPHASEA | Accumulated Breaker Duty, Phase A | 0 to 9999999 $A^x$sec. | 100 | 0 |
| 405 | IXTPHASEB | Accumulated Breaker Duty, Phase B | 0 to 9999999 $A^x$sec. | 100 | 0 |
| 406 | IXTPHASEC | Accumulated Breaker Duty, Phase C | 0 to 9999999 $A^x$sec. | 100 | 0 |
| 407 ‡ | NUM_OP | Present Number of Breaker Operations | 0 to 9999 | 1 | 0 |
| 407 † | NUM_OP_A | Present Number of Breaker Operations for Phase A | 0 to 9999 | 1 | 0 |
| 408 † | NUM_OP_B | Present Number of Breaker Operations for Phase B | 0 to 9999 | 1 | 0 |
| 409 † | NUM_OP_C | Present Number of Breaker Operations for Phase C | 0 to 9999 | 1 | 0 |
| INPUTS | | | | | |
| 501 | CC1 | Contact Converter 1 | 0 to 32 * | 1 | 12 |
| 502 | CC2 | Contact Converter 2 | 0 to 32 * | 1 | 13 |
| 503 | CC3 | Contact Converter 3 | 0 to 32 * | 1 | 10 |
| 504 | CC4 | Contact Converter 4 | 0 to 32 * | 1 | 11 |
| 505 | CC5 | Contact Converter 5 | 0 to 32 * | 1 | 7 † |
| 506 | CC6 | Contact Converter 6 | 0 to 32 * | 1 | |
| 507 | CC7 | Contact Converter 7 | 0 to 32 * | 1 | 1 † |
| 508 | CC8 | Contact Converter 8 | 0 to 32 * | | 2 †, 4 ‡ |
| 509 | CC9 † | Contact Converter 9 | 0 to 32 * | 1 | 3 † |
| 510 | CC10 † | Contact Converter 10 | 0 to 32 * | 1 | 4 † |
| 511 | CC11 † | Contact Converter 11 | 0 to 32 * | 1 | 5 † |
| 512 | CC12 † | Contact Converter 12 | 0 to 32 * | 1 | 6 † |

† Applicable to the Single Phase Tripping model only.
‡ Applicable to the Three Phase Tripping model only.
* Contact converter output normally appears as a Logic 1 with normally open contact connected; to invert output to Logic 0, add 1000 to the number.

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**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 1 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|---|---|---|---|---|---|
| Z1 DISTANCE | | | | | |
| 101 | Z1PHASE | Z1 Phase Distance | NO, YES | | |
| 102 | Z1PHREACH | Z1 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 103 | Z1PLEVDET | Z1 Phase Level Detector (Series Capacitor Model Only) | 0.0 to 9.9 p.u. volts step 0.1 | | |
| 104 | Z1GROUND | Z1 Ground Distance | NO, YES | | |
| 105 | Z1GRDREACH | Z1 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 106 | Z1GRDCHAR | Z1 Ground Characteristic | MHO, REACT, QUAD [†] | | |
| 107 | Z1SUREACH | Z1 Ground Reaction Mho Supervision Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250 ohms step 0.05 | |
| 108 | Z1GROUNDK0 | Z1 Ground K0 | 1.0 to 7.0 step 0.01 | | |
| 109 | Z1GLEVDET | Z1 Ground Level Detector (Series Capacitor Model Only) | 0.0 to 9.9 p.u. volts step 0.1 | | |
| 110 | Z1BLOCK | Blocking Supervision of Z1 | NO, YES | | |
| 111 [‡] | Z1GCHARANG | Z1 Ground Characteristic Timer Angle | 80° to 155° step 1 | | |
| 112 [‡] | Z1RGREACH | Z1 Resistive Ground Reach | 0.01 to 100.00 Ω step 0.01 | 0.05 to 500 Ω step 0.01 | |
| Z2DISTANCE | | | | | |
| 201 | Z2PHASE | Z2 Phase Distance | NO, YES | | |
| 202 | Z2PHREACH | Z2 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 203 | Z2PCHARANG | Z2 Phase Characteristic Angle | 90 to 120° step 5 | | |
| 204 | Z2GROUND | Z2 Ground Distance | NO, YES | | |
| 205 | Z2GRDCHAR | Z2 Ground Characteristic | MHO, GDOC, MHOGDOC, MHO2GDOC, QUAD [†] | | |
| 206 | Z2GRDREACH | Z2 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 207 | Z2GCHARANG | Z2 Ground Characteristic Angle | 80 to 155 deg. step 5 | | |
| 208 | Z2TIMERS | Z2 Timers | NO, YES | | |
| 209 | Z2P_TIME | Z2 Phase Timer | 0.10 to 3.0 sec. step 0.01 | | |
| 210 | Z2G_TIME | Z2 Ground Timer | 0.10 to 3.0 sec. step 0.01 | | |
| 211 [‡] | Z2RGREACH | Zone 2 Resistive Ground Reach | 0.01 to 100.00 Ω step 0.01 | 0.05 to 500 Ω step 0.01 | |
| Z3DISTANCE | | | | | |
| 301 | Z3PHASE | Z3 Phase Distance | NO, YES | | |
| 302 | Z3PHREACH | Z3 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 303 | Z3PCHARANG | Z3 Phase Characteristic Angle | 90 to 120 deg. step 5 | | |
| 304 | Z3GROUND | Z3 Ground Distance | NO, YES | | |
| 305 | Z3GRDREACH | Z3 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 306 | Z3GCHARANG | Z3 Ground Characteristic Angle | 80 to 155 deg. step 5 | | |
| 307 | Z3P_TIME | Z3 Phase Timer | 0.10 to 10.0 sec. step 0.01 | | |
| 308 | Z3G_TIME | Z3 Ground Timer | 0.10 to 10.0 sec. step 0.01 | | |

[†] Setting value QUAD applies to Revision B models only.
[‡] Setting applicable to Revision B models only.
[^] Setting applicable to Single Phase Tripping models only.

**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 2 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|-----|----------|-------------|------------|------------|--------------|
| 309 | Z3GRDCHAR‡ | Z3 Ground Characteristic | MHO, QUAD | | |
| 310 | Z3RGREACH‡ | Z3 Resistive Ground Reach | 0.01 to 100 ohms step 0.01 | 0.05 to 500 ohms step 0.05 | |
| **Z4DISTANCE** | | | | | |
| 401 | Z4PHASE | Z4 Phase Distance | NO, YES | | |
| 402 | Z4PHREACH | Z4 Phase Reach | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 403 | Z4PCHARANG | Z4 Phase Characteristic Angle | 80 to 120 deg. step 5 | | |
| 404 | Not Used | | | | |
| 405 | Z4GRND | Z4 Ground Distance | NO, YES | | |
| 406 | Z4GRDREACH | Z4 Ground Reach | 0.01 to 50.0 ohms step 0.01 | 0.01 to 250.0 ohms step 0.05 | |
| 407 | Z4GCHARANG | Z4 Ground Characteristic Angle | 80 to 155 deg., step 5 | | |
| 408 | Z4DIRECTN | Z4 Direction | FORWRD, REVERS | | |
| 409 | Z4_TIMERS | Z4 Timers | NO, YES | | |
| 410 | Z4P_TIME | Z4 Phase Timer | 0.10 to 10.0 sec. step 0.01 | | |
| 411 | Z4G_TIME | Z4 Ground Timer | 0.10 to 10.0 sec. step 0.01 | | |
| 412 ‡ | Z4GRDCHAR | Z4 Ground Characteristic | MHO, QUAD | | |
| 413 ‡ | Z4RGREACH | Z4 Resistive Ground Reach | 0.01 to 100 ohms step 0.01 | 0.05 to 500 ohms step 0.05 | |
| **CURVSUPVISN** | | | | | |
| 501 | IT_PICKUP | Trip Supervision Current | 0.20 to 4.0 amps step 0.01 | 0.04 to 0.8 amps step 0.01 | |
| 502 | IB_PICKUP | Block Supervision Current | 0.20 to 4.0 amps step 0.01 | 0.04 to 0.8 amps step 0.01 | |
| 503 | IPT_PICKUP | GDOC Trip Current | 0.50 to 5.0 amps step 0.01 | 0.10 to 1.0 amps step 0.01 | |
| 504 | IPB_PICKUP | GDOC Block Current | 0.25 to 3.75 amps step 0.01 | 0.05 to 0.75 amps step 0.01 | |
| 505 | IPBKFACTOR | IPB I1 Restraint | 0.0, 0.066 | | |
| 506 | NT_OFFSET | NT/NB Offset | 0.0 to 20.0 ohms step 0.01 | 0.0 to 100 ohms step 0.01 | |
| 507 | UNBALALARM | Unbalanced Current Alarm | NO, YES | | |
| **OVERCURRNT** | | | | | |
| 601 | 50 | Phase Instantaneous Overcurrent | NO, YES | | |
| 602 | 50_DIRCNL | Directional Control of 50 | NO, YES | | |
| 603 | 50PICKUP | 50 Pickup Setting | 2.0 to 160.0 amps step 0.1 | 0.4 to 32.0 amps step 0.1 | |
| 604 | 50PICKUPFF | 50 Pickup during fuse failure | 2.0 to 160.0 amps step 0.1 | 0.4 to 32.0 amps step 0.1 | |
| 605 | 50G | Ground Instantaneous Overcurrent | NO, YES | | |
| 606 | 50G_DIRCNL | Directional Control of 50G | NO, YES | | |
| 607 | 50GPICKUP | 50G Pickup Setting | 0.5 to 80.0 amps step 0.1 | 0.1 to 16.0 amps step 0.1 | |
| 608 | 50GPCKPFF | 50G Pickup during fuse failure | 0.5 to 80.0 amps step 0.1 | 0.1 to 16.0 amps step 0.1 | |
| 609 | 50GRESTNT | 50G Restraint Setting | 0.0, 0.3 | | |
| 610 | 51G | Ground Time Overcurrent | NO, YES | | |
| 611 | 51G_DIRCNL | Directional Control of 51G | NO, YES | | |

† Setting value QUAD applies to Revision B models only.
‡ Setting applicable to Revision B models only.
^ Setting applicable to Single Phase Tripping models only.

**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 3 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|---|---|---|---|---|---|
| 612 | 51GPICKUP | 51G Pickup Setting | 0.20 to 15.0 amps step 0.01 | 0.04 to 3.0 amps step 0.01 | |
| 613 | 51GPCKUPFF | 51G Pickup during fuse failure | 0.20 to 15.0 amps step 0.01 | 0.04 to 3.0 amps step 0.01 | |
| 614 | 51GCURVE | 51G Curve | INV, V-INV, E-INV, CUSTOM, DEFT | | |
| 615 | 51GTIMDIAL | 51G Time Dial | 0.5 to 10.0 step 0.1 | | |
| 616 | DEFTIMDELY | Definite Time Delay | 0.5 to 30.0 sec. step 0.1 | | |
| 617 | 51G_RESET | 51G Reset Characteristic | FAST, EM | | |
| VOLTAGE | | | | | |
| 701 | RATEDVOLTS | Rated Per Unit Voltage | 100, 105,110,115, 120 volts | | |
| 702 | PHASEOVER | Select Phase Overvoltage | NO, YES | | |
| 703 | PHOVPICKUP | Phase Overvoltage Pickup | 0.0 to 1.4 p.u. volts step 0.01 | | |
| 704 | PHOVTMDLY | Phase Overvoltage Time Delay | 0.0 to 10.0 sec. step 0.01 | | |
| 705 | V1OVER | Select Positive Sequence Overvoltage (Overvoltage Model Only) | NO, YES | | |
| 706 | V1OVINSTPU | Instantaneous Positive Sequence Overvoltage Pickup (Overvoltage Model Only) | 1.0 to 1.4 p.u. volts step 0.01 | | |
| 707 | V1OVTIMPU | TOV Positive Sequence Overvoltage Pickup (Overvoltage Model Only) | 1.0 to 1.4 p.u. volts step 0.01 | | |
| 708 | V1OVTIMDLY | Positive Sequence Overvoltage Time Delay (Overvoltage Model Only) | 0.0 to 10.0 sec. step 0.01 sec. | | |
| 709 | V1COMP | Compensated Positive Sequence Overvoltage (Overvoltage Model Only) | NO, YES | | |
| 710 | V1COMPRCH | Compensated Positive Sequence Overvoltage Impedance (Overvoltage Model Only) | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 711 | V1COMPINPU | INST Compensated Positive Sequence OV Pickup (Overvoltage Model Only) | 0.0 to 1.4 p.u. volts step 0.01 | | |
| 712 | V1COMPTDPU | TOV Compensated Positive Sequence OV Pickup (Overvoltage Model Only) | 0.0 to 1.4 p.u. volts step 0.01 | | |
| 713 | V1COMPTDLY | Compensated Positive Sequence OV Time Delay (Overvoltage Model Only) | 0.0 to 10.0 sec. step 0.01 | | |
| 714 | FUSEFAIL | Potential Fuse Failure Blocking | NO, YES | | |
| BLK RECLOS | | | | | |
| 801 | ALL_BELOW | Block reclosing for any function | NO, YES | | |
| 802 | OUTOFSTEP | Block for Out of Step | NO, YES | | |
| 803 | ALL_3_Z2PH | Block for 3 phase faults | NO, YES | | |
| 804 | 50G_BLOCK | Block for 50G trip | NO, YES | | |
| 805 | Z2TIMETRIP | Block for Z2 Time Delayed Trip | NO, YES | | |
| 806 | Z3TIMETRIP | Block for Z3 Time Delayed Trip | NO, YES | | |
| 807 | Z4TIMETRIP | Block for Z4 Time Delayed Trip | NO, YES | | |
| 808 | Z1PHASTRIP | Block for any Z1 Phase Fault | NO, YES | | |
| 809 | ANYZ2PHASE | Block for any Z2 Phase Fault | NO, YES | | |
| 810 | CONFGTRIP | Block For Configurable Trip Logic | NO, YES | | |

† Setting value QUAD applies to Revision B models only.
‡ Setting applicable to Revision B models only.
^ Setting applicable to Single Phase Tripping models only.

**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 4 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|-----|----------|-------------|------------|------------|--------------|
| LINEPICKUP | | | | | |
| 901 | LINEPICKUP | Select Line Pickup | NO, YES | | |
| 902 | BYPASSTL3 | Bypass Line Pickup Time Delay | NO, YES | | |
| 903 | I1PICKUP | I1 Pickup | 1.0 to 15.0 amps step 0.1 | 0.2 to 3.0 amps step 0.1 | |
| REMOTEOPEN (THREE-PHASE SYSTEMS ONLY) | | | | | |
| 1001 | REMOTEOPEN | Select Remote Open Detector | NO, YES | | |
| 1002 | TL20PICKUP | Remote Open Detector Time Delay | 10 to 100 msec. step 1 | | |
| LINEOVERLD | | | | | |
| 1101 | LINEOVERLD | Select Line Overload Protection | NO, YES | | |
| 1102 | LEVEL1PU | Level 1 pickup current | 2.5 to 20 amps step 0.1 | 0.5 to 4.0 amps step 0.1 | |
| 1103 | LEVEL2PU | Level 2 pickup current | 5.0 to 40.0 amps step 0.1 | 1.0 to 8.0 amps step 0.1 | |
| 1104 | LEVEL1TDLY | Level 1 time delay | 10 to 200 sec. step 1 | | |
| 1105 | LEVEL2TDLY | Level 2 time delay | 10 to 99 sec. step 1 | | |
| SCHEME | | | | | |
| 1201 | PICKSCHEME | Select a scheme logic | STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK, HYBRIDP | | |
| 1202 | NUMRCVR | Select a number of receivers | 0, 1, 2, 4 | | |
| 1203^ | TRIPMODE | 1-phase / 3-phase Trip Mode | 3POLE, 1POLE, 1POLEZ2 | | |
| 1204 | CARRSTART | Select Function to use to Start Carrier in BLOCKing scheme | DIR, IPB, FD | | |
| 1205 | WKINFTRIP | Select Weak Infeed Tripping for HYBRID scheme | NO, YES | | |
| SCHMTIMERS | | | | | |
| 1301 | TL1PICKUP | Trip Integrator | 1 to 200 msec. step 1 | | |
| 1302 | TL4PICKUP | POTT Coord Timer PU | 0 to 50 msec. step 1 | | |
| 1303 | TL4DROPOUT | POTT Coord Timer DO | 0 to 50 msec. step 1 | | |
| 1304 | TL5PICKUP | BKR1 b sw Coord Timer PU | 0 to 200 msec. step 1 | | |
| 1305 | TL5DROPOUT | BKR1 b sw Coord Timer DO | 0 to 200 msec. step 1 | | |
| 1306 | TL6PICKUP | BKR2 b sw Coord Timer PU | 0 to 200 msec. step 1 | | |
| 1307 | TL6DROPOUT | BKR2 b sw Coord Timer DO | 0 to 200 msec. step 1 | | |
| 1308 | TL16PICKUP | Weak Infeed Trip Timer | 8 to 99 msec. step 1 | | |
| 1309 | TL24DRPPOUT | GDOC Blocking Timer | 30 to 500 msec. step 1 | | |
| 1310 | TL25DRPOUT | Distance Blocking Timer | 30 to 500 msec. step 1 | | |
| 1311 | TL26PICKUP | Repeat Delay Timer | 0 to 50 msec. step 1 | | |
| LINE INFO | | | | | |
| 1401 | POSSEQANG | Positive Sequence Impedance Angle | 25 to 90 deg. step 1 | | |
| 1402 | ZERSEQANG | Zero Sequence Impedance Angle | 25 to 90 deg. step 1 | | |
| 1403 | ZLINE | Positive Sequence Line Impedance in sec.ohms | 0.01 to 50.0 ohms step 0.01 | 0.05 to 250.0 ohms step 0.05 | |
| 1404 | ZEROSEQK0 | Z0/Z1 Ratio | 1.0 to 7.0 step 0.01 | | |
| 1405 | LINELENGTH | Line Length | 0.0 to 500.0 step 0.1 | | |
| 1406 | LINEUNIT | Units of Length | MILES, KM, PERCENT | | |
| 1407 | CTRATIO | CT Ratio | 1 to 5000 step 1 | | |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 5 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|---|---|---|---|---|---|
| 1408 | PTRATIO | PT Ratio | 1 to 7000 step 1 | | |
| SCADA_DTA | | | | | |
| 1501 | FLTLOCK | Hold Time | 0 to 99.9 sec. step 0.1 | | |
| 1502 | FLTRESET | Fault Location Reset Time | 0 to 999 minutes step 1 | | |
| 1601 | MOBZONE | Coordinating Zone | ZONE2, ZONE3, ZONE4 | | |
| OS BLOCKING | | | | | |
| 1602 | MOBCHARANG | MOB Characteristic Angle | 30 to 130 deg. step 1 | | |
| 1603 | BLOCKWHAT | Block during OS | BLKALL, BLKDIST, BLKPHAS, BLKNONE | | |
| 1604 | BLOCKZ1 | Block all Zone 1 Functions | NO, YES | | |
| 1605 | BLOCKZ2 | Block all Zone 2 Functions | NO, YES | | |
| 1606 | BLOCKZ3 | Block all Zone 3 Functions | NO, YES | | |
| 1607 | BLOCKZ4 | Block all Zone 4 Functions | NO, YES | | |
| OS TRIPPING (OUT-OF-STEP TRIPPING MODELS ONLY) | | | | | |
| 1701 | USE_OST | Select OST | NO, YES | | |
| 1702 | NUMBRCHAR | Select Number of Characteristics | 2, 3 | | |
| 1703 | TRIPIN_OUT | Trip Entering or Leaving Inner | IN, OUT | | |
| 1704 | FWDREACH | OST Forward Reach | 0.1 to 75.0 ohms step 0.1 | 0.5 to 375.0 ohms step 0.5 | |
| 1705 | REVREACH | OST Reverse Reach | 0.1 to 75.0 ohms step 0.1 | 0.1 to 375.0 ohms step 0.5 | |
| 1706 | OUTER | Outer Characteristic Angle | 40 to 165 deg. step 1 | | |
| 1707 | MIDDLE | Middle Characteristic Angle | 40 to 165 deg. step 1 | | |
| 1708 | INNER | Inner Characteristic Angle | 40 to 165 deg. step 1 | | |
| 1709 | TLOS1PU | Coordinating Timer 1 Pickup | 1 to 100 msec. step 1 | | |
| 1710 | TLOS1DO | Coordinating Timer 1 Dropout | 1 to 100 msec. step 1 | | |
| 1711 | TLOS2PU | Coordinating Timer 2 Pickup | 1 to 100 msec. step 1 | | |
| 1712 | TLOS3PU | Coordinating Timer 3 Pickup | 1 to 100 msec. step 1 | | |
| 1713 | TLOS4PU | Coordinating Timer 4 Pickup | 1 to 100 msec. step 1 | | |
| RECLOSER | | | | | |
| 1801 | RECLMODE | Select Reclosing Option | OFF, NONE, INTERNAL, EXTERNAL, BOTH | | |
| 1802 ^ | RECTYPE | Set Reclosing Type | 1POLE, 3POLE, 1POLE/3POLE | | |
| 1803 ^ | NUM1P | Number of Attempts Following 1P Trip | 1 to 4 step 1 | | |
| 1804 ^ | 1PDELAY1 | 1 Pole First Delay | 0.1 to 300 sec. step 0.1 | | |
| 1805 ^ | 1PDELAY2 | 1 Pole Second Delay | 0.1 to 300 sec. step 0.1 | | |
| 1806 ^ | 1PDELAY3 | 1 Pole Third Delay | 0.1 to 300 sec. step 0.1 | | |
| 1807 ^ | 1PDELAY4 | 1 Pole Fourth Delay | 0.1 to 300 sec. step 0.1 | | |
| 1808 | NUM3P | Number of Attempts Following 3P Trip | 1 to 4 step 1 | | |
| 1809 | 3PDELAY1 | 3 Pole First Delay | 0.1 to 300 sec. step 0.1 | | |
| 1810 | 3PDELAY2 | 3 Pole Second Delay | 0.1 to 300 sec. step 0.1 | | |
| 1811 | 3PDELAY3 | 3 Pole Third Delay | 0.1 to 300 sec. step 0.1 | | |
| 1812 | 3PDELAY4 | 3 Pole Fourth Delay | 0.1 to 300 sec. step 0.1 | | |
| 1813 | RESETTIME | Reset Time | 0.1 to 300 sec. step 0.1 | | |
| 1814 | DWELLTIME | Contact Dwell Time | 0.1 to 2 sec. step 0.1 | | |

† Setting value QUAD applies to Revision B models only.
‡ Setting applicable to Revision B models only.
^ Setting applicable to Single Phase Tripping models only.

**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 6 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|-----|----------|-------------|------------|------------|--------------|
| 1815 | HOLD | Inhibit Hold Select | NO, YES | | |
| 1816 | HOLDTIME | Inhibit Hold Time | 1 to 1000 sec. step 1 | | |
| 1817 | HOLDSENSE | Contact Input Status | CC, CO | | |
| 1818 | SYNCCHECK | Synch Check Supervision | NO, YES | | |
| 1819 | CLOSEANG | Closing Angle | 0 to 75 deg. step 1 | | |
| 1820 | SLIPFREQ | Slip Frequency | 0.1 to 5 Hz step 0.1 | | |
| 1821 | BUSLINE | Bus or Line Voltage | BUS, LINE | | |
| 1822 | SYNCPHASE | Voltage used by SYNCCHECK | VA, VB, VC, VAB, VBC, VCA | | |
| 1823 | SYNCHOLD | SYNCCHECK Hold Time | 1 to 100 sec. step 1 | | |
| 1824 ^ | SP1DELAY2 | Supervise 2nd 3P Reclose after 1P Trip | NO, YES | | |
| 1825 ^ | SP1DELAY3 | Supervise 3rd 3P Reclose after 1P Trip | NO, YES | | |
| 1826 ^ | SP1DELAY4 | Supervise 4th 3P Reclose after 1P Trip | NO, YES | | |
| 1827 | SP3DELAY1 | Supervise 1st 3P Reclose after 3P Trip | NO, YES | | |
| 1828 | SP3DELAY2 | Supervise 2nd 3P Reclose after 3P Trip | NO, YES | | |
| 1829 | SP3DELAY3 | Supervise 3rd 3P Reclose after 3P Trip | NO, YES | | |
| 1830 | SP3DELAY4 | Supervise 4th 3P Reclose after 3P Trip | NO, YES | | |
| 1831 | SYNCMANCLS | Supervise Manual Close | NO, YES | | |
| 1832 | VBUSLIVE | Live Bus Voltage | 0.1 to 130 volts step 0.1 | | |
| 1833 | VBUSDEAD | Dead Bus Voltage | 0.1 to 130 volts step 0.1 | | |
| 1834 | VLINELIVE | Live Line Voltage | 0.1 to 130 volts step 0.1 | | |
| 1835 | VLINEDEAD | Dead Line Voltage | 0.1 to 130 volts step 0.1 | | |
| 1836 | LBUSDLINE | Live Bus Dead Line | NO, YES | | |
| 1837 | DBUSLLINE | Dead Bus Live Line | NO, YES | | |
| 1838 | DBUSDLINE | Dead Bus Dead Line | NO, YES | | |
| 1839 | DELTAV | Voltage Difference | 0.1 to 30 volts step 0.1 | | |
| 1840 | DELTAVBLK | Block Synch Check by DELTAV | NO, YES | | |
| NONCRIT_AL | | | | | |
| 1901 | NCAIN1 | Non-Critical Alarm Input #1 *These 8 inputs are ORed together and then outputted to the contact assigned to the Non-Critical Alarm* | 0 to 256 step 1 | | |
| 1902 | NCAIN2 | Non-Critical Alarm Input #2 | 0 to 256 step 1 | | |
| 1903 | NCAIN3 | Non-Critical Alarm Input #3 | 0 to 256 step 1 | | |
| 1904 | NCAIN4 | Non-Critical Alarm Input #4 | 0 to 256 step 1 | | |
| 1905 | NCAIN5 | Non-Critical Alarm Input #5 | 0 to 256 step 1 | | |
| 1906 | NCAIN6 | Non-Critical Alarm Input #6 | 0 to 256 step 1 | | |
| 1907 | NCAIN7 | Non-Critical Alarm Input #7 | 0 to 256 step 1 | | |
| 1908 | NCAIN8 | Non-Critical Alarm Input #8 | 0 to 256 step 1 | | |
| OUTPUTS | | | | | |
| 2001 | T1 | T1 Contract | 0 to 256 step 1 | | |
| 2002 | T2 | T2 Contact | 0 to 256 step 1 | | |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

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**Table 2–13: PROTECTION SETTINGS DATA SHEET (Sheet 7 of 7)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A) | RANGE (1A) | USER SETTING |
|---|---|---|---|---|---|
| 2003 | T3 | T3 Contact | 0 to 256 step 1 | | |
| 2004 | T4 | T4 Contact | 0 to 256 step 1 | | |
| 2005 ^ | T5 | T5 Contact | 0 to 256 step 1 | | |
| 2006 ^ | T6 | T6 Contact | 0 to 256 step 1 | | |
| 2007 | A1 | A1 Contact (configurable) | 0 to 256 step 1 | | |
| 2008 | A2 | A2 Contact (configurable) | 0 to 256 step 1 | | |
| 2009 | A3 | A3 Contact (configurable) | 0 to 256 step 1 | | |
| 2010 | A4 | A4 Contact (configurable) | 0 to 256 step 1 | | |
| 2011 | A5 | A5 Contact (configurable) | 0 to 256 step 1 | | |
| 2012 | A6 | A6 Contact (configurable) | 0 to 256 step 1 | | |
| 2013 | A7 | A7 Contact (configurable) | 0 to 256 step 1 | | |
| 2014 | A8 | A8 Contact (configurable) | 0 to 256 step 1 | | |
| 2015 ^ | A9 | A9 Contact (configurable) | 0 to 256 step 1 | | |
| 2016 ^ | A10 | A10 Contact (configurable) | 0 to 256 step 1 | | |
| 2017 ^ | A11 | A11 Contact (configurable) | 0 to 256 step 1 | | |
| 2018 ^ | A12 | A12 Contact (configurable) | 0 to 256 step 1 | | |
| 2019 | C1 | C1 Contact (configurable) | 0 to 256 step 1 | | |
| 2020 | C2 | C2 Contact (configurable) | 0 to 256 step 1 | | |
| 2021 | KT1 | KT1 Contact (configurable) | 0 to 256 step 1 | | |
| 2022 | KT2 | KT2 Contact (configurable) | 0 to 256 step 1 | | |
| 2023 | KT3 | KT3 Contact (configurable) | 0 to 256 step 1 | | |
| 2024 | KT4 | KT4 Contact (configurable) | 0 to 256 step 1 | | |
| 2025 | CONFTRIP | Initiate Three phase Trip with Input from Xpression Builder | 0 to 256 step 1 | | |
| 2026 | CONFOSC | Initiate Oscillography Capture with Xpression Builder Input | 0 to 256 step 1 | | |

**†** Setting value QUAD applies to Revision B models only.
**‡** Setting applicable to Revision B models only.
**^** Setting applicable to Single Phase Tripping models only.

**Table 2–14: GENERAL SETTINGS DATA SHEET (Sheet 1 of 2)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A & 1A) | STEP | USER SETTING |
|---|---|---|---|---|---|
| CONFIGURE | | | | | |
| 101 | UNITID | Unit ID | 0000 to 9999 | 1 | |
| 102 | SYSFREQ | System Frequency | 50 Hz, 60 Hz | N/A | |
| 103 | PHASROTATE | Phase Rotation | ABC, ACB | N/A | |
| 104 | TIMESYNCH | Time Synch Source | INTERNAL, IRIG-B | N/A | |
| 105 | NUM_BKR | Number of Breakers | 1, 2 | N/A | |
| 106 | NUM_TC | Number of Trip Circuits | 1, 2 | N/A | |
| 107 | NUM_MON | Number of Trip Circuit Monitors | for 1P tripping: format = abcdef; for 3P tripping: format = abcd | a-f = 0 (on) or 1(off) | |
| 108 | DISPLAYVAL | Value Display Mode | PRI, SEC | N/A | |
| 109 | LANGUAGE | Language Option | ENGLISH, SPANISH | N/A | |
| 110 | SYSIN1-4 | System Inputs 1 to 4 | 0000 to 1111 (binary) 0 to 15 (decimal) | 1 | |
| COMMPORTS | | | | | |
| 201 | COMPORT1 | Communications Port #1 Settings | Baud Rate (xx), Parity (y), Stop Bits (z) *format = xxyz* | xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2 | |
| 202 | COMPORT2 | Communications Port #2 Settings | Interface (i), Baud Rate (xx), Parity (y), Stop Bits (z) *format = ixxyz* | i = 0 (RS232), 1 (RS485); xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2 | |
| 203 | COMPORT3 | Communications Port #3 Settings | Interface (i), Baud Rate (xx), Parity (y), Stop bits (z) format = ixxyz | i = 0 (RS232), 1 (RS485); xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2 | |
| 204 | PROTOCOL1 | Communications Port #1 Protocol | GE-MODEM, ASCII | N/A | |
| 205 | PROTOCOL2 | Communications Port #2 Protocol | GE-MODEM, ASCII | N/A | |
| 206 | PROTOCOL3 | Communications Port #3 Protocol | GE-MODEM, ASCII | N/A | |
| OSC_GRAPHY | | | | | |
| 301 | NUMFAULTS | Number of Fault Records | 2,4,8,12 (std. mem.) 6,12,24,36 (exp mem)[†] | N/A | |
| 302 | PREFAULT | Number of Pre-fault Cycles | 1 to 8 | 1 | |
| 303 | SPLITREC | Splits Fault Record and captures this percentage at end, with 1-SPLITREC captured at beginning | 0 to 100% | 1 | |
| BRKR DUTY | | | | | |
| 401 | EXPONENT | Exponent in $I^x t$ calculation | 1.0 to 2.0 | 0.1 | |
| 402 | MAX_OP | Maximum Number of Breaker Operations for a Breaker | 0 to 9999 | 1 | |
| 403 | MAX_IXT | Maximum Breaker Duty for a Breaker | 0 to 9999999 A$^x$sec. | 100 | |

† Applicable to the Single Phase Tripping model only.
‡ Applicable to the Three Phase Tripping model only.
* Contact converter output normally appears as a Logic 1 with normally open contact connected; to invert output to Logic 0, add 1000 to the number

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**Table 2–14: GENERAL SETTINGS DATA SHEET (Sheet 2 of 2)**

| NO. | MNEMONIC | DESCRIPTION | RANGE (5A & 1A) | STEP | USER SETTING |
|---|---|---|---|---|---|
| 404 | IXTPHASEA | Accumulated Breaker Duty, Phase A | 0 to 9999999 A$^x$sec. | 100 | |
| 405 | IXTPHASEB | Accumulated Breaker Duty, Phase B | 0 to 9999999 A$^x$sec. | 100 | |
| 406 | IXTPHASEC | Accumulated Breaker Duty, Phase C | 0 to 9999999 A$^x$sec. | 100 | |
| 407 [‡] | NUM_OP | Present Number of Breaker Operations | 0 to 9999 | 1 | |
| 407 [†] | NUM_OP_A | Present Number of Breaker Operations for Phase A | 0 to 9999 | 1 | |
| 408 [†] | NUM_OP_B | Present Number of Breaker Operations for Phase B | 0 to 9999 | 1 | |
| 409 [†] | NUM_OP_C | Present Number of Breaker Operations for Phase C | 0 to 9999 | 1 | |
| INPUTS | | | | | |
| 501 | CC1 | Contact Converter 1 | 0 to 32 * | 1 | |
| 502 | CC2 | Contact Converter 2 | 0 to 32 * | 1 | |
| 503 | CC3 | Contact Converter 3 | 0 to 32 * | 1 | |
| 504 | CC4 | Contact Converter 4 | 0 to 32 * | 1 | |
| 505 | CC5 | Contact Converter 5 | 0 to 32 * | 1 | |
| 506 | CC6 | Contact Converter 6 | 0 to 32 * | 1 | |
| 507 | CC7 | Contact Converter 7 | 0 to 32 * | 1 | |
| 508 | CC8 | Contact Converter 8 | 0 to 32 * | | |
| 509 | CC9 [†] | Contact Converter 9 | 0 to 32 * | 1 | |
| 510 | CC10 [†] | Contact Converter 10 | 0 to 32 * | 1 | |
| 511 | CC11 [†] | Contact Converter 11 | 0 to 32 * | 1 | |
| 512 | CC12 [†] | Contact Converter 12 | 0 to 32 * | 1 | |

† Applicable to the Single Phase Tripping model only.
‡ Applicable to the Three Phase Tripping model only.
* Contact converter output normally appears as a Logic 1 with normally open contact connected; to invert output to Logic 0, add 1000 to the number

![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.**

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: FRONT AND REAR VIEW).

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. place by restraining screws on the front of the module trays.

The rear of the case supports terminal blocks for external connections to the relay. The printed circuit board modules are mounted horizontally inside the case and connected via a bus card behind the front panel. The boards also have rear edge connectors that electrically connect with the rear terminal blocks and are held firmly 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.

An outline drawing is shown in Figure 3–1: DIMENSIONS above, presenting the front and rear views of the horizontal mount ALPS. The figure provides a panel cutout and drill pattern for mounting the ALPS.
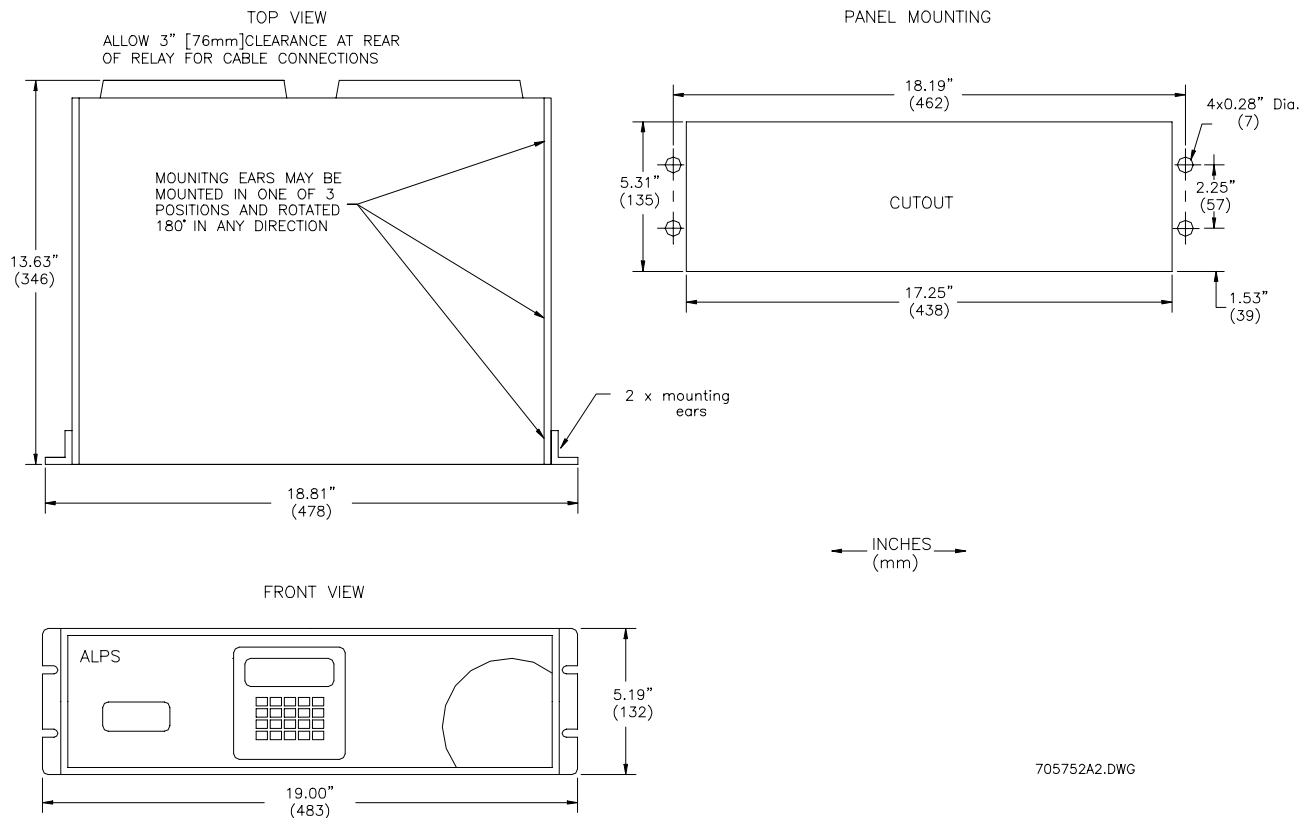


**Figure 3–1: DIMENSIONS**

## Front View

**LEDs**
STATUS: relay status
TRIP: trip has been issued

**DISPLAY**
4 line, backlit LCD display
for viewing data & settings

Relay power

Target reset/metering
push button

**KEYPAD**
20 button keypad allows the user to interrogate the
relay, change settings, display metering data, and
display event information

**COMMUNICATION**
RS232 serial data port
for local computer access

## Rear View

**TERMINAL BLOCK A**
*4 or 6 configurable trip contacts
 8 configurable alarm contacts

**TERMINAL BLOCK B**
*0 or 4 configurable alarm contacts
4 high speed configurable contacts
2 auxiliary configurable contacts
1 critical alarm
1 power supply alarm

**TERMINAL BLOCK C**
current and voltage inputs

**PL3**
optional serial port,
RS232 or RS485

**PL2A**
RS232 serial port

**TERMINAL BLOCK D**
 IRIG-B input
*8 or 12 configurable inputs
fault location I/V

**PL2B**
RS485 serial port

*Note: Lower number for three phase: higher number for single phase

705753A8.CDR

**Figure 3–2: FRONT AND REAR VIEW**

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 consisting 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 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.
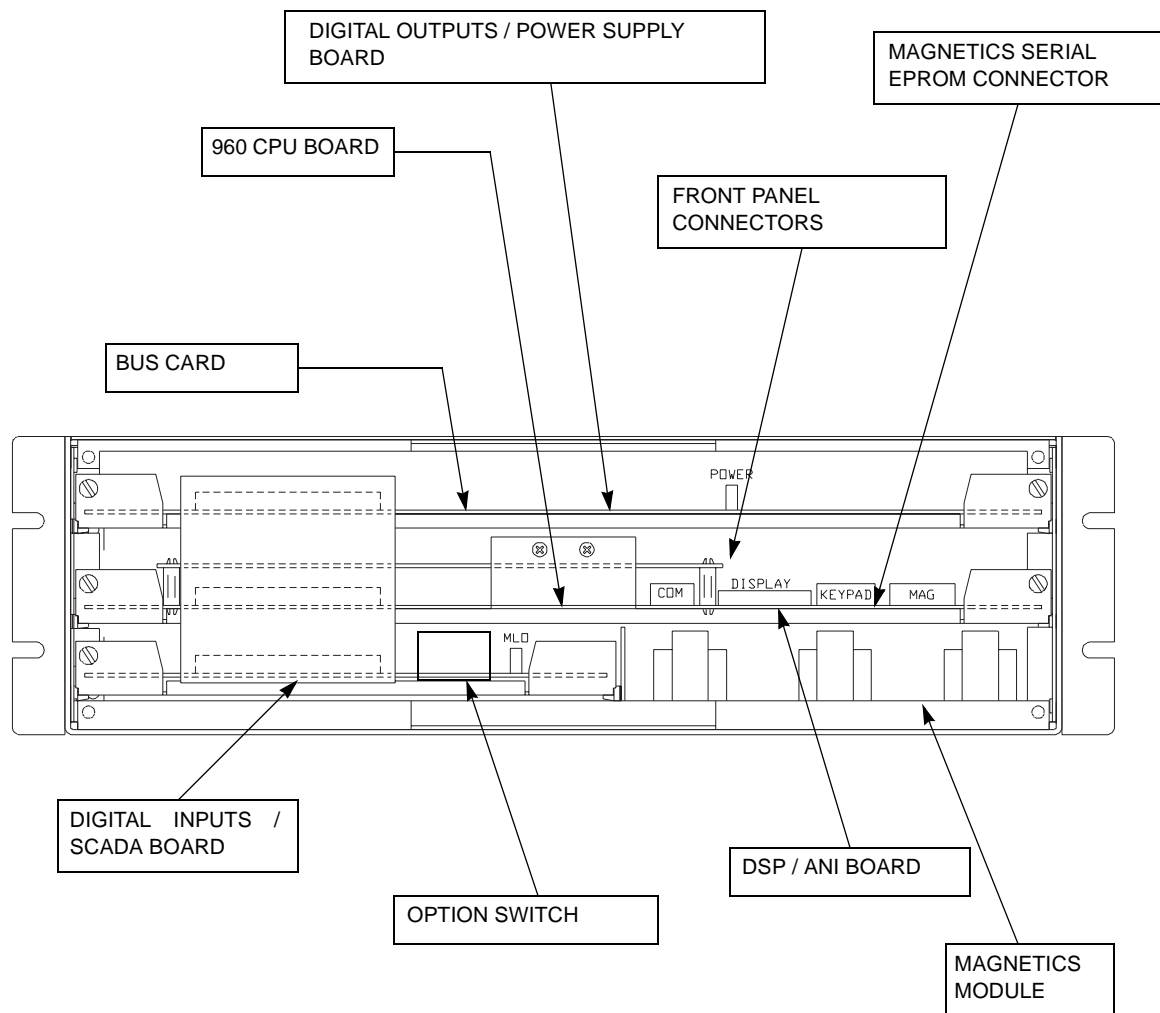


**Figure 3–3: CIRCUIT BOARD LOCATIONS**

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.

The diagram below illustrates the external connections and the interconnections between the system modules.
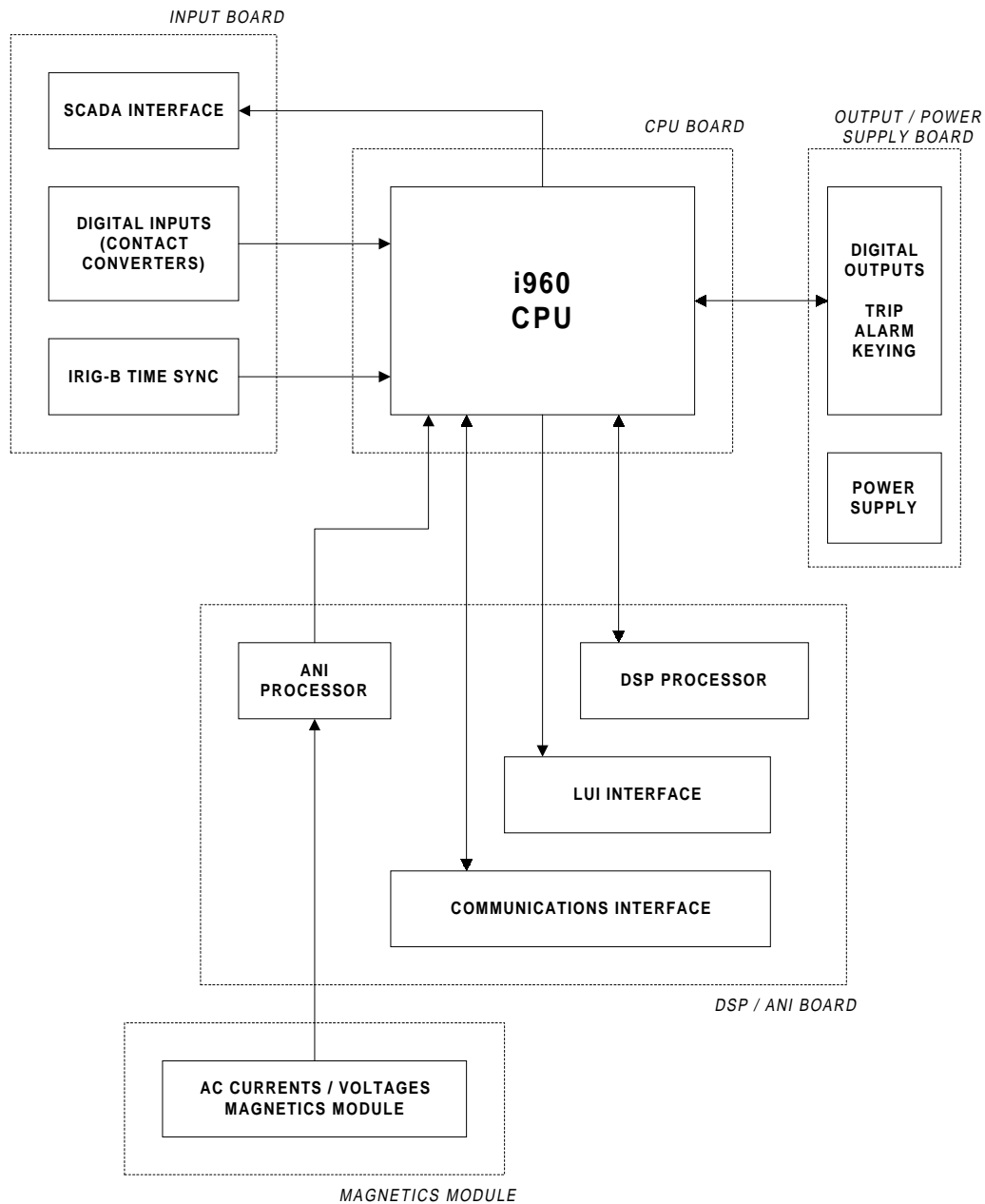
**Figure 3–4: ALPS SYSTEM BLOCK DIAGRAM**

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.

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.

The ALPS case has been designed for standard rack mounting. The case is three Rack Units (3 RU) high. Figure 3–1: DIMENSIONS on page 3–1 shows the outline and mounting dimensions.

External connections are made according to the elementary diagrams indicated below:

*   Figure 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING) on page 1–49

*   Figure 1–28: ELEMENTARY DIAGRAM WITH DEFAULT I/O (THREE PHASE TRIPPING) on page 1–50

*   Figure 1–29: ELEMENTARY DIAGRAM (SINGLE PHASE TRIPPING) on page 1–51

*   Figure 1–30: ELEMENTARY DIAGRAM (THREE PHASE TRIPPING) on page 1–52

These are 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.

⚠ **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 diagrams, Figures 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING) to 1–30: ELEMENTARY DIAGRAM (THREE PHASE TRIPPING) on pages 1–49 to 1–52. The connection to the ground bus must be made as short as possible, using #12 wire or larger.

**3**

> ⚠️
> **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: CIRCUIT BOARD LOCATIONS on page 3–3.

**3.3.2 BASIC CONSTRUCTION**

Each module consists of a printed-circuit board and aluminum plate. The printed circuit board is securely mounted to five standoffs 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.

**3.3.3 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.**

**3.3.4 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 RS232 port, and the 20-character keypad. The interface logic is contained on two printed circuit boards (DSP/ANI and LUI).

- 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 (RS232 / ASCII), a Critical Alarm Timer, various output relay drivers, and user-selectable switches to enable remote functions.

**3.3.5 INPUT BOARD**

The input board contains the input logic which includes the programmable contact converter optocouplers. The SCADA I/V (current/voltage) selection switch, SW1, is in the back, left corner on this board. The IRIG-B input is also on this board. See Figure 3–5: INPUT BOARD DIAGRAM on page 3–7 for a block diagram of the input board.

EDGE CONNECTOR

SW1

SW1 determines I or V for the SCADA I/F. Left switch position is voltage Right Switch Position is current

**V      I**

IRIG-B REAL TIME CLOCK INPUT

**J12   J11   J10   J9   J8   J7   J6   J5   J4   J3   J2   J1**

J1 through J24 select the input DC voltage range for the digital input contact converters. Refer to the table below for jumper placement. Place jumper on 1 pin for OPEN position, otherwise place jumper as designated

**Table 3–1: JUMPER POSITION**

| INPUT RANGE † | J1-J12 POSITION | J13-J14 POSITION |
|---|---|---|
| 5V - 300V DC | 1-2 | IN |
| 8V - 300V DC | 1-2 | OPEN |
| 38.5V - 300V DC | 2-3 | OPEN |
| 80V - 300V DC | OPEN | OPEN |

† Some Input boards only have J1-J12 and are dual range inputs only. Jumper in = 38.5 to 300V; Jumper out = 80 to 300V.

**J24   J23   J22   J21   J20   J19   J18   J17   J16   J15   J14   J13**

Switch 1:    KEYBOARD EN ON (Keyboard Enable) - UP keypad is disabled / DOWN keypad is enabled †

Switch 2:    RM SETT CHG ON (Remote Settings Change) - UP settings changes through communications is disabled / DOWN enabled †

Switch 3:    RM BRKR ON (Remote Breaker Operation) - UP breaker operations through communications disabled † / DOWN enabled

Switch 4:    Not used

NOTE: Relay Power switch must be in the off position before changing switch positions

† Default position

**1  2  3  4**

OPTION SWITCH

**BUS CARD CONNECTOR**

**Figure 3–5: INPUT BOARD DIAGRAM**

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). See Figure 3–6: BLOCK DIAGRAM OF THE MAGNETICS MODULE below.
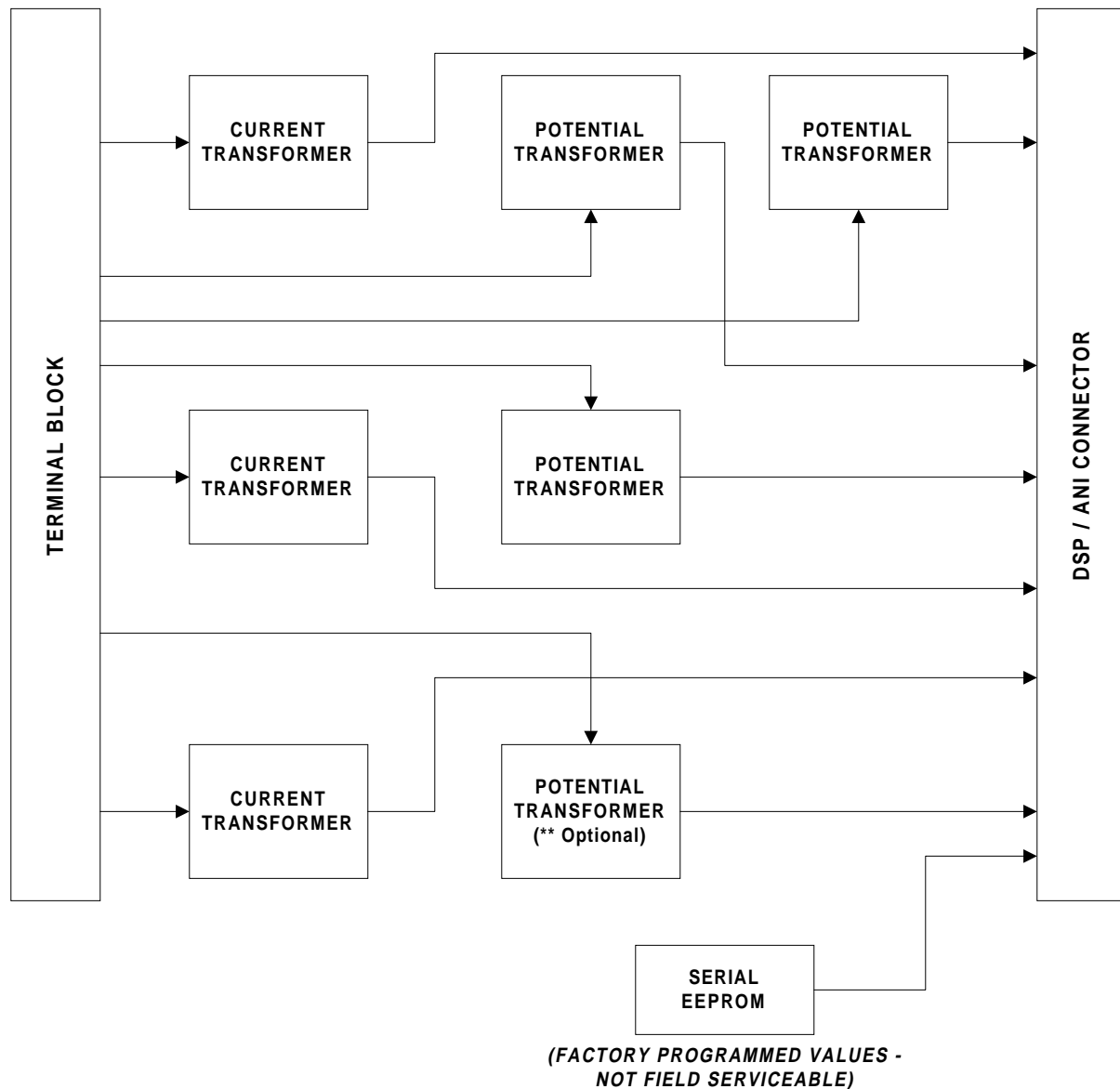


**Figure 3–6: BLOCK DIAGRAM OF THE MAGNETICS MODULE**

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 RS232 and RS485. See the description below for details. See Figure 3–7: BLOCK DIAGRAM OF THE COMMUNICATIONS MODULE below.

JP4 and JP5 select the RS485 type when RS485 commmunications is selected (2 wire/4 wire)
    Both jumpers installed: 2-wire type RS485
    Both jumpers uninstalled: 4-wire type RS485
*(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)*

**EXTERNAL CONNECTOR AREA**

3 2 1

3 2 1

**EDGE CONNECTOR**

**EDGE CONNECTOR**

Jumpers JP1, JP2, and JP3 are used to determine the types of communications

| JP1 | JP2 | JP3 | TYPE OF COMMUNICATIONS |
|------|------|------|---------------------------|
| OPEN | 2-3 | OPEN | RS232 |
| 2-3 | OPEN | 2-3 | RS485 |
| 1-2 | 1-2 | 1-2 | Programmable from keypad or communications (refer to Chapters 2 and 12) |

**Figure 3–7: BLOCK DIAGRAM OF THE COMMUNICATIONS MODULE**

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. See the block diagram below.
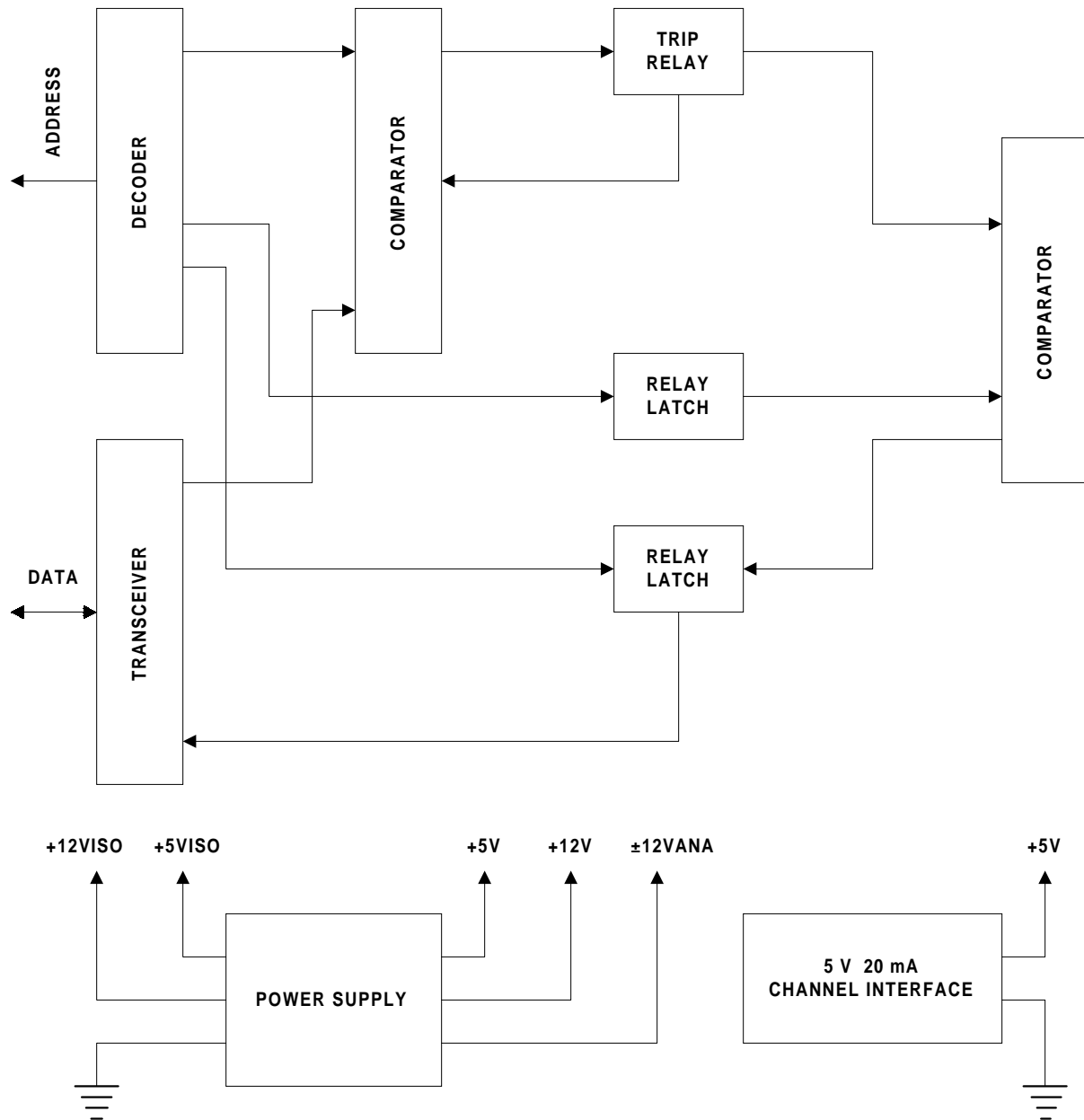


**Figure 3–8: BLOCK DIAGRAM OF THE DIGITAL OUPUT / POWER SUPPLY**

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 3–9: BLOCK DIAGRAM OF THE DSP / COMM / LUI MODULE is the block diagram of the DSP/ANI Board.
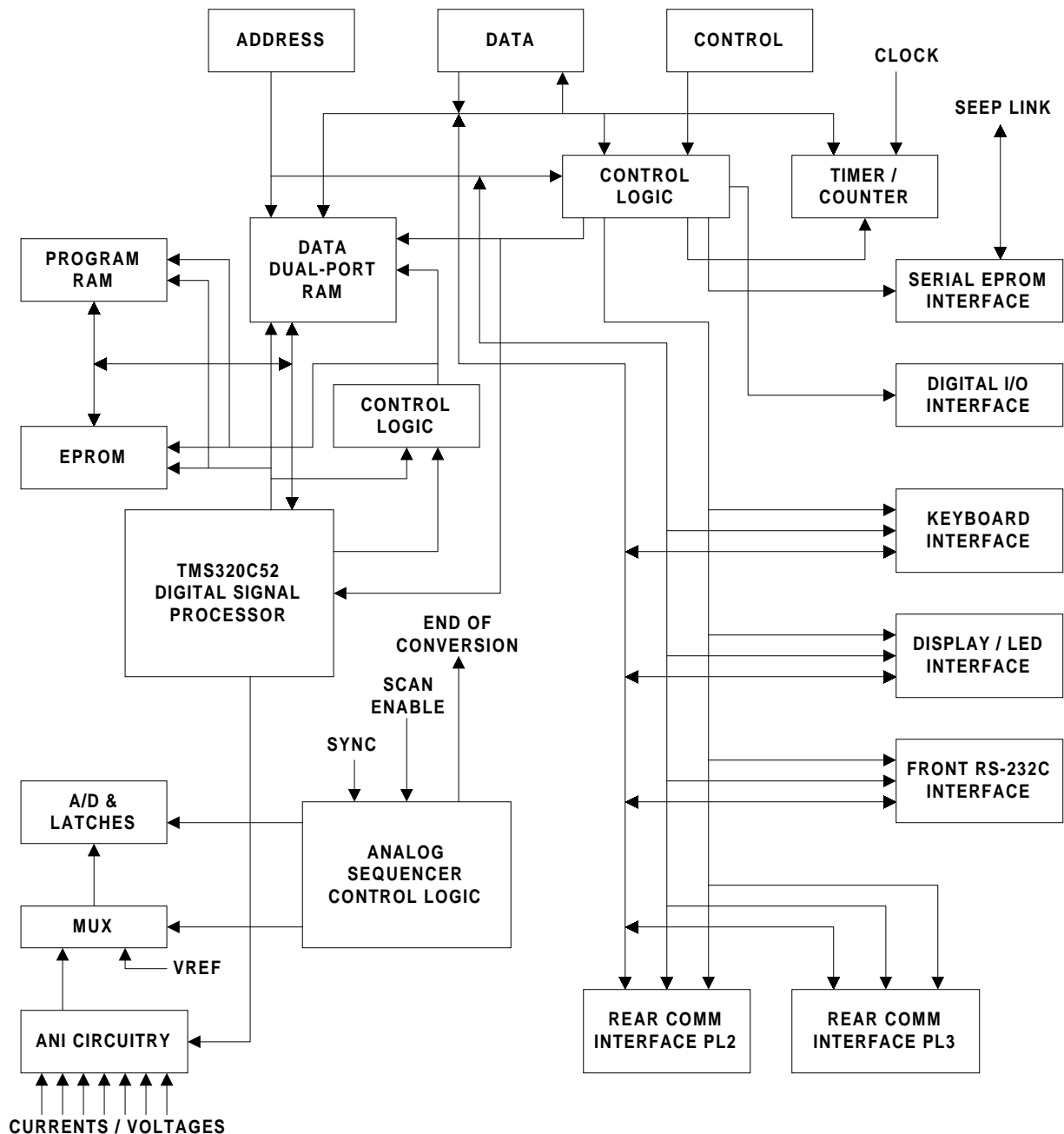
**Figure 3–9: BLOCK DIAGRAM OF THE DSP / COMM / LUI MODULE**

The 960 CPU board contains the 960 processor, 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 CPU board:

- Scheme Logic
- Test Mode
- Peripheral Protection Trip Logic
- Digital Output Logic
- Fault Reporting
- Power System Alarming
- Communications and Printer Control

The figure below contains the block diagram of the CPU logic.
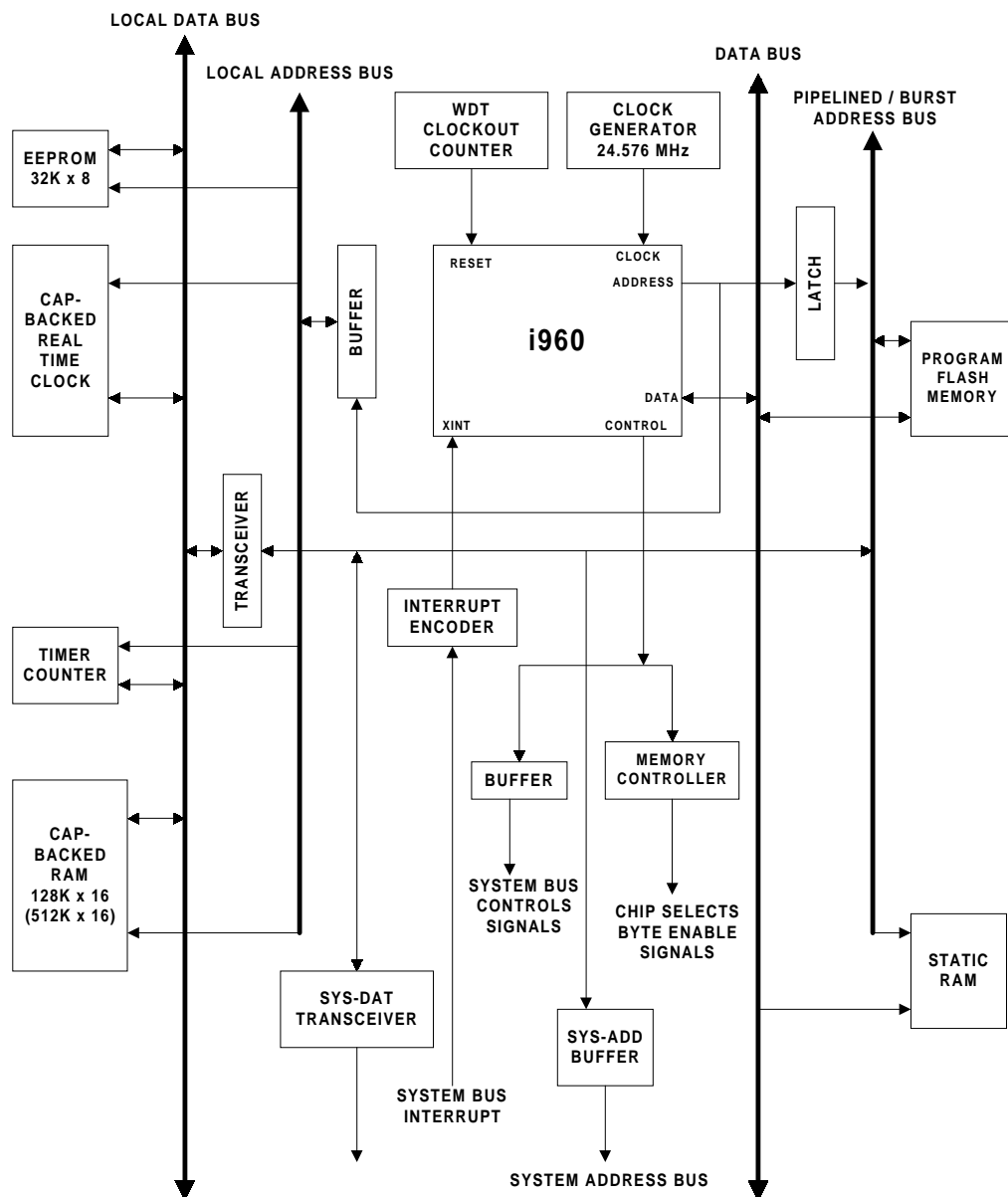


**Figure 3–10: BLOCK DIAGRAM OF THE SYSTEM PROCESSOR (i960 CPU)**

### 4.1.1 INTRODUCTION

⚠️ **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.**

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

### 4.1.2 TEST EQUIPMENT

The following test equipment is required:

•    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.

### 4.1.3 DRAWINGS AND REFERENCES

The following drawings should be used for reference during testing.

Elementary Diagrams

•    Figure 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING) on page 1–49

•    Figure 1–28: ELEMENTARY DIAGRAM WITH DEFAULT I/O (THREE PHASE TRIPPING) on page 1–50

•    Figure 1–29: ELEMENTARY DIAGRAM (SINGLE PHASE TRIPPING) on page 1–51

•    Figure 1–30: ELEMENTARY DIAGRAM (THREE PHASE TRIPPING) on page 1–52

Logic Diagrams:

•    Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS on page 1–11

•    Figure 1–4: LINE PICKUP LOGIC DIAGRAM (THREE PHASE TRIPPING) on page 1–12

•    Figure 1–5: LINE PICKUP LOGIC DIAGRAM (SINGLE PHASE TRIPPING) on page 1–13

51G curves:

The following Chapters should also be used for reference:

- Chapter 11: ALPS-LINK USER GUIDE

- Chapter 12: ASCII COMMUNICATIONS

**4**

### 4.1.4 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 Hi-Pot testing purposes).**

### 4.1.5 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).

### 4.1.6 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, such as a digital ohmmeter, to monitor the A1 contact during relay testing.

**NOTE** Tripping contacts 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 settings table in Chapter 2: CALCULATION OF SETTINGS.

**4.1.7 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: LOCAL USER INTERFACE for further details on making setting changes.

**a) 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. The message **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: LOCAL USER INTERFACE for details on changing the password.

3. Enter the current settings level password. If the password is not known, see Chapter 8: LOCAL USER INTERFACE 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 enter "5.6" on the keypad. The inputs appear on the display and the equals sign (**=**) 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 [ENT]. The blinking colon (**:**) changes back to an equals sign (**=**). 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 **Z1GRDREACH** setting to its original value before beginning the test. You will have to enter the settings level password again.

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. The **Enter Password** prompt 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: LOCAL USER 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 USER GUIDE 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 the message **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 the message **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.

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 USER GUIDE 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 USER GUIDE or Chapter 12: ASCII COMMUNICATIONS for more details on using ALPS-Link.

**a) 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: LOCAL USER INTERFACE for connecting to the ALPS to a PC.

**b) 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: ALPS-LINK USER GUIDE 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.

### c) LOAD & START ALPS-LINK

1.  Use the installation guide in Chapter 11: ALPS-LINK USER GUIDE for directions on installing ALPS-Link.

2.  Double-click on the group icon that contains ALPS-Link to open the window. Start the program by double-clicking the ALPS-Link icon.

### d) SET LOCAL PC CONFIGURATION

1.  When you start ALPS-Link the main menu bar is displayed.

2.  Click on the **SupportFunc > Host Setup > Ports** 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.

### e) CREATE TEST UNIT DESCRIPTION

The next step is to create a new Unit Description that matches the baud rate, phone number, and switch code of the ALPS. 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 **Device > Device Setup** from the main menu and click the **Add** button.

2.  In the text box for the **Device Name**, type TEST. A new unit description called TEST is created and must now have parameters set for it. Note that the **Device Setup** dialog box contains spaces for **Phone Number**, **Switch Code**, **Baud Rate**, **Stop Bits**, and **Parity**.

3.  At **Phone Number**, 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.

The Unit Description for TEST is complete. Click **OK** to return to the **Device Directory** dialog box.

### f) 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 below in Table 4–1.

**Table 4–1: FACTORY DEFAULT COMMUNICATIONS PARAMETERS**

| PARAMETER | SETTING |
|---|---|
| Unit ID | 0 |
| View Password | VIEW! |
| Control Password | CONTROL! |
| Settings Password | SETTING! |
| Master Password | MASTER! |
| Baud Rate | 9600 |

### g) LOGGING INTO THE RELAY

1.  Select **Connect** from the **Device** 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 USER GUIDE or Chapter 12: ASCII COMMUNICATIONS for details on changing a password.

3.  Type in the current password and click **OK**. If the password is not known, refer to Chapter 8: LOCAL USER INTER-FACE 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 **Device** menu and select **OK**.

### h) 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 **Device > Settings** or **Device > Local Settings** from the ALPS-Link menu bar. Information on changing settings is provided in Chapter 11: ALPS-LINK USER GUIDE.

It is important to remember to click **End** from the ALPS Settings list 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. Clicking **End** changes the settings in the relay itself.

### i) ENTERING 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 **Actions** menu.

2.  Enter the Control Level password. If the password is not known, see Chapter 8: LOCAL USER INTERFACE for details on viewing the current password.

3.  When the password is accepted, the message **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.

### j) EXITING 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.

### k) 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 **Device > 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. Click **Save ALPS** in the ALPS Settings window. 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 USER GUIDE or Chapter 12: ASCII COMMUNICATIONS.

The ALPS status is reported through the 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.

**a) STATUS CHECK**

This test demonstrates the use of the Keypad/Display Interface to check relay status. See Chapter 11: ALPS-LINK USER GUIDE 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 in on

    **1. ALPS STATUS**

3.  Press the [ENT] key. The display should contain the message **STATUS: OK**, indicating that the relay is operational and there are no errors.

4.  Verify the setting of the trip circuit monitor (General Setting 107) 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 the message

    **1. ALPS STATUS**

6.  Press the [ENT] key. The display should contain the message

    **STATUS: FAIL**
    **FAIL: TRIP CKT #1 CONTINUITY ERROR**

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

7.  Change the setting of the trip circuit monitor to **NUM_MON** = 0000 (000000) to re-check the status. The display should read **STATUS: OK**

8.  Change the setting of the trip circuit monitor back to **NUM_MON** = 0011 (000111) before starting the next test.

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.

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 8.4.1: HARDWARE SWITCHES on page 8–24 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: DIGITAL OUTPUTS TEST CONNECTIONS on page 4–9.

2. Press the [ACT] key and enter the control level password.

3. Use the arrow key to select **8. Digital Output Test**

4. Press the [ENT] key. Before a contact is allowed to be tested, the display prompts **DISABLE PROTECT?**

5. 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).

6. 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.

7. 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.

8. 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.

**Table 4–2: DIGITAL OUTPUTS TEST CONNECTIONS**

| OUPTUT | X | Y | OUTPUT | X | Y |
|--------|-----|-----|--------|-----|-----|
| T1 | A3 | A19 | A12 † | B4 | B20 |
| T2 | A4 | A20 | KT1 (no) | B5 | B21 |
| T3 | A5 | A21 | KT1 (nc) | B5 | B22 |
| T4 | A6 | A22 | KT2 (no) | B5 | B21 |
| T5 † | A7 | A23 | KT2 (nc) | B23 | B7 |
| T6 † | A8 | A24 | KT3 (no) | B8 | B24 |
| A1 | A9 | A25 | KT3 (nc) | B8 | B25 |
| A2 | A10 | A26 | KT4 (no) | B26 | B9 |
| A3 | A11 | A27 | KT4 (nc) | B26 | B10 |
| A4 | A12 | A28 | C1A (no) | B11 | B27 |
| A5 | A13 | A29 | C1B (nc) | B11 | B28 |
| A6 | A14 | A30 | C2A (no) | B29 | B12 |
| A7 | A15 | A31 | C2B (nc) | B29 | B13 |
| A8 | A16 | A32 | CA (nc) | B14 | B30 |
| A9 † | B1 | B17 | CA (no) | B14 | B31 |
| A10 † | B2 | B18 | PWR (nc) | B32 | B15 |
| A11 † | B3 | B19 | PWR (no) | B32 | B16 |

**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
**PWR** - Power Supply Alarm
**†** These digital outputs apply to the Single Phase Tripping model only.
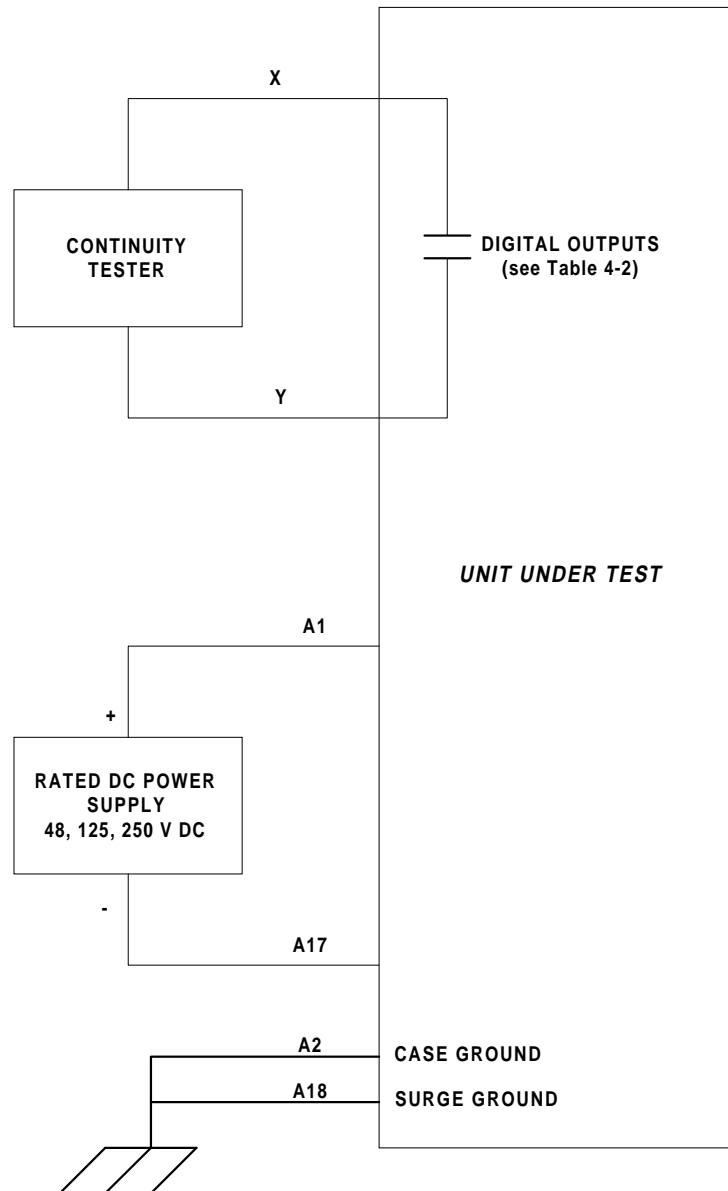
**Figure 4–1: DIGITAL OUTPUTS TEST CONNECTIONS**

### 4.2.4 T3 – CONFIGURABLE INPUT AND OUTPUT TEST

The ALPS includes 8 configurable inputs and 18 configurable outputs for Single Phase Tripping models and 12 configurable inputs and 24 configurable outputs for Three Phase Tripping models. These provide great flexibility in applying and testing the relay. The configurable inputs are programmed to determine their use. For example, one input could trigger oscillography, while another could 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.

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 DC from CC8.

9.  (Single Phase Tripping model only) 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 CC10.

10. (Single Phase Tripping model only) 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. (Single Phase Tripping model only) 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 CC11.

12. (Single Phase Tripping model only) 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 CC12.

### 4.2.5 T4 – AC SYSTEM INPUT TEST

This test uses present values to determine if 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 the relay voltages and currents.

1.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

2.  Set VA to 67 V rms $\angle 0°$, VB to 57 V rms $\angle -120°$, and VC to 47 V rms $\angle 120°$.

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 $I_{op}$ to 1.0 amp rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

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. Reduce the test current to zero amps.
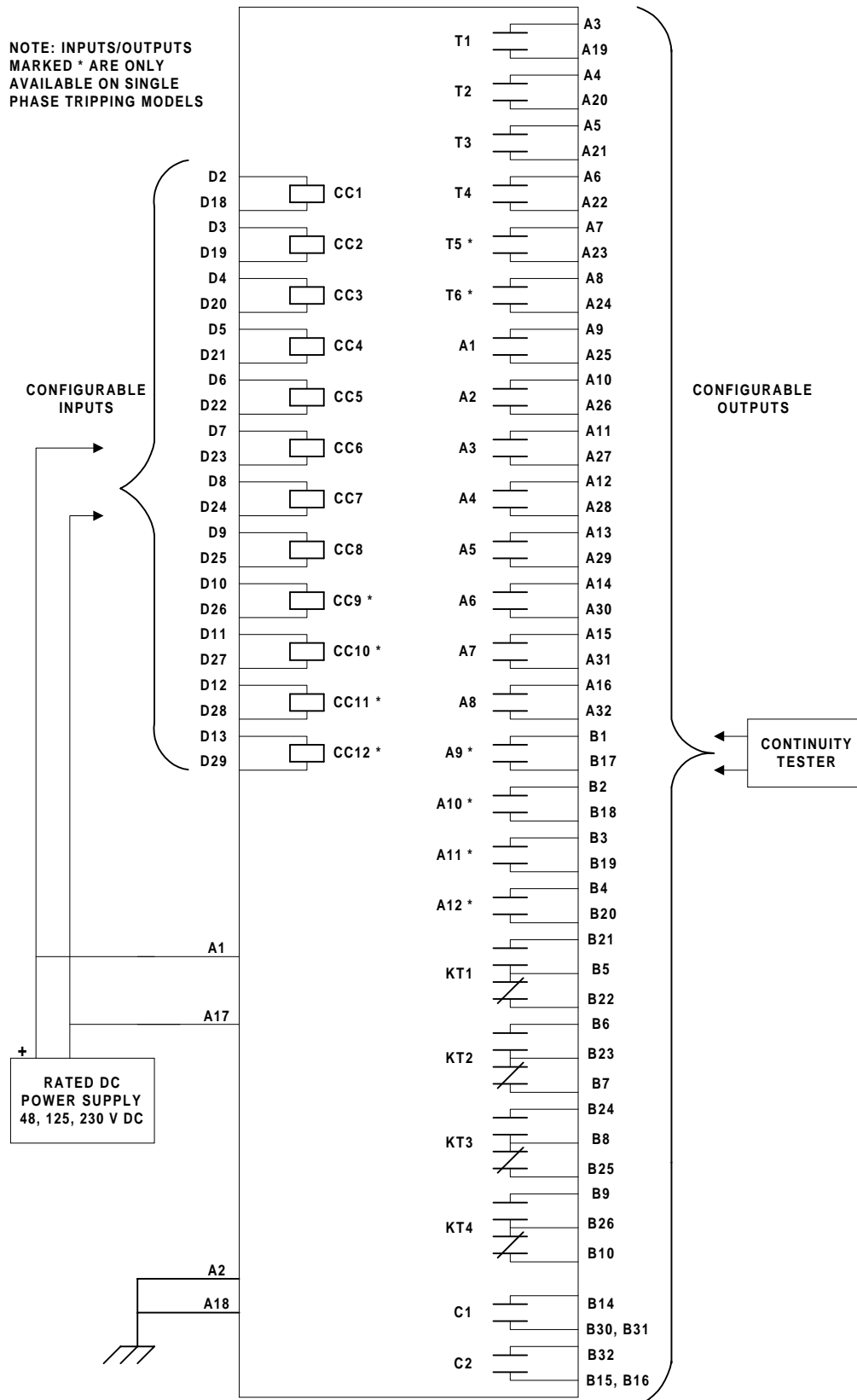
**Figure 4–2: CONFIGURABLE INPUT/OUTPUT TEST CONNECTIONS**

**4**



**Table 4–3:**

| PHASE UNDER TEST | TERMINAL BLOCK # |
|---|---|
| AG | C1 |
| BG | C3 |
| CG | C5 |
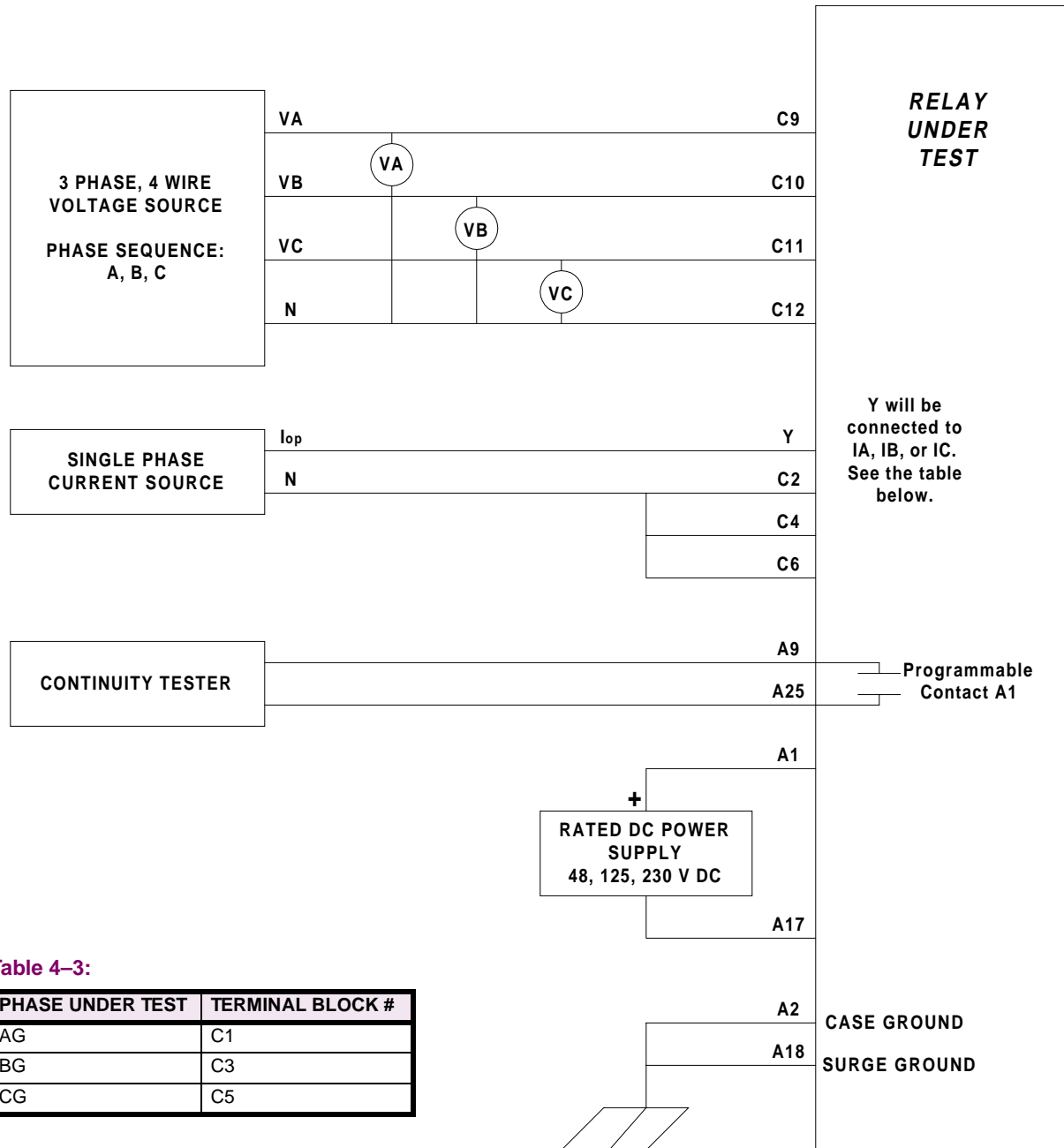
**Figure 4–3: PHASE TO GROUND TEST CONNECTIONS**

## a) MEASURING UNIT TESTS

- T1 – FD Fault Detector

- T2 – IT Trip Supervision

- T3 – IB Blocking Supervision

- T4 – Ground Directional Trip

- T5 – Ground Directional Block

- T6 – Phase Instantaneous Overcurrent

- T7 – Ground Instantaneous Overcurrent

- T8 – Ground Time Overcurrent

- T9 – Undervoltage

- T10 – Overvoltage

## b) ZONE GROUND / PHASE REACH and TIMERS TESTS

- T11 – Zone 1 Ground Reach M1G

- T12 – Zone 2 Ground Reach MTG

- T13 – Zone 3 Ground Reach M3G

- T14 – Zone 4 Ground Reach M4G

- T15 – Ground (Zone Backup) Timer

## c) PHASE-TO-PHASE ZONE REACH TESTING

- T16 – Zone 1 Phase Reach M1

- T17 – Zone 2 Phase Reach MT

- T18 – Zone 3 Phase Reach M3

- T19 – Zone 4 Phase Reach M4

- T20 – Phase (Zone Backup) Timer

- T21 – Out-of-Step Reach MOB

Refer to Section 4.1: OVERVIEW for information on beginning functional tests.

> ⚠ **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.**

> ⚠ **CAUTION**
> **Before starting to test the ALPS, download all the relay settings to your PC using the ALPS-Link program**

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: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

2.  Set the relay into test mode 38 (the fault detector). The relay displays **FAULT DETECTOR ON**

3.  Protection Settings:

    Z1DISTANCE
    (101)   **Z1PHASE** = NO
    (104)   **Z1GROUND** = NO

    Z2DISTANCE
    (201)   **Z2PHASE** = NO
    (204)   **Z2GROUND** = NO

    Z3DISTANCE
    (301)   **Z3PHASE** = NO
    (304)   **Z3GRND** = NO

    Z4DISTANCE
    (401)   **Z4PHASE** = NO
    (405)   **Z4GRND** = NO

    OVERCURRENT
    (605)   **50G** = NO
    (610)   **51G** = NO

4.  Set the voltages as follows:

    VA = 67 V rms $\angle 0°$
    VB = 67 V rms $\angle -120°$
    VC = 67 V rms $\angle +120°$

5.  Slowly increase $I_{op}$ to 1.2 (0.40) A rms, at approximately 0.1 (0.01) A per second. Slowly decrease the current to 0 A. The A1 contact should not close.

6.  Immediately increase $I_{op}$ to 1.5 (0.2) A rms. The A1 contact should close momentarily.

7.  Slowly increase $I_{op}$ to 2.5 (0.4) A rms. The A1 contact should close until current is removed.

8.  Reduce $I_{op}$ to 0.

1.  Settings:

    Z1DISTANCE

    (104)   **Z1GROUND** = YES

    CURSUPVIS

    (501)   **IT_PICKUP** = 0.25 (0.05) A

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

3.  Set the relay into test mode 34 (IT Detector). The LUI should display **IT DETECTOR ON**

4.  Set the voltages as follows:

    VA = 67 V rms $\angle 0°$
    VB = 67 V rms $\angle -120°$
    VC = 67 V rms $\angle +120°$.

5.  Set $I_{op}$ to 0.40 (0.08) A rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to 0.15 (0.03) A rms, at which point the A1 contact should open.

6.  Reduce $I_{op}$ to 0.

### 5.2.3 T3 – IB BLOCKING SUPERVISION TEST

1.  Setting:

    Z4DISTANCE
    (405)   **Z4GRND** = YES

    CURSUPVISN
    (502)   **IB_PICKUP** = 0.2 (0.04) A

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

3.  Set the relay into test mode 35 (IB Detector). The LUI should display **IB DETECTOR ON**

4.  Set the voltages as follows:

    VA = 67 V rms ∠0°
    VB = 67 V rms ∠−120°
    VC = 67 V rms ∠+120°

5.  Set $I_{op}$ to 0.30 (0.06) A rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to 0.10 (0.02) A rms, at which point the A1 contact should open.

6.  Reduce $I_{op}$ to 0.

### 5.2.4 T4 – GROUND DIRECTIONAL TRIP TEST, IPT + NT

1.  Setting:

    Z2DISTANCE
    (204)   **Z2GROUND** = YES
    (205)   **Z2GRDCHAR** = GDOC

    CURSUPVIS
    (503)   **IPT_PICKUP** = 0.5 (0.1) Amps

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

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 $I_{op}$, to 0.70 (0.14) A rms ∠−85°, and apply to the relay. The A1 contact should close. Lower $I_{op}$ to 0.40 (0.08) A rms, at which point the A1 contact should open.

6.  Reduce $I_{op}$ to 0.

### 5.2.5 T5 – GROUND DIRECTIONAL BLOCK TEST, IPB + NB

1.  Settings:

    CURSUPVIS
    (504)   **IPB_PICKUP** = 0.25 (0.05) A

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

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 $I_{op}$, to 0.40 (0.08) A rms ∠−265° and apply to the relay. The A1 contact should close. Lower $I_{op}$ to 0.15 (0.03) A rms, and the A1 contact should open.

6.  Reduce $I_{op}$ to 0 A.

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 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for a phase AB, BC, or CA fault. Note that the leading phase is 180 degrees 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 $I_{op}$ to 2.8 (0.6) A rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to 2.0 (0.4) A rms, at which point the A1 contact should open.

5.   Reduce $I_{op}$ to 0 A.

6.   Restore the following Protection settings

OVERCURRNT
(602)   **50_DIRCNL** = YES
(603)   **50PICKUP** = 20.0 (4.0) Amps

1.   Protection settings:

OVERCURRNT
(605)   **50G** = YES
(606)   **50G_DIRCNL** = NO (Directnl ctrl off)
(607)   **50GPICKUP** = 2.5 (0.5) Amps
(609)   **50GRESTNT** = 0

2.   Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

3.   Set the relay into test mode 44 (Ground Overcurrent). The LUI displays **INST GND OVRC ON**

4.   Set $I_{op}$ to 4.0 (0.80) A rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to 2.4 (0.40) A rms, at which point the A1 contact should open.

5.   Reduce $I_{op}$ to zero.

6.   Restore the following settings

OVERCURRNT
(605)   **50G_DIRCNL** = YES
(605)   **50GPICKUP** = 10 (2.0) Amps

1.   Record the pre-test values for Protection Settings 610, 611, 612, 614, and 615. and make the following changes:

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 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–7.

**NOTE**   **Start the timer when $I_{op}$ is applied, and stop the timer when A1 closes (the relay trips).**

3. For this test remove the relay from test mode and assign TOCTRP to A1.

   (2007)   **A1** = index 119; TOCTRP

4. Apply $I_{op}$ 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 $I_{op}$ to zero.

6. Repeat steps 3 and 4 with values for $I_{op}$ from the table below. Verify that the **51G** times out within the specified time.

| $I_{OP}$, A RMS | 51G TIME OUT, S |
|---|---|
| 3 | 2.8 to 3.2 |
| 6 | 0.9 to 1.1 |
| 10 | 0.6 to 0.8 |

7. Restore these Protection settings

   OVERCURRNT
   (610)   **51G** = *Pretest setting*
   (611)   **51G_DIRCNL** = *Pretest setting*
   (612)   **51GPICKUP** = *Pretest setting*
   (615)   **51GTIMDIAL**= *Pretest setting*

   OUTPUTS
   (2007)   **A1** = *Pretest setting*

### 5.2.9 UNDERVOLTAGE TEST

1. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–7.

2. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°
   VB: 67 volts rms ∠−120°
   VC: 67 volts rms ∠+120°

3. Set $I_{op}$ to zero Amps.

4. Set the relay into test mode 48 The LUI displays **UNDERVOLTAGE ON**

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.

### 5.2.10 T9 – T10 – OVERVOLTAGE TEST

1. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–7 and make the following Protection settings:

   VOLTAGE
   (701)   **RATEDVOLTS** = 115 (V rms)
   (702)   **PHASEOVER** = YES
   (703)   **PHOVPICKUP** = 1.10 (pu Volts)
   (704)   **PHOVTMDLY** = 0.5

2. Set the relay into test mode 47. The LUI displays **OVERVOLTAGE ON**

3. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°
   VB: 67 volts rms ∠−120°
   VC: 67 volts rms ∠+120°.

4. Set $I_{op}$ to zero Amps.

5. Set phase A voltage to 74 V and check that contact A1 is closed. Set phase A voltage back to 67 V and check that contact A1 opens. Repeat for phases B and C.

**5**



**Table 5–1:**

| PHASE UNDER TEST | INPUT Y TERMINAL BLOCK NUMBER | INPUT X TERMINAL BLOCK NUMBER |
|---|---|---|
| AB | C1 | C3 |
| BC | C3 | C5 |
| CA | C5 | C1 |
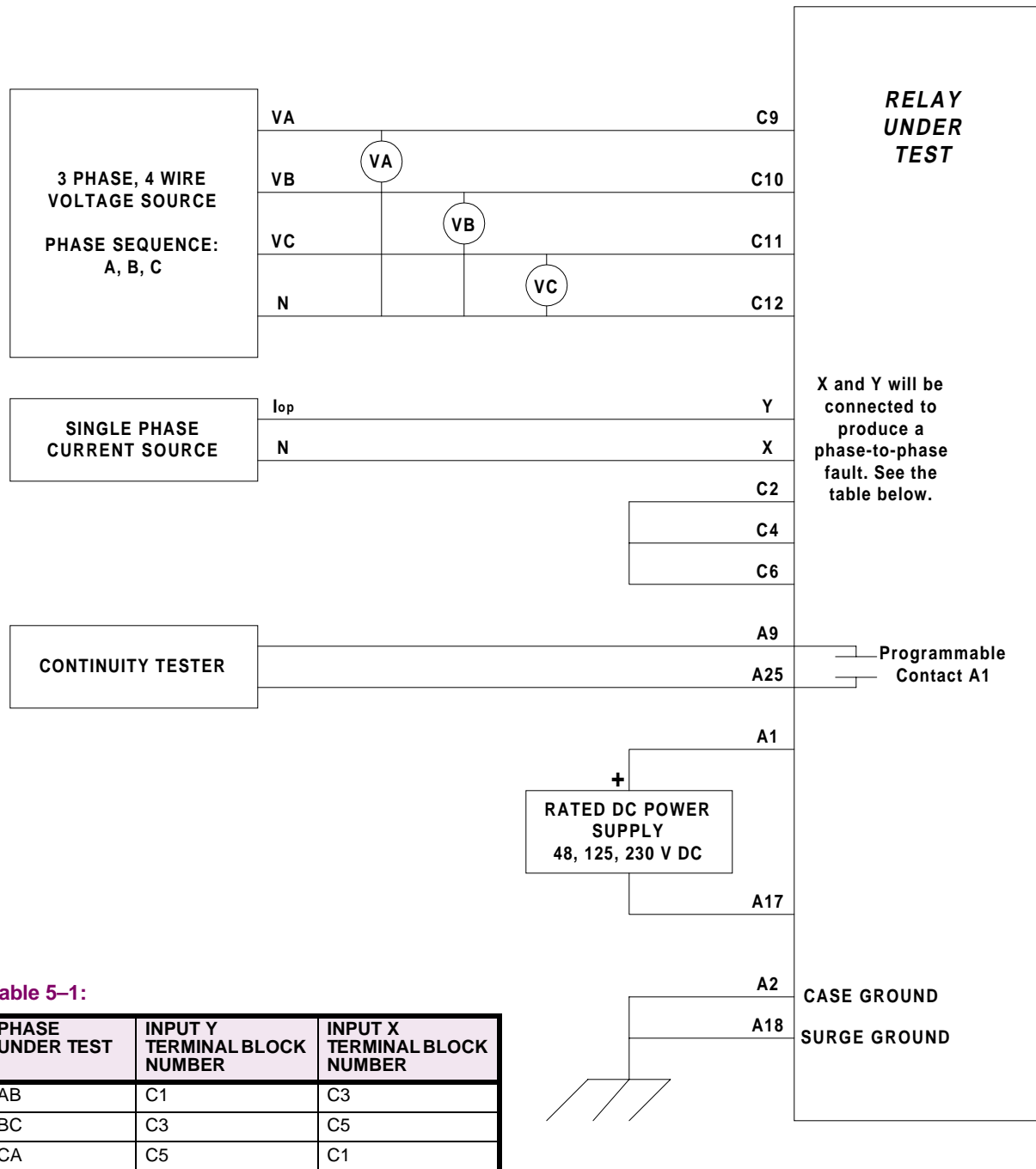
**Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS**
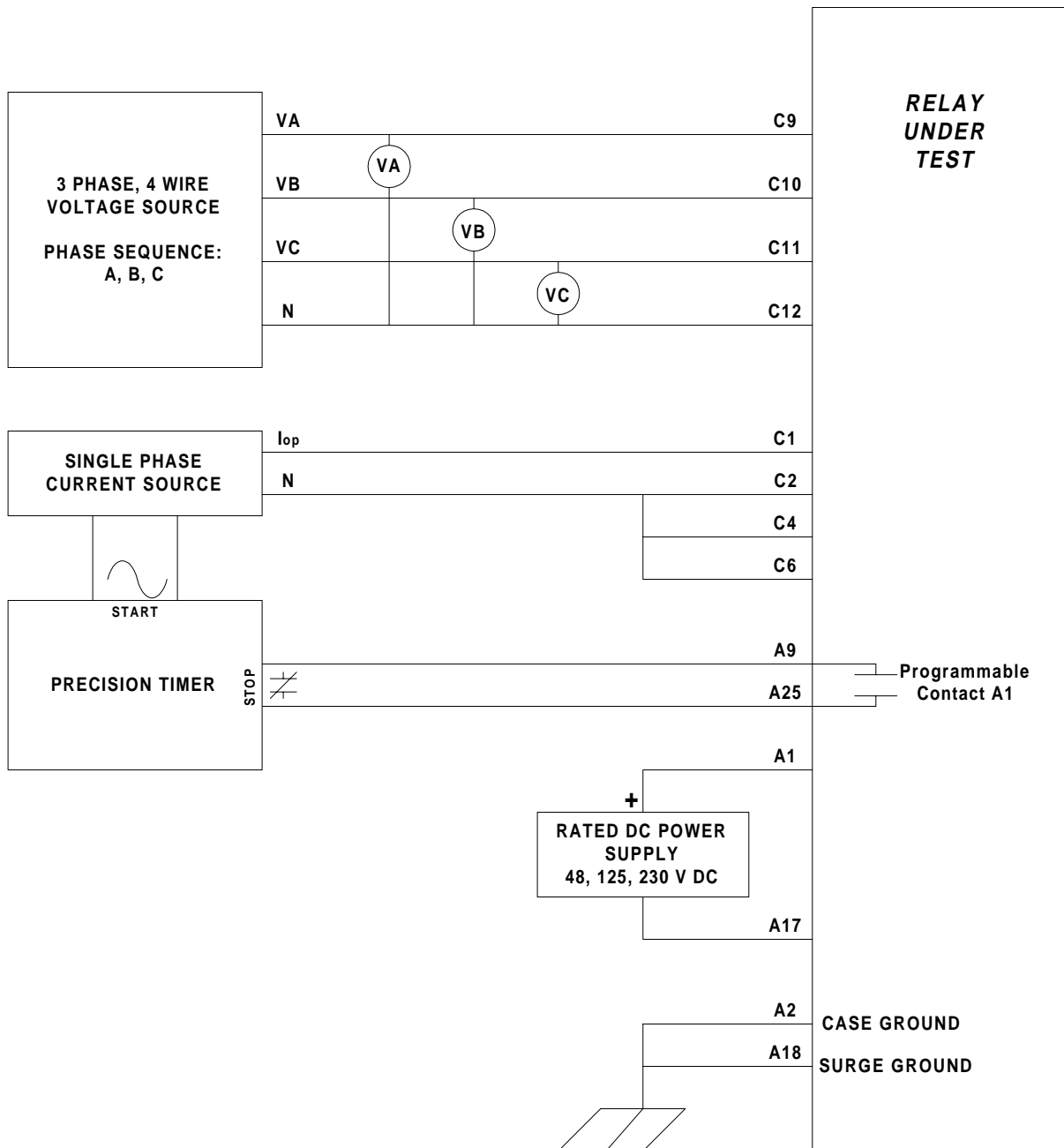
**Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS**

### 5.3.1 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 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:

OVERCURRNT
(601)    **50** = NO
(605)    **50G** = NO
(610)    **51G** = NO

OS BLOCKING
(1603)   **BLOCKWHAT** = 3 (BLKNONE)

> **After the zone reach testing is completed, restore these settings to their pretest values.**
> **NOTE**

### 5.3.2 T11 – ZONE 1 GROUND REACH, M1G GROUND FAULTS

1. Protection settings:

Z1DISTANCE
(101)    **Z1PHASE** = NO
(104)    **Z1GROUND** = YES

Z2DISTANCE
(201)    **Z2PHASE** = NO
(204)    **Z2GROUND** = NO

Z3DISTANCE
(301)    **Z3PHASE** = NO
(304)    **Z3GRND** = NO

Z4DISTANCE
(401)    **Z4PHASE** = NO
(405)    **Z4GRND** = NO

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 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 $\angle 0°$
VB: 67 volts rms $\angle -120°$
VC: 67 volts rms $\angle +120°$

5. Set the fault current, $I_{op}$, to the phase angle listed below (increase VA, VB, and VC to 75 V when $\angle I_{op} = -79°$).

| ∠I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| –49 | 56 to 63 | – |
| –79 | 65 to 73 | 82 to 88 |
| –109 | 56 to 63 | – |

[†] Reference Only

6. 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 above.

7.  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"**, where "DIST" is the displayed target.

8.  Repeat the test for BG and CG faults.

### 5.3.3 T12 – ZONE 2 GROUND REACH, MTG GROUND FAULTS

1.  Protection settings:

    Z1DISTANCE
    (101)    **Z1PHASE** = NO
    (104)    **Z1GROUND** = NO

    Z2DISTANCE
    (201)    **Z2PHASE** = NO
    (204)    **Z2GROUND** = YES

    Z3DISTANCE
    (301)    **Z3PHASE** = NO
    (304)    **Z3GRND** = NO

    Z4DISTANCE
    (401)    **Z4PHASE** = NO
    (405)    **Z4GRND** = NO

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 for the appropriate phase under test.

3.  Set the relay to test mode 15 (Any Zone 2 Ground). The LUI displays: **ANY Z2 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 ∠+120°.

5.  Set the fault current, $I_{op}$, to the phase-angle value listed below (increase VA, VB, and VC to 75 V when $\angle I_{op}$ = –79°).

| ∠I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| –49 | 56 to 63 | – |
| –79 | 65 to 72 | 146 to 154 |
| –109 | 56 to 63 | – |

[†] Reference only

6.  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 above.

7.  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"**, where "DIST" is the displayed target.

8.  Repeat the test for BG and CG faults.

### 5.3.4 T13 – ZONE 3 GROUND REACH, M3G GROUND FAULTS

1.  Protection Settings:

    Z1DISTANCE
    (101)    **Z1PHASE** = NO
    (104)    **Z1GROUND** = NO

    Z2DISTANCE
    (201)    **Z2PHASE** = NO
    (204)    **Z2GROUND** = NO

Z3DISTANCE
(301)    **Z3PHASE** = NO
(304)    **Z3GRND** = YES

Z4DISTANCE
(401)    **Z4PHASE** = NO
(405)    **Z4GRND** = NO

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 for the appropriate phase under test.

3.  Set the relay to test mode 16 (Any Z3 Ground). The LUI displays: **ANY Z3 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 ∠+120°.

5.  Set the fault current, $I_{op}$, to the phase-angle value listed below (increase VA, VB, and VC to 75V when ∠ $I_{op}$ = − 79°).

| ∠I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| −49 | 57 to 64 | – |
| −79 | 66 to 73 | 195 to 205 |
| −109 | 57 to 64 | – |

**†** Reference only

6.  Set the fault current to 3.5 (0.7) A rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within the limits above.

7.  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"**, where "DIST" is the displayed target.

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

### 5.3.5 T14 - ZONE 4 GROUND REACH, M4G GROUND FAULTS

1.  Setting:
    Z1DISTANCE
    (101)    **Z1PHASE** = NO
    (104)    **Z1GROUND** = NO

    Z2DISTANCE
    (201)    **Z2PHASE** = NO
    (204)    **Z2GROUND** = NO

    Z3DISTANCE
    (301)    **Z3PHASE** = NO
    (304)    **Z3GRND** = NO

    Z4DISTANCE
    (401)    **Z4PHASE** = NO
    (405)    **Z4GRND** = YES

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 for the appropriate phase under test.

3.  Set the relay into test mode 17 (Any Zone 4 Ground). The LUI displays **ANY Z4 GRD ON**

4.  Set the voltage inputs to the following values:

    VA: 67 volts rms ∠0°,
    VB: 67 volts rms ∠−120°,
    VC: 67 volts rms ∠+120°.

5.  Set the fault current, $I_{op}$, to the phase-angle value listed below (increase VA, VB, VC to 75V when $\angle I_{op} = -79°$).

| ∠I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| –49 | 56 to 63 | – |
| –79 | 62 to 72 | 290 to 310 |
| –109 | 56 to 63 | – |

[†] Reference only

6.  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 above.

7.  Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as **TRIP AG Z3 "DIST"**, where "DIST" is the displayed target.

8.  Repeat the test for BG and CG faults.

### 5.3.6 T15 – GROUND (ZONE BACKUP) TIMER TESTS

1.  For this test, remove the relay from test mode. Record the pre-test values for all Protection Settings used in the test.

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)  **Z3GRND** = YES
(307)  **Z3P_TIME** = 3.0
(308)  **Z3G_TIME** = 3.0

Z4DISTANCE
(401)  **Z4PHASE** = NO
(405)  **Z4GRND** = YES
(410)  **Z4P_TIME** = 5.0
(411)  **Z4G_TIME** = 5.0

OUTPUTS
(2007)  **A1** = Z2GTMR; Index 129

**a) ZONE 2 TIMER**

3.  Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–7 for the appropriate phase under test.

4.  Set the voltage inputs to the following values:

VA: 55 volts rms ∠0°,
VB: 67 volts rms ∠–120°,
VC: 67 volts rms ∠+120°.

5.  Set the phase angle of the fault current $I_{op}$ to –55°.

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

7. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a Zone 2 trip, such as: **TRIP AG Z2**. This verifies that the second zone tripped. The time for the trip should be in the range 0.9 to 1.1 seconds.

8. Leave the voltages at the values of step 4.

### b) ZONE3 TIMER

9. Settings:

   Z2DISTANCE
   (201)   **Z2PHASE** = NO
   (204)   **Z2GROUND** = NO

   OUTPUTS
   (2007)   **A1** = Z3GTMR; Index 130

10. Apply the fault current at 8.2 (1.6) A rms to the relay and start the Precision Timer (the fault current should not be ramped, but applied at the required level) This is an AG fault that is within pickup of all four zones.

11. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a Zone 3 trip, such as: **TRIP AG Z3**. This verifies that the third zone tripped. The time for the trip should be in the range 2.9 to 3.1 seconds.

12. Leave the voltages at the values of step 4.

### c) ZONE4 TIMER

13. Settings:

   Z3DISTANCE
   (301)   **Z3PHASE** = NO
   (304)   **Z3GRND** = 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, but applied at the required 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 Zone 4 trip, such as: **TRIP AG Z4**. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8 to 5.2 seconds.

16. If you are not continuing with Phase Reach testing, return all settings to their pretest values.

### 5.4.1 T16 – ZONE 1 PHASE REACH, M1 FAULTS

1.  Protection Settings:

    Z1DISTANCE
    (101)  **Z1PHASE** = YES
    (104)  **Z1GROUND** = NO

    Z2DISTANCE
    (201)  **Z2PHASE** = NO
    (204)  **Z2GROUND** = NO

    Z3DISTANCE
    (301)  **Z3PHASE** = NO
    (304)  **Z3GRND** = NO

    Z4DISTANCE
    (401)  **Z4PHASE** = NO
    (405)  **Z4GRND** = NO

    OVERCURRNT
    (601)  **50** = NO
    (605)  **50G** = NO
    (610)  **51G** = NO

    OS BLOCKING
    (1603)  **BLOCKWHAT** = 3 (BLKNONE)

2.  Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 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 as follows: VA: 67 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle +120°$.

4.  Set the phase angle of the fault current $I_{op}$ to the phase-angle value listed in the table below. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.

    | $\angle$I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
    |---|---|---|
    | –25 | 51 to 57 | – |
    | –55 | 59 to 66 | 82 to 88 |
    | –85 | 51 to 57 | – |

    [†] Reference only

5.  Set the fault current to 10.0 (2.0) amps rms. Reduce the voltage of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown above.

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"**, where "DIST" is the displayed target.

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

### 5.4.2 T17 – ZONE 2 PHASE REACH, M2 FAULTS

1.  Protection 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)   **Z3GRND** = NO

Z4DISTANCE
(401)   **Z4PHASE** = NO
(405)   **Z4GRND** = NO

OVERCURRNT
(601)   **50** = NO
(605)   **50G** = NO
(610)   **51G** = NO

OS BLOCKING
(1603)   **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for the appropriate phases under test. Set the relay to test mode 31 (Any Zone 2 Phase). The LUI displays: **ANY Z2 PHASE ON**

3. Set the voltage inputs as follows: VA: 67 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle +120°$.

4. Set the fault current, $I_{op}$, to the phase-angle value listed below. 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 $\angle I_{op} = -55°$).

| ∠I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| −25 | 57 to 64 | – |
| −55 | 65 to 73 | 146 to 154 |
| −85 | 57 to 64 | – |

**†** Reference only

5. Set the fault current to 6.7 (1.4) amps rms. Reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown above.

6. 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"**, where "DIST" is the displayed target.

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

### 5.4.3 T18 – ZONE 3 PHASE REACH, M3 FAULTS

1. Protection Settings:

Z1DISTANCE
(101)   **Z1PHASE** = NO
(104)   **Z1GROUND** = NO

Z2DISTANCE
(201)   **Z2PHASE** = NO
(204)   **Z2GROUND**=NO

Z3DISTANCE
(301)   **Z3PHASE** = YES
(304)   **Z3GRND** = NO

Z4DISTANCE
(401)   **Z4PHASE** = NO
(405)   **Z4GRND** = NO

OVERCURRNT
(601)   **50** = NO
(605)   **50G** = NO
(610)   **51G** = NO

OS BLOCKING
(1603)   **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for the appropriate phase under test. Set the relay to test mode 32 (Any Zone 3 Phase). The LUI displays: **ANY Z3 PHASE ON**

3. Set the voltage inputs as follows: VA: 67 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle +120°$.

4. Set the fault current, $I_{op}$, to the phase-angle value listed below. 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 $\angle I_{op} = -55°$)

| $\angle$I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| −25 | 56 to 63 | – |
| −55 | 65 to 73 | 195 to 205 |
| −85 | 56 to 63 | – |

[†] Reference only

5. 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 the table above.

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: **TRIP: AB Z3 "DIST"**, where "DIST" is the displayed target.

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

### 5.4.4 T19 – ZONE 4 PHASE REACH, M4 FAULTS

1. Protection Settings:

   Z1DISTANCE
   (101)   **Z1PHASE** = NO
   (104)   **Z1GROUND** = NO

   Z2DISTANCE
   (201)   **Z2PHASE** = NO
   (204)   **Z2GROUND** = NO

   Z3DISTANCE
   (301)   **Z3PHASE** = NO
   (304)   **Z3GRND** = NO

   Z4DISTANCE
   (401)   **Z4PHASE** = YES
   (405)   **Z4GRND** = NO
   (410)   **Z4P_TIME** = 0.1
   (411)   **Z4G_TIME** = 0.1

   OVERCURRNT
   (601)   **50** = NO
   (605)   **50G** = NO
   (610)   **51G** = NO

   OS BLOCKING
   (1603)   **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for the appropriate phase under test. Set the relay to test mode 33 (Any Zone 4 Phase). The LUI displays: **ANY Z4 PHASE ON**

3. Set the voltage inputs as follows: VA: 67 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle +120°$.

4.   Set the fault current, $I_{op}$, to the phase-angle value listed below. 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 $\angle I_{op}$ = –55°).

| I DEGREES | VOLTS RMS | DISPLAYED TARGET[†] |
|---|---|---|
| –25 | 56 to 63 | – |
| –55 | 64 to 72 | 290 to 310 |
| –85 | 56 to 63 | – |

**†** Reference only

5.   Set the fault current to 3.3 (0.7) 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 the table above.

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 Z4 "DIST"**, where "DIST" is the displayed target.

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

### 5.4.5 T20 – PHASE (ZONE BACK-UP) TIMER TESTS

1.   For this test remove the relay from test mode and record the pre-test values for all Protection settings used in this test.

2.   Protection Settings:

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)   **Z3GRND** = NO
(307)   **Z3P_TIME** = 3.0
(308)   **Z3G_TIME** = 3.0

Z4DISTANCE
(401)   **Z4PHASE** = YES
(405)   **Z4GRND** = NO
(410)   **Z4P_TIME** = 5.0
(411)   **Z4G_TIME** = 5.0

OVERCURRNT
(601)   **50** = NO
(605)   **50G** = NO
(610)   **51G** = NO

OS BLOCKING
(1603)   **BLOCKWHAT** = 3 (BLKNONE)

OUTPUTS
(2007)   **A1** = Z2PTMR; Index 132

**a) ZONE 2 TIMER**

3.   Connect the relay as shown in Figure 5–3: PHASE-REACH TIMER TEST CONNECTIONS on page 5–18 for an AB fault.

4.   Set the voltage inputs as follows: VA: 55 V rms ∠0°, VB: 55 V rms ∠–120°, VC: 67 V rms ∠+120°.

5.   Set the phase angle of the fault current, $\angle I_{op}$, to –55°.

6. 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 but applied at that level). This is an AB fault that is within pickup of all four zones.

7. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a Zone 2 trip, such as: **TRIP AB Z2**. This verifies that the second zone tripped. The time for the trip should be in the range 0.9 to 1.1 seconds.

8. Leave the voltages at the values of step 4.

**b) ZONE 3 TIMER**

9. Settings:

   Z2DISTANCE
   (201)    **Z2PHASE** = NO
   (204)    **Z2GROUND** = NO

   OUTPUTS
   (2007)    **A1** = Z3PTMR; Index 133

10. 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 but applied at that level). This is an AB fault that is within pickup of all four zones.

11. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a Zone 3 trip, such as: **TRIP AB Z3**. This verifies that the third zone tripped. The time for the trip should be in the range 2.9 to 3.1 seconds.

12. Leave the voltages at the values in step 4.

**c) ZONE 4 TIMER**

13. Settings:

   Z3DISTANCE
   (301)    **Z3PHASE** = NO
   (304)    **Z3GRND** = NO

   OUTPUTS
   (2007)    **A1**= Z4PTMR; Index 134

14. 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 but applied at that level. This is an AG fault 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 Zone 4 trip, such as: **TRIP AB Z4**. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8 to 5.2 seconds.

16. If not continuing with MOB testing, return all settings to their pre-test values.
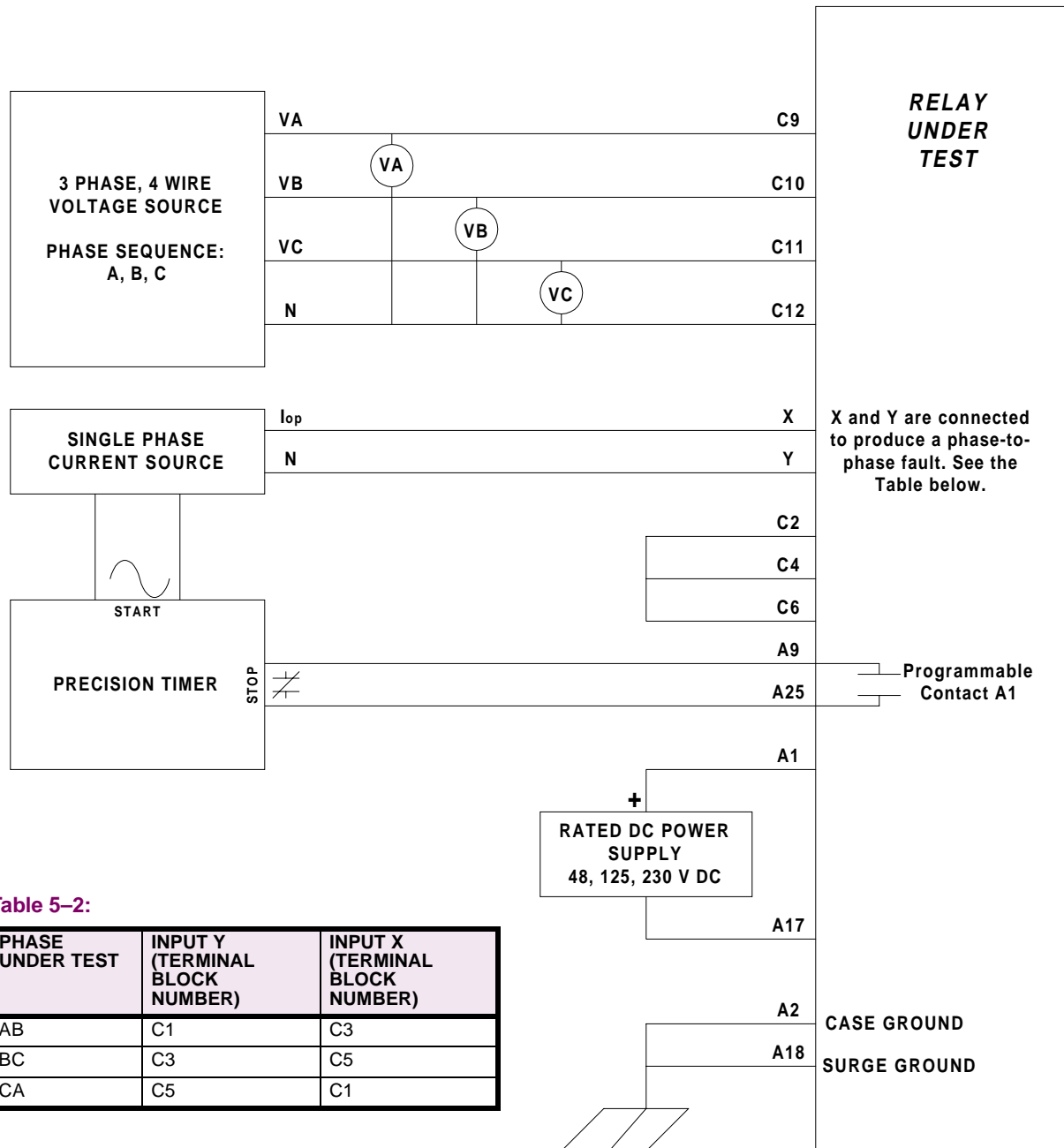
**5**

**5**



**Table 5–2:**

| PHASE UNDER TEST | INPUT Y (TERMINAL BLOCK NUMBER) | INPUT X (TERMINAL BLOCK NUMBER) |
| --- | --- | --- |
| AB | C1 | C3 |
| BC | C3 | C5 |
| CA | C5 | C1 |

**Figure 5–3: PHASE-REACH TIMER TEST CONNECTIONS**

1.  Record the pre-test values of the Protection Settings used for this test.

2.  Settings:

    OS BLOCKING
    (1601)  **MOBZONE** = 0 (Zone 2)
    (1603)  **BLOCKWHAT** = 0 (BLKALL)

    Z1DISTANCE
    (101)  **Z1PHASE** = NO
    (104)  **Z1GROUND** = NO

    Z2DISTANCE
    (201)  **Z2PHASE** = YES
    (204)  **Z2GROUND** = NO

    Z3DISTANCE
    (301)  **Z3PHASE** = NO
    (304)  **Z3GRND** = NO

    Z4DISTANCE
    (401)  **Z4PHASE** = NO
    (405)  **Z4GRND** = NO

3.  Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for the appropriate phase under test.

4.  Set the relay to test mode 40 (Out of Step). The LUI displays the following: **OUT OF STEP ON**

5.  Set the voltage inputs as follows: VA: 75 V rms ∠0°, VB: 75 V rms ∠−120°, VC: 75 V rms ∠+120°.

6.  Set the fault current, $I_{op}$, to the phase-angle value listed in the Table below. 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 to 72 |
| −25 | 62 to 72 |

7.  Set the currents in the faulted phases to 6.3 (1.3) amps rms. Reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in the table above.

8.  Reduce the current in the faulted phase to zero.

9.  Repeat the test for phases BC and CA. Return settings to their pre-test values when finished testing.

**5.5.2 ENDING FUNCTIONAL TESTS**

Ensure that the relay is no longer in test mode by selecting **END TEST MODE** from the test mode menu. Print out or scroll through all 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.

**5**

⚠️ **CAUTION**  **Power down the relay, either with the power switch or by removing a connection plug, before removing or inserting modules. Failure to do so may permanently damage the relay.**

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/PERIODIC 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/PERIODIC TESTS for details.

**a) 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

**b) 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

**c) BACKUP PROTECTION TESTS**

• T9 – Phase Instantaneous Overcurrent 50

• T10 – Ground Instantaneous Over-current 50G

• T11 – Ground Time Over-current 51G

**d) 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

**a) DRAWINGS**

The following drawings should be used for reference during testing:

Elementary Diagrams

- Figure 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING) on page 1–49
- Figure 1–28: ELEMENTARY DIAGRAM WITH DEFAULT I/O (THREE PHASE TRIPPING) on page 1–50
- Figure 1–29: ELEMENTARY DIAGRAM (SINGLE PHASE TRIPPING) on page 1–51
- Figure 1–30: ELEMENTARY DIAGRAM (THREE PHASE TRIPPING) on page 1–52

Logic Diagrams

- Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS on page 1–11
- Figure 1–4: LINE PICKUP LOGIC DIAGRAM (THREE PHASE TRIPPING) on page 1–12
- Figure 1–5: LINE PICKUP LOGIC DIAGRAM (SINGLE PHASE TRIPPING) on page 1–13
- Figure 1–6: REMOTE-OPEN DETECTOR LOGIC (ROD) on page 1–14
- Figure 1–8: OSB LOGIC DIAGRAMS on page 1–15
- Figure 1–8: OSB LOGIC DIAGRAMS on page 1–15
- Figure 1–10: STEP DISTANCE LOGIC DIAGRAM on page 1–24
- Figure 1–12: PUTT LOGIC DIAGRAM on page 1–26
- Figure 1–13: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1) on page 1–28
- Figure 1–14: POTT WITH BLOCKING FUNCTIONS (POTT2) on page 1–29
- Figure 1–15: BLOCKING SCHEME LOGIC DIAGRAM on page 1–31
- Figure 1–18: HYBRID LOGIC DIAGRAM on page 1–34
- Figure 1–24: OUT-OF-STEP TRIPPING LOGIC on page 1–42

51G curves

- Figure 2–18: INVERSE CURVE on page 2–48
- Figure 2–19: VERY INVERSE CURVE on page 2–49
- Figure 2–20: EXTREMELY INVERSE CURVE on page 2–50

**b) REFERENCE**

- Chapter 11: ALPS-LINK USER GUIDE
- Chapter 12: ASCII COMMUNICATIONS

**6**

### 6.1.3 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.**

### 6.1.4 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. The message **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: LOCAL USER 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 USER GUIDE 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 the message **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.

### 6.1.5 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/PERIODIC TESTS to test the relay with ALPS-Link or ASCII.

### 6.2.1 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 USER GUIDE 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** indicating the relay is operational and all self-tests pass.

### 6.2.2 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.

### 6.2.3 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 8.4.1: HARDWARE SWITCHES on page 8–24 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: DIGITAL OUTPUTS TEST CONNECTIONS on page 4–9.

2.  Press the ACT key and enter the control level password.

3.  Use the arrow keys to select: **8. Digital Output Test**

4.  Press the ENT key. Before a contact is allowed to be tested, the display prompts: **DISABLE PROTECT?**

5.  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).

6.  Use the arrow keys to scroll to the desired output test (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.

7.  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.

8.  End the test mode by scrolling to the **END TEST MODE** selection and press the ENT key. Alternatively, press END followed by the ENT key to end the test and re-enable protection.

### 6.2.4 T4 – AC SYSTEM INPUT TEST

This test uses the Present Values to determine that the voltages and currents are properly connected to the terminal strip. The VALUES function can be used any time during testing to verify the relay voltages/currents.

1.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

2.  Set VA to 67 V rms $\angle 0°$, VB to 57 V rms $\angle -120°$, and VC to 47 V rms $\angle 120°$.

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 $I_{op}$ to 1.0 A rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS.

6.  Verify 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**

⚠️
**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.

### 6.3.2 T5 – $I_T$ TRIP SUPERVISION TEST

1.  Protection Settings:

    CURSUPVISN
    (501)   **IT_PICKUP** = [_____] amps,

    where $I_T$ is set as follows: $I_T = I_A$, $I_B$, or $I_C$    (eq. 6–1)

    The test current, $I_{op}$, is single-phase and is applied to $I_A$. The ALPS should pick up when $I_{op}$ is equal to $I_T$.

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

3.  Set the relay into test mode 34 (IT Detector). The LUI display contains: **IT DETECTOR ON**

4.  Set the level of $I_{op}$ to $I_T$ + 0.1 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to $I_T$ – 0.1 = [_____] amps rms; the A1 contact should open.

5.  Reduce $I_{op}$ to zero.

### 6.3.3 T6 – $I_B$ BLOCKING SUPERVISION TEST (BLOCKING SCHEMES)

1.  Protection Settings:

    Z2DISTANCE
    (205)   **Z2GRDCHAR** = GDOC

    CURSUPVISN
    (502)   **IB_PICKUP** = [_____] amps

    SCHEME
    (1201)   **PICKSCHEME** = BLOCK

    where $I_T$ is set as follows:   $I_T = I_A$, $I_B$  , or $I_C$   (eq. 6–2)

    The test current, $I_{op}$, is single-phase and is applied to $I_A$. The ALPS should pick up when $I_{op}$ is equal to $I_B$.

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

3.  Set the relay into test mode 35 ($I_B$ Detector). The LUI display contains: **IB DETECTOR ON**

4.  Set the level of $I_{op}$ to $I_B$ + 0.1 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to $I_B$ – 0.1 = [_____] amps rms; the A1 contact should open.

5.  Reduce $I_{op}$ to zero.

### 6.3.4 T7 – GROUND DIRECTIONAL TRIP TEST, IPT + NT

📝
**NOTE**

**This test applies to blocking schemes only**.

1.  Protection Settings:

    Z2DISTANCE
    (205)   **Z2GRDCHAR** = GDOC

    CURSUPVISN
    (503)   **IPT_PICKUP** = [_____] amps

SCHEME
(1201)  **PICKSCHEME** = BLOCK

The IPT operating quantity is given by:   $3 \times |I_0| - 3 \times KTx|I_1|$     (eq. 6–3)

where $I_0$ is the Zero-Sequence Current; $I_1$ the Positive-Sequence Current; and $KT$ is 0.1 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

$I_0 = I_{op}/3$     (eq. 6–4)
$I_1 = I_{op}/3$     (eq. 6–5)

Substituting Equations 6–4 and 6–5 into Equation 6–3 and assuming a Blocking or Hybrid scheme yields

$\text{PUIPT}$   $= I_{op} - 0.1\,I_{op}$     (eq. 6–6)
      $= 0.9\,I_{op}$

Therefore IPT will pick up when $I_{op}$ = PUIPT / 0.9.

2.   Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

3.   Set the voltage inputs to the following values: VA: 55 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle +120°$

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.

### 6.3.5 T8 – GROUND DIRECTIONAL BLOCK TEST, IPB + NB

**NOTE**   **This test applies to blocking schemes only**.

1.   Protection Settings:

Z2DISTANCE
(205)  **Z2GRDCHAR** = GDOC

CURSUPVISN
(503)  **IPT_PICKUP** =  [_____] amps

SCHEME
(1201)  **PICKSCHEME** = BLOCK

The IPT operating quantity is given by:   $3 \times |I_0| - 3 \times KB \times |I_1|$     (eq. 6–7)

where $I_0$ is equal to the zero-sequence current; $I_1$ is equal to the positive-sequence current; and $KB$ is equal to 0.066 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes. Since the test current, $I_{op}$, is single-phase, $I_0$ and $I_1$ are given by:

$I_0 = I_{op} / 3$     (eq. 6–8)
and $I_1 = I_{op} / 3$     (eq. 6–9)

Substituting Equations 6–8 and 6–9 into Equation 6–7 and assuming a Blocking or Hybrid scheme yields

$\text{PUIPT}$   $= I_{op} - 0.066 \cdot I_{op}$     (eq. 6–10)
      $= 0.934 I_{op}$

Therefore IPT will pick up when $I_{op}$ = PUIPT / 0.934.

2.   Connect the relay as shown in Figure 4–1: DIGITAL OUTPUTS TEST CONNECTIONS on page 4–9.

3.   Set the voltage inputs to the following values: VA: 55 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle +120°$.

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 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to (PUIPB / 0.934) – 0.1 = [_____] amps rms; the A1 contact should open.

6.   Reduce $I_{op}$ to zero.

**6.4.1 T9 – PHASE INSTANTANEOUS OVERCURRENT 50**

1. Protection Settings:

   OVERCURRNT
   (601)   **50** = YES
   (602)   **50_DIRCNL** = NO
   (603)   **50PICKUP** =  [_____] amps

   **50** is calculated with the following equation:

   $$\mathbf{50} = (I_A - I_B) \text{ or } (I_B - I_C) \text{ or } (I_C - I_A) \qquad \text{(eq. 6–11)}$$

   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 $(I_{op} - (-I_{op})) = 2I_{op}$. Therefore **50** will pick up when $I_{op} = 0.5 \times \mathbf{50}$

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 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} = 0.5 \cdot \mathbf{50} + 0.05 \cdot \mathbf{50} = $ [_____] amps rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to $0.5 \cdot \mathbf{50} - (0.05 \cdot \mathbf{50}) = $ [_____] amps rms; the A1 contact should open.

5. Reduce $I_{op}$ to zero.

**6.4.2 T10 – GROUND INSTANTANEOUS OVERCURRENT 50G**

1. Protection Settings:

   OVERCURRNT
   (605)   **50G** = YES
   (606)   **50G_DIRCNL** = NO
   (607)   **50GPICKUP** = [_____] amps,

   **50G** is given by:   $\mathbf{50G} = 3 \times I_0 - 0.9 \times |I_1| \qquad$ (eq. 6–12)

   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

   $$I_0 = I_{op} / 3 \quad \text{(eq. 6–13)} \quad \text{and} \quad I1 = I_{op} / 3 \quad \text{(eq. 6–14)}$$

   Substituting Equations 6–13 and 6–14 into Equation 6–12 yields

   $$\mathbf{50G} = I_{op} - 0.3 I_{op} = 0.7 I_{op} \qquad \text{(eq. 6–15)}$$

   Therefore IPT will pick up when $I_{op} = \mathbf{50G} / 0.7$.

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12.

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 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower $I_{op}$ to (**50G** / 0.7) – 0.5 = [_____] amps rms; the A1 contact should open.

5. Reduce $I_{op}$ to zero.

6. Change the setting of **50G_DIRCNL** back to YES to restore directional control, if required.

1.  Setting:

    OVERCURRNT
    (610)   **51G** = YES
    (611)   **51G_DIRCNL** =   NO
    (612)   **51GPICKUP** =   [_____] amps,
    (615)   **51GTIMDIAL** =   [_____] Time dial,
    (614)   **51GCURVE** =   [_____] Curve,

    **51G** is calculated with the equation

    $$51G = 3 \times I_0 \qquad \text{(eq. 6–16)}$$

    where $I_0$ is equal to the zero-sequence current. Since $I_{op}$ is single-phase, $I_0$ is given by

    $$I_{op} / 3 = I_0 \qquad \text{(eq. 6–17)}$$

    Substituting Equation 6–17 into Equation 6–16 yields

    $$I_{op} = 51G \qquad \text{(eq. 6–18)}$$

    Therefore, **51G** will pick up when $I_{op}$ = **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 x _In_ (_In_ is the rated current), then the current test should be applied with a 50% duty cycle. For instance, if current is applied for 5 minutes, it should be left off for 5 minutes before it is reapplied.**

2.  Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–7.

    📝 **NOTE**   **Start the timer when $I_{op}$ is applied and stop the timer when the A1 closes (the relay trips).**

3.  For this test remove the relay from test mode and assign TOCTRP to A1.

    (2007) **A1** = index 119, TOCTRP

4.  Apply $I_{op}$ at 2·**51G** = [_____] amps rms and start the timer. Leave the current on until the A1 contact closes, then stop the timer. The time should be within ±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·**51G** = [_____] and 10·**51G** = [_____].

7.  Change the setting of **51G_DRCNL** (0611) back to YES if directional control of **51G** is required.

**6**

Testing the reach of the relay requires a few organized steps, as follows:

1.  Choosing a test current (IT) 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, ALPS-TEST, can be used to generate test currents and voltage pickups for the complete characteristic. ALPS-TEST is included the ALPS software suite on the GE Power Systems Products CD.

**6.5.2 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:

1.  Choose a test current.

2.  Calculate the impedance of the zone.

3.  Calculate the operate voltage at the test current and impedance.

The test current, $I_T$, is determined from Table 6–1: TEST CURRENT RANGES FOR PHASE-TO-GROUND REACH on page 6–11. 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

$$V_{NOM} = \left( \frac{Z \cdot Z_R \cdot I_T}{\cos(\varnothing I - \varnothing Z - \varnothing T + 90°)} \right) \cdot \cos(\varnothing I - \varnothing Z - \varnothing T - 90°)$$  (eq. 6–19)

for   $(\varnothing Z + \varnothing T - 180°) < \varnothing I < \varnothing Z$ ,

or

(eq. 6–20)

$$V_{NOM} = \left( \frac{Z \cdot Z_R \cdot I_T}{\cos(\varnothing I - \varnothing Z - \varnothing T + 90°)} \right) \cdot \cos(\varnothing I - \varnothing Z + \varnothing T - 90°)$$

for   $\varnothing Z < \varnothing I < (\varnothing Z - \varnothing T + 180°)$ .

**a) DEFINITONS**

$Z$ = Calculated Impedance
$Z_R$ = Relay reach for Z1G, Z2G, Z3G, or Z4G.
$\varnothing Z$ = Angle of maximum reach.
$I_T$ = Test current for $I_{op}$, chosen for the zone.
$\varnothing T$ = Characteristic timer of the zone.
$\varnothing I$ = Test current angle with respect to the faulted phase.
$K_0$ = Zero-sequence compensation factor of the zone.
**POSSEQANG** = Positive-sequence angle of maximum reach.
**ZERSEQANG** = Zero-sequence angle of maximum reach.

**b) SETTINGS AND CALCULATIONS**

1.  Record the following relay protection settings:

    (1401), **POSSEQANG** = [_____]

    (1402), **ZERSEQANG** = [_____]

    (105), **Z1GRDREACH** = [_____] (Zone 1)

    (206), **Z2GRDREACH** = [_____] (Zone 2)

(305), **Z3GRDREACH** = [_____] (Zone 3)

(406), **Z4GRDREACH** = [_____] (Zone 4)

(111), **Z1GCHARANG** = [_____] (Fixed at 90° for Zone1 on single-phase tripping models)

(207), **Z2GCHARANG** = [_____] (Zone 2)

(306), **Z3GCHARANG** = [_____] (Zone 3)

(406), **Z4GCHARANG** = [_____] (Zone 4)

(108), **Z1GROUNDK0** = [_____] (Zone 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 6–1: TEST CURRENT RANGES FOR PHASE-TO-GROUND REACH below.

$I_T$(Z1GR) = [_____] Amps rms

$I_T$(Z2GR) = [_____] Amps rms

$I_T$(Z3GR) = [_____] Amps rms

$I_T$(Z4GR) = [_____] Amps rms

**Table 6–1: TEST CURRENT RANGES FOR PHASE-TO-GROUND REACH**

| $Z_R$ REACH ($I_N$ = 5 A) | $I_T$ (A) | $Z_R$ REACH ($I_N$ = 1 A) | $I_T$ (A) |
|---|---|---|---|
| 0.1 to 2.5 | 10 | 0.5 to 12.5 | 2 |
| 2.5 to 6.0 | 7 | 12.5 to 30.0 | 1.4 |
| 6.0 to 12.0 | 3.5 | 30.0 to 60.0 | 0.7 |
| 12.0 to 20.0 | 2.1 | 60.0 to 100.0 | 0.4 |
| 20.0 to 30.0 | 1.4 | 100.0 to 150.0 | 0.3 |
| 30.0 to 40.0 | 0.8 | 150.0 to 200.0 | 0.2 |
| 40.0 to 50.0 | 1.0 | 200.0 to 250.0 | 0.2 |

3.   Calculate the impedance, $Z$, for each zone, where $Z$ equals the magnitude of the expression:

$$\left(\frac{2}{3}\right)\angle \text{POSSEQANG} + \left(\frac{K_0}{3}\right)\angle \text{ZERSEQANG}$$

The real and imaginary components of $Z$ are given by

$$\text{real}(Z) = \frac{2}{3}\cos(\text{POSSEQANG}) + \frac{K_0}{3}\cos(\text{ZERSEQANG}) \quad \text{(eq. 6–21)}$$

$$\text{imag}(Z) = \frac{2}{3}\sin(\text{POSSEQANG}) + \frac{K_0}{3}\sin(\text{ZERSEQANG}) \quad \text{(eq. 6–22)}$$

The magnitude is then given by:

$$|Z| = \sqrt{\text{real}(Z)^2 + \text{imag}(Z)^2} \quad \text{(eq. 6–23)}$$

The settings are:

$Z_1$ = [_____] (Zone magnitude)

$Z_n$ = [_____] (magnitude of Zones 2, 3, and 4)

**6**

4. Calculate the impedance angle, $\varnothing Z$, for each zone, where $\varnothing Z$ is the phase angle of the expression,

$$\left(\frac{2}{3}\right)\angle \text{POSSEQANG} + \left(\frac{K_0}{3}\right)\angle \text{ZERSEQANG}$$

and is given by

$$\varnothing Z = \arctan\left(\frac{\text{imag}(Z)}{\text{real}(Z)}\right) \quad \text{(eq. 6–24)}$$

The settings are

$\varnothing Z_1$ = [_____]° (impedance angle of Zone 1)

$\varnothing Z_n$ = [_____]° (impedance angle of Zones 2, 3, and 4)

Choose the IT test angle (øI) for the zone:

$\varnothing I_1$ = [_____]° (Zone 1)

$\varnothing I_2$ = {_____]° (Zone 2)

$\varnothing I_3$ = [_____]° (Zone 3)

$\varnothing I_4$ = [_____]° (Zone 4)

Calculate VNOM for each zone by substituting the values of $Z_R$, $Z$, $\varnothing Z$, and $\varnothing I$ into Equation 6–19 or 6–20.

$V_{NOM1}$ = [_____] Volts rms (nominal test voltage Zone 1)

$V_{NOM2}$ = [_____] Volts rms (nominal test voltage Zone 2)

$V_{NOM3}$ = [_____] Volts rms (nominal test voltage Zone 3)

$V_{NOM4}$ = [_____] Volts rms (nominal test voltage Zone 4)

> **NOTE**
> **If Zone 4 is reversed (Protection Setting 408: Z4DIRECTN = REVERS), remember to add 180° to both the test angle, øI4, and the impedance angle, øZ4.**

### 6.5.3 T12 – ZONE 1 GROUND REACH TEST, M1G GROUND FAULTS

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = YES
   (105) **Z1GRDREACH** = [_____] ohms,
   $V_{NOM1}$ = [_____] V,
   $I_T$ = [_____] A,
   $\varnothing I_1$ = [_____]°,

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 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 as follows: VA: 67 V rms $\angle 0°$, VB: 67 V rms $\angle -120°$, VC: 67 V rms $\angle -240°$.

5. Set the fault current, $I_{op}$, phase angle to $\varnothing I$ = [_____], lagging.

6. 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 $V_{NOM}$.

7. Reduce the fault current to zero.

8. Return the Zone 1 phase, **Z1PHASE**, to your specific setting.

### 6.5.4 T13 – ZONE 2 GROUND REACH, MTG GROUND FAULTS

1.  Protection Settings:

    Z2DISTANCE
    (201)   **Z2PHASE** = NO
    (204)   **Z2GROUND** = YES
    (206)   **Z2GRDREACH** = [_____] ohms,
    $V_{NOM2}$ = [_____] V,
    $I_T$ = [_____] A,
    $\phi I_2$ = [_____]°,

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 for the appropriate phase under test.

3.  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**

4.  Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.

5.  Set the fault current, $I_{op}$, phase angle to $\phi I$ = [_____]°, lagging.

6.  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 $V_{NOM}$.

7.  Reduce the fault current to zero.

8.  Return Zone 2 phase, **Z2PHASE**, to your specific setting.

### 6.5.5 T14 – ZONE 3 GROUND REACH, M3G GROUND FAULTS

1.  Protection Settings:

    Z3DISTANCE
    (301)   **Z3PHASE** = NO
    (304)   **Z3GRND** = YES
    (305)   **Z3GRDREACH** = [_____] ohms,
    $V_{NOM3}$ = [_____] V,
    $I_T$ = [_____] A,
    $\phi I_3$ = [_____]°,

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS for the appropriate phase under test.

3.  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**

4.  Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.

5.  Set the fault current, $I_{op}$, phase angle to $\phi I$ = [_____]°, lagging.

6.  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 $V_{NOM}$.

7.  Reduce the fault current to zero.

8.  Return Zone 3 phase, **Z3PHASE**, to your specific setting.

**6**

**6.5.6 T15 – ZONE 4 GROUND REACH, M4G GROUND FAULTS**

1. Setting:

   Z4DISTANCE
   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = YES
   (406) **Z4GRDREACH** = [_____] ohms,
   $V_{NOM4}$ = [_____] V,
   $I_T$ = [_____] A,
   $øI_4$ = [_____]°,

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 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 as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.

5. Set the fault current, $I_{op}$, phase angle to $øI$ = [_____]°, lagging.

6. 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 $V_{NOM}$.

7. Reduce the fault current to zero.

8. Return Zone 4 phase, **Z4PHASE**, to your specific setting.

**6.5.7 ZONE 1 TO 4 PHASE-PHASE REACH CALCULATIONS**

This section describes how to determine the test currents and voltages for Z1PHASE, Z2PHASE, Z3PHASE, and Z4PHASE. The same procedure is used for each zone to determine the test values.

The test current, IT, is determined from Table 6–2: TEST CURRENT RANGES FOR PHASE-TO-PHASE REACH on page 6–15. The value of $I_T$ is chosen according to the value of 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.

$V_{NOM}$ 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

$$V_{NOM} = \left(\frac{(2/1.732) \cdot Z_R \cdot I_T}{\cos(90° - ØT)}\right) \cdot \cos((ØI + 30°) - ØZ - ØT + 90°) \quad \text{(eq. 6–25)}$$

for   $(ØZ + ØT - 180°) < ØI < ØZ$   , or

$$V_{NOM} = \left(\frac{(2/1.732) \cdot Z_R \cdot I_T}{\cos(90° - ØT)}\right) \cdot \cos((ØI + 30°) - ØZ + ØT - 90°) \quad \text{(eq. 6–26)}$$

for   $ØZ < ØI < (ØZ - ØT + 180°)$   .

where:  $Z_R$  = relay reach for Z1P, Z2P, Z3P, or Z4P.
       $øZ$ = Angle of maximum reach.
       $I_T$ = Test current for $I_{op}$, chosen for the zone.
       $øT$ = Characteristic timer of the zone.
       $øI$ = Test current angle with respect to the faulted phase
       **POSSEQANG** = Positive sequence angle of maximum reach.

**a) SETTINGS AND CALCULATIONS**

1.  Record the following relay settings:

    (1401), **POSSEQANG** = [_____]

    (102), **Z1PRREACH** = [_____] (Zone 1)

    (202), **Z2PHREACH** = [_____] (Zone 2)

    (302), **Z3PHREACH** = [_____] (Zone 3)

    (402), **Z4PHREACH** = [_____] (Zone 4)

    **Z1PCHARANG** = 90° (fixed for Zone 1)

    (203), **Z2PCHARANG** = [_____] (Zone 2)

    (303), **Z3PCHARANG** = [_____] (Zone 3)

    (403), **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) = [_____] Amps rms

    $I_T$ (Z2R) = [_____] Amps rms

    $I_T$ (Z3R) = [_____] Amps rms

    $I_T$ (Z4R) = [_____] Amps rms

**Table 6–2: TEST CURRENT RANGES FOR PHASE-TO-PHASE REACH**

| $Z_G$ REACH ($I_N$ = 5 A) | $I_T$ (A) | $Z_G$ REACH ($I_N$ = 1 A) | $I_T$ (A) |
|---|---|---|---|
| 0.1 to 2.5 | 10 | 0.5 to 12.5 | 2 |
| 2.5 to 6.0 | 8 | 12.5 to 30.0 | 2 |
| 6.0 to 12.0 | 5 | 30.0 to 60.0 | 1 |
| 12.0 to 20.0 | 3 | 60.0 to 100.0 | 0.6 |
| 20.0 to 30.0 | 2 | 100.0 to 150.0 | 0.4 |
| 30.0 to 40.0 | 1.5 | 150.0 to 200.0 | 0.3 |
| 40.0 to 50.0 | 1.0 | 200.0 to 250.0 | 0.2 |

3.  Choose $\varnothing I$ (the $I_T$ angle). $V_{NOM}$ is at maximum when $\varnothing I = \varnothing Z - 30°$.

    $\varnothing I_1$ = [_____]° (Zone 1)

    $\varnothing I_2$ = [_____]° (Zone 2)

    $\varnothing I_3$ = [_____]° (Zone 3)

    $\varnothing I_4$ = [_____]° (Zone 4)

4.  Calculate $V_{NOM}$ for each zone by substituting the values of $Z_R$, $\varnothing Z$ (**POSSEQANG**), $I_T$, and $\varnothing I$ into Equations 25 and 26 for $V_{NOM}$ according to zone.

    $V_{NOM1}$ = [_____] Volts rms (nominal test voltage for Z1P)

    $V_{NOM2}$ = [_____] Volts rms (nominal test voltage for Z2P)

    $V_{NOM3}$ = [_____] Volts rms (nominal test voltage for Z3P)

    $V_{NOM4}$ = [_____] Volts rms (nominal test voltage for Z4P)

    > **NOTE** If Zone 4 is reversed (Protection Setting 408: **Z4DIRECTN** = REVERS), remember to add 180° to both the test current angle, $\varnothing I_4$, and the impedance angle, $\varnothing Z_4$. If Zone 4 has a non-zero offset, use the ALPS-Test software to calculate $V_{NOM4}$.

5.  Record $V_{NOMn}$, $I_T$, and $\varnothing I_n$ in the space provided in the appropriate Zone reach test.

### 6.5.8 T16 – ZONE 1 PHASE REACH, M1 FAULTS

1.  Setting:

    Z1DISTANCE
    (101)  **Z1PHASE** = YES
    (104)  **Z1GROUND** = NO
    (102)  **Z1PREACH** = [_____] ohms,
    $V_{NOM1}$ = [_____] V,
    $I_T$ = [_____] A,
    $\varnothing I_1$ = [_____]°,

2.  Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–12 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 as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.

5.  Set the fault current, $I_{op}$, phase angle to $\varnothing I$ = [_____]°, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

6.  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 $V_{NOM}$.

7.  Reduce the fault current to zero.

8.  Return Zone 1 ground **Z1GROUND** to your specific setting.

### 6.5.9 T17 – ZONE 2 PHASE REACH, MT FAULTS

1.  Setting:

    Z2DISTANCE
    (201) **Z2PHASE** = YES
    (204) **Z2GROUND** = NO
    (202) **Z2PHREACH** = [_____] ohms,
    $V_{NOM2}$ = [_____] V,
    $I_T$ = [_____] A,
    $\varnothing I_2$ = [_____]°,

2.  Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–7 for the appropriate phases under test.

3.  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**

4.  Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.

5.  Set the fault current, $I_{op}$, phase angle to $\varnothing I$ = [_____]°, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

6.  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 $V_{NOM}$.

7.  Reduce the current in the faulted phase to zero.

8.  Return Zone 2 ground **Z2GROUND** to your specific setting.

1.  Protection Settings:

    Z3DISTANCE
    (301)   **Z3PHASE** = YES
    (304)   **Z3GRND** = NO
    (302)   **Z3PHREACH** = [_____] ohms,
    $V_{NOM3}$ = [_____] V,
    $I_T$ = [_____] A,
    $\phi I_3$ = [_____]°,

2.  Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for the appropriate phase under test.

3.  Set the relay to the Zone 3 Phase test mode for the appropriate phase under test. For example: **ZONE 3 AB ON**

4.  Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠−120°, VC: 67 V rms ∠+120°.

5.  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 to which it is shorted.

6.  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 $V_{NOM}$.

7.  Reduce the fault current to zero.

8.  Return Zone 3 ground **Z3GRND** to your specific setting.

1.  Protection Settings:

    Z4DISTANCE
    (401)   **Z4PHASE** = YES
    (405)   **Z4GRND** = NO
    (402)   **Z4PHREACH** = [_____] ohms,
    $V_{NOM4}$ = [_____] V,
    $I_T$ = [_____] A,
    $\phi I_4$ = [_____]°,

2.  Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–6 for the appropriate phase under test.

3.  Set the relay into the Zone 4 Phase test mode for the appropriate phase under test. For example: **ZONE 4 AB ON**

4.  Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠−120°, VC: 67 V rms ∠+120°.

5.  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.

6.  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 $V_{NOM}$.

7.  Reduce the fault current to zero.

8.  Return Zone 4 ground **Z4GRND** to your specific setting.

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.

**6**

## ELECTRICAL RATINGS

| | |
|---|---|
| Rated Frequency: | 50 to 60 Hz |
| Rated Voltage (ph-ph): | 100 to 120 V AC |
| Rated Current $I_n$: | 1 A or 5 A |

DC Control Voltage, operating range:

| | |
|---|---|
| 48 V DC | 38.5 to 60 V DC |
| 110/125 V DC | 88 to 150 V DC |
| 220/250 V DC | 176 to 300 V DC |

Maximum Permissible AC voltage:

| | |
|---|---|
| Continuous | 138 V AC (ph-n) |
| 1 minute | 208 V AC (ph-n) |

Maximum Permissible current:

| | |
|---|---|
| Continuous | 3 x $I_n$ |
| 3 seconds | 50 x $I_n$ |
| 1 second | 100 x $I_n$ |

| | |
|---|---|
| Sample Rate: | 64 per cycle |
| Hi-Pot (DC Test): | ANSI C37.90; IEC 255-5 |

Surge Withstand Capability: ANSI C37.90.1; IEC 255-22-1

Impulse Voltage Withstand Fast Transient:

5 kV peak, 1.2/50 ms, 0.5 J
ANSI C37.90.1
IEC255-4

Radio Frequency Interference Withstand:

ANSI C37.90.1;
IEC 255-22-1

| | |
|---|---|
| Electrostatic Discharge: | IEC255-22-2 |
| Humidity: | 95% without condensation |

Ambient Temperature Range

| | |
|---|---|
| Storage: | –30°C to 75°C |
| Operation: | –20°C to 65°C |

## BURDEN RATINGS

| | |
|---|---|
| Current Circuit: | $I_n$ = 1 A: 0.12 Ω @ 30° |
| | $I_n$ = 5 A: 0.022 Ω @ 5° |
| Voltage Circuit: | 0.15 VA @ 60 Hz |
| | 0.20 VA @ 50 Hz |

DC Battery:

| | |
|---|---|
| (contact converters): | 2.5 mA at rated DC input |
| (power supply): | < 20 W |
| Trip Circuit Motor: | 150 mA for current-flow sensor |

## CONTACT RATINGS

| | |
|---|---|
| Fault Location I/V: | 0 to 1 mA, 10V load or 0 to 5 V output |
| | (4 V = full scale; 5 V = error) |

Trip Outputs (T1 to T4/T6):

| | |
|---|---|
| Continuous Rating: | 5 A |
| Make and Carry: | 30 A (per ANSI C 37.90) |
| Interrupting: | 25 VA |
| Pickup: | < 4 ms |
| SCR Outputs: | same as Trip Outputs |

Auxiliary Outputs (A1 to A8/A12, C1, C2):

| | |
|---|---|
| Continuous Rating: | 5A |
| Make and Carry: | 30 A (per ANSI C 37.90) |
| Interrupting: | 25 VA |

| | |
|---|---|
| Pickup: | < 8 ms |

High Speed (KT1 to KT4):

| | |
|---|---|
| Continuous Rating: | 0.5A |
| Maximum Voltage: | 280 V DC |
| Pickup: | < 0.5 ms |

Contact Converter Inputs: 38.5 to 300 V DC

## PROTECTION SCHEME SELECTION

| | |
|---|---|
| Protection Schemes: | Step Distance |
| | POTT1 & POTT2 |
| | PUTT |
| | Blocking |
| | Hybrid |
| | Phase-Identified Channel |
| | Programmable Logic |
| Directional Control: | Forward or Reverse |
| Time Synchronization: | by demodulated IRIG-B signal (5 V DC) |

Out-of-Step Blocking

| | |
|---|---|
| Reach: | The reach of MOB is that of the zone it is coordinated with: Zone 2, Zone 3, or Zone 4 |
| Characteristic Angle: | 30° to 130° |

## REACH SETTINGS

M1 (Zone 1 Phase Reach), M1G (Zone 1 Ground Reach)

| | |
|---|---|
| Range: | $I_n$ = 1 A: 0.05 to 250 Ω |
| | $I_n$ = 5 A: 0.01 to 50 Ω |
| Resolution: | $I_n$ = 1A: 0.01 Ω |
| | $I_n$ = 5 A: 0.01 Ω |

MT (Zone 2 Phase Reach), MTG (Zone 2 Ground Reach)

| | |
|---|---|
| Range: | $I_n$ = 1 A: 0.05 to 250 Ω |
| | $I_n$ = 5 A: 0.01 to 50 Ω |
| Resolution: | $I_n$ = 1A: 0.01 Ω |
| | $I_n$ = 5 A: 0.01 Ω |

M3 (Zone 3 Phase Reach), M3G (Zone 3 Ground Reach)

| | |
|---|---|
| Range: | $I_n$ = 1 A: 0.05 to 250 Ω |
| | $I_n$ = 5 A: 0.01 to 50 Ω |
| Resolution: | $I_n$ = 1A: 0.01 Ω |
| | $I_n$ = 5 A: 0.01 Ω |

M4 (Zone 4 Phase Reach), M4G (Zone 4 Ground Reach)

| | |
|---|---|
| Range: | $I_n$ = 1 A: 0.05 to 250 Ω |
| | $I_n$ = 5 A: 0.01 to 50 Ω |
| Resolution: | $I_n$ = 1A: 0.01 Ω |
| | $I_n$ = 5 A: 0.01 Ω |

## CURRENT SUPERVISION FUNCTION

| FUNCTION | RANGE A | | RESOLUTION A | |
|---|---|---|---|---|
| | $I_n$ = 5 A | $I_n$ = 1 A | $I_n$ = 5 A | $I_n$ = 1A |
| IPT | 0.50 to 5.00 | 0.10 to 1.00 | 0.01 | 0.01 |
| IPB | 0.25 to 3.75 | 0.05 to 0.75 | 0.01 | 0.01 |
| IT | 0.20 to 4.00 | 0.20 to 4.00 | 0.01 | 0.01 |
| IB | 0.20 to 4.00 | 0.20 to 4.00 | 0.01 | 0.01 |

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**OVERCURRENT BACKUP**

| FUNCTION | RANGE ▲ | | RESOLUTION ▲ | |
|---|---|---|---|---|
| | In = 5 A | In = 1 A | In = 5 A | In = 1A |
| 50 | 2.0 to 160.0 | 0.4 to 32.0 | 0.1 | 0.1 |
| 50G | 0.5 to 80.0 | 0.1 to 16.0 | 0.1 | 0.1 |
| 51G | 0.2 to 15.0 | 0.04 to 3.0 | 0.01 | 0.01 |

**TOC TIME DIAL**

Range:               0.5 to 10 times pickup setting

Steps:               0.1

**LINE PICKUP**

| FUNCTION | RANGE ▲ | | RESOLUTION ▲ | |
|---|---|---|---|---|
| | $I_n$ = 5 A | $I_n$ = 1 A | $I_n$ = 5 A | $I_n$ = 1A |
| I1 | 1.0 to 15.0 | 0.2 to 3.0 | 0.1 | 0.1 |

**REMOTE OPEN DETECTOR**

Range:               10 to 100 ms

Step:                1 ms

**LINE OVERLOAD**

Overcurrent Settings:

| FUNCTION | RANGE ▲ | | RESOLUTION ▲ | |
|---|---|---|---|---|
| | $I_n$ = 5 A | $I_n$ = 1 A | $I_n$ = 5 A | $I_n$ = 1A |
| Level 1 PU | 2.5 to 20.0 | 0.5 to 4.0 | 0.1 | 0.1 |
| Level 2 PU | 5.0 to 40.0 | 1.0 to 8.0 | 0.1 | 0.1 |

Overload Settings:

LV1 timer LEVEL1TDLY

    Range:          10 to 99 seconds

    Resolution      0.01 sec.

LV2 timer LEVEL2TDLY

    Range:          10 to 99 seconds

    Resolution      0.01 sec.

**COMPENSATION FACTOR**

Range:               1.0 to 7.0

Resolution:          0.01

**PROTECTION SCHEME LOGIC TIMERS**

| TIMER | DESCRIPTION | RANGE | RESOLUTION |
|---|---|---|---|
| TL1PICKUP | Trip integrator pickup | 1 to 50 ms | 1 ms |
| Z2P_TIME Z2G_TIME | Zone 2 timer | 0.1 to 3.0 s | 0.01 s |
| Z3P_TIME Z3G_TIME | Zone 3 timer | 0.1 to 10.0 s | 0.01 s |
| Z4P_TIME Z4G_TIME | Zone 4 timer | 0.1 to 10.0 s | 0.01 s |
| TL4 | POTT/PUTT coordination | 0.1 to 50 s | 0.01 s |
| (TL5) TL5PICKUP TL5DRPOUT | **b** contact coordination for Breaker 1 (pickup & dropout timers) | 0 to 200 ms | 1 ms |
| (TL6) TL6PICKUP TL6DRPOUT | **b** contact coordination for Breaker 2 (pickup & dropout timers) | 0 to 200 ms | 1 ms |
| (TL16) TL16PICKUP | Weak infeed trip pickup | 8 to 99 ms | 1 ms |
| (TL24) TL24DROPOUT | GDOC Blocking Timer | 30 to 500 ms | 1 ms |
| (TL25) TL25DROPOUT | Distance Blocking Timer | 30 to 500 ms | 1 ms |
| (TL26) TL26PICKUP | Repeat Delay Timer | 0 to 50 ms | 1 ms |

**SYSTEM CONFIGURATION**

Communications baud rate:300, 1200, 2400, 4800, 9600,

Number of breakers:     1 to 2

CT Ratios:              1 to 5000

PT Ratios:              1 to 7000

Distance Units:         Miles or Kilometers

**ACCURACIES**

Distance measuring units:Reach: ±5% of setting at angle of maximum reach and rated current

Zone Timers:            ±2 ms

Fault Locator:          ±3% (typical)

RMS Values:             ±1% of rating ($< 2 \times$ CT)

Watts and Vars:         ±3% of full-scale from 1A to MAX rated current

Data Sample time tag

resolution:             ±1 ms

**DIMENSIONS AND WEIGHT**

Height:                 5.31" (135 mm)
                        3 standard rack-units

Width:                  19.00" with ears (3 standard rack-units)
                        16.90" without ears (430 mm)

Depth:                  13.63" (347 mm)

Weight:                 The standard rack-mounted unit weighs 23 pounds.

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*SPECIFICATONS ARE SUBJECT TO CHANGE WITHOUT NOTICE*

The Local User Interface (LUI) for the ALPS Advanced Line Protection System consists of a 4-line liquid crystal display (LCD), a keypad, and trip and status LEDs.

There 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. To scroll back up through the different levels previously scrolled down, the same command key is used. For example, in the ACTIONS menu, 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 a mistake is made while entering data, press the [CLR] key once. Verify that the incorrect text has been deleted and re-type 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 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 be 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.

### a) 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 Section 8.1.11: ACTIONS on page 8–8.

### b) KEYPAD

The keypad consists of twenty keys: 10 numeric keys, a decimal point, eight function keys and an [INV] key.
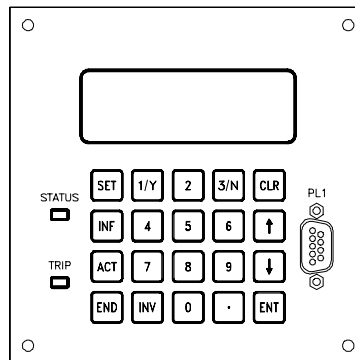


**Figure 8–1: ALPS KEYPAD**

The keys are divided into three groups:

1. The **Command keys**: SETTINGS [SET], INFORMATION [INF], ACTIONS [ACT] and [END]. These keys begin or end a command sequence. They are discussed in detail later in this section.

2. The **Control keys**: ENTER ([ENT]), UP-ARROW (↑), DOWN-ARROW (↓) AND CLEAR [CLR]. These keys may cause the relay to take some action.

3. The **Data Entry keys**: all the numeric keys, the decimal point and the [INV] key. These keys are used to 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 ON, 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.

### a) METERING/CLEAR KEY [CLR]

Depending on the current state of the display, the [CLR] key has the following uses: aborting a key sequence in progress, clearing 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 the [CLR] key is pressed, the entire display will be blanked and the relay screen will be displayed.

When a keypad error message is displayed, press [CLR] to remove it (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 display the trip information. 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 (that is, the one whose TRIP message was on display before pressing the [CLR] key). The trip time resolution is one millisecond. A typical trip information display is shown below.

```
                  #1
             19:10:01.259
                06/29/95
          TRIP AB Z2 145.0MI
```

If [CLR] is pressed again, the target information, trip time, and date for the next most recent fault is displayed. 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 the arrow keys is not possible; thus 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 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 Section 8.2.4: REQUEST PRESENT VALUES on page 8–18. 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.

### b) 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 ↑ and ↓ keys, the user can select any item in the menu displayed. The display 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 [ENT] 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 ↑ or ↓ keys to scroll through these items. The ↑ key scrolls in a reverse direction through a list of categories or items while the ↓ key scrolls forward through a list. The ↑ key will select the item before it in a list (for example, from item 5 to item 4). The ↓ key will select the item after it in a list (for example, from item 5 to item 6).

Both the ↑ and ↓ keys wrap. Wrapping occurs when the top or bottom of a list are reached. The last item becomes the first and the first item becomes the last.

### c) ENTER KEY [ENT]

The [ENT] key is used to enter data or to enter a choice. When a category name or command is selected on the display and the [ENT] key is pressed, the user is choosing to scroll through that category. After the user selects an item with 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.

### d) DATA ENTRY KEYS

The numeric keys 1 and 3 have two meanings depending on the context of their use. 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 interpreted as YES and the [3/N] key is interpreted as NO.

The [INV] (!) key is used to invert the values of logic signals used with the programmable outputs. For example, if you need to invert the value of the ZONE 1 AG logic signal (signal number 81) for input into programmable output A1, enter [INV] followed by "81" (display: !81).

<div align="right">

**8.1.4 MESSAGES**

</div>

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 (for example, ABG), a three character trip type (see Section 8.2.3: REQUEST FAULT INFORMATION on page 8–17 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. It has the following format:

```
        BBB FAIL–XXXXXXXXXXXXX
        XXXXXXXXXXXXXXXXXXXXXX
```

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-XXXXXXXXXXX
        XXXXXXXXXXXXXXXXXXXX
```

Since a trip has occurred, the LCD background for all four lines will be flashing.

Warning messages are always shown on the bottom two lines of the display using the same format as failure messages. 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 displayed 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.

Initialization messages are displayed while the relay is initializing during a power-up (but not during a warm restart). All other messages are the result of keypad operations and remain 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.

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Though there are some exceptions (e.g. the display of present values and events,) the following applies for any user initiated interaction:

- 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.

**8.1.5 SETTINGS**

The [SET] command key allows the user to view or edit Protection and General Settings, change the active settings group, and modify the date and time.

Pressing the [SET] key prompts the user for the Settings level password. If the password is invalid, **PASSWORD INVALID** will be displayed on the bottom line of the display. The [CLR] key deletes this error message and prompts for the password again.

If the password is valid, the privilege level is set to that associated with the password entered.

> **NOTE** A password is required only when the user does not have SETTING or MASTER level access privilege at the time of pressing the [SET] key.

> **NOTE** When the relay is shipped, the CONTROL, SETTING and MASTER passwords are loaded with factory values. The factory values for the passwords are: SETTING (123.), ACTIONS (456.) and MASTER (789.). Selecting *these* passwords will not increase the privilege level. All three passwords must first be changed to user-defined passwords. The user will not obtain higher privilege levels until these default passwords have been changed. See Section 1.1.2: PASSWORDS, FACTORY SET for details.

**8.1.6 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 settings can be viewed but not changed 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. The Protection 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 is assigned a number so that it may be accessed directly.

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 or an error message will displayed. The **Act Grp=** displayed on the bottom line indicates which group of settings is being used for protection. This group number is only informational.

After the group to be edited has been selected, press the [ENT] key. If the blinking digit appears (indicating that there are settings changes that have not been saved for that group), the display indicates 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. Press [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 [3/N] (NO) is pressed, the group selection prompt is redisplayed. It is recommended the settings changes be saved in the EEPROM by pressing the [END] key. It is still possible to re-select a group number which is blinking by pressing the [ENT] 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 of things should be noted at this point.

- The user can directly enter a setting number. 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 is displayed.

- There is a blinking square cursor on the left side of the display. This indicates the currently selected item. To select a different item with the cursor, use the ↑ and ↓ keys. Pressing the [ENT] key will activate the item in the current cursor position.

The [SET] key has an additional function – it will 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 [SET] will return to the list of settings in the current category. Pressing it again will return to the list of settings categories.

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 **Z3DISTANCE**, the following will be displayed:

```
Z3DISTANCE Gn S0301
  Z3PHASE = YES
Z3PHREACH = 20.32
Z3PCHARANG = 105
```

with the cursor positioned on the second line. **Gn** indicates the group number currently being edited and **S####** indicates the setting number on which the cursor is currently placed.

The setting number can be chosen by entering the number and pressing the [ENT] key. The entered number is echoed at the same place (right corner of the top line) where the current setting item number is displayed. After the [ENT] key is pressed, the number is checked for validity. If it is valid, the cursor will be positioned on the corresponding setting; if it is invalid, an error message is displayed.

To edit a setting, the item should be indicated with the cursor then selected with the [ENT] key. The information related to the setting 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 equals sign (**=**) will be replaced by a blinking colon (**:**). Each data entry key will be displayed as it is pressed, and the colon (**:**) symbol will continue to blink. Remember that the [1/Y] key represents the YES key and the [3/N] represents 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 blinking colon (**:**) will be replaced by the equals sign (**=**) and the relay will store and display the new setting. If the value is not valid, an error message will be displayed on the fourth line and the old setting value will be retained, as shown below:

```
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 a setting value, the setting name and value remain on the display. The arrow keys may be pressed to edit the next setting in the category or any Command key pressed 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 arrow keys may then be used to select another setting item.

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If the [SET] key is pressed again, the setting category screen will be displayed. If the [SET] key is pressed for the third time, the group selection display will appear with the current group number blinking. If any of the other Command keys are pressed, the command menu associated with the Command key will be displayed.

Note that the ALPS continues its protection activities while setting values are being entered. Entered settings are stored in a temporary buffer until the user presses [END] and selects one of the save settings items. 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), all of the settings in temporary storage will be lost.

As soon as the first valid setting change has been made, the ALPS Status LED starts blinking as reminder to save the settings. It continues to blink until the settings are saved or the relay times out (15 minutes). As a safeguard, the following message will be displayed whenever the [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 to proceed with other operations. The setting changes will continue to reside in temporary memory until the user presses the [END] key or the relay times out.

### 8.1.7 [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. Each function can be accomplished without the other. If no settings changes have been made, the only option when pressing [END] is **Quit**. This returns to the default privilege level. If settings changes were made, then three choices are available:

1.  **Save set & quit** – The edited settings are saved and the privilege level is returned to default. The messages **SETTINGS SAVED** and **SESSION ENDED** are displayed, reporting the action taken (see below).

```
              END
        Settings changed.
        SETTINGS SAVED.
        SESSION ENDED.
```

2.  **Save settings** – The edited settings are saved and the current privilege level is retained. For this choice only **SETTINGS SAVED** is displayed.

3.  **Quit** – If the settings have not been saved, the relay prompts to save them. If [1/Y] (YES) and [ENT] are pressed, the settings are saved and the privilege level returns to default. Both **SETTINGS SAVED** and **SESSION ENDED** are displayed. If [3/N] (NO) and [ENT] are pressed, the settings are not saved and the privilege level returns to default.

After the session is finished, the display clears after 10 seconds and the default privilege level is restored. If no setting changes are made prior to pressing the [END] key, the only choice will be **Quit**. If the [ENT] key is pressed, **SESSION ENDED** is displayed and the default privilege level is restored.

**NOTE** **I**f the Digital Output Test was started, it will be terminated when a choice containing **Quit** is selected. If the settings are saved, they are copied to EEPROM. If the settings affect protection and no fault is currently in progress, the settings change is complete. Otherwise, an error message is issued.

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 GEN
          1.CONFIGURE
          2.COMMPORTS
          3.OSC_GRAPHY
```

Using this option, the user can display or change settings other than Protection Settings (e.g. Configuration, Communications, Oscillography, etc.). Unlike the Protection Settings, there is only one group of General Settings. SETTING or MASTER privilege level must be active to change General Settings. It is possible, however, to view General Settings with CONTROL or default privilege level.

Viewing/Editing of General Settings and the response to key selection is similar to that described for Protection Settings.

```
         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 shown above. The cursor is positioned on the second line. and **n** indicates the group number currently active. If group number selection is currently controlled by contact converter inputs, the display will contain the message **EXTERNAL**.

When the active group number is changed, the equals sign (**=**) will be replaced by a blinking colon (**:**) until the [ENT] key is pressed. The user can enter a value between 0 to 4. Entering 1 to 4 followed by [ENT] key selects Setting Group 1 to 4 for use by protection. Entering the group number 0 tells the relay to read the active group number from contact converter inputs. If any number other than 0 to 4 is entered, an error message is displayed on the second line until the [CLR] key is pressed.

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 and/or time, however, 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 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 equals sign (**=**) is replaced by a blinking colon (**:**) until the [ENT] key is pressed. If the entered digits do not represent a valid date or time, the old date or time is retained and an error message displayed.

In both cases, two checks are performed: privilege level must be SETTING or MASTER and entered data must be in the correct format. If the checks fail then an error message is displayed and the change is not performed.

```
                    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 PASS-WORD ENABLE/DISABLE command and all relay tests require MASTER privilege level.

```
                    ACTIONS
             Enter Password:
```

When the [ACT] key is pressed, the relay requests a password. The cursor will be located at the beginning of the third line. A password may be entered and the [ENT] key pressed. If the [ENT] key is pressed without entering a password, the current privilege level is retained and the [ACT] command category menu is displayed. When a password is entered, each character of the password is echoed on the display as an asterisk (*). When the [ENT] key is pressed, the 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 password can be re-entered. If the password is valid, the privilege level is set accordingly.

**NOTE**   The ALPS requests a password only when the privilege level is not CONTROL or MASTER at the time the [ACT] key is pressed. When the relay is shipped from the factory, the CONTROL, SETTING and MASTER passwords are loaded with factory values. Selecting these default passwords does not increase privilege level. Higher privilege levels are obtained only after the factory passwords have been changed.

The following list describes the available ALPS actions:

1. Disable outputs
2. Trip breaker
3. Relay test
4. LUI test
5. Playback
6. Enable/Disable passwords
7. Reset recloser

8. Enable outputs
9. Close breaker
10. Channel test
11. Digital output test
12. Change password
13. Reset data
14. Adjust contrast

The display will be similar to the settings display. The first line will display **ACTIONS** when in the Actions menu. The next three lines will contain the ACTIONS commands. Other menu items are selected by pressing the ↑ and ↓ keys. To go directly to a menu item, type the menu item number. The menu item number 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 in the selected category is displayed. The displayed list can be scrolled through with the arrow keys. To select another actions category, press the [ACT] key and repeat the previous steps.

This command inhibits the relay from energizing any of the Digital Output contacts except for the critical alarm and power supply alarm outputs.

The relay will ask whether to disable the outputs. Press the [3/N] key for NO or the [1/Y] for YES followed by the [ENT] key. If NO is selected, **CANCELED** is displayed and no ALPS action occurs. If YES is selected, 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 turns RED. If a key other than a [1/Y] or [3/N] is pressed, an error message is displayed and the outputs are not disabled. If this category is selected when outputs are already disabled, the following message is displayed and must be cleared with the [CLR] key.

```
┌─────────────────────────────────────┐
│           DISABLE OUTPUTS           │
│                                     │
│         OUTPUTS CURRENTLY           │
│              DISABLED.              │
└─────────────────────────────────────┘
```

### 8.1.13 ENABLE OUTPUTS

This command is used to enable the digital outputs of the relay.

The relay will ask whether to enable the outputs. Press [3/N] for NO or [1/Y] for YES and then press the [ENT] key. If NO is selected, **CANCELED** is displayed and no ALPS action occurs. If YES is selected, two checks are performed: for the CONTROL or MASTER privilege level and whether communication is in the process of performing an action. If the test fails, 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 will turn GREEN if there are no status problems with the relay. If a key other than [1/Y] or [3/N] is pressed, an error message is displayed and the outputs are not enabled.

If this category is selected when outputs are already enabled, the relay will display a message which must be cleared with the [CLR] key.

### 8.1.14 TRIP BREAKER

This command manually trips a breaker. Each breaker controlled by the relay must be tripped individually. If the relay is controlling two breakers when this category is selected, the relay will request which breaker to trip.

To indicate the breaker, press [1] or [2] followed by the [ENT] key (any other Data Entry key will cause an error message to be displayed). If the relay is set to control one breaker, this query will be skipped.

The relay will then ask whether to trip the selected breaker. Select [3/N] (NO) or [1/Y] (YES) followed by the [ENT] key. If NO is chosen, **CANCELED** appears on the display and no action occurs. If YES is chosen, two 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 a Data Entry key other than [3/N] or [1/Y] is pressed, an error message is displayed and the breaker is not tripped.

```
┌─────────────────────────────────────┐
│            TRIP BREAKER             │
│          Trip Breaker 1/2?          │
│                                     │
└─────────────────────────────────────┘
```

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.

### 8.1.15 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. If the relay is controlling two breakers when this category is selected, the relay will request which breaker to close.

The user presses [1] or [2] (any other Data Entry key will cause an error message to be displayed) followed by the [ENT] key to indicate the breaker. If the relay is controlling only one breaker, this query is skipped.

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The relay will ask whether to close the selected breaker. Press [3/N] (NO) or [1/Y] (YES) followed by the [ENT] key. If NO is selected, **CANCELED** appears on the display and no action occurs. If YES is selected, 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 a key other than [3/N] or [1/Y] is pressed, an error message is displayed and the breaker is not closed.

**8.1.16 RELAY TEST**

This command tests the protection functions of the relay. MASTER password level privilege is required and protection must be enabled to perform this test. If protection has been turned off before entering this test, the relay will prompt to enable it. If the [3/N] (NO) key is pressed, **CANCELED** is displayed and the test is canceled. If the [1/Y] (YES) key is pressed, the user will be asked if 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 asks to disable the digital outputs. If the answer is YES, all outputs except contact A1 are disabled and the status LED turns RED to indicate the digital outputs have been disabled. They may be enabled when **End Test Mode** is selected. If the answer is 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.

When the relay test items are displayed, the cursor will be positioned on the second line. Additional tests can be displayed with the arrow keys or by entering the test number followed by the [ENT] key. The entered digits are echoed in the top right corner of the display. If the [ENT] key is pressed and 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 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
                1.ANY Z2 PHASE ON
                 2.ANY Z3 PHASE
                 3.ANY Z4 PHASE
```

One test may be performed at a time. When a new test is selected, the previous test will be deselected. Other activities using the [SET], [ACT] or [INF] keys may be performed during the relay test. When the relay test category is re-selected, the test started earlier will be remembered only if the [END] key has not been used. If the digital outputs were enabled, the relay will again ask if they should be disabled. If protection was disabled, the relay will prompt to enable it before proceeding with the tests again.

> **NOTE** The Disable Output? screen may appear first.

To remove the relay from test mode, select **1. End Test Mode** and press the [ENT] key. The cursor can be moved to the item in two ways: by using the arrow keys or by entering [1] followed by [ENT] key. If **End Test Mode** is selected, the message **ON** will be removed from the line of the item under test and the test terminated.

If outputs have been disabled before the relay test, a prompt appears after the selection of **1. End Test Mode** option, as shown below:

```
                    RELAY TEST
                 Enable outputs?
```

If YES is chosen, 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 ACT command menu is displayed. If NO is chosen, the outputs remain disabled, the status LED stays RED and the ACT command menu is displayed. If any other key is pressed, an error message is generated and [CLR] key must be pressed to clear the message.

The available ALPS tests and their corresponding numbers are:

| | | |
|---|---|---|
| 1: End Test Mode | 17: ANY Z4 GND | 33: ANY Z4 PHASE |
| 2: ZONE 1 AG | 18: ZONE 1 AB | 34: IT DETECTOR |
| 3: ZONE 1 BG | 19: ZONE 1 BC | 35: IB DETECTOR |
| 4: ZONE 1 CG | 20: ZONE 1 CA | 36: GRD DIR TRIP |
| 5: ZONE 2 AG | 21: ZONE 2 AB | 37: GRD DIR BLOCK |
| 6: ZONE 2 BG | 22: ZONE 2 BC | 38: FAULT DETECTOR |
| 7: ZONE 2 CG | 23: ZONE 2 CA | 39: REM OP DETCT |
| 8: ZONE 3 AG | 24: ZONE 3 AB | 40: OUT OF STEP BLK |
| 9: ZONE 3 BG | 25: ZONE 3 BC | 41: V1 DETECTOR |
| 10: ZONE 3 CG | 26: ZONE 3 CA | 42: LINE OVERLOAD |
| 11: ZONE 4 AG | 27: ZONE 4 AB | 43: INST PHS OVRC |
| 12: ZONE 4 BG | 28: ZONE 4 BC | 44: INST GND OVRC |
| 13: ZONE 4 CG | 29: ZONE 4 CA | 45: LINE PICKUP |
| 14: ANY Z1 GND | 30: ANY Z1 PHASE | 46: OVER VOLTAGE |
| 15: ANY Z2 GND | 31: ANY Z2 PHASE | 47: UNDER VOLTAGE |
| 16: ANY Z3 GND | 32: ANY Z3 PHASE | 48:OUT OF STEP TRIP |

### 8.1.17 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 HYBRIDP) 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 [3/N] (NO) key is pressed, **CANCELED** is displayed and the test canceled. If the [1/Y] (YES) key is pressed, the relay checks the outputs. If they are enabled, the test item is displayed. If the outputs are disabled, the user is prompted 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 **2. Channel test** is selected, 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 **1. End Chnl Test**, the test is terminated and the user is returned to the Actions menu.

This command will test the display, keypad, and LEDs. This test does not require a specific privilege level.

```
              LUI TEST
           1.Display
            2.LEDs
            3.Keypad
```

A test is selected using the arrow keys followed by the [ENT] key.

If **Display** 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 relay screen is displayed. If the [ACT] key is pressed, the LUI TEST choices screen will be displayed.

If **LEDs** is chosen, 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 LEDs. After each LED state the user will be prompted to press the [ENT] key and move to the next test. When the [ENT] key is pressed after the last test, the LEDs return to their pre-test state and the **LUI TEST** item menu is displayed.

If **Keypad** is chosen, 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.

This command tests 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, protection must be disabled (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.

To select a test item, scroll through the list using arrow keys or enter the test number. If the test pre-requisites are satisfied, the word **ON** will display to the right of test item. If the password 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. Only one output can be monitored at a time. When a new output is tested, the old output will be reset.

Other activities using the [SET], [ACT] or [INF] keys may be performed at any time. When the user returns to the Digital Output tests, they are asked questions about Protection enable and then the selected test and its following tests are displayed, starting from the second line.

Press the arrow keys until **End Test Mode** is displayed or press the [1], [ENT] keys to stop the digital output test. Press [ENT] again. The digital output test is terminated and the following message will be displayed:

```
              DO TEST
         Enable Protection?
```

The cursor will be stationed on the third line. If [1/Y] (YES), [ENT] is entered, protection is turned ON. The LED indicating ALPS status turns GREEN (if performing digital output test was the only cause for it being RED) and the ACT command menu is displayed with the cursor positioned on **Dig output test**. The above prompt will be also displayed when the user tries to exit the digital output test category without ending the test.

If [3/N] (NO) is entered followed by [ENT] key, protection is not enabled and the status LED remains RED. The ACT command menu is displayed with the cursor positioned on the item **Dig output test**. The test may be stopped by pressing the [END] [ENT] key sequence. This ends relay session with protection turned ON.

The available tests and their corresponding numbers are listed below. The digital outputs with asterisks (*) refer to outputs that are available only on Single Phase Tripping models.

| | | |
|---|---|---|
| 1: End Test Mode | 10: A3 | 19: A12 * |
| 2: T1 | 11: A4 | 20: C1A/C1B |
| 3: T2 | 12: A5 | 21: C2A/C2B |
| 4: T3 | 13: A6 | 22: KT1 |
| 5: T4 | 14: A7 | 23: KT2 |
| 6: T5 * | 15: A8 | 24: KT3 |
| 7: T6 * | 16: A9 * | 25: KT4 |
| 8: A1 | 17: A10 * | 26: CA-A/B (Critical Alarm) |
| 9: A2 | 18: A11 * | |

### 8.1.20 PLAYBACK

This category checks the relay logic and 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 (if protection is currently disabled):

```
            PLAYBACK
       Disable Outputs?
```

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 relay asks whether to disable the outputs, if they are currently enabled. 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 [1/Y] is pressed, the outputs are disabled and then the playback mode is continued. The outputs can be enabled after the playback is complete. If [3/N] is pressed, the outputs remain enabled. Any control actions issued by the relay 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. The option **Factory test case** is chosen by moving the cursor to that line and pressing the [ENT] key. The user is prompted to select the settings which used during playback. If [1/Y] is pressed followed by [ENT] key, the relay settings currently in effect will be used during playback. If [2] is pressed followed by [ENT], the settings stored with the oscillography data will be used.

The factory test case is a phase to phase 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 response 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.

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If the second choice, **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 case**. An oscillography file may be uploaded by using LPSO-Link (refer to Chapter 11 ALPS-LINK USER GUIDE). The playback is started after all prompts are answered. The word **ON** will be displayed as long as playback lasts.

The only data files that can be uploaded to the relay are OSC files downloaded from another LPS-O, LPS-D, or ALPS model relay, or a binary or ASCII Commtrade file from another source (Commtrade details are explained below). 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 relay after it has been converted to OSC format using the CTRD2OSC.exe program provided with the ALPS software suite. It will be installed into the same directory as ALPS-Link. 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 are 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, 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, **Data in relay,** is selected, the user is asked to select the settings (current/fault) for playback. After the settings have been selected, the summary of faults to be selected is displayed. 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. To move cursor to an item, use the arrow keys or enter the fault number followed by the [ENT] key. If entering a number, the digits pressed are echoed at the top right corner of the display. Pressing the [ENT] key after moving the cursor to the desired item starts playback. The top line changes to indicate 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 **End Playback** is chosen and the outputs are disabled, the relay prompts with the dialogue:

```
        Enable Outputs?
```

If YES is chosen, the outputs are enabled, the status LED turns GREEN (if playback test was the only reason to turn it RED), and the ACT command category selection is displayed. If NO is chosen, the outputs remain disabled, the Status LED remains RED, and the ACT command category selection is displayed.

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**8.1.21 CHANGE PASSWORD**

This category is used to change the SETTINGS, CONTROL and MASTER passwords. The arrow keys may be used to scroll to 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 an asterisk (*) for privacy. When the [ENT] key is pressed, the old password is checked for validity. If the password is valid, the relay will prompt for the new password.

Only the number keys can be used to enter the new password. Once the new password has been entered, the relay will prompt to re-enter the new password to ensure no mistakes were made while typing.

If the two password entries are identical then **PASSWD CHANGED** is displayed and the new password replaces the old one. Otherwise, **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.

This category is used to enable/disable LUI passwords. MASTER privilege level is required.

If passwords are currently enabled the relay will ask to disable the passwords; if passwords are currently disabled, the relay will ask to enable the passwords. In either case, if [3/N] (NO) is pressed, **CANCELED** is displayed and the command is terminated.

The [1/Y] (YES) is pressed, the current state for the operation of the passwords will be changed. If the current state is disabled, the relay will ask for the MASTER password. **PASSWORDS ENABLED** is displayed and passwords will be required to perform most of the relay commands through the keypad. When the passwords are enabled, the passwords in effect before disabling the passwords are restored. If the passwords are disabled when the command is executed, **PASSWORDS DISABLED** is displayed and no passwords will be required to perform most relay commands. Remember: a MASTER level password is required to perform this command whether or not passwords are enabled.

This command is used to reset the fault, event, oscillography and breaker health data.

Use the arrow keys or choose the item number 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 [3/N] (NO), [ENT] is pressed, **CANCELED** is displayed and the data is not reset. If [1/Y] (YES), [ENT] is pressed, the data is reset and a message 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.

This command is used to manually reset the recloser. It is only available if the optional recloser is installed in the relay. CONTROL or MASTER privilege level is required to use this command. Communication interference is checked for before the reset operation.

When the Reset Recloser command is chosen, the relay prompts to start the test. If the user presses [1/Y] (YES) followed by the [ENT] key, the relay attempts to reset the recloser. After the reset operation is attempted the status of recloser after the operation is displayed. A message is displayed to report the result of the operation. Either the recloser was successfully reset, the reset operation was unsuccessful, or the recloser was manually locked out. The [CLR] key must be used to clear the message. If the user presses [3/N] (NO) followed by the [ENT] key, the command is canceled and **CANCELED** is displayed.

The contrast level of the LCD display can be adjusted using this command. The ↑ or ↓ keys are used to increase or decrease the contrast of the display, respectively. As the arrow keys are pressed, 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 minimum or maximum contrast limit has been reached, the relay will change the prompt to **INCREASE** or **DECREASE** only (depending on the limit reached). Pressing the other arrow will not affect the contrast.

An error message will be displayed if the data entry keys are used. CONTROL or MASTER privilege is required to use this command.

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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.   ALPS 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.   ALPS Model/Version

10.  Snaps hot oscillography

```
             INFORMATION
         1.ALPS status
            2.Faults
         3.Present values
```

Use the arrow keys to select the desired category. Categories may also be selected by entering the category number followed by the [ENT] key.

The user can scroll through the list of categories by pressing the ↑ or ↓ 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.

```
          ALPS STATUS
        Trip Bus Check Fail
          Setting changes
              started
```

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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 relay 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.

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 YYY MM/DD HH:MM
     XXX YYY MM/DD HH:MM
     XXX YYY 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)               CAG  (phases C-A to ground)

BG  (phase B to ground)               AB  (phases A-B)

CG  (phase C to ground)               BC  (phases B-C)

ABG  (phases A-B to ground)           CA  (phases C-A)

BCG  (phases B-C to ground)           3PH  (3-phase)

Trip Types:

Z1  (Zone 1)                          REM  (Remote open)

Z2  (Zone 2)                          WI  (Weak Infeed)

Z3  (Zone 3)                          OSC  (Oscillography Trigger)

Z4  (Zone 4)                          SZ1  (Single Pole Zone 1 Trip)

PLT  (Pilot)                          SZ2  (Single Pole Zone 2 Trip)

50G  (Ground instantaneous overcurrent)    SPI  (Single Pole Pilot Trip)

50P  (Phase instantaneous overcurrent)     SWI  (Single Pole Weak Infeed)

51G  (Ground time delayed overcurrent)     CTB  (configurable trip bus trip)

LPU  (Line pick up)

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**8.2.4 REQUEST PRESENT VALUES**

This category displays 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 ↓ key is pressed, the next screen of information will be displayed. Using the ↑ key will display the information 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, when primary display is selected. The asterisk symbol (*) used for Watts; Vars can be: blank, K (for 1000), or M (for 1,000,000). The breaker duty is calculated according to the values in the Equipment Duty General Settings. In general, the units of breaker duty are (Amps)$^X$(Seconds) where $X$ is General Setting 401: **EXPONENT**. The breaker duty values are displayed with the units 'A' (A x sec.), 'K' (kA x sec., in thousands) or 'M' (MA x sec., in millions). In the LPSO-Link program, the voltages will be shown in secondary values only.

**8.2.5 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** The ALPS has 12 contact converters. The contact converter is OPEN if the status is a '0'. The contact converter is CLOSED if the status is a '1'. 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.

**8.2.6 DIGITAL OUTPUT STATUS**

This command displays the definition and the state of each digital output in the relay. This information is displayed three lines at a time. Use the arrow keys to scroll through the digital outputs (displayed in groups).

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** The above example is for the Single Phase Tripping model version of the relay. The Three Phase Tripping model is similar except that the DO status displayed are: **T1 – T4**, **A1 – A8**, **KT1 – KT4**, **C1 – C2** AND **CA**.

If the DO status is shown as **0** it means it is open. If it is **1**, it is closed.

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:

- Fail: CPU board SRAM
- Fail: 960 access to DPRAM
- Fail: EEPROM
- Fail: Digital output test
- Fail: Interrupt test
- Fail: ANI ADC Control logic
- Fail: ANI ref. channel test
- Fail: DMA interrupt failure
- Fail: ANI board timer
- Fail: ANI board serial EEPROM test
- Fail: MAG module serial EEPROM test
- Fail: Digital output serial EEPROM test
- Fail: DTA serial EEPROM test
- Fail: DSP PROM failure
- Fail: DSP internal RAM
- Fail: DSP internal RAM checksum error
- Fail: DSP access to DPRAM
- Fail: DSP interrupt
- Fail: Digital input test
- Fail: Model number - critical in nature
- Fail: MAG module configuration mismatch
- Fail: ANI module configuration mismatch
- Fail: Digital input module configuration mismatch
- Fail: Digital output module configuration mismatch
- Fail: Trip circuit continuity monitor #1
- Fail: Trip circuit continuity monitor #2
- Fail: Trip circuit continuity monitor #3
- Fail: Trip circuit continuity monitor #4
- Fail: Trip circuit continuity monitor #5
- Fail: Trip circuit continuity monitor #6
- Fail: Software version error
- Fail: DSP software version error
- Fail: More than 4 warm restarts occurred in an hour
- Fail: i960 DSP interface
- Fail: Runtime flash test CRC check
- i960 Instruction fault
- i960 Arithmetic fault
- Too many bogus interrupts
- Warning: CPU board timer test
- Warning: Zero crossing logic
- Warning: CAPRAM failure
- Warning: RTC test failure

- Warning: Comm front port failure
- Warning: Comm rear port 1 failure
- Warning: Comm rear port 2 failure
- Warning: Watch dog timer failure
- Warning: LCD display failure
- Warning: IRIGB failure
- Warning: Rear port 2 absent
- Warning: Non critical field in model number
- Warning: CAPRAM size mismatch
- Warning: Frequency error
- Warm restart
- ANI reference corrected
- Digital input error corrected
- MAG module error corrected
- ANI module error corrected
- LCD display error corrected
- Remote communication login failure
- Passwords changed
- Outputs enabled
- Outputs disabled
- Manual trip
- Manual close
- Manual trip failed
- Manual close failed
- Manual recloser reset
- Setting changes started
- Setting changes completed
- Protection OFF
- Protection ON
- Fault queue in CAPRAM re-initialized
- Event queue in CAPRAM re-initialized
- OST oscillography data area re-initialized
- Equipment duty is reset
- Active setting group changed
- Protection re-initialized
- Request for protection re-initialization not serviced
- Factory settings done
- Error in constants used by protection
- Error in code area of configurable logic
- ALPS Initialized
- Trip signals ON
- Trip signals reset

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- Trip A signal ON
- Trip A signal reset
- Trip B signal ON
- Trip B signal reset
- Trip C signal ON
- Trip C signal reset
- Out of step block ON
- Out of step block OFF
- Breaker #1 open
- Breaker #1 closed
- Breaker #2 open
- Breaker #2 closed
- Fuse failure alarm ON
- Fuse failure alarm OFF
- Receive carrier ON
- Receive carrier OFF
- Key transmitter ON
- Key transmitter OFF
- Trip circuit #1 energized
- Trip circuit #2 energized
- Trip circuit #3 energized
- Trip circuit #4 energized
- Trip circuit #5 energized
- Trip circuit #6 energized
- Line overload alarm ON
- Line overload alarm OFF
- Trip circuit #1 monitor alarm ON
- Trip circuit #1 monitor alarm OFF
- Trip circuit #2 monitor alarm ON
- Trip circuit #2 monitor alarm OFF
- Trip circuit #3 monitor alarm ON
- Trip circuit #3 monitor alarm OFF
- Trip circuit #4 monitor alarm ON
- Trip circuit #4 monitor alarm OFF
- Trip circuit #5 monitor alarm ON
- Trip circuit #5 monitor alarm OFF
- Trip circuit #6 monitor alarm ON
- Trip circuit #6 monitor alarm OFF
- Pilot protection ON
- Pilot protection OFF
- Oscillography trigger
- Fail: Trip bus check
- Unbalanced system detection alarm ON
- Unbalanced system detection alarm OFF

- Zone measurement units alarm ON
- Zone measurement units alarm OFF
- Overcurrent monitor alarm ON
- Overcurrent monitor alarm OFF
- 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
- Manual recloser lockout ON
- TOC curve changed
- Runtime NO DMA interrupt
- Manual recloser lockout OFF
- External reclose initiate - 1P
- External reclose initiate - 3P
- External recloser reset
- Recloser lockout - reclose cancel
- Reclose lockout - breaker failure
- Out of step trip ON
- Out of step trip OFF
- 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
- Recloser in reset
- Recloser in progress start
- Recloser in progress end
- 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
```

This category is used to view the communications passwords in encrypted form. Viewing of encrypted passwords is determined by the user's 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 the SETTINGS or ACTIONS categories and enter the password. The [SET] key and the [ACT] key are the only two keys that allow you to set the privilege level. If only the SETTINGS privilege level is desired, the [SET] key must be used. The [ACT] key must be used only if CONTROL privilege level is desired. Either may be used for the MASTER privilege level. See the following table for decoding information.

**Table 8–1: PASSWORD ENCRYPTION KEY TABLE**

| DISPLAYED | DECODED | DISPLAYED | DECODED | DISPLAYED | DECODED |
|-----------|---------|-----------|---------|-----------|---------|
| (space)   | P       | 8         | B       | M         | 7       |
| !         | T       | 9         | F       | P         | (space) |
| "         | X       | :         | J       | Q         | $       |
| $         | Q       | ;         | N       | R         | (       |
| %         | U       | <         | C       | S         | ,       |
| &         | Y       | =         | G       | T         | !       |
| (         | R       | >         | K       | U         | %       |
| )         | V       | ?         | O       | V         | )       |
| *         | Z       | @         | 0       | W         | -       |
| ,         | S       | A         | 4       | X         | "       |
| -         | W       | B         | 8       | Y         | &       |
| 1         | D       | D         | 1       | Z         | *       |
| 2         | H       | E         | 5       | [         | .       |
| 3         | L       | F         | 9       | \         | #       |
| 4         | A       | H         | 2       | ]         | '       |
| 5         | E       | I         | 6       | ^         | +       |
| 6         | I       | L         | 3       | _         | /       |
| 7         | M       |           |         |           |         |

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 longer 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 are displayed on the fourth line.**

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This category is used to display the Model and Version numbers for the relay.

```
                    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.

**Table 8–2: KEYPAD / DISPLAY INTERFACE ERROR MESSAGES**

| 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:<br>The [ENT] key is pressed to view events.<br>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. |

**8**

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: MODEM CABLE. Virtually any standard communications package on a PC with a serial interface may be used. The ASCII serial interface must be programmed to the same parameters as the remote communications ports. The ASCII port's handshaking mode must be set to either XON/XOFF or DTR ready. The ALPS setting COMFORT affects both the baud rate of the RS232 port (plug PL1) and the ASCII port PL2. Figure 8–3: 25-PIN NULL MODEM CABLE shows a Null modem cable for the 9-pin front port PL-1.
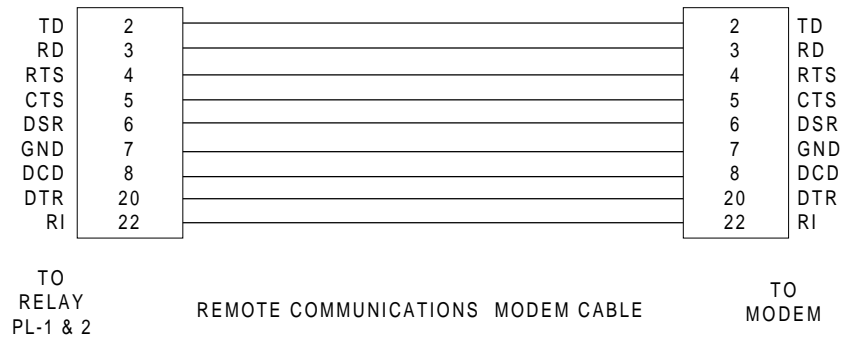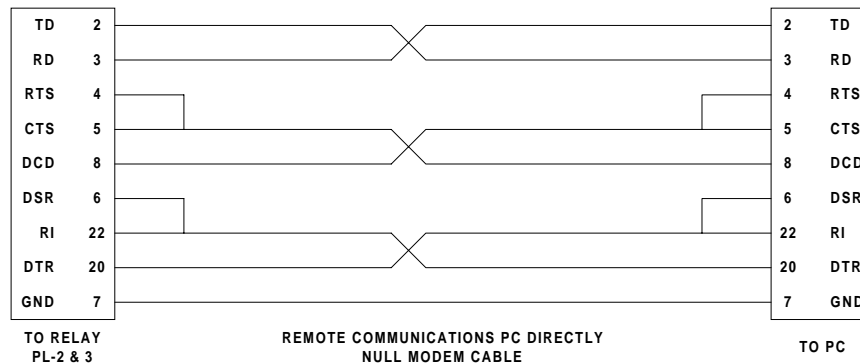


|  | |
|---|---|
| TD 2 | 2 TD |
| RD 3 | 3 RD |
| RTS 4 | 4 RTS |
| CTS 5 | 5 CTS |
| DSR 6 | 6 DSR |
| GND 7 | 7 GND |
| DCD 8 | 8 DCD |
| DTR 20 | 20 DTR |
| RI 22 | 22 RI |

TO RELAY PL-1 & 2          REMOTE COMMUNICATIONS  MODEM CABLE          TO MODEM

**Figure 8–2: MODEM CABLE**



TO RELAY PL-2 & 3          REMOTE COMMUNICATIONS PC DIRECTLY NULL MODEM CABLE          TO PC

**Figure 8–3: 25-PIN NULL MODEM CABLE**

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.

• Procomm Plus (vendor: Datastorm)

• Windows Terminal Program (vendor: Microsoft; included in Windows 3.1/95/98 system)

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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.

1. The proper sequence for setting these switches is as follows:

2. Remove four thumbscrews holding the plastic cover in place and lay aside with plastic cover.

3. Turn the power switch off on the front panel.

4. Remove DC power from the ALPS.

⚠ **WARNING**   **Completely power down the relay by disconnecting the control DC 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!**

5. Remove the four 1/4" hex nuts at the four corners of the front panel and carefully remove the front panel.

6. Disconnect the power and the ribbon cables from the front panel and lay the panel aside

7. The Switches are located in the middle on the front edge of the board. Move the switches up to turn a function off. Figure 3–5: INPUT BOARD DIAGRAM on page 3–7 indicates the location of the jumpers on the board.

8. Reinstall the PC board retainers with the four phillips head screws.

9. Reinstall the power cable and the bus card on the PC boards.

10. 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.

11. Turn on the front panel power switch.

12. Restore DC power to the relay.

13. Reinstall the plastic cover with the four thumbscrews.

14. The hardware switches are defined below.

**Table 8–3: HARDWARE SWITCH DESCRIPTIONS**

| 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. |

When establishing communication between the relay and a remote PC, two modems connected by a phone line are required. 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 8–3: 25-PIN NULL MODEM CABLE on page 8–23. Both modems must be "Hayes-compatible," meaning that they accept standardized modem configuration commands first developed by Hayes. This is necessary since the ALPS-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.

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 below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B1 | P | Y0 | &K3 | &S0 | S7=30 | S11=95 | S26=1 |
| E1 | Q0 | &C0 | &L0 | &T4 | S8=2 | S12=50 | S36=1 |
| L2 | V1 | &D0 | &P0 | &X0 | S9=6 | S18=0 | S37=0 |
| M1 | W0 | &G0 | &Q5 | S0=0 | S10=14 | S25=5 | S38=20 |
| N1 | X4 | &J0 | &R0 | S6=2 | | | |

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 modem manual for an explanation of this syntax.

### 8.4.3 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 Section 8.4.2: MODEM CON-NECTIONS AND SETTINGS are valid for ALPS-Link. The configuration settings critical to the operation of ALPS-Link are sent to the modem from the software:

> +++
> (delay 2 seconds)
> ATE0L0Q0S7=60V0X4Y0

These are explained in the following table:

**Table 8–4: COMMAND SEQUENCE SENT TO MODEM**

| 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 seconds |

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, the modem will not operate properly. In addition to the configuration settings listed in Table 8–5, it is suggested that the following 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. An ALPS-Link setting establishes the baud rate, which must match the ALPS baud rate setting. 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.

### 8.4.4 ALPS 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 the table below:

**Table 8–5: CONFIGURATION SETTINGS FOR THE MODEM CONNECTED TO THE RELAY**

| 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 signal |
| &D0 | Modem resets on the ON-OFF transition of DTR (Data Terminal Ready) |
| &Q0 | Asynchronous mode |
| S0=1 | Enable auto-answer |

If any of the settings in Table 8–5 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 8–6 lists the modem command set required to communicate to the relay from a remote PC.

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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 below in Figure 8–4: 25-PIN NULL MODEM CABLE. The pin-to-pin connections for a null-modem cable to the 9-pin connector on the KEYPAD/DISPLAY INTERFACE are shown below in Figure 8–5: NULL MODEM CABLE FOR PORT PL1. The null modem cable should be no more than 50 feet long.

| TO RELAY PL-2 & 3 | | REMOTE COMMUNICATIONS PC DIRECTLY NULL MODEM CABLE | TO PC | |
|---|---|---|---|---|
| TD | 2 | | 2 | TD |
| RD | 3 | | 3 | RD |
| RTS | 4 | | 4 | RTS |
| CTS | 5 | | 5 | CTS |
| DCD | 8 | | 8 | DCD |
| DSR | 6 | | 6 | DSR |
| RI | 22 | | 22 | RI |
| DTR | 20 | | 20 | DTR |
| GND | 7 | | 7 | GND |

**Figure 8–4: 25-PIN NULL MODEM CABLE**

| TO RELAY PL-1 | | REMOTE COMMUNICATIONS FROM PL-1 MODULE NULL MODEM CABLE | TO PC | |
|---|---|---|---|---|
| TD | 2 | | 2 | TD |
| RD | 3 | | 3 | RD |
| DSR | 6 | | 6 | DSR |
| RI | 9 | | 9 | RI |
| DTR | 4 | | 4 | DTR |
| RTS | 7 | | 7 | RTS |
| CTS | 8 | | 8 | CTS |
| DCD | 1 | | 1 | DCD |
| GND | 5 | | 5 | GND |
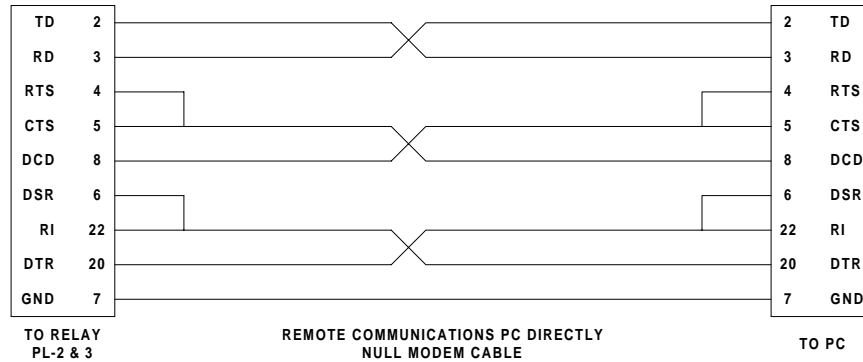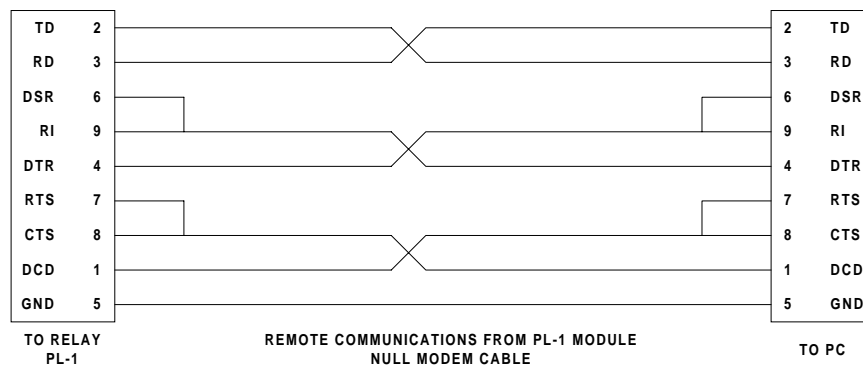
**Figure 8–5: NULL MODEM CABLE FOR PORT PL1**

**Table 8–6: MODEM COMMANDS FOR COMMUNICATION BETWEEN RELAY AND PC**

| FUNCTION | ALPS 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) |

**8**

**8**

### 9.1.1 DESCRIPTION

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 trouble-shoot 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 ALPS 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.**

### 9.1.2 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 an 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

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**Table 9–1: COMPONENTS TESTED DURING START-UP TESTS**

| 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 9–2: RUN-TIME BACKGROUND SELF-TESTS**

| COMPONENT | METHOD | PROCESSOR | NATURE |
|---|---|---|---|
| Flash Memory (PROM) | CRC-type check | 960 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 9–3: RUN-TIME FOREGROUND 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 |

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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/PERIODIC TESTS for tests of the Local User Interface (LUI) display, keypad, and the measuring units.

Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5 contains 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: **ALPS status**

3.  Press the ENT key. The display indicates a failure with the words: **STATUS: FAIL**

Press the ↑ key to get a detailed report of all the failures. A complete list of the possible errors is found in Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5. The FAIL and WARN messages are also included. Their descriptions may also be displayed 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.

**Table 9–4: SYSTEM STATUS ERROR MESSAGES**

| 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.

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 bring up the fail message. If the ALPS successfully restarts, the status LED turns green.

If the failure still exists, the status LED remains red and the critical alarm contact 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 Section 9.2.7: SERVICE SYSTEM STATUS FAILURES for the list of mnemonic failure codes and their meanings.

> **NOTE**
>
> The Information–ALPS Status command can be used to display all the current failures.

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**9.2.4 LOCATING THE DEFECTIVE BOARD**

Use Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5 or the Information Status command to isolate the cause of the failure. Then refer to Figure 3–3: CIRCUIT BOARD LOCATIONS on page 3–3 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 the 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 an anti-static bag.

8.  Remove the defective PC board and place into an anti-static bag for storage or shipment.

9.  Remove the replacement board from its anti-static container and insert 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 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.

**9.2.5 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 Section 9.2.7 SERVICE SYSTEM STATUS FAILURES for the list of Warning codes and their meanings.

> 🗒️ **NOTE** As an alternative, the Information Status command can be used to display the warning type directly on the LCD Display.

**9.2.6 LOCATING THE DEFECTIVE BOARD**

Use Section 9.2.7: SERVICE SYSTEM STATUS FAILURES 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.

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.

**e) FAILURE MESSAGES: 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 CONFG. 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

**f) FAILURE MESSAGES: MAGNETICS MODULE**

- FAIL-MAG SEEPROM

**g) FAILURE MESSAGES: 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

**h) FAILURE MESSAGES: MISCELLANEOUS FAILURES**

- CON MONITOR ALARM
- UNBALANCED SYS ALARM
- FUSE FAILURE

- TRIP BUS CHK FAIL
- TIME STROBE FAIL

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### i) FAILURE MESSAGES: 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

### j) FAILURE MESSAGES: 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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**10.1.1 DESCRIPTION**

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

Install the program from the GE Power Management Products CD or from the GE Power Management Web site at www.ge.com/indsys/pm. See Section 11.1.5: SOFTWARE INSTALLATION on page 11–3 for instructions on installing the ALPS software suite. This installation procedure will install ALPS-TEST along with the ALPS-Set, ALPS-Link, and Xpression Builder software packages.

The ALPS-Test menus are shown below:
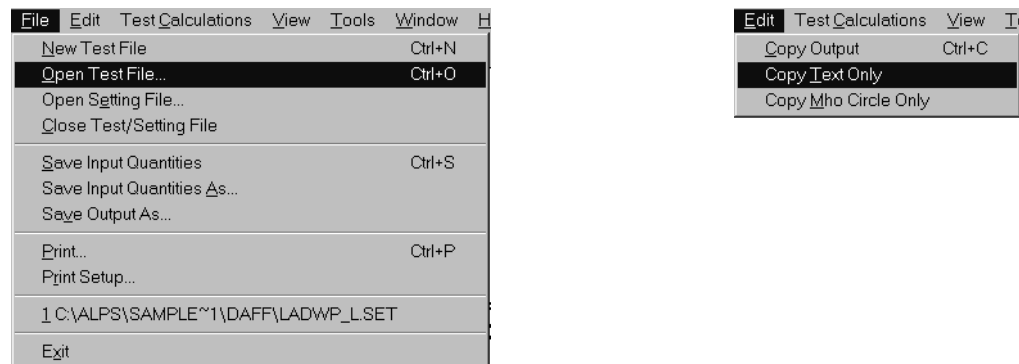
**Figure 10–1: FILE AND EDIT MENUS**
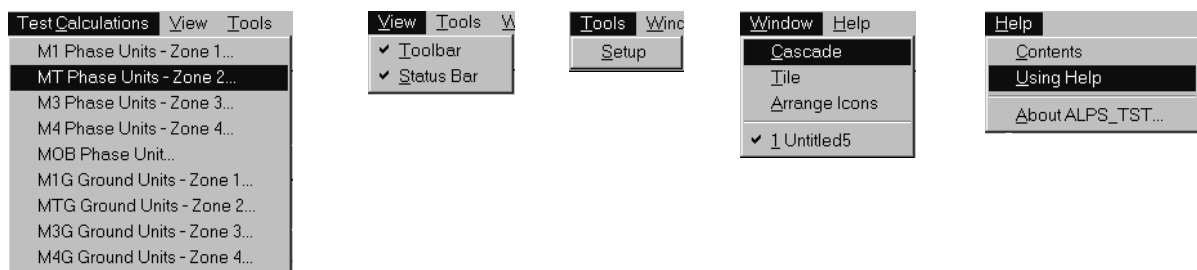
**Figure 10–2: ADDITIONAL ALPS-TEST MENUS**

**10.1.2 STARTING PROGRAM AFTER THE FIRST TIME**

Start the program as in the previous section. When the program is started, the opening screen is displayed.

• The title bar of the main window has the currently opened file name which is the file name the user selected

• Pull down the **File** menu. The most recent file is this same file name.

**10.2.1 DESCRIPTION**

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.

**Table 10–1: INPUT QUANTITIES**

| INPUT QUANTITY | RANGE | DEFAULT VALUES |
|---|---|---|
| Rated current | 1 or 5 A | 1 A |
| Reach (reach in forward/reverse direction) | 1 A: 0.01 to 250.00<br>5 A: 0.01 to 50.00 | 0.01 |
| Positive Sequence Reach Angle | 45° to 90° | 45° |
| Characteristic Timer | M1: 90°<br>MT: 90° to 120° in steps of 5°<br>M3: 90° to 120° in steps of 5°<br>M4: 90° to 120° in steps of 5°<br>MOB: 30° to 130°<br>M1G: 90°<br>MTG: 80° to 155° in steps of 5°<br>M3G: 80° to 155° in steps of 5°<br>M4G: 80° to 155° in steps of 5° | 90° 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° | 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 |

**10.2.2 ENTERING INPUT QUANTITIES**

When the user clicks on a **Select** button from a **TestCalculations** dialog box, 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. Select the **Help** button from the **Enter Value** dialog box. A help screen is displayed describing how to use this dialog box.
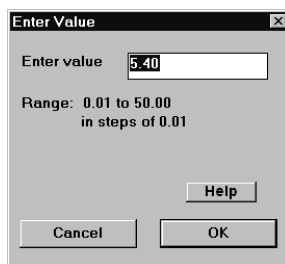


**Figure 10–3: ENTER VALUE DIALOG BOX**

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Click on a **Select** button from one of the test dialog boxes (**M1 Phase Units – Zone 1** is shown below) for an input quantity that has a continuous range.
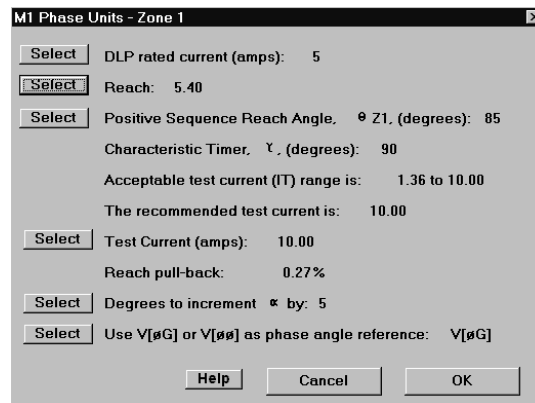


**Figure 10–4: INPUT TEST DIALOG BOX: M1 PHASE UNITS – ZONE 1**

Select **Test Current (amps)**, the display the **Enter Value** dialog box. Enter a valid new value and click **OK**. The dialog box clears from the screen and the value in the test dialog box is changed to the value just entered.

Click on a **Select** button from one of the test dialog boxes (see above for example) for an input quantity that has a list of values. An **Enter Value** dialog box will appear. 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.

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.



**Figure 10–5: M1 PHASE UNITS – ZONE 1 DIALOG BOX**

**10.2.6 MT PHASE 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.
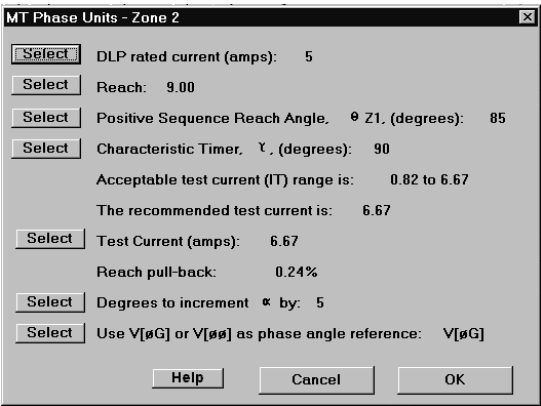


**Figure 10–6: MT PHASE UNITS – ZONE 2 DIALOG BOX**

**10.2.7 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.
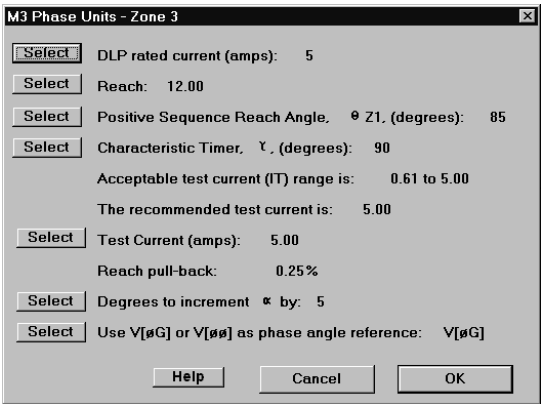


**Figure 10–7: M3 PHASE UNITS – ZONE 3 DIALOG BOX**

**10**

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.
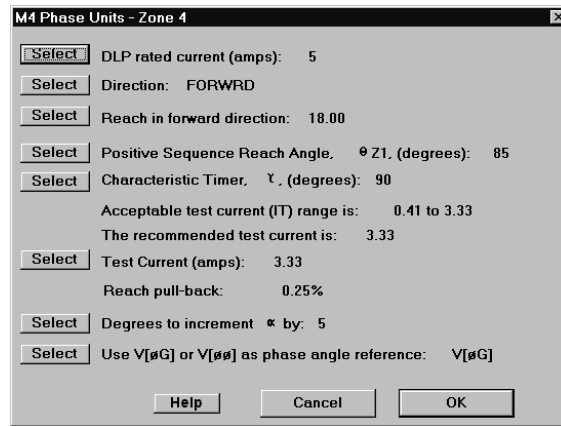


**Figure 10–8: M4 PHASE UNITS – ZONE 4 DIALOG BOX**

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.
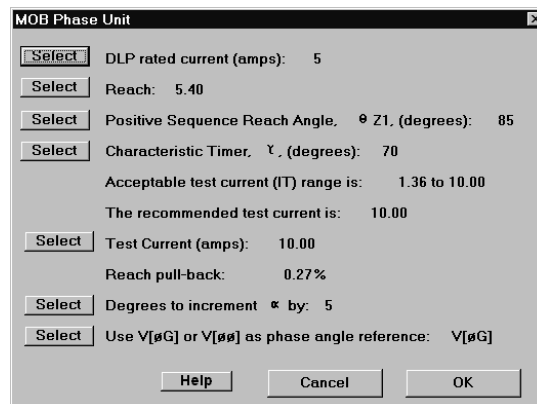


**Figure 10–9: MOB PHASE UNIT DIALOG BOX**

**10.2.10 MIG 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.
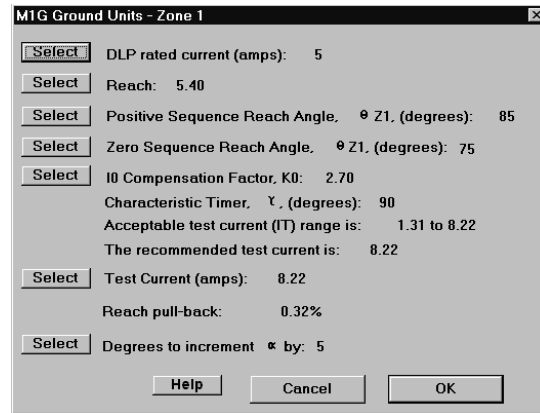


**Figure 10–10: M1G GROUND UNITS – ZONE 2 DIALOG BOX**

**10.2.11 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.
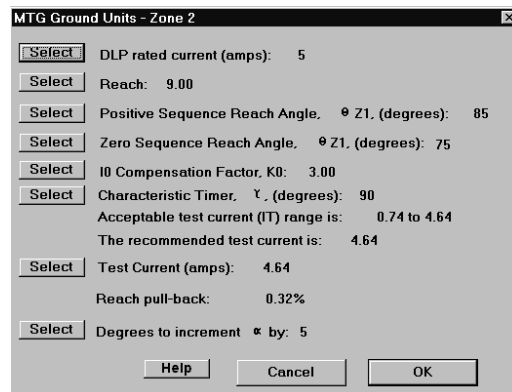


**Figure 10–11: MTG GROUND UNITS – ZONE 2 DIALOG BOX**

**10**

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.



**Figure 10–12: M3G GROUND UNITS – ZONE 3 DIALOG BOX**

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.



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.

The **File** menu is shown below:
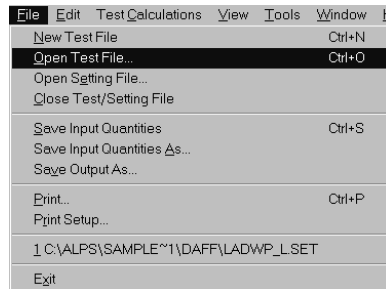


**Figure 10–13: FILE MENU**

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 "Untitledx" in the title bar. The 'x' is a digit corresponding to the number of new documents created.

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).

The following is a list of protection 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 |
| 406 | **Z4GRDREACH** | Z4 Ground Reach |
| 407 | **Z4GCHARANG** | Z4 Ground Characteristic Angle |
| 408 | **Z4DIRECTN** | Z4 Direction |

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| 1401 | **POSSEQANG** | Pos. Seq. Impedance Angle |
| 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.

### 10.3.4 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 with a text editor.

### 10.3.5 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.

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- 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.

### 10.3.6 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.

### 10.3.7 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.

### 10.3.8 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.

### 10.3.9 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 Windows determines it should behave.

### 10.3.10 LAST 4 OPENED SETTINGS FILES

The last 4 opened settings files are displayed in the File menu, and may be selected here.

### 10.3.11 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.

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The **Edit** menu is shown below.
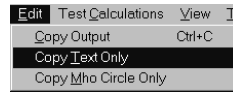


**Figure 10–14: EDIT MENU**

Select a test, set the input quantities to the desired values, and click the **OK** button.

Select **Copy** from the **Edit** menu.

**10.4.2 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.

**10.4.3 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.

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**10.5.1 DESCRIPTION**

These menu items are supplied and manipulated by Microsoft. Therefore the testing will be brief as these items behave however Microsoft and the Windows operating system determines they should behave. The one exception is the items on the toolbar.

**Figure 10–15: VIEW MENU**

**10.5.2 TOOLBAR**

The items on the toolbar (shown below) are, from left to right:

**Figure 10–16: ALPS TEST TOOLBAR**

- 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 **View > Toolbar** menu item. The toolbar is removed from the display.

Select the **View > Toolbar** menu item again. The toolbar is displayed.

**10.5.3 STATUS BAR**

Verify the items on the status bar (shown below):

For Help, press F1                                                                          NUM SCRL

**Figure 10–17: ALPS TEST 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.

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There is one menu item **Setup**. Click on **Setup** and the following dialog box is displayed.
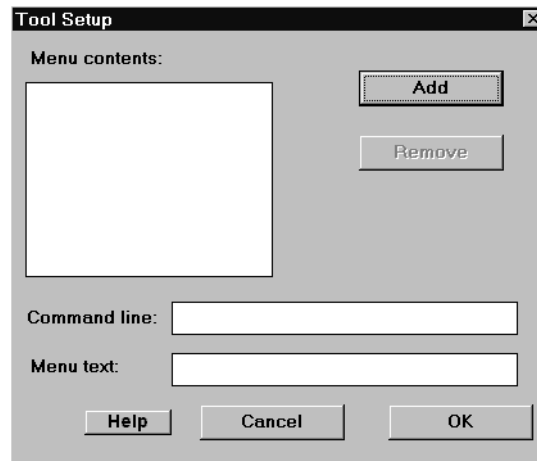
**Figure 10–18: TOOL SETUP DIALOG BOX**

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 (for example, 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.

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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.

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**10.7.1 DESCRIPTION**

These menu items are supplied and manipulated by Microsoft. Therefore the testing will be brief as these items behave however Microsoft and the Windows operating system determines they should behave.

**Figure 10–19: WINDOW MENU**

**10.7.2 CASCADE**

Have more that one test file active in the program. Select the **Cascade** menu item. The windows are displayed in a cascaded style.

**10.7.3 TILE**

Have more that one test file active in the program. Select the **Tile** menu item. The windows are displayed in a tiled style.

**10.7.4 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.

Move the icons around on the screen.

Select the **Arrange Icons** menu item. The icons are rearranged across the bottom of the screen.

**10.7.5 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.

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**10.8.1 CONTENTS**

The **Help** menu is shown below.
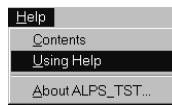


**Figure 10–20: HELP MENU**

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.

**10.8.2 ABOUT ALPS_TST**

Select **About ALPS_TST** from the **Help** menu. The following dialog box is displayed:
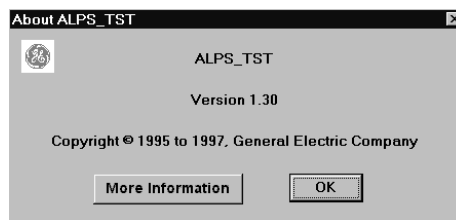


**Figure 10–21: ABOUT ALPS_TST DIALOG BOX**

Click on the **More Information** button. Information about who to contact is displayed.

Click on **OK**. The dialog box is cleared from the screen.

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This chapter 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.

This section 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

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.

The minimum system configuration required to run ALPS-Link software is:

Personal Computer (PC) with an Intel 80386 or better processor with:

- 8 MB RAM

- minimum 200 MB of free Hard Disk space

- 3.5", 1.44 MB Floppy Disk drive (or CD-ROM if using GE Products CD)

- VGA / EGA or better display card and monitor

- PC/AT keyboard

- One or more RS-232 serial ports

- One parallel port for printer

- Mouse

- Any printer supported by Microsoft Windows

- Windows 95, Windows 98, Windows NT, Windows 3.1

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 hosts RS232 port; for connection via the ALPS 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 RS485 line, a converter can be used between the device and the COS.

The printer is connected to the parallel port of the PC.

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.

**11**
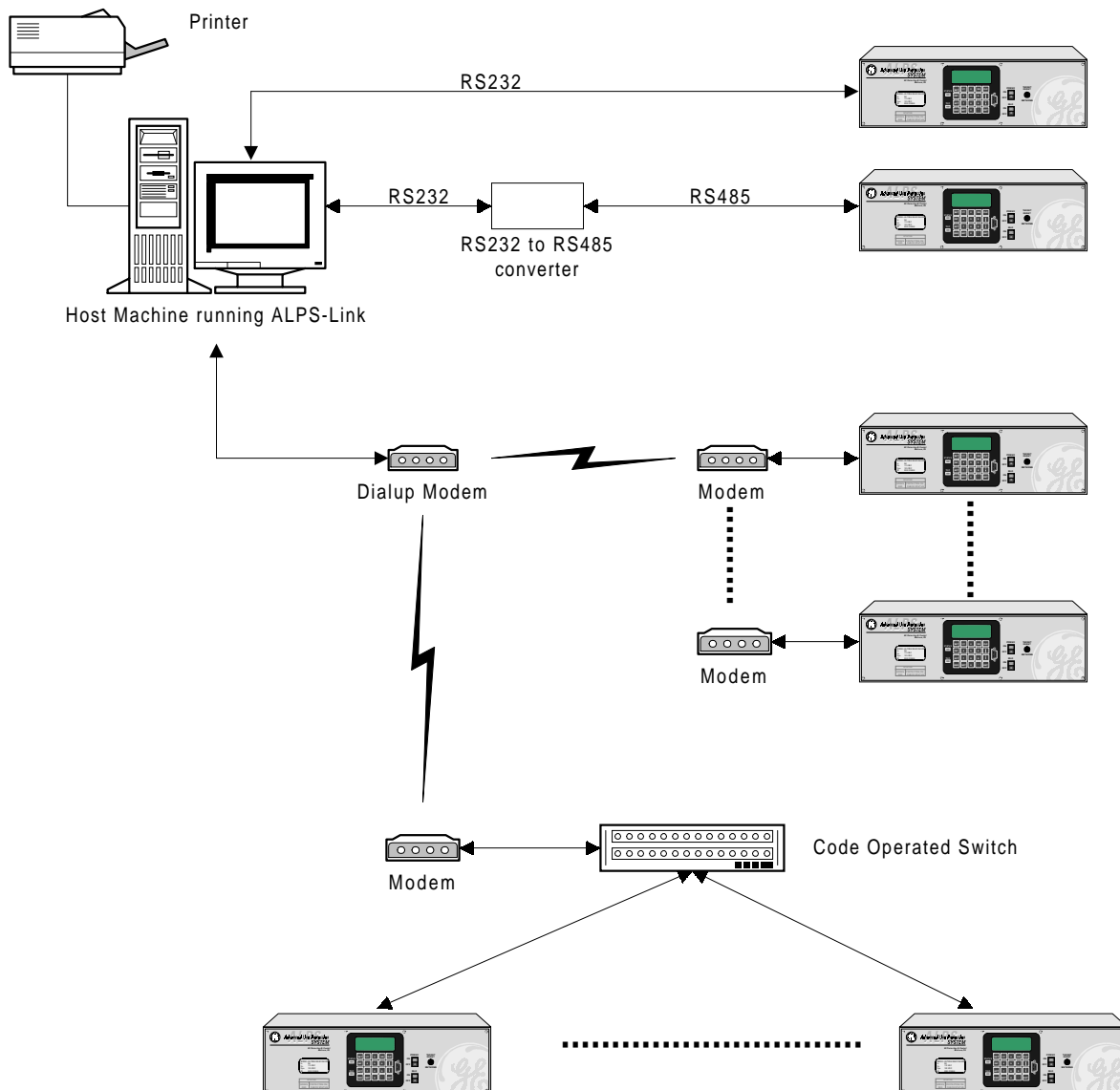


**Figure 11–1: SUPPORTED ARCHITECTURE**

**11.1.5 SOFTWARE INSTALLATION**

**11**

Installation of ALPS-Link and its accompanying software packages (ALPS-Set, Xpression Builder, and ALPS-Test) is accomplished as follows.

1.  Ensure that Microsoft Windows® is running on the local PC.

2.  Insert the GE Power Management CD into your CD-ROM drive or direct your web browser to the GE Power Management website at www.GEindustrial.com/pm. The Products CD is essentially a "snapshot" of the GE Power Management website at the date indicated on the CD and should launch automatically in your default web browser (if not, it may be opened manually). As such, the procedures for installation from the CD and the Web are identical. To ensure the most recent software, installation from the Web is recommended.



**Figure 11–2: GE POWER MANAGEMENT WELCOME SCREEN**

3.  Click the **Index by Product Name** menu item from the GE Power Management main page and then select **ALPS Advanced Line Protection System** from the product list to open the ALPS product page.

4.  Select the Software item from the Product Resources List to proceed to the ALPS software page.

5.  The latest version of the ALPS-Link software suite will be shown along with some support materials. Click on the ALPS/LPS PC Software menu item and download the installation package to your local PC. Run the downloaded installation program.

**11**

6.    The following dialog box is displayed:
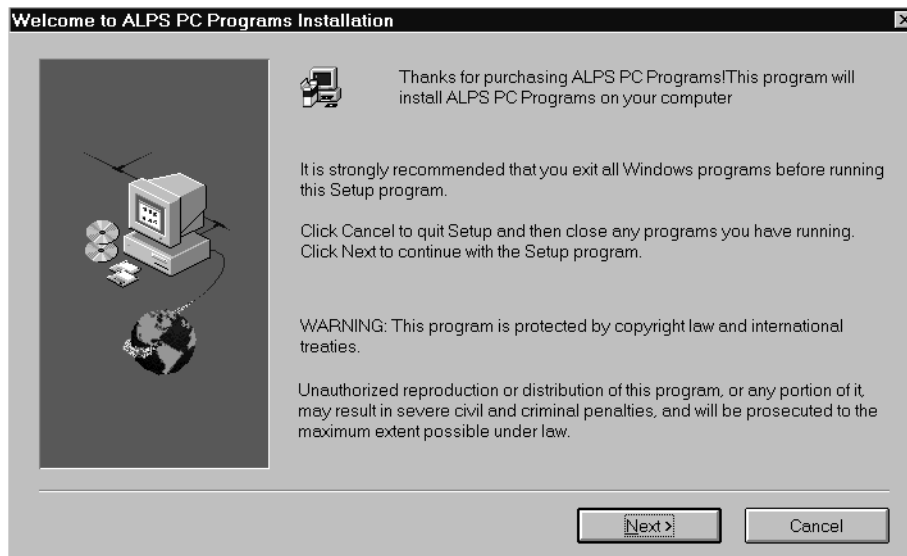


Figure 11–3: ALPS SOFTWARE INSTALLATION WELCOME SCREEN

7.    Click **Next** button to begin the installation.

8.    The Software License dialog box will appear. Carefully read the Software license agreement. Click **Yes** if you agree with the terms of license; clicking **No** terminates the Setup program.

9.    Setup will prompt for a directory to install the ALPS software. Click **Browse** to choose an appropriate directory or **Next** to accept the default directory C:\GEPM\ALPS.

10.   The Setup Options dialog box will appear. Choose between **Complete**, **Custom**, or **Typical** installation. **Typical** is recommended.

11.   Setup will then prompt for a Program Folder for the ALPS software. Enter a folder or choose the default ALPS PC Programs and click **Next**.

12.   ALPS-Link Setup will now install the software and prompt for an appropriate directory for the Xpression Builder software. It is highly recommended to install Xpression Builder now. Choose an appropriate directory (e.g. C:\GEPM\XPRESS) and click **Next**.

13.   The Installation Complete dialog box will appear. Check **Yes, I want to view the ReadMe file** to view the latest software information and click **Finish**. The software is now installed.

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 any other running programs are terminated before starting ALPS-Link as they might affect its performance and that of related applications.

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**11.2.1 STARTUP**

This sub-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.

**11.2.2 MENU BAR**

The items in the ALPS-Link application window menu bar are: **Device**, **Report**, **Log**, **Support Func**, **Protocol**, **Window** and **Help**. The items in each menu change when a device is connected. For example, Log will not have the current item now but will display it when the device is connected.

**11.2.3 TOOLBAR**



**Figure 11–4: ALPS-LINK TOOLBAR**

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, from left to right, **Connect**, **Hang-up** (if a telephone line is used), **Device Setup**, **Local Settings**, **archive**, **printer**, **Help** and **Context Sensitive Help**.

**11.2.4 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.



For Help, press F1                                    04/27/99 10:11:05 LOG CAP NUM

**Figure 11–5: ALPS-LINK STATUS BAR**

**11**

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.

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 RS232 line or an RS485 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 setup the serial (COM) port choose the **Support Functions > Host setup** menu item.

A pop up menu with **Ports/Modem/Printer** will be displayed. Choose the **Ports** item. The **Port Setup** dialog box will appear.
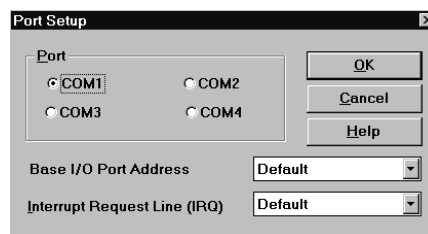


**Figure 11–6: PORT SETUP DIALOG BOX**

Change the **Base I/O 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.

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 setup the Modem, choose the **Support Functions > Host Setup** menu item. A pop up menu r will be displayed. Choose the **Modem** item from this menu. The **Modem Setup** dialog box will appear.
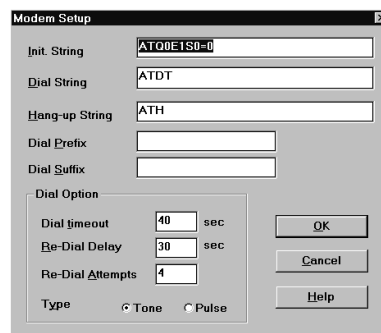


**Figure 11–7: MODEM SETUP DIALOG BOX**

**11**

The **Init. String**, **Dial String** and the **Hang-up String** text boxes 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 timeout**. 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 **Re-dial Delay** is in addition to the timeout 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-dial Attempts** 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.

### 11.3.4 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 **SupportFunc** menu. Choose the **Host Setup** item from the **Support Func** pull down menu in the menu bar. From the pop-up menu choose the **Printer** item.
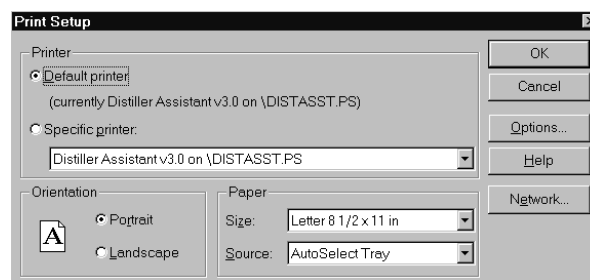


**Figure 11–8: PRINTER SETUP DIALOG BOX**

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.

### 11.3.5 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: for example, 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.

### 11.3.6 ADDING A DEVICE

You can introduce a new device to ALPS-Link system or modify the setup of an existing device using the device setup feature.

1.  Choose the **Device > Device Setup** menu item. A **Device Directory** dialog box shows the list of the devices already known to ALPS-Link. Click on the scroll button of the device name field to see this list.

2.  To add a new device click on **Add**. The **Device Setup** dialog box appears with the default parameters.

3.  Click in the **Device Name** text box and enter the name for the relay. Do the same for the **Unit ID** text box.

4.  From the **Baud rate** list, select the communication speed that matches the relay Name (Device Name).

5.  Specify the number of **Data Bits**, **Stop Bits** and the **Parity** in the specified fields for communication with this device.

6.  The **Break Signal** is needed for communication with certain Code Operated Switches (COS) used on the other side of the communication line. Click this if the COS you are using needs this.

7.  **Duration of Break** refers to the time gap required to specify a certain message is for the COS. This may be needed with or without the break signal.

8.  The **Phone No**. text box is the phone number the host machine must dial to get connected to this device. A maximum of 60 characters can be entered in this field.



**Figure 11–9: DEVICE SETUP DIALOG BOX**

9.  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 fields.

10. In the Device Setup dialog box, click on one of the radio buttons to indicate the mode of communication as the RS-232 or **RS-485**.

11. The **Switch Code** text box is a string of characters sent to the code operated switch. It accepts a maximum of six characters in Hexadecimal format.

12. 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. Alternatively, choose the **Cancel** button to quit the dialog box without updating the device setup.

Clicking on **Use As Default** 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.

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 dialog box 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** dialog box 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.

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### 11.4.1 DESCRIPTION

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.

### 11.4.2 CONNECT TO A DEVICE

To connect to a device, choose the **Connect** item 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.

### 11.4.3 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 from 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 from the **Actions** menu. If the device is in the Test mode, choose the **End Test** item from the **Actions** menu.

To logout from a device when a modem is being used, a hang-up request must be explicitly made. You can request hang-up without logging out of a device. ALPS-Link will perform 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. 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.

**11**

**a) DESCRIPTION**

The ALPS performs protection functions in a power system according to the device settings values. The settings are grouped into categories. The ALPS has four 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.

**b) 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 **Protection Category** field, you can select a particular category. Click the scroll button to see the list of available categories. Selecting a particular category displays 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. See Figure 11–10: PROTECTION CATEGORY SCROLL LIST.

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 to 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 settings file.

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** 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.**

**11**
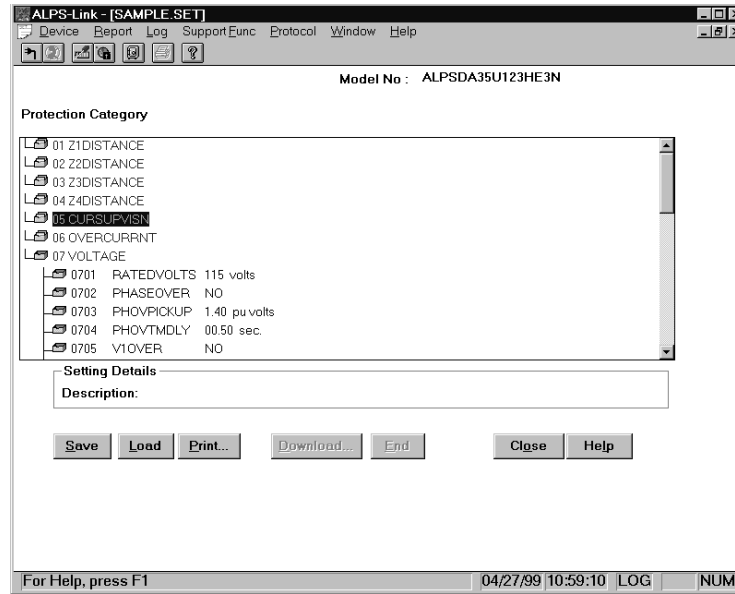


**Figure 11–10: PROTECTION CATEGORY SCROLL LIST**

#### c) LOAD LOCAL SETTINGS

You can view, modify and print settings loaded from a local file. It is not essential to connect to the device to load local settings. The settings file 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 dialog box appears where you can select the file to load from with the settings dialog box with the settings. Multiple files can be opened simultaneously for viewing, modifying and printing. Refer to Section b): UPLOAD SETTINGS for an explanation on the **Settings** dialog box features.

#### d) 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.

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.

#### e) 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.

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### f) 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.

### g) 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.

**11.5.2 ACTIONS**

### a) DESCRIPTION

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.

### b) 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.

### c) 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.

### d) 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.

1. 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.

2. 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.

3. 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.

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### e) 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. 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.

### f) 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.

### g) 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**  **The error message *OTHER USER IS ACCESSING THIS RESOURCE* will appear if the relay is in test mode from another port, or the keypad.**

### h) 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.

### i) 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.

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Different types of information stored in the ALPS can be fetched and viewed in a desired report format. ALPS-Link facilitates the acquisition and presentation of this information. Reports can be viewed, printed, or stored for later use. You can select the report you want from the **Reports** menu. A list of available reports will be displayed when you choose the **Open** item. You can also view an existing report from a local file. You should be logged into a device before you deal with any of the information.

**11.6.2 OPEN REPORT**

The reports item is not visible in the menu bar until you are logged into 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.
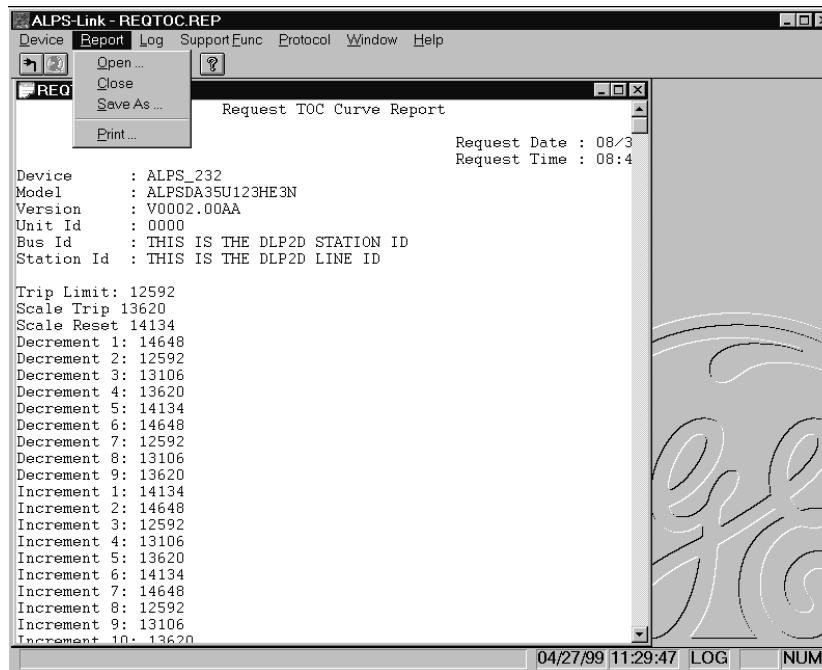


**Figure 11–11: REPORT MENU WITH OPEN REPORT**

**11.6.3 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 available reports is 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 cannot 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.

The report can be printed 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. To print or save a report when multiple reports are in view, ALPS-Link saves or prints the active report. Ensure that the desired report 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. All of the reports and their associated dialog boxes (if any) are explained in the following sub-sections.

When you choose the **Faults** report, a dialog box with the list of faults available with the device is displayed. Select the fault to report and choose **OK**. ALPS-Link will fetch relevant data from the device.

To retrieve an oscillography report from the relay, select the **Report > Regular Oscillography** menu item. 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 file 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, select the **Report > Save** (or **Save As**) menu item. Type in a descriptive file name, but do not add an extension. Five files will be saved and three 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 Section 8.1.20: 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.

Select the **Report > Breaker Health** menu item to see the current breaker health values.

With **Demand Report** it is necessary to select the demand number (or range) for which you want demand data. Normally the allowed range is 1 to 192. If **Extended Demand Option** is set, then the valid range is 1 to 3360. If you want to see the report for a particular number and not the range, enter the same value in both the **Start Interval** and **End Interval** entries.

Select **Diagnostics** from the **Report** menu to see a listing of all the diagnostic events occurred at the device.

Select **Event** from the **Report** menu to see the events data fetched from a connected device.

When you select **Present Values** from the **Report** 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** option or stop monitoring by selecting **Close** option on the special dialog box monitoring these values.

> **NOTE** When General setting 108 is set to Primary (DISPLAYVAL = PRI), the Current values are in amps and the voltage values are in KV. The ALPS-Link Present Value display will show the units as V.

Select **Status** from the **Report** menu to get the status report of various system components.

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### 11.6.12 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.

### 11.6.13 LUI PASSWORD REPORT

Select **LUI Password** to get a report on passwords of all the three levels.

### 11.6.14 OPEN REPORT

The report must have been fetched earlier from the device and stored in the file. When you choose the **Open** item in the **Report** 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.

### 11.6.15 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.

### 11.6.16 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.

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### 11.7.1 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, that is, after the 100th log, the overwriting re-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.

### 11.7.2 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.

### 11.7.3 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.

### 11.7.4 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.

### 11.7.5 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.

### 11.7.6 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.

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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 (for example, floppy disk) and give the destination name and path.

If retrieving any of the log files, ensure the file is copied to `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, that is, you can name it test.log. For **Report** and **Settings**, you can select the directory and name of your choice.

The ALPS has a built-in ASCII interface which can communicate using any standard terminal emulator. 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 keypad operation can also 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 COM 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 flow control. When the terminal emulator is ready and the relay connected, press [ENT]. 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 your ASCII communications program to save relay responses to a file.

1. The "Press" prompt 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 are not 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 (for example: 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 he 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 depending on the privilege level.

| PRIVELEGE LEVEL | PROMPT |
|---|---|
| VIEW | ALPS_INF> |
| ACTIONS | ALPS_ACT> |
| SETTINGS | ALPS_SET> |
| MASTER | ALPS_MST> |

Communication using the 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 12–1: OSCILLOGRAPHY DATA STRUCTURE. Each sample appears on a separate line.

**Table 12–1: OSCILLOGRAPHY DATA STRUCTURE**

| ITEM | DATA FORMAT (ASCII CHARACTERS) | DESCRIPTION |
|---|---|---|
| Sample No | decimal integer | Sample number within the cycle |
| Ia | signed decimal (resolution of 0.01 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 |

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**Table 12–2: ASCII COMMAND LIST (Sheet 1 of 5)**

| ASCII COMMAND MNEMONIC | COMMAND DESCRIPTION | LOWEST LEVEL PASSWORD NEEDED | RELAY PROMPT | USER RESPONSE |
|---|---|---|---|---|
| LOGIN | Login to the relay | NONE | Unit ID?<br>Password?<br><br>Reports the access level granted **or** that the password entered is INVALID | Relay ID number; up to 10 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<br>Do you want to logout?<br>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<br>Enter New Password<br>Re-enter New Password<br>Password changed **or** INVALID; password not changed | old password;<br>new password;<br>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**<br>VA rms: V          IA rms: A<br>VB rms: V          IB rms: A<br>VC rms: V          IC rms: A<br>                       In rms: A<br>VA: V degs         IA: A degs<br>VB: V degs         IB: A degs<br>VC: V degs         IC: A degs<br>                       In: A degs<br>Watts: KW          Vars: kVar<br>Power Factor       Frequency: Hz<br>Setting Group Number:1   No. of Breakers: 2<br>Breaker 1: Closed   Breaker 2: N/A<br><br>**Breaker Health**<br>Phase A accumulated   Breaker Operations: 129<br>Amps: 45.2 A<br>Phase B accumulated<br>Amps: 11.1 A<br>Phase C accumulated<br>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. | | | |
| FAUlts | Display fault reports. The list of available faults is displayed first then a number is chosen to view a particular fault | VIEW | FLTNO DATE TIME  TRIP   FAULT DISTANCE<br>                          TYPE   TYPE<br> 1    07/09/98         EXT     AG       0.2mi<br>          15:32:23.6833<br><br>Enter Fault Number (press ESC to quit): 1<br><br>Report for Fault No: 1<br>TRIP DATE: 07/03/98<br>TRIP TIME: 16.32.23.6833<br>Trip Type(s): Z1<br>Fault Type: ABG<br>Relay Operating Time: 488 ms<br>Breaker Operating Time: 1152 ms<br>Distance: 9999 miles<br><br>ITEM                    A      B      C      D<br>Prefault Current (A)  0.00   0.00   0.00   0.00<br>Fault Current (A)     0.00   0.00   0.00   0.00<br>Fault Voltage (kV)    0.00   0.00   0.00   0.00<br><br>Press ENTER to Continue<br><br>List of Fault Events:<br><br>TIME                EVENT<br>16:32:23.7025       Oscillography Capture<br>16:32:23.7041       RMS Oscillography Data<br><br>Press Y to get oscillography data<br>Press ESC to quit<br>Press Any Key to continue | Press E for expanded mode, ESC to end<br><br><br>Two digit number, 1 to 16 |

**Table 12–2: ASCII COMMAND LIST (Sheet 2 of 5)**

| 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:<br><br>06/30/98 16:26:29.7562 Host Logoff on MMI<br>06/30/98 16:24:37.5944 Host Logon OK on Port 2<br>06/30/98 16:10:45.6505 Recloser in RESET state<br>06/30/98 16:10:40.0000 Settings File 0 in Use<br>06/30/98 16:10:40.0000 System booted<br><br>Press ENTER to continue, B to go back a screen, or ESC to quit | None |
| 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)<br>TRIP BREAKER 1,! Are you sure? (Y/N)<br>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)<br>CLOSE BREAKER 1,! Are you sure? (Y/N)<br>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)<br>Outputs are disabled **or** Outputs cannot be disabled | Y for OK, N to cancel; command |
| DISABle outputs | Disable outputs | CONTROL | Disable Outputs, Are you sure? (Y/N)<br>Outputs are disabled **or** Outputs cannot be disabled | Y for OK, N to cancel; command |
| STATUs | Display status of the relay | VIEW | RELAY STATUS<br>Refer to the servicing section for status messages for the ALPS<br>Press ENTER to continue | None |
| DATAReset | Clear various data logs maintained in the relay | SETTING | To clear FAULT REPORT and OSCILLOGRAPHY enter F<br>To clear OST REPORT enter S<br>To clear EVENT DATA enter E<br>To reset target LED and clear warn, failure, and trip messages enter L<br>To clear BREAKER HEALTH enter B<br><br>To quit press ESC<br>Enter your choice: | 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 | Turn Protection off (Y/N):<br>Enter the number of the Digital Output to be tested (1 to 18)<br>Enter END to end test<br>To see list of Digital Outputs enter H<br>To quit press ESC<br>Enter your choice: 4<br><br>Digital Output #4 is Activated<br>Turn Protection on? (Y/N): | Enter letter; Enter digit form 1 to 18; enter letter |
| GROUP | | SETTING | The active Protectioning Setting Group number is 1<br><br>To select a Setting Group enter Setting Group Number ('1' - '4')<br>To select active setting group through Contact Converter Inputs enter '0'<br>To quit press ESC<br>Enter your choice:<br><br>Are you sure (Y/N):? y<br>  New Active Group = 3 | Enter digit from 0 to 4; enter letter |
| INPuts | Request contact converter status | VIEW | Contact Converter #0=0 (SETTING GROUP BIT 0)<br>Contact Converter #1=1 (SETTING GROUP BIT 1)<br>Contact Converter #2=1    (not assigned)<br>Contact Converter #3=0    (not assigned)<br>Contact Converter #4=0    (not assigned)<br>Contact Converter #5=1    (not assigned)<br>Contact Converter #6=0    (not assigned)<br>Contact Converter #7=1    (not assigned) | None |

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**Table 12–2: ASCII COMMAND LIST (Sheet 3 of 5)**

| ASCII COMMAND MNEMONIC | COMMAND DESCRIPTION | LOWEST LEVEL PASSWORD NEEDED | RELAY PROMPT | USER RESPONSE |
|---|---|---|---|---|
| MODEL | Retrieve the model number, serial number, and version of the relay | VIEW | MODEL: ALPSDA35U143VE3S<br>VERSION: V0001.11 | None |
| CRCcalc | Recalculates the CRC of various settings groups (this is primarily a troubleshooting command - it is used only where a relay may have gone through a loss power during a settings change, and the settings are corrupted beyond the ability of the relay to correct). | SETTINGS | CRCs are recalculated | None |
| STLINID | Allows the station and line IDs to be changed | SETTINGS | Station ID: Current Station ID<br>Line ID: Current Line ID<br><br>Do you want to change Station and/or<br>Line ID? (Y/N): y<br>Enter new Station ID (max. 32 characters): NEW STATION ID<br>Enter new Line ID (max. 32 characters): NEW FEEDER ID<br>Are you sure? (Y/N): y | Y to change, N to exit; NEW STATION ID or ENTER to keep current ID; NEW FEEDER ID or ENTER to keep current ID; enter letter |
| 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):<br><br>Select the function to be tested (2 to 49)<br>To stop the test in progress enter I<br>To see the list of functions enter H<br>To quit without suspending the test enter Q<br><br>To quit press ESC<br>Enter your choice: 2<br><br>Z1 AG test function is routed to contact A! | Enter letter Y or N; one to two digit number, 1 to 49; enter letter 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<br><br>Oscillography is triggered | Enter letter Y or N |
| 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 | Enter letter B or E |
| PLAYBack | Re-run a fault produced earlier or test case for relay. There are three choices for running a fault: 1) re-run a fault saved in the relay; 2) with factory test data; 3) download oscillography into relay and run fault | ACTION | To run the relay on Fault Data enter Fault Number<br>To run the relay on factory test case enter F<br>To run the relay on downloaded test data enter D<br>To quit press ESC<br>Enter your choice: 5<br><br>The fault is absent<br>There is no factory test data in the relay<br>There is no downloaded data in the relay | Fault number, F, D, or ESC |
| LUIPass | Display coded LUI passwords. See decoding table in Chapter 8 | VIEW | MMI PASSWORDS<br><br>Settings Password: [DHLPPPPPPPPPPP<br>Control Password: [AEIPPPPPPPPPPPP<br>Master Password: [MBFPPPPPPPPPPPP | None |
| HELP | Displays the ASCII command mnemonics as well as descriptions of each command | VIEW | | None |

**Table 12–2: ASCII COMMAND LIST (Sheet 4 of 5)**

| ASCII COMMAND MNEMONIC | COMMAND DESCRIPTION | LOWEST LEVEL PASSWORD NEEDED | RELAY PROMPT | USER RESPONSE |
|---|---|---|---|---|
| OUTPuts | Displays the current state of the digital outputs | VIEW | Output Contact #1, T1=0    Output Contact #2, T2=0<br>Output Contact #3, T3=0    Output Contact #4, T4=0<br>Output Contact #5, A1=0    Output Contact #6, A2=0<br>Output Contact #7, A3=0    Output Contact #8, A4=0<br>Output Contact #9, A5=0    Output Contact #10, A6=0<br>Output Contact #11, A7=0    Output Contact #12, A8=0<br>Output Contact #13, KT1=0    Output Contact #14, KT2=0<br>Output Contact #15, KT3=0    Output Contact #16, KT4=0<br>Output Contact #17, C1=0    Output Contact #18, C2=0 | None |
| DATE | Displays the current ALPS date | SETTINGS | Do you want to change date? (Y/N):<br>Enter new date (mm/dd/yy):<br>Command is executed | Enter letter Y or N; 6 digit date code |
| TIMe | Displays the current ALPS time | SETTINGS | Do you want to change time? (Y/N):<br>Enter new time (hh:mm:ss):<br>Command is executed | Enter letter Y or N; 6 digit time code |
| 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): | Enter 24, 25, 48, or 50 |
| GEModem | Changes communications type to GE-Modem after user has logged out | SETTINGS | | None |
| ECHo | Toggles the echo state and reports its status | VIEW | Echo is turned ON (OFF) | None |
| PORTparam | Changes and displays the current port parameters for the ALPS serial communications port | SETTINGS | Do you want to change communication port parameters? (Y/N):<br>Interface is (0 - RS232, 1 - RS485): 0<br>Enter Interface Type (0 - RS232, 1 - RS485):<br><br>Baud rate is 9600<br>Enter baud rate (19200, 9600, 4800, 2400, 1200, 300):<br><br>Parity check type is (0 -none, 1 - odd, 2 - even): 0<br>Enter parity check type (0 -none, 1 - odd, 2 - even):<br><br>Number of stop bits is 1<br>Enter number of stop bits (1 or 2):<br><br>Save changes? (Y/N): | Y displays parameter to be changed, N exits; 0 for RS233, 1 for RS485; press ENTER for no change; choose baud rate matching PC port; Enter 0, 1, or 2;<br><br>Enter 0, 1, or 2;<br><br>Enter Y or N |
| END | Ends the session | VIEW | | None |

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**Table 12–2: ASCII COMMAND LIST (Sheet 5 of 5)**

| ASCII COMMAND MNEMONIC | COMMAND DESCRIPTION | LOWEST LEVEL PASSWORD NEEDED | RELAY PROMPT | USER RESPONSE |
|---|---|---|---|---|
| SHOWSET | Displays the current values of selected settings | VIEW | To see PROTECTION GROUP Settings press Setting Group no 1 to 4<br>To see GENERAL Settings press G<br>To quit press ESC<br><br>Enter your choice:2<br><br>To view Category of Settings press C<br>To view ALL Settings press A<br>To go back to previous menu press B<br>To quit press ESC<br><br>Enter your choice: C<br><br>To view protection SETTINGS in a category enter category number 1 to 20<br>To view protection settings CATEGORY names enter C<br>To go back to previous menu press B<br>To quit press ESC<br><br>Enter your choice: 5<br><br>Press ENTER to continue or ESC to quit | Enter 1, 2, 3, 4, G, or press ESC<br><br><br>Enter C, A, B, or press ESC<br><br><br><br><br>Enter numbers between 1 to 20, the letters C and B, or press ESC<br><br>Press ENTER or ESC |
| SET | Allows the user to change settings | SETTINGS | To view/change PROTECTION GROUP Settings press Setting Group no 1 to 4<br>To view/change GENERAL Settings press G<br>To quit press ESC<br><br>Enter your choice:2<br><br>To view/change Category of Settings press C<br>To view/change ALL Settings press A<br>To go back to previous menu press B<br>To quit press ESC<br><br>Enter your choice: C<br><br>To view/change protection SETTINGS in a category enter category number 1 to 20<br>To view/change protection settings CATEGORY names enter C<br>To go back to previous menu press B<br>To quit press ESC<br><br>Enter your choice: 1<br><br>Press ENTER to continue or ESC to quit | Enter 1, 2, 3, 4, G, or press ESC<br><br><br>Enter C, A, B, or press ESC<br><br><br><br><br>Enter numbers between 1 to 20, the letters C and B, or press ESC<br><br>Press ENTER or ESC |

**13.1.1 OVERVIEW**

The ALPS relay has been designed to allow flexibility in the operation of contact converter inputs and contact outputs. The inputs and outputs are not hard-wired to any function; the functions of each input and output are defined by a software file which is downloaded to the relay as a part of each setting group.

The software file represents the linkage between the contact converters, internally generated protection flags, and contact outputs; it contains information regarding the logical relationships among each entity. This file is built using a windows based application called Xpression Builder.

Xpression Builder allows the utility engineer to design the interconnection of the inputs and outputs with Boolean operators, latches, timers, and counters in a graphical environment. The application performs the task of compiling the design from a graphical format, and allows the engineer to download the file to a relay setting group with ALPS-Link. Each setting group can contain different Xpression Builder logic. The ALPS comes with a default Configurable Logic implementation.

**13.1.2 INSTALLATION**

If the ALPS software suite has been installed from the Products CD or GE Power Management website, Xpression Builder is probably already installed. To install Xpression Builder by itself from the Products CD or website, consult the procedure in Section 11.1.5 SOFTWARE INSTALLATION on page 11–3, and choose Xpression Builder from the ALPS software menu.

To install the software from the GE Power Management web site enter the following URL in your Web browser:

> www.GEindustrial.com/pm

The home page is the same as that shown in Figure 11–2: GE POWER MANAGEMENT WELCOME SCREEN on page 11–3. Follow the procedure in Section 11.1.5 SOFTWARE INSTALLATION on page 11–3  to continue the installation.

**13.1.3 DESIGN CONSIDERATIONS**

Xpression Builder logic is processed every other millisecond. This should be considered when designing logic to implement in the relay. The more gates connected in series, the longer the time delay from the initial logic input to the final logic output (roughly 2 ms per gate) of the expected result. This delay applies to the Xpression Builder logic only. The scheme logic outputs of the relay will not be delayed with the use of configurable logic.
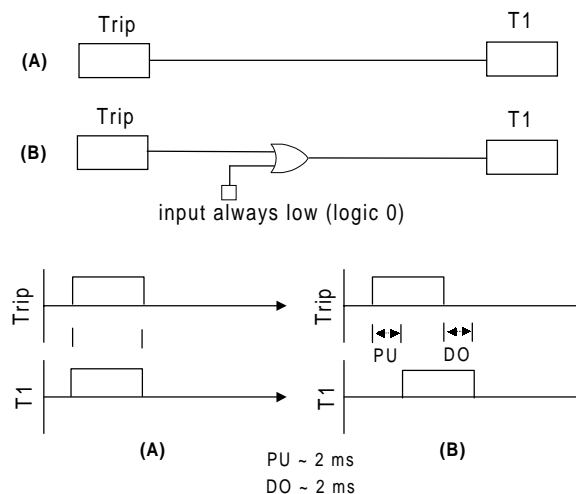


**Figure 13–1: LOGIC PROCESSING DELAY**

For example, the TRIP (flag #33) output of the scheme logic, when directly connected to an output contact, will close that contact when it becomes high (logic 1) with no additional processing delay as shown in part A of the figure above. If the TRIP flag is connected to a Boolean gate before it reaches an output contact, a gate processing delay of 2 ms should be added to the expected function operating time as shown in part B above. This should be taken into consideration in the design of the relay configurable logic. This is why it is recommended all user defined logic be tested in a laboratory environment before installation in the field. This will ensure user confidence and expected performance of the configurable logic developed with the relay internal flags.

**a) BOOLEAN OPERATORS**

The operation of the Boolean operators (AND, OR, and NOT) are self explanatory. Each gate may have up to four (4) inputs. Each of the inputs may be logically inverted by clicking the right mouse button when the cursor is at the input of the gate. A small circle at the gate input will indicate the inversion of the input signal. The output can also be inverted by clicking the right mouse button when the cursor is at the output of the gate. A small circle at the gate output will indicate the inversion of the output signal.

**b) LATCHES**

A "D" flip-flop is used in the Xpression Builder logic as shown in Figure 13–2: LATCH AND TRUTH TABLE. The D input is where the data bit to be stored is applied. The T or clock input controls the flip-flop. It determines whether the data on the D input line is recognized (clocked) or ignored. If the T input line is high (binary 1), the data on the D input line is stored in the flip-flop. If the T input line is low (binary 0), the D input line is not recognized. The Q output line directly reflects the state of the flip-flop. If the flip-flop is set, then Q equals a high (binary 1). If Q equals a low (binary 0), then the flip-flop is reset.



| T | D | Q |
|---|---|---|
| L | X | $Q_0$ |
| H | L | L |
| H | H | H |
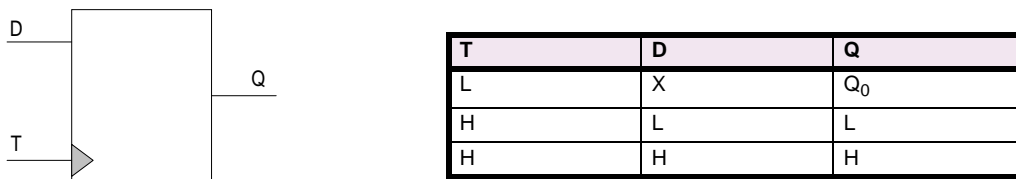
**Figure 13–2: LATCH AND TRUTH TABLE**

**c) TIMERS**

There are two types of timers used in the Xpression Builder: the Pickup/Dropout Timer and the Pickup Relay Timer.

The simplest type is the Pickup/Dropout timer shown in the figure below. The PU = 300 indicates the pickup delay in milliseconds and DO = 250 indicates the dropout delay in milliseconds. In both parts A and B, the IN/OUT time charts describe how the timer functions. If the input is high (binary 1) for a time equal to the pickup delay, the output becomes high (binary 1). Any reset of the input (high to low) causes the accumulated pickup time to reset immediately to zero. Once the output occurs, it remains high as long as the input remains high, and when the input subsequently goes low the output stays high for a time equal to the dropout delay. Once the dropout timer has started, it will continue to time out even if the input goes high during the reset time. Time chart A shows a second input pulse occurring after the output goes low. Since this pulse length is less than the 300 ms pickup delay, the output stays low. Time chart B shows a second input pulse occurring 100 ms after the first input pulse goes low. The output goes low as shown in time chart B, but the output then goes high 300 ms after the leading edge of the second input pulse or 150 ms after the trailing edge of the first output pulse. The pickup and dropout timers are independent of each other.
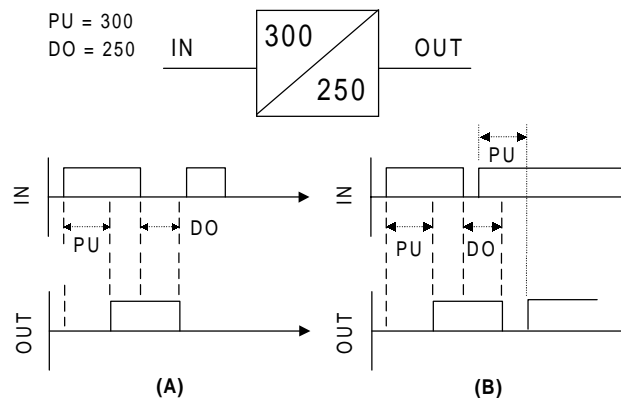


**Figure 13–3: PICKUP/DROPOUT TIMER**

The second type of timer is basically a pickup delay timer with a reset input/output feature. As shown in Figure 13–4: PICKUP DELAY TIMER, there are two inputs, two outputs, and a user selected pickup delay (in milliseconds). In its "initial" state with no inputs applied, both R and S are low (binary 0), the timer outputs RO and SO are both low (binary 0). The timer starts counting when the S input is high (binary 1). When the count becomes equal to the set time delay (1000 ms for our example), the SO output is set high (binary 1) and the RO output is set low (binary 0). If the R input becomes high (binary 1) while the timer IS NOT counting, then both outputs RO and SO are set low (binary 0) which returns the timer to its "initial state". See Table 13–1: PICKUP DELAY TIMER TRUTH TABLE for a summary of the pickup delay timer function.

**1000**
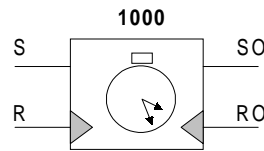
**Figure 13–4: PICKUP DELAY TIMER**

**Table 13–1: PICKUP DELAY TIMER TRUTH TABLE**

| S | R | PREVIOUS TIMER STATE | CURRENT TIMER STATE | RO | SO |
|---|---|---|---|---|---|
| L | L | NOT TIMING | NOT TIMING | $RO_{n-1}$ | L |
| ↑ | L | NOT TIMING | TIMING DOWN | L | L |
| X | L | TIMING DOWN | TIMER EXPIRED | L | H |
| X | H | TIMING DOWN | TIMER RESET | H | L |
| X | ↑ | NOT TIMING | NOT TIMING | L | L |

**d) COUNTERS**

The counter has two input line, one output line, and a user selected count threshold (in milliseconds) as shown in Figure 13–5: COUNTER. A transition from low (binary 0) to high (binary 1) on the S input line increments the counter by a value of one. The O output line is high (binary 1) when the accumulated count is equal to or greater than the count threshold. If the O output line is low (binary 0), then the accumulated count is less than the set value. A transition from low (binary 0) to high (binary 1) on the R input line resets the counter to zero.
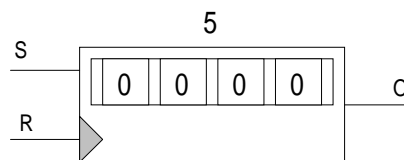
**5**

S

0 0 0 0    O

R

**Figure 13–5: COUNTER**

**Table 13–2: CONTACT CONVERTER INPUT FLAGS**

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 0 | No Assignment to Input | NONE |
| 1 | Breaker #1 52b Contact Input | 52B_1 |
| 4 | Breaker #2 52b Contact Input | 52B_2 |
| 8 | Change Setting Group Input Bit 0 | CGST1 |
| 9 | Change Setting Group Input Bit 1 | 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 |
| 15 | External Reclose Initiate 3-Pole | EXRI3P |
| 16 | External Reclose Inhibit | EXRINH |
| 17 | External Reclose Cancel | EXRCNL |
| 18 | Reclose Reset | RCLRST |
| 19 | External Manual Close | EMNCLS |
| 22 | External Contact Input to Disable Outputs | DISOUT |
| 23 | External Contact to Trigger Oscillography | OSCTRG |
| 24 | Manual Lock-Out | MANLKT |
| 25 | Configurable Input 1 | CNFDI1 |
| 26 | Configurable Input 2 | CNFDI2 |
| 27 | Configurable Input 3 | CNFDI3 |
| 28 | Configurable Input 4 | CNFDI4 |
| 29 | Configurable Input 5 | CNFDI5 |
| 30 | Configurable Input 6 | CNFDI6 |
| 31 | Configurable Input 7 | CNFDI7 |
| 32 | Configurable Input 8 | CNFDI8 |

**13.2.2 INPUT/OUTPUT FLAGS**

The input flags available for assignment to user defined logic are as follows:

**Table 13–3: CONFIGURABLE INPUTS**

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 25 | Configurable Input 1 | CNFDI1 |
| 26 | Configurable Input 2 | CNFDI2 |
| 27 | Configurable Input 3 | CNFDI3 |
| 28 | Configurable Input 4 | CNFDI4 |
| 29 | Configurable Input 5 | CNFDI5 |
| 30 | Configurable Input 6 | CNFDI6 |
| 31 | Configurable Input 7 | CNFDI7 |
| 32 | Configurable Input 8 | CNFDI8 |

**Table 13–4: SCHEME LOGIC AND RECLOSER OUTPUTS**

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 33 | Trip | TRIP |
| 37 | Reclose Initiate | RI |
| 38 | Reclose Cancel Output from Scheme Output | CANCL |
| 39 | Key Xmtr 1 (Carrier Start from Scheme Logic) | KEY1 |
| 40 | Key Xmtr 2 (Carrier Stop from Scheme Logic) | KEY2 |
| 43 | Warm Restart | WARMST |
| 44 | Reclose in Progress | RIP |
| 45 | Line Overload Alarm Output | LNOVLD |
| 46 | Critical Alarm Output | CRTALM |
| 47 | Recloser Lockout | LORCL |
| 48 | Trip Circuit Monitor 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 |
| 56 | Manual Open Breaker # 1 | MNOPN1 |
| 57 | Manual Open Breaker # 2 | MNOPN2 |
| 58 | Manual Close Breaker # 1 | MNCLS1 |
| 59 | Manual Close Breaker # 2 | MNCLS2 |
| 100 | All Phases Open | OPEN |
| 114 | Line Pick-Up | LPU |
| 115 | Fuse Failure Alarm | FF |
| 120 | Out-of-Step Blocking | OSB |
| 121 | Out-of-Step Tripping | OST |
| 122 | Configurable Trip Bus | CNFTRP |
| 123 | Configurable Oscillography Trigger | CNFOSC |
| 135 | Any Trip Bus | TRPBUS |
| 136 | Weak Infeed Trip | WITRIP |
| 140 | Any Phase Overvoltage Pickup | OVRVPU |
| 141 | Positive Sequence Overvoltage Pickup | V1TPU |
| 142 | Compensated Positive Sequence Overvoltage Pickup | V1CPU |
| 144 | Block Reclose Initiate | BLK-RI |
| 145 | Manual Close In Progress | CLS IP |
| 146 | Breaker Close | BKRCLS |
| 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 | OVRVLT |

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### Table 13–5: SCHEME LOGIC INPUTS

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 1 | Breaker #1 52b Contact Input | 52B_1 |
| 4 | Breaker #2 52b Contact Input | 52B_2 |
| 8 | Change Setting Group Input Bit 0 | CGST1 |
| 9 | Change Setting Group Input Bit 1 | 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 |
| 15 | External Reclose Initiate 3-Pole | EXRI3P |
| 16 | External Reclose Inhibit | EXRINH |
| 17 | External Reclose Cancel | EXRCNL |
| 18 | Reclose Reset | RCLRST |
| 19 | External Manual Close | EMNCLS |
| 20 | External Contact to Reset Trip Target Display | RESET |
| 21 | External Contact Input to Disable Protection | DISPRT |
| 22 | External Contact Input to Disable Outputs | DISOUT |
| 23 | External Contact to Trigger Oscillography | OSCTRG |
| 24 | Manual Lock-Out | MANLKT |

### Table 13–6: DISTANCE UNITS (Sheet 1 of 2)

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 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 Zone 1 Phase Distance Function | Z1PH |
| 78 | Any Zone 2 Phase Distance Function | Z2PH |
| 79 | Any Zone 3 Phase Distance Function | Z3PH |
| 80 | Any Zone 4 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 |

**Table 13–6: DISTANCE UNITS (Sheet 2 of 2)**

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 90 | Zone 4 AG Distance Function | Z4AG |
| 91 | Zone 4 BG Distance Function | Z4BG |
| 92 | Zone 4 CG Distance Function | Z4CG |
| 93 | Any Zone 1 Ground Distance Function | Z1GRD |
| 94 | Any Zone 2 Ground Distance Function | Z2GRD |
| 95 | Any Zone 3 Ground Distance Function | Z3GRD |
| 96 | Any Zone 4 Ground Distance Function | Z4GRD |
| 129 | Zone 2 Ground Timer | Z2GTMR |
| 130 | Zone 3 Ground Timer | Z3GTMR |
| 131 | Zone 4 Ground Timer | Z4GTMR |
| 132 | Zone 2 Phase Timer | Z2PTMR |
| 133 | Zone 3 Phase Timer | Z3PTMR |
| 134 | Zone 4 Phase Timer | Z4PTMR |
| 106 | TL1 Timer Output | TL1 |
| 124 | TL16 Timer Output | TL16 |
| 125 | TL24 Timer Output | TL24 |
| 128 | TL25 Timer Output | TL25 |
| 126 | Ground Forward Flag (NT) | GRDFWD |
| 127 | Ground Reverse Flag (NB) | GRDREV |

**Table 13–7: CURRENT AND VOLTAGE UNITS**

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 103 | Any Phase Undervoltage | ANYUVT |
| 104 | All Voltage High (No Phase Undervoltage) | ALLVLT |
| 105 | Fault Detector (FD) | FLTDET |
| 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   AND   IPT) | GRDTRP |
| 113 | Ground Directional Block (NB   AND   IPB) | GRDBLK |
| 116 | Instantaneous Phase Overcurrent (50P/PH4) | 50 |
| 117 | Instantaneous Ground Overcurrent (50G/IDT) | 50G |
| 118 | Ground Time Overcurrent Pick-Up | TOCACT |
| 119 | Ground Time Overcurrent Trip (51G/TOC) | TOCTRP |

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### Table 13–8: MISCELLANEOUS

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| 137 | Sync Check | SYNC |
| 138 | Number of Breaker Operation Alarm | BRMNOP |
| 139 | Breaker Equipment Duty Alarm | BRMNDT |
| 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 |
| 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 |

### Table 13–9: USER DEFINABLE OUTPUT FLAGS

| INDEX | DESCRIPTION | MNEMONIC |
|---|---|---|
| - | Trip Contacts | T1 to T6 |
| - | Auxiliary Contacts | A1 to A12 |
| - | Control Contacts | C1 to C2 |
| - | High Speed Channel Contacts | KT1 to KT4 |
| - | User Defined Trip | CONFTRIP |
| - | User Defined Oscillography Capture | CONFOSC |
| - | User Defined Non-Critical Alarm | NC Alarm |

In the Xpression Builder program, Select **File** followed by **New**. A menu window for ALPS / LPS / DFP200 options will be displayed as shown in Figure 13–6: CREATING A NEW FILE. For examination purposes, select **ALPS 3-Pole Configurable Logic**. A working screen will be displayed for an ALPS Three Phase Tripping unit.
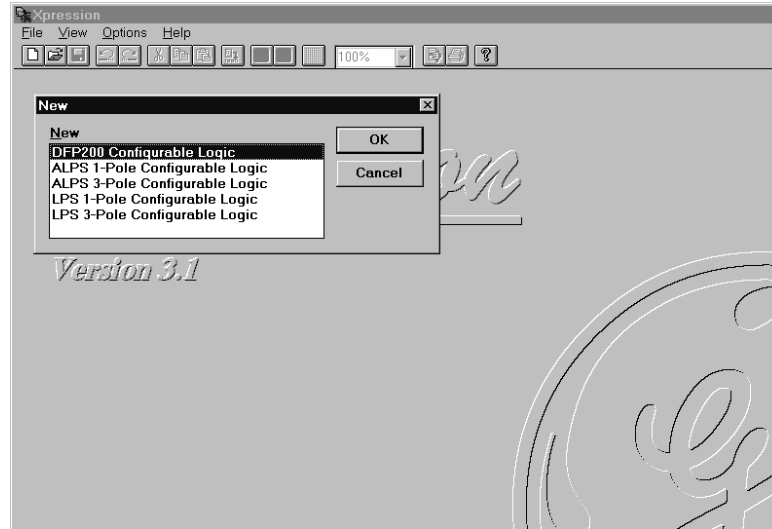


**Figure 13–6: CREATING A NEW FILE**

The next step in the design of configurable logic is to determine the need for digital inputs. Typical inputs assigned to contact converters are channel receivers and 52_b contacts. Other inputs can come from external contacts, other relay outputs, or the feedback of one of the ALPS outputs to an input. The list of available contact converter input assignments can be found in Table 13–2: CONTACT CONVERTER INPUT FLAGS. In effect, this process does nothing more than associate a given digital input with a name that Xpression Builder can use. Selection of the contact converter (CC) box, for example CC1, with the left mouse button will activate a pull down menu from where flags can be assigned to the respective input as shown in Figure 13–7: CONTACT CONVERTER INPUTS (CC). Double clicking on the CC box near the input bar with the right mouse button will give the input an inverted sense and a NOT logical gate will appear on the input bar as shown in Figure 13–8: INVERTED CC INPUTS. A straight input will require a pickup voltage presence to be considered a high input (logic 1). An inverted input will require a pickup voltage presence to be considered a low input (logic 0).
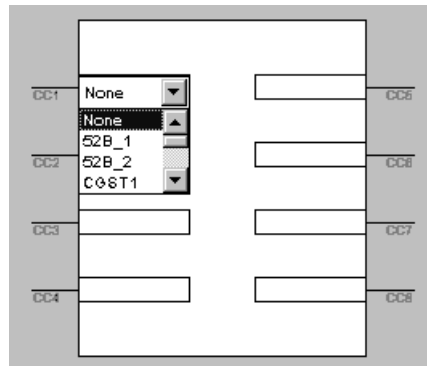


**Figure 13–7: CONTACT CONVERTER INPUTS (CC)**
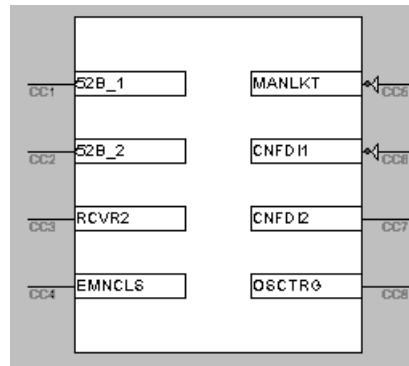
**Figure 13–8: INVERTED CC INPUTS**

The next step is to take advantage of the internal protection flags in the relay, and put them to work in logical combinations necessary to your specific application. Select the **Input** flags icon as shown below. The input flags are listed by group beginning with Table 13–3: CONFIGURABLE INPUTS. You can move between groups by using the mouse to scroll through the pull-down menu. Simply select the flag by clicking the left mouse button. Move the cursor to the location where the flag is going to be used and click the left mouse button again. This action will place the flag at the desired location.



**Figure 13–9: INPUT, OPERATOR, AND OUTPUT ICONS**

Select the **Operator** icon as shown above. The available operators are AND, OR, NOT, Latches, Counters, PD Timers, and Timers. Simply select the operator by clicking the left mouse button. Move the cursor to the location where the operator is going to be used and click the left mouse button again. This action will place the operator at the desired location.

The next step is selecting the output contacts which will be used in the relay application. Select the **Output** flag icon as shown above. The output contacts are listed in Table 13–9: USER DEFINABLE OUTPUT FLAGS. Select the output flag by clicking the left mouse button. Move the cursor to the location where the flag is going to be used and click the left mouse button again. This action will place the flag at the desired location.

Start connecting the inputs to the Boolean operators and to the output gates. To use straight line connections, select the **Connection** icon as shown below. To use orthogonal line connections, select the **Orthoconnection** icon as shown in below. Once the type of connection is selected, click the left mouse button on an input or Boolean operator output connection stud. Move the mouse and click the left button on the connection stud of an output or the input of a Boolean operator.

If all the inputs are connected to logic gates and/or output contacts, the logic is ready for compilation.
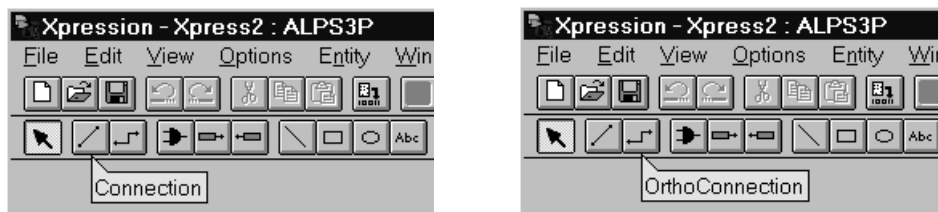


**Figure 13–10: STRAIGHT AND ORTHO-CONNECTION ICONS**

**13.3.2 COMPILING AND DOWNLOADING XPRESSION BUILDER LOGIC**

Once the logic has been created you are ready to compile. Under the **File** header, select **Compile**. If you are connected to the relay at the time you can download the logic to the relay by selecting the **Download** command under the **File** header. After you compile the logic, under the **File** header, select **Save_As** and give the file a name with a .BIN extension. The BIN file is a binary formatted file which is downloaded to the relay. A user should also save the logic with an .EXP extension. The EXP file saves the graphical layout of the logic. When both formats are saved, the logic uploaded from the relay can be matched to the graphical layout saved for the configurable logic file (Note: when Xpression Builder is launched, it prompts the user for the location of the EXP file; if the EXP file was not created, select **Cancel** and Xpression Builder will give the relay logic a graphical layout which is logically correct, but may have a poor layout).

**13.3.3 BREAKER FAILURE EXAMPLE**

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The figure below is an example of a simple breaker failure scheme which can be implemented in the relay using Xpression Builder logic. Use the description in the previous sections to select the external contact input to block pilot tripping (BPL-TRIP), the external configurable input (CNFDI1), the internal block supervision current flag (IB), the Boolean operators (OR, AND, and P/D Timer), and the output contact (A1).
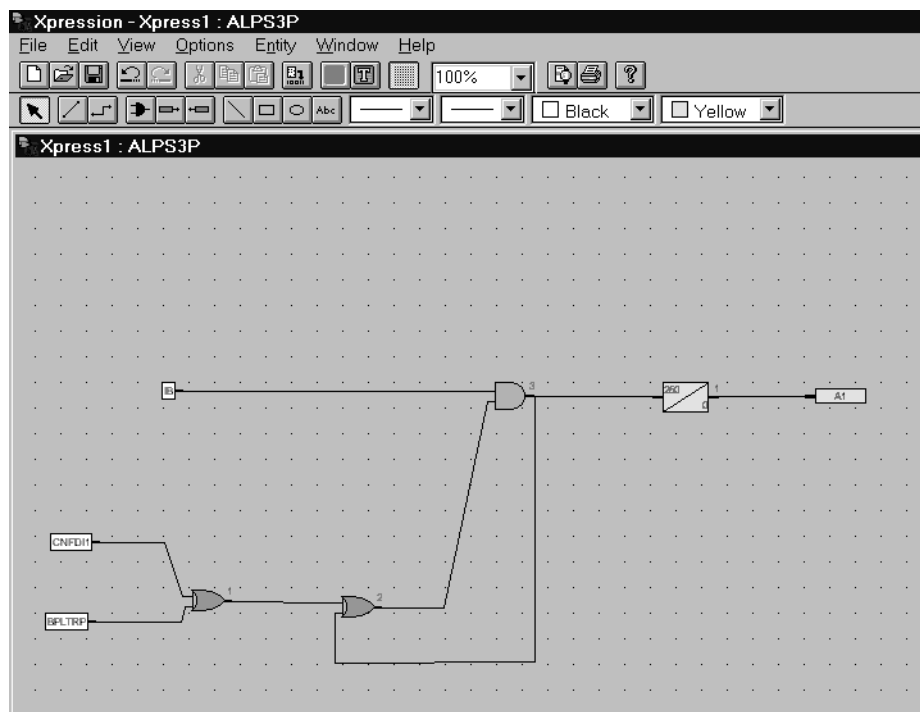


**Figure 13–11: SAMPLE BREAKER FAILURE LOGIC**

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The ALPS-SET program can be installed from the GE Products CD or downloaded from the GE Power Management web-site at www.GEindustrial.com/pm. See Section 11.1.5: SOFTWARE INSTALLATION on page 11–3 for installation instructions.

- Open the ALPS PC Programs Software Folder

- Click on ALPS-SET

- After reading the Disclaimer, click on the OK button. The following dialog box is displayed:
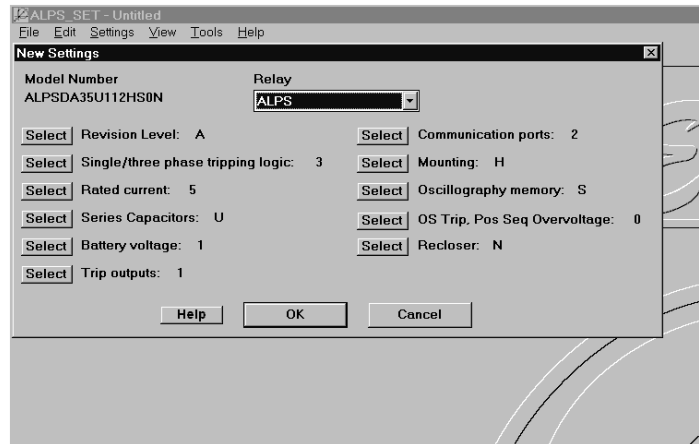


**Figure 14–1: NEW SETTINGS DIALOG BOX**

The **Select** button for the Revision Level displays the following dialog box (the list of items to select from will be different for different **Select** buttons).



**Figure 14–2: CHANGE MODEL NUMBER ITEM DIALOG BOX**

For each **Select** button in the **New Settings** dialog box, select an item that is different from the currently selected item in the drop down list box and select **OK**. Verify that:

- The model number changes

- The new selection is displayed to the right of the **Select** button.

For one **Select** button, select an item that is different from the currently selected one in the drop down list box and select **Cancel**. Verify that:

- The model number does not change

- The new selection that is displayed to the right of the **Select** button does not change.

Select **OK** to create settings for the model number. Verify that the **Select Protection Scheme** dialog box is displayed:

**Figure 14–3: SELECT PROTECTION SCHEME DIALOG BOX**

Note that there is no **Cancel** button. For new settings, the user must make a scheme selection. Click on the **Help** button. This displays the help text for the **Select Protection Scheme** dialog box.

Select a scheme and click **OK**. An instruction box provides instructions on changing the selected scheme. For the STEP-DST scheme, choose the **Settings > Protection Settings** menu item. The **Change Settings – Protection** dialog box is displayed. Individual settings for the scheme selected may now be changed.

- Only the protection settings that apply to the model number and the firmware version are displayed in the list box.
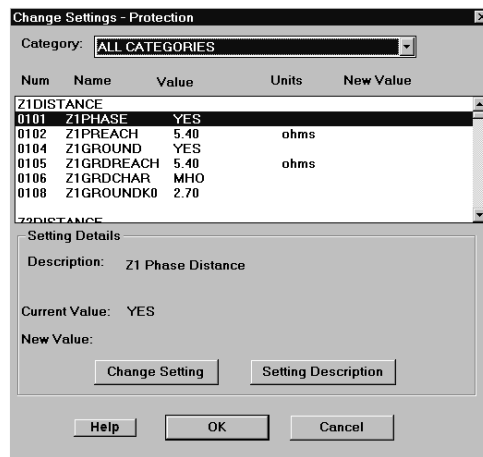
**Figure 14–4: CHANGE SETTINGS – PROTECTION DIALOG BOX**

Click on the **Change Setting** button in the **Change Settings – Protection** dialog box. This displays the **Change Setting Value** dialog box:
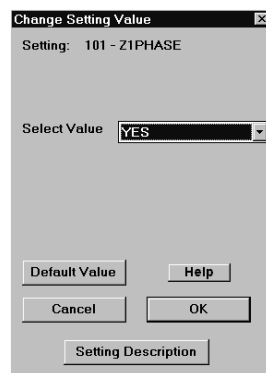
**Figure 14–5: CHANGE SETTING VALUE DIALOG BOX**

- Each setting may be individually changed by selecting the setting and entering the required value. The range of the setting is displayed.

- The help command will give you detailed information about the setting to be changed.

- If a setting is selected that has specific values, the following dialog box is displayed.

Select **Cancel** to close the **Change Settings – Protection** dialog box.

Select **Save Settings** from the **File** menu. The **Save Settings As** dialog box is displayed since this is a new settings file and has not yet been given a name. Select **Cancel**.

### 14.1.3 PRINT SETTINGS REPORT

Select **Print Settings Report** from the **File** menu. The **Select Categories** dialog box is displayed as follows.
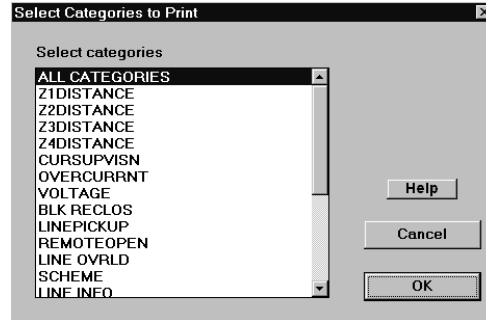


**Figure 14–6: SELECT CATEGORIES TO PRINT DIALOG BOX**

Select the desired categories and click on the **OK** button.

### 14.1.4 EDIT MENU – COPY SETTINGS REPORT

Select **Copy Settings Report** from the **Edit** menu. The **Select Categories** dialog box is displayed as shown in Section 14.1.3: PRINT SETTINGS REPORT.

The dialog box title is now titled **Select Categories to Copy**. Select **ALL CATEGORIES** from the **Select Categories** list box to copy all categories.

### 14.1.5 TOOLS MENU

There is one menu item – **Setup**. Click on **Setup** and the following dialog box is displayed.
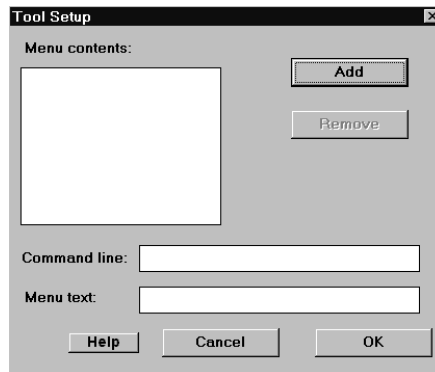


**Figure 14–7: TOOL SETUP DIALOG BOX**

Any Microsoft compatible tool can be added to the toolbar by selecting **Add** and browsing for the tool.

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. Verify that each topic has the appropriate explanation.

The **Using Help** menu item aids in calculating the settings. By selecting the setting you need help on, the instruction book text is displayed to inform the user how to calculate the setting.

Select **About ALPS_SET** from the **Help** menu. The following dialog box is displayed:
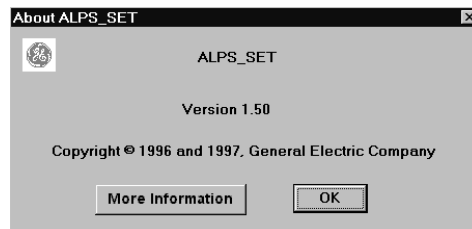
**Figure 14–8: ABOUT ALPS-SET DIALOG BOX**

The version number and dates may be different than shown above.

**A**

### Why doesn't the relay accept the default LUI passwords?

A new relay comes with LUI (Local User Interface) and remote factory setting passwords. The master factory setting password must be changed in order to login and perform actions with the relay through the keypad. To change a factory setting password, perform the following steps:

1.  Press the action key (ACT)

2.  Press the enter key (ENT); no password is required

3.  Scroll down the menu to item 10, CHANGE PASSWORD

4.  Press the ENT key

5.  Select the password to be changed

6.  Enter the factory password

7.  Enter your new password

8.  Re-enter your new password

9.  Logout by pressing the END key followed by the ENT key

10. The factory setting password has now been successfully changed

### What are the LUI and remote factory setting passwords?

The LUI factory passwords for the different privilege levels are:

•   **789.** (master)

•   **456.** (actions)

•   **123.** (settings)

Note: the period is part of the password.

The LUI passwords stored in the relay may be viewed, in encoded format, via remote communications. The remote factory passwords for the different privilege levels are

•   **master!** (master)

•   **actions!** (actions)

•   **setting!** (setting)

•   **view!** (view)

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

### Why can't I communicate with the relay using ALPS-Link?

If you are unable to communicate with the ALPS relay using ALPS-Link, perform the following checks:

•   Verify the ALPS-Link program is selected for the comm port you are using on your PC or laptop

•   Verify the cable you are using is a null modem cable

•   Verify the protocol of the relay comm port you are using is set for GE-Modem. Note: rear port PL2A is factory set for ASCII.

•   Verify the unit ID, baud rate, stop bits, and parity settings of the relay comm port you are using to match with the settings in the device setup for the ALPS-Link session.

### What would I do if the ALPS gives a red LED status indication?

If the ALPS relay displays a red LED status, prompt the relay for failure messages. Press the information key (INF) and select Status. Scroll down the list and write the failure messages of the relay. Protection is not active when the Status LED is red. This condition could indicate a critical failure: contact GE.

**A**

**In which format should I save Xpression Builder configurable logic?**

When configurable logic is created with Xpression Builder, it must be saved with a .BIN extension. The BIN file is a binary formatted file which is downloaded to the relay. The user should *also* save the logic with an .EXP extension. The EXP file saves the graphical layout of the logic. When both formats are saved, the logic uploaded from the relay can be matched to the graphical layout saved for the configurable logic file. If an EXP file is not created, Xpression Builder will give the relay logic a graphical layout which is logically correct, but may have a poor layout.

**Which do I download first: Xpression Builder configurable logic or relay settings?**

First, download protection and general settings using the ALPS-Link program. Secondly, download the configurable logic into the relay. The order of these two steps is important because downloading configurable logic or settings change the inputs and outputs of the relay. The last settings downloaded are saved in the relay.

**Does ALPS-Link work with Windows NT?**

Yes. ALPS-Link versions 3.30304 and later work on Windows 3.1, Windows 95, and Windows NT platforms. The install program will look to see what operating system the user is running and will install the correct executable.

Are the Trip Output Contacts (T1 to T4/T6) polarity sensitive?

Yes. The Trip Output Contacts are polarity sensitive even if the user does not have an SCR model. The internal circuitry requires the correct polarity for the trip circuit monitor function to operate properly. The contact polarities are shown in Figures 1–27: ELEMENTARY DIAGRAM WITH DEFAULT I/O (SINGLE PHASE TRIPPING) to 1–30: ELEMENTARY DIAGRAM (THREE PHASE TRIPPING).

**Can I create a settings file without having a relay?**

Yes. The ALPS PC software package includes a program called ALPS-Set which allows you to create a settings file based upon your relay model number. See Chapter 14: ALPS-SET PC SOFTWARE.

**Can I plot the phase and ground characteristics of my settings for the relay?**

Yes. The ALPS PC software package includes a program called ALPS-Test which allows you to plot the phase and ground characteristics from your settings file. See Chapter 10: ALPS TEST PROGRAM.

**What format should I choose when saving oscillography data?**

If you use the GE-DATA program to view oscillography, save the data in DAFF format. For other comtrade compatible viewers, save the data in the COMTRADE format. Note: a readme file in the ALPS/UTIL directory describes the procedure to convert ALPS oscillography for use with the DL-DATA program.

Why are so many files created when I save oscillography data?

Several files are created when oscillography data is retrieved from the relay because they each serve different purposes.

Saving data in the DAFF format creates an OSC, DAF, and REP file. The OSC file is used to playback a waveform to the relay. The DAF file is used by the GE-DATA program to view the waveforms and flags within the relay. The REP file contains the fault report and settings in the relay at the time of the fault.

Saving data in the COMTRADE format creates an OSC, HDR, CFG, DAT, ASC, and REP file. The OSC file is used to playback a waveform to the relay. The HDR file contains the fault report and the settings in the relay at the time of the fault. The CFG file contains the configuration of the data such as sample rate and description of channels. The DAT file contains the actual oscillography data in a binary format. The ASC file contains the oscillography data in an ASCII format. The REP file contains instructions on saving the oscillography data.

To view the latest version of this FAQ and other documents, visit the GE Power Management Home page at www.ge.com/indsys/pm.

This appendix describes the functional specifications/memory map of the Modbus RTU protocol interface for the ALPS Advanced Line Protector System revision A (ALPS-A). The specifications cover Modicon Modbus application messages supported by the ALPS interface software module.

The ALPS relay provides the user interface to configure the Modbus communications parameters. The Modbus device address and the Baud Rate for RS485/RS232 port are configurable from the MMI of the ALPS.

There will be a delay before the ALPS is ready to answer Modbus requests from the Modbus master on power up. This is due to internal data and baud rate synchronized tasks to be performed. Device address changes and baud rate changes will affect the operation of the device once the device is communicating.

Before using the ALPS in a Modbus RTU network, the communications parameters must be set appropriately. The Baud Rate and the Modbus unit address must be set in the ALPS device. The ALPS does not respond to Modbus address 0.

**Table B–1: REQUIRED SETTINGS FOR MODBUS COMMUNICATIONS**

| SETTING | MODBUS VALUE/MEANING | FACTORY DEFAULT VALUE |
|---|---|---|
| UNIT ID | Modbus Address: valid only from 1 to 247. | 0000 |
| REMOTE BAUD RATE | Modbus Baud Rate: 1200, 2400, 4800, and 9600 | 9600 |

The ALPS will support a subset of Modbus Commands. All these commands are supported are listed below.

| FUNCTION CODE (DEC) | NAME | PURPOSE | REGISTER GROUPS |
|---|---|---|---|
| 03/04 | Read Holding (Setpoint) Registers; Read Input Registers | Reading the setpoint/actual value registers | Setpoint registers; control registers; dynamic values, fixed values, faults, events, and reports |
| 05 | Force Single Coil | Activate single coil or control trigger | Coil registers |
| 06 | Preset Single Register | Writing one register | Setpoint registers; control registers |
| 16 | Preset Multiple Registers | Writing one or more registers | Setpoint registers (limited set only: Date, Time, Station ID and Line ID) |

Both monitoring and control is possible using read and write functions mentioned above. The following table shows the device register categories.

| REGISTER TYPE | CATEGORY | START ADDRESS | CONTENTS | ACCESS |
|---|---|---|---|---|
| Input Registers | Fixed Value Registers | 0000 | Fixed data reported by the device. | Read Only |
| Input Registers | Dynamic Value Registers | 1000 | Metering data and dynamic status data. | Read Only |
| Input Registers | Fault Registers | 1500 | Summary of fault data. | Read Only |
| Report Registers | Event Registers | 2000 | Summary of Event data. | Read Only |
| Report Registers | Fault Report Registers | 20000 | Report data | --- |
| Report Registers | Oscillography Report Registers. | 20000 | Report data. | Read Only |
| Setpoint Registers | Setting Registers | 3000 | Device settings. | Read/Write |
| Coil Registers | Coil Command Registers | 500 | Command coils used for activation. | Write Only |

**B.1.4 EXCEPTION OR ERROR REPLIES**

When a system host command received by an ALPS cannot be performed, it replies with an error code. This is different from detecting communication related errors, such as a CRC error, for which the ALPS ignores the command.

The format of an error reply is to return the received address and function back to the system host with the most significant bit of the function code set. Also, a one-byte error code is added to the reply packet to identify the problem. The error codes supported by the ALPS are:

01: **Illegal Function**: The function code received in the query is not an allowable action for the slave.

02: **Illegal Address**: The data address received in the query is not an allowable address for the slave. This exception is returned if the query contains a reserved address or an address that is not supported by the ALPS model.

03: **Illegal Data Value**: A value contained in the query data is not an allowable value for the slave.

04: **Slave Device Failure**: An unrecoverable error occurred while the slave was attempting to perform the requested action. Note that this exception is returned if an EEPROM CRC or data contents error is detected during startup.

05: **Acknowledge**: The slave has accepted a request for a long duration command.

06: **Slave Device Busy**: The slave is busy servicing another long duration command. The master should retransmit this message at a later time. This exception is reported if the query target resource is being accessed by another interface.

07: **Negative Acknowledge**: The slave cannot perform the function received in the query. This exception is reported if the query requests data that is not available, such as a non-existent fault report.

09: **Invalid Index**.

**B.1.5 DATA FORMATS**

The ALPS is a digital protection, control, metering and monitoring system. Most of the measurement values are stored in word wide integer variables. Fixed point format values are implemented as integers as well; for example, value ranges from 0.01 to 50.00 may be stored as 1 to 5000. LSB will be stored in the lower byte and MSB in Upper byte of 16 bit registers. Even while transmission LSB will be the first bit to be transmitted.

**a) FIXED VALUE REGISTERS (START ADDRESS 0000)**

This is fixed data (read-only) reported by the ALPS.

**b) DYNAMIC VALUE REGISTERS (START ADDRESS 1000)**

This is metered actual values and other dynamic data reported by the ALPS.

**c) EVENT REGISTERS (START ADDRESS 2000)**

All Events stored in the ALPS will be in time order, starting with the most recent event. There can be at most 150 events.

**d) REPORT REGISTERS (START ADDRESS 1131; DATA STARTS AT 20000)**

Report registers are a special set of registers that must be accessed by following a strict protocol sequence. The nature of some reports is such that the report data varies with certain values of device settings. Given the fact that report data is variable, it is not possible to assign a fixed number of registers that will represent this data. Instead, the following sections provide a byte sequence that describe the format of the different reports.

**FAULT REPORT**

Detailed information about a fault can be accessed from the device by requesting a fault report read. The byte sequence for fault reports is as follows:

**Table B–2: FAULT REPORT BYTE SEQUENCE**

| REGISTER | FIELD | SIZE (BYTES) | BYTE FORMAT | DESCRIPTION |
|---|---|---|---|---|
| 20000 | FAULT NUMBER | 2 | Unsigned Integer | Current fault report number |
| 20001 | TRIP DATE | 4 | F1 | Date of trip in MM/DD/YYYY format |
| 20003 | TRIP TIME | 4 | F2 | Time of trip in HH.MM.SS.sss format |
| 20005 | RELAY OPERATING TIME | 2 | Unsigned Integer | Relay operating time in sample counts |
| 20006 | BREAKER OPERTATING TIME | 2 | Unsigned Integer | Breaker operating time in sample counts |
| 20007 | FAULT TYPE | 2 | F61 | Fault type message |
| 20008 | TRIP TYPE | 2 | F17 | Trip type message |
| 20009 | DISTANCE in miles | 2 | P10 | Distance in miles |
| 20010 | PREFAULT Ia | 2 | P100 | RMS phase A current |
| 20011 | PREFAULT Ib | 2 | P100 | RMS phase B current |
| 20012 | PREFAULT Ic | 2 | P100 | RMS phase C current |
| 20013 | PREFAULT In | 2 | P100 | RMS neutral current |
| 20014 | FAULT Va | 2 | P10 | RMS phase A voltage |
| 20015 | FAULT Vb | 2 | P10 | RMS phase B voltage |
| 20016 | FAULT Vc | 2 | P10 | RMS phase C voltage |
| 20017 | FAULT Ia | 2 | P100 | RMS phase A current |
| 20018 | FAULT Ib | 2 | P100 | RMS phase B current |
| 20019 | FAULT Ic | 2 | P100 | RMS phase C current |
| 20020 | FAULT In | 2 | P100 | RMS neutral current |
| 20021 | CYCLES | 2 | Unsigned Integer | Cycles per fault |
| 20022 | PREFAULT | 2 | Unsigned Integer | Prefault cycles per fault |
| 20023 | PRTRIP | 2 | Unsigned Integer | Percent of oscillography fault data to put as pretrip data |
| 20024 | OSC DATA CONTINUITY | 2 | Unsigned Integer | 0:  Oscillography data is continuous<br>1:  Delayed trip is taken care of by incorporating discontinuity in the oscillography data |
| 20025 | NUMSETT | 2 | Unsigned Integer | Number of settings in the ALPS |

Succeeding blocks of the fault report contain the events associated with the fault. The number of events reported is limited to 14.

**Table B–3: FAULT REPORT EVENTS SEQUENCE**

| REGISTER | FIELD | FORMAT | DESCRIPTION |
|----------|-------|--------|-------------|
| 20026 | TIME (1) | F2 | 4 bytes total |
| 20028 | EVENT CODE (1) | F61 | 2 bytes total |
| 20029 | EVENT SOURCE (1) | F69 | 2 bytes total |
| 20030 | TIME (2) | F2 | 4 bytes total |
| 20032 | EVENT CODE (2) | F61 | 2 bytes total |
| 20033 | EVENT SOURCE (2) | F69 | 2 bytes total |
| ↓ | ↓ | ↓ | ↓ |
| 20082 | TIME (14) | F2 | 4 bytes total |
| 20084 | EVENT CODE (14) | F61 | 2 bytes total |
| 20085 | EVENT SOURCE (14) | F69 | 2 bytes total |

The block size is 16 bytes per event. If the number of events present is less than 14 the event code for the nonexistent event will be 255; that is, if there are 12 actual events, the event code for event number 13 and 14 will be 255.

To read a report, the host should send a preset single register command (Function 06) to the Report Control Register (address 4400). The values written should be specified as shown in the memory map. The ALPS responds with a valid Modbus response if no other report request is pending. The host can read only one report at a time, otherwise the ALPS generates an exception response (Exception code 06: "Busy servicing another long duration command").

### e) SETTINGS REGISTERS (START ADDRESS 3000)

The Modbus ALPS has setpoints that are organized in 5 general groups, the GENERAL SETTINGS and the four PROTEC-TION SETTINGS groups of which only one group can be active at a given time. The group number of the ACTIVE PRO-TECTION SETTING GROUP is stored in register 3070 of the General Settings group and determines the current active group number. The Modbus host identifies the group number of the ACTIVE SETTING group by reading this register.

### f) COIL COMMANDS REGISTERS (START ADDRESS 0500)

These are write-only registers representing command coils used for activation.

**B**

**Table B–4: MODBUS MEMORY MAP (Sheet 1 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE | | UNITS | DEFAULT | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 A | 5 A | | 1 A | 5 A |
| **FIXED VALUE REGISTERS** | | | | | | | | | |
| 0002 | Model Number | RO | ASCII | 8 | - | - | - | - | |
| 0010 | PROM Version | RO | ASCII | 6 | - | - | - | - | |
| 0016 | Serial Number | RO | ASCII | 8 | - | - | - | - | |
| 0024 | Unit ID | RO | Unsigned Int | 1 | - | - | - | - | |
| 0025 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | - | - | - | - | - | - | - | - |
| 0499 | Reserved | RO | - | - | - | - | - | - | - |
| **COIL COMMAND REGISTERS** | | | | | | | | | |
| 0500 | Operate Breaker 1 | WO | bitmask | 1 | 0000=Force OFF FF00=force ON | | - | - | - |
| 0501 | Operate Breaker 2 | WO | bitmask | 1 | 0000=Force OFF FF00=force ON | | - | - | - |
| 0502 | Enable/Disable Outputs | WO | F26 | 1 | 0, 1 | | - | - | - |
| 0503 | OSC Trigger | WO | bitmask | 1 | FF00=trigger oscillography | | - | - | - |
| 0504 | Cancel Report | WO | bitmask | 1 | FF00=cancel active report | | - | - | - |
| 0505 | Channel Test | WO | bitmask | 1 | 0000=Start Test FF00=Stop Test | | - | - | - |
| 0506 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | - | - | - | - | - | - | - | - |
| 0999 | Reserved | RO | - | - | - | - | - | - | - |
| **DYNAMIC VALUE REGISTERS** | | | | | | | | | |
| 1000 | Date | RO | F1 | 2 | MM/DD/YY | | - | - | |
| 1002 | Time | RO | F2 | 2 | HH:MM:sec.ms | | - | - | |
| 1004 | Va RMS | RO | Float | 2 | | | V | | |
| 1006 | Vb RMS | RO | Float | 2 | | | V | | |
| 1008 | Vc RMS | RO | Float | 2 | | | V | | |
| 1010 | Ia RMS | RO | Float | 2 | | | A | | |
| 1012 | Ib RMS | RO | Float | 2 | | | A | | |
| 1014 | Ic RMS | RO | Float | 2 | | | A | | |
| 1016 | In RMS | RO | Float | 2 | | | A | | |
| 1018 | Va | RO | Float | 2 | | | V | | |
| 1020 | Angle Va | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1021 | Vb | RO | Float | 2 | | | V | | |
| 1023 | Angle Vb | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1024 | Vc | RO | Float | 2 | | | V | | |
| 1026 | Angle Vc | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1027 | Ia | RO | Float | 2 | | | A | | |
| 1029 | Angle Ia | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1030 | Ib | RO | Float | 2 | | | A | | |
| 1032 | Angle Ib | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1033 | Ic | RO | Float | 2 | | | A | | |
| 1035 | Angle Ic | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1036 | In | RO | Float | 2 | | | A | | |

[1, 2, 3, 4, 5, 6, 7, 8]  See page B–14 for footnote explanations.

**Table B–4: MODBUS MEMORY MAP (Sheet 2 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 1038 | Angle In | RO | Integer | 1 | −180 to 180 | | deg | | |
| 1039 | Watts Real Power | RO | Float | 2 | | | W | | |
| 1041 | Vars | RO | Float | 2 | | | vars | | |
| 1043 | Power Factor | RO | Float | 2 | −1.0 to 1.0 | | | | |
| 1045 | Frequency | RO | Float | 2 | 0.00 to 60.00 | | Hz | | |
| 1047 | Active Setting Group | RO | Unsigned Int | 1 | 1 to 4 | | | | |
| 1048 | Number of Breakers | RO | Unsigned Int | 1 | 1 to 2 | | | | |
| 1049 | Bkr1/1A | RO | F3 | 1 | | | | | |
| 1050 | Bkr1B | RO | F3 | 1 | | | | | |
| 1051 | Bkr1C | RO | F3 | 1 | | | | | |
| 1052 | Bkr2/2A | RO | F3 | 1 | | | | | |
| 1053 | Bkr2B | RO | F3 | 1 | | | | | |
| 1054 | Bkr2C | RO | F3 | 1 | | | | | |
| 1055 | Phase A Equipment Duty | RO | Float | 2 | | | | | |
| 1057 | Phase A Multiplier | RO | F49 | 1 | 2 | | | | |
| 1058 | Phase B Equipment Duty | RO | Float | 2 | | | | | |
| 1060 | Phase B Multiplier | RO | F49 | 1 | 2 | | | | |
| 1061 | Phase C Equipment Duty | RO | Float | 2 | - | - | - | - | - |
| 1063 | Phase C Multiplier | RO | F49 | 1 | 2 | | - | - | - |
| 1064 | Phase A NumBkrOp | RO | Unsigned Int | 1 | 0 to 9999 | | - | - | - |
| 1065 | Phase B NumBkrOp | RO | Unsigned Int | 1 | 0 to 9999 | | - | - | - |
| 1066 | Phase C NumBkrOp | RO | Unsigned Int | 1 | 0 to 9999 | | - | - | - |
| 1067 | Stop Carrier | RO | F4 | 1 | - | - | - | - | - |
| 1068 | Blk plt trp | RO | F4 | 1 | - | - | - | - | - |
| 1069 | Recls State | RO | F5 | 1 | - | - | - | - | - |
| 1070 | Event/Fault flag | RO | F50 | 1 | - | - | - | - | - |
| 1071 | EEP_960STAT1 | RO | F6 | 1 | - | - | - | - | - |
| 1072 | EEP_960STAT2 | RO | F7 | 1 | - | - | - | - | - |
| 1073 | EEP_ANISTAT | RO | F8 | 1 | - | - | - | - | - |
| 1074 | EEP_DSPSTAT | RO | F9 | 1 | - | - | - | - | - |
| 1075 | EEP_MISCSTAT1 | RO | F10 | 1 | - | - | - | - | - |
| 1076 | EEP_MISCSTAT2 | RO | F11 | 1 | - | - | - | - | - |
| 1077 | STATUS BITS for Output | RO | F28 | 2 | - | - | - | - | - |
| 1079 | STATUS BITS for Contact Converters | RO | F27 | 1 | - | - | - | - | - |
| 1080 | Download Status | RO | F20 | 1 | - | - | - | - | - |
| 1081 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | - | - | - | - | - | - | - | - |
| 1130 | Reserved | RO | - | - | - | - | - | - | - |
| **REPORT REGISTERS** | | | | | | | | | |
| 1131 | Available FIFO Registers | RO | Unsigned Int | 1 | - | - | - | - | - |
| 1132 | Active Report Type | RO | Unsigned Int | 1 | 0=No report is active, 2 = Fault Report | | - | - | - |
| 1133 | Available Fault Reports | RO | Unsigned Int | - | - | - | - | - | - |
| **EVENT REGISTERS (150 EVENTS TOTAL)** | | | | | | | | | |
| 2000 | Total events number | RO | Unsigned Int | 1 | 1 to 150 | | - | - | - |

1, 2, 3, 4, 5, 6, 7, 8   See page B–14 for footnote explanations.

**Table B–4: MODBUS MEMORY MAP (Sheet 3 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | Date (Event 1) | RO | F1 | 2 | MM/DD/YY | | - | - | - |
| 2003 | Time (Event 1) | RO | F2 | 2 | HH:MM:sec.ms | | - | - | - |
| 2005 | Event Code (Event 1) | RO | F61 | 1 | | | - | - | - |
| 2006 | Event Source (Event 1) | RO | F69 | 1 | | | - | - | - |
| 2007 | Date (Event 2) | RO | F1 | 2 | MM/DD/YY | | - | - | - |
| 2009 | Time (Event 2) | RO | F2 | 2 | HH:MM:sec.ms | | - | - | - |
| 2011 | Event Code (Event 2) | RO | F61 | 1 | | | - | - | - |
| 2012 | Event Source (Event 2) | RO | F69 | 1 | | | - | - | - |
| 2013 | Date (Event 3) | RO | F1 | 2 | MM/DD/YY | | - | - | - |
| 2015 | Time (Event 3) | RO | F2 | 2 | HH:MM:sec.ms | | - | - | - |
| 2017 | Event Code (Event 3) | RO | F61 | 1 | - | - | - | - | - |
| 2018 | Event Source (Event 3) | RO | F69 | 1 | - | - | - | - | - |
| ↓ | ↓ | ↓ | - | - | - | - | - | - | - |
| 2895 | Date (Event 150) | RO | F1 | 2 | MM/DD/YY | | - | - | - |
| 2897 | Time (Event 150) | RO | F2 | 2 | HH:MM:sec.ms | | - | - | - |
| 2899 | Event Code (Event 150) | RO | F61 | 1 | - | - | - | - | - |
| 2900 | Event Source (Event 150) | RO | F69 | 1 | - | - | - | - | - |
| 2901 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | RO | - | - | - | - | - | - | - |
| 2999 | Reserved | RO | - | - | - | - | - | - | - |
| **SETTINGS REGISTERS GROUP 1** | | | | | | | | | |
| **GENERAL SETTINGS: CONFIGURE** | | | | | | | | | |
| 3000 | Date | R/W | F1 | 2 | MM/DD/YY | | - | - | - |
| 3002 | Time | R/W | F2 | 2 | HH:MM:sec.ms | | - | - | - |
| 3004 | Reserved | - | - | - | - | - | - | - | - |
| ↓ | ↓ | - | - | - | - | - | - | - | - |
| 3025 | Reserved | - | - | - | - | - | - | - | - |
| 3026 | SYSFREQ | R/W | Integer | 1 | 50, 60 | | Hz | 60 | |
| 3027 | PHASEROTATE | R/W | Integer | 1 | 0 = ABC; 1 = ACB | | - | 0 | |
| 3028 | TIMESYNCH | R/W | Integer | 1 | 0 = internal, 1 = IRIG-B | | - | 0 | |
| 3029 | NUM_BKR | R/W | Integer | 1 | 1, 2 | | - | 1 | |
| 3030 | NUM_TC | R/W | Integer | 1 | 1, 2 | | - | 1 | |
| 3031 | NUM_MON | R/W | Integer | 1 | 0 to 64 (1-phase) 0 to 16 (3-phase) | | - | 7 (1-phase) 0 (3-phase) | |
| 3032 | DISPLAYVAL | R/W | F60 | 1 | 0 = Primary, 1 = Secondary | | - | 0 | |
| 3033 | LANGUAGE | R/W | Integer | 1 | 0 = English, 1 = Spanish | | | | |
| **GENERAL SETTINGS: COMMUNICATIONS PORTS** | | | | | | | | | |
| 3035 | COMPORT1 | R/W | F12 | 1 | - | - | - | 9601 | |
| 3036 | COMPORT2 | R/W | F13 | 1 | - | - | - | 09601 | |
| 3037 | COMPORT3 | R/W | F13 | 1 | - | - | - | 09601 | |
| **GENERAL SETTINGS: OSCILLOGRAPHY** | | | | | | | | | |
| 3038 | NUMFAULTS | R/W | Integer | 1 | 2, 4, 8, 12 (std. mem) 6, 12, 24, 36 (exp.mem) | | - | 12 | |
| 3039 | PREFAULT | R/W | Integer | 1 | 1 to 8 | | - | 5 | |
| 3040 | SPLITREC | R/W | Integer | 1 | 0 to 100 | | % | 0% | |
| **GENERAL SETTINGS: BREAKER DUTY** | | | | | | | | | |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**B**

**Table B–4: MODBUS MEMORY MAP (Sheet 4 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 3041 | EXPONENT | R/W | P10 | 1 | 10 to 20 | | - | 20 | |
| 3042 | MAX_OP | R/W | Integer | 1 | 0 to 9999 | | - | 0 | |
| 3043 | MAX_IXT | R/W | F48 | 1 | | | $A^x$sec. | 0 | |
| 3044 | IXTPHASEA | R/W | F48 | 1 | | | $A^x$sec. | 0 | |
| 3045 | IXTPHASEB | R/W | F48 | 1 | | | $A^x$sec. | 0 | |
| 3046 | IXTPHASEC | R/W | F48 | 1 | | | $A^x$sec. | 0 | |
| 3047 | NUM_OP | R/W | Integer | 1 | 0 to 9999 | | - | 0 | |
| 3048 | NUM_OP_A | R/W | Integer | 1 | 0 to 9999 | | - | 0 | |
| 3049 | NUM_OP_B | R/W | Integer | 1 | 0 to 9999 | | - | 0 | |
| 3050 | NUM_OP_C | R/W | Integer | 1 | 0 to 9999 | | - | 0 | |
| **GENERAL SETTINGS: INPUTS** | | | | | | | | | |
| 3051 | CC1 | R/W | Integer | 1 | 0 to 32 | | - | 12 | |
| 3052 | CC2 | R/W | Integer | 1 | 0 to 32 | | - | 13 | |
| 3053 | CC3 | R/W | Integer | 1 | 0 to 32 | | - | 10 | |
| 3054 | CC4 | R/W | Integer | 1 | 0 to 32 | | - | 11 | |
| 3055 | CC5 | R/W | Integer | 1 | 0 to 32 | | - | 7 | |
| 3056 | CC6 | R/W | Integer | 1 | 0 to 32 | | - | 0 | |
| 3057 | CC7 | R/W | Integer | 1 | 0 to 32 | | - | 1 | |
| 3058 | CC8 | R/W | Integer | 1 | 0 to 32 | | - | 2 (1-phase) 4 (3-phase) | |
| 3059 | CC9 | R/W | Integer | 1 | 0 to 32 | | - | 3 | |
| 3060 | CC10 | R/W | Integer | 1 | 0 to 32 | | - | 4 | |
| 3061 | CC11 | R/W | Integer | 1 | 0 to 32 | | - | 5 | |
| 3062 | CC12 | R/W | Integer | 1 | 0 to 32 | | - | 6 | |
| 3063 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | RO | - | - | - | - | - | - | - |
| 3099 | Reserved | RO | - | - | - | - | - | - | - |
| **GENERAL SETTINGS: MISCELLANEOUS** | | | | | | | | | |
| 3100 | Group Setting | R/W | | 1 | 1 to 4 | | - | - | - |
| 3101 | Reset Type | WO | F43 | 1 | 0 to 4 | | - | - | - |
| 3102 | Reserved | - | - | - | - | - | - | - | - |
| ↓ | ↓ | - | - | - | - | - | - | - | - |
| 3108 | Reserved | - | - | - | - | - | - | - | - |
| 3109 | Station ID | R/W | ASCII | 16 | - | - | - | - | - |
| 3125 | Line ID | R/W | ASCII | 16 | - | - | - | - | - |
| 3141 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | RO | - | - | - | - | - | - | - |
| 3199 | Reserved | RO | - | - | - | - | - | - | - |
| **PROTECTION SETTINGS: ZONE 1 DISTANCE** | | | | | | | | | |
| 3200 | Z1PHASE | R/W | Integer | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3201 | Z1PHREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 2700 | 540 |
| 3202 | Z1PLEVDET | R/W | P10 | 1 | 0 to 99 | | pu V | 0 | |
| 3203 | Z1GROUND | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3204 | Z1GRDREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 2700 | 540 |
| 3205 | Z1GRDCHAR | R/W | Unsigned Int | 1 | 0=Mho, 1=React | | - | 0 | |
| 3206 | Z1SUREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 10000 | 2000 |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**Table B–4: MODBUS MEMORY MAP (Sheet 5 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 3207 | Z1GROUNDK0 | R/W | P100 | 1 | 100 to 700 | | - | 270 | |
| 3208 | Z1GLEVDET | R/W | Float | 1 | 0.0 to 9.9 | | pu V | 0 | |
| 3209 | Z1BLOCK | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3210 | Z1GCHARANG | R/W | Unsigned Int | 1 | 80 to 155 | | deg | 90° | |
| 3211 | Z1RGREACH | R/W | P100 | 1 | 1 to 10000 | 5 to 50000 | - | 810 | 4050 |
| **PROTECTION SETTINGS: ZONE 2 DISTANCE** | | | | | | | | | |
| 3212 | Z2PHASE | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3213 | Z2PHREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 4500 | 900 |
| 3214 | Z2PCHARANG | R/W | Unsigned Int | 1 | 90 to 120 | | deg | 90° | |
| 3215 | Z2GROUND | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3216 | Z2GRDCHAR | R/W | Unsigned Int | 1 | 0=Mho, 1=GDOC, 2=MHOGDOC | | - | 0 | |
| 3217 | Z2GRDREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 4500 | 900 |
| 3218 | Z2GCHARANG | R/W | Unsigned Int | 1 | 80 to 155 | | deg | 90° | |
| 3219 | Z2TIMERS | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3220 | Z2P_TIME | R/W | P100 | 1 | 10 to 300 | | sec. | 10 | |
| 3221 | Z2G_TIME | R/W | P100 | 1 | 10 to 300 | | sec. | 10 | |
| 3222 | Z2RGREACH | R/W | P100 | 1 | 1 to 10000 | 5 to 50000 | - | 1350 | 6750 |
| **PROTECTION SETTINGS: ZONE 3 DISTANCE** | | | | | | | | | |
| 3223 | Z3PHASE | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3224 | Z3PHREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 6000 | 1200 |
| 3225 | Z3PCHARANG | R/W | Unsigned Int | 1 | 90 to 120 | | deg | 90° | |
| 3226 | Z3GROUND | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3227 | Z3GRDREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 6000 | 1200 |
| 3228 | Z3GCHARANG | R/W | Unsigned Int | 1 | 80 to 155 | | deg | 90° | |
| 3229 | Z3P_TIME | R/W | P100 | 1 | 10 to 1000 | | sec. | 200 | |
| 3230 | Z3G_TIME | R/W | P100 | 1 | 10 to 1000 | | sec. | 200 | |
| 3231 | Z3GRDCHAR | R/W | Unsigned Int | 1 | 0 = MHO, 1 = QUAD | | - | MHO | |
| 3232 | Z3RGREACH | R/W | P100 | 1 | 1 to 10000 | 5 to 50000 | - | 1800 | 9000 |
| **PROTECTION SETTINGS: ZONE 4 DISTANCE** | | | | | | | | | |
| 3233 | Z4PHASE | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3234 | Z4PHREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 9000 | 1800 |
| 3235 | Z4PCHARANG | R/W | Unsigned Int | 1 | 80 to 120 | | deg | 90° | |
| 3236 | Reserved | RO | - | - | - | - | - | - | - |
| 3237 | Z4GROUND | R/W | Unsigned Int | 1 | 0 = No, 1 = Yes | | - | 1 | |
| 3238 | Z4GRDREACH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 9000 | 1800 |
| 3239 | Z4GCHARANG | R/W | Unsigned Int | 1 | 80 to 155 | | deg | 90° | |
| 3240 | Z4DIRECTN | R/W | Unsigned Int | 1 | 0=Forward, 1=Reverse | | - | 0 | |
| 3241 | Z4TIMERS | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3242 | Z4P_TIME | R/W | P100 | 1 | 10 to 1000 | | sec. | 300 | |
| 3243 | Z4G_TIME | R/W | P100 | 1 | 10 to 1000 | | sec. | 300 | |
| 3244 | Z4GRDCHAR | R/W | Unsigned Int | 1 | 0 = MHO, 1 = QUAD | | - | MHO | |
| 3245 | Z4RGREACH | R/W | P100 | 1 | 1 to 10000 | 5 to 50000 | - | 13500 | 2700 |
| **PROTECTION SETTINGS: CURRENT SUPERVISION** | | | | | | | | | |
| 3246 | IT_PICKUP | R/W | P100 | 1 | 4 to 80 | 20 to 400 | A | 4 | 20 |
| 3247 | IB_PICKUP | R/W | P100 | 1 | 4 to 80 | 20 to 400 | A | 4 | 20 |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**Table B–4: MODBUS MEMORY MAP (Sheet 6 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 3248 | IPT_PICKUP | R/W | P100 | 1 | 10 to 500 | 50 to 2500 | A | 15 | 75 |
| 3249 | IPB_PICKUP | R/W | P100 | 1 | 5 to 75 | 25 to 375 | A | 5 | 25 |
| 3250 | IPBKFACTOR | R/W | Unsigned Int | 1 | 0 = 0.0; 1 = 0.066 | | - | 1 | |
| 3251 | NT_OFFSET | R/W | P100 | 1 | 0 to 100 | | Ω | 0.25 | 0.05 |
| 3252 | UNBALALARM | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| **PROTECTION SETTINGS: OVERCURRENT** | | | | | | | | | |
| 3253 | 50 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3254 | 50_DIRCNL | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3255 | 50PICKUP | R/W | P10 | 1 | 4 to 320 | 20 to 1600 | A | 40 | 200 |
| 3256 | 50PICKUPFF | R/W | Float | 1 | 4 to 320 | 20 to 1600 | A | 60 | 300 |
| 3257 | 50G | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3258 | 50G_DIRCNL | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3259 | 50GPICKUP | R/W | P10 | 1 | 1 to 160 | 5 to 800 | A | 20 | 100 |
| 3260 | 50GPICKUPFF | R/W | P10 | 1 | 1 to 160 | 5 to 800 | A | 60 | 300 |
| 3261 | 50GRESTNT | R/W | Unsigned Int | 1 | 0 = 0.0; 1 = 0.3 | | - | 1 | |
| 3262 | 51G | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3263 | 51G_DIRCNL | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3264 | 51GPICKUP | R/W | P100 | 1 | 4 to 300 | 20 to 1500 | A | 20 | 100 |
| 3265 | 51GPICKUPFF | R/W | P100 | 1 | 4 to 300 | 20 to 1500 | A | 40 | 200 |
| 3266 | 51GCURVE | R/W | Unsigned Int | 1 | 0=Inv, 1=V-Inv, 2=E-Inv, 3=Custom, 4=DefT | | - | 1 | |
| 3267 | 51GTIMDIAL | R/W | P10 | 1 | 5 to 100 | | - | 50 | |
| 3268 | DEFTIMDELY | R/W | P10 | 1 | 5 to 300 | | sec. | 10 | |
| 3269 | 51G_RESET | R/W | Unsigned Int | 1 | 0 = Fast, 1 = EM | | - | 0 | |
| **PROTECTION SETTINGS: VOLTAGE** | | | | | | | | | |
| 3270 | RATEDVOLTS | R/W | Unsigned Int | 1 | 100, 105, 110, 115, 120 | | V | 115 | |
| 3271 | PHASEOVER | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3272 | PHOVPICKUP | R/W | P100 | 1 | 0 to 140 | | pu V | 1 | |
| 3273 | PHOVTMDLY | R/W | P100 | 1 | 0 to 1000 | | sec. | 50 | |
| 3274 | V1OVER | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3275 | V1OVINSTPU | R/W | P100 | 1 | 100 to 140 | | pu V | 125 | |
| 3276 | V1OVTIMPU | R/W | P100 | 1 | 100 to 140 | | pu V | 125 | |
| 3277 | V1OVTIMDLY | R/W | P100 | 1 | 0 to 1000 | | sec. | 25 | |
| 3278 | V1COMP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3279 | V1COMPRCH | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 3000 | 600 |
| 3280 | V1COMPINPU | R/W | P100 | 1 | 100 to 140 | | pu V | 140 | |
| 3281 | V1COMPTDPU | R/W | P100 | 1 | 100 to 140 | | pu V | 140 | |
| 3282 | V1COMPTDLY | R/W | P100 | 1 | 0 to 1000 | | sec. | 150 | 30 |
| 3283 | FUSEFAIL | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| **PROTECTION SETTINGS: BLOCK RECLOSING** | | | | | | | | | |
| 3284 | ALL_BELOW | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3285 | OUTOFSTEP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3286 | ALL_3_Z2PH | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3287 | 50G_BLOCK | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3288 | Z2TIMETRIP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3289 | Z3TIMETRIP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**Table B–4: MODBUS MEMORY MAP (Sheet 7 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 3290 | Z4TIMETRIP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3291 | Z1PHASTRIP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3292 | ANYZ2PHASE | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3293 | CONFGTRIP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| **PROTECTION SETTINGS: LINE PICKUP** | | | | | | | | | |
| 3294 | LINEPICKUP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3295 | BYPASSTL3 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3296 | I1PICKUP | R/W | P10 | 1 | 2 to 30 | 10 to 150 | A | 20 | 100 |
| 3297 | REMOTEOPEN | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3298 | TL20PICKUP | R/W | Unsigned Int | 1 | 10 to 100 | | ms | - | |
| **PROTECTION SETTINGS: LINE OVERLOAD** | | | | | | | | | |
| 3299 | LINEOVERLD | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3300 | LEVEL1PU | R/W | P10 | 1 | 5 to 40 | 25 to 200 | A | 20 | 100 |
| 3301 | LEVEL2PU | R/W | P10 | 1 | 10 to 80 | 50 to 400 | A | 40 | 200 |
| 3302 | LEVEL1TDLY | R/W | Unsigned Int | 1 | 10 to 200 | | sec. | 50 | |
| 3303 | LEVEL2TDLY | R/W | Unsigned Int | 1 | 10 to 99 | | sec. | 25 | |
| **PROTECTION SETTINGS: SCHEME** | | | | | | | | | |
| 3304 | PICKSCHEME | R/W | Unsigned Int | 1 | 0 =STEPDST, 1=PUTT, 2=POTT1, 3=POTT2, 4=HYBRID, 5=BLOCK, 6=HYBRID BLOCK | | - | 0 | |
| 3305 | NUMRCVR | R/W | Unsigned Int | 1 | 0, 1, 2 | | - | 0 | |
| 3306 | TRIPMODE | R/W | Unsigned Int | 1 | 0=3POLE, 1=1POLE, 2=1POLEZ2 | | - | 0 | |
| 3307 | CARRSTART | R/W | Unsigned Int | 1 | 0=DIR, 1=IPB, 2=FD | | - | 1 | |
| 3308 | WKINFTRIP | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| **PROTECTION SETTINGS: SCHEME TIMERS** | | | | | | | | | |
| 3309 | TL1PICKUP | R/W | Unsigned Int | 1 | 1 to 200 | | ms | 5 | |
| 3310 | TL4PICKUP | R/W | Unsigned Int | 1 | 0 to 50 | | ms | 0 | |
| 3311 | TL4DROPOUT | R/W | Unsigned Int | 1 | 0 to 50 | | ms | 0 | |
| 3312 | TL5PICKUP | R/W | Unsigned Int | 1 | 0 to 200 | | ms | 50 | |
| 3313 | TL5DROPOUT | R/W | Unsigned Int | 1 | 0 to 200 | | ms | 50 | |
| 3314 | TL6PICKUP | R/W | Unsigned Int | 1 | 0 to 200 | | ms | 50 | |
| 3315 | TL6DROPOUT | R/W | Unsigned Int | 1 | 0 to 200 | | ms | 50 | |
| 3316 | TL16PICKUP | R/W | Unsigned Int | 1 | 8 to 99 | | ms | 8 | |
| 3317 | TL24DROPOUT | R/W | Unsigned Int | 1 | 30 to 500 | | ms | 30 | |
| 3318 | TL25DROPOUT | R/W | Unsigned Int | 1 | 30 to 500 | | ms | 30 | |
| 3319 | TL26PICKUP | R/W | Unsigned Int | 1 | 0 to 50 | | ms | 0 | |
| **PROTECTION SETTINGS: LINE INFORMATION** | | | | | | | | | |
| 3320 | POSSEQANG | R/W | Unsigned Int | 1 | 25 to 90 | | deg | 85° | |
| 3321 | ZERSEQANG | R/W | Unsigned Int | 1 | 25 to 90 | | deg | 75° | |
| 3322 | ZLINE | R/W | P100 | 1 | 5 to 25000 | 1 to 5000 | Ω | 3000 | 600 |
| 3323 | ZEROSEQK0 | R/W | P100 | 1 | 100 to 700 | | - | 300 | |
| 3324 | LINELENGTH | R/W | P10 | 1 | 0 to 5000 | | mi/km | 1000 | |
| 3325 | LINEUNIT | R/W | Unsigned Int | 1 | 0=Miles, 1=Km | | - | 0 | |
| 3326 | CTRATIO | R/W | Unsigned Int | 1 | 1 to 5000 | | - | 2000 | 400 |
| 3327 | VTRATIO | R/W | Unsigned Int | 1 | 1 to 7000 | | - | 3000 | |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**B**

### Table B–4: MODBUS MEMORY MAP (Sheet 8 of 10)

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | 5 A | UNITS | DEFAULT 1 A | 5 A |
|---|---|---|---|---|---|---|---|---|---|
| **PROTECTION SETTINGS: SCADA DTA** | | | | | | | | | |
| 3328 | FLTLOCK | R/W | P10 | 1 | 0 to 999 | | sec. | 0 | |
| 3329 | FLTRESET | R/W | Unsigned Int | 1 | 0 to 999 | | min. | 0 | |
| **PROTECTION SETTINGS: OUT-OF-STEP BLOCKING** | | | | | | | | | |
| 3330 | MOBZONE | R/W | Unsigned Int | 1 | 0=Zone2, 1=Zone3, 2=Zone4 | | - | 1 | |
| 3331 | MOBCHARANG | R/W | Unsigned Int | 1 | 30 to 130 | | deg | 70° | |
| 3332 | BLOCKWHAT | R/W | Unsigned Int | 1 | 0=BLKALL, 1=BLKDIST, 2=BLKPHAS, 3=BLKNONE | | - | 0 | |
| 3333 | BLOCKZ1 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3334 | BLOCKZ2 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3335 | BLOCKZ3 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| 3336 | BLOCKZ4 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 1 | |
| **PROTECTION SETTINGS: OUT-OF-STEP TRIPPING** | | | | | | | | | |
| 3337 | USE_OST | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3338 | NUMBRCHAR | R/W | Unsigned Int | 1 | 2, 3 | | - | 3 | |
| 3339 | TRIPIN_OUT | R/W | Unsigned Int | 1 | 0=In, 1=Out | | - | 1 | |
| 3340 | FWDREACH | R/W | P10 | 1 | 5 to 3750 | 1 to 750 | Ω | 750 | 150 |
| 3341 | REVREACH | R/W | P10 | 1 | 5 to 3750 | 1 to 750 | Ω | 250 | 50 |
| 3342 | OUTER | R/W | Unsigned Int | 1 | 40 to 165 | | deg | 90° | |
| 3343 | MIDDLE | R/W | Unsigned Int | 1 | 40 to 165 | | deg | 105° | |
| 3344 | INNER | R/W | Unsigned Int | 1 | 40 to 165 | | deg | 120° | |
| 3345 | TLOS1PU | R/W | Unsigned Int | 1 | 1 to 100 | | ms | 40 | |
| 3346 | TLOS1DO | R/W | Unsigned Int | 1 | 1 to 100 | | ms | 40 | |
| 3347 | TLOS2PU | R/W | Unsigned Int | 1 | 1 to 100 | | ms | 40 | |
| 3348 | TLOS3PU | R/W | Unsigned Int | 1 | 1 to 100 | | ms | 40 | |
| 3349 | TLOS4PU | R/W | Unsigned Int | 1 | 1 to 100 | | ms | 40 | |
| **PROTECTION SETTINGS: RECLOSER** | | | | | | | | | |
| 3350 | RECLMODE | R/W | Unsigned Int | 1 | 0=None, 1=Internal, 2=External, 3=Off | | - | 3 | |
| 3351 | RECTYPE | R/W | Unsigned Int | 1 | 0=3POLE, 1=1POLE, 2=1POLE/3POLE | | - | 0 | |
| 3352 | NUM_1P | R/W | Unsigned Int | 1 | 1 to 4 | | - | 1 | |
| 3353 | 1PDELAY1 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3354 | 1PDELAY2 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3355 | 1PDELAY3 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3356 | 1PDELAY4 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3357 | NUM_3P | R/W | Unsigned Int | 1 | 1 to 4 | | - | 1 | |
| 3358 | 3PDELAY1 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3359 | 3PDELAY2 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3360 | 3PDELAY3 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3361 | 3PDELAY4 | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3362 | RESETTIME | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3363 | DWELLTIME | R/W | P10 | 1 | 1 to 3000 | | sec. | 1 | |
| 3364 | HOLD | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3365 | HOLDTIME | R/W | Unsigned Int | 1 | 1 to 1000 | | sec. | 1 | |
| 3366 | HOLDSENSE | R/W | Unsigned Int | 1 | 0=CC, 1=CO | | - | 0 | |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**Table B–4: MODBUS MEMORY MAP (Sheet 9 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 3367 | SYNCHCHECK | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3368 | CLOSEANG | R/W | P10 | 1 | 0 to 750 | | deg | 300 | |
| 3369 | SLIPFREQ | R/W | P10 | 1 | 1 to 50 | | Hz | 10 | |
| 3370 | BUSLINE | R/W | Unsigned Int | 1 | 0=BUS, 1=LINE | | - | 1 | |
| 3371 | SYNCHPHASE | R/W | Unsigned Int | 1 | 0=VA, 1=VB, 2=VC, 3=VAB, 4=VBC, 5=VCA | | - | 0 | |
| 3372 | SYNCHHOLD | R/W | Unsigned Int | 1 | 1 to 1000 | | sec. | 1 | |
| 3373 | SP1PDELAY2 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3374 | SP1PDELAY3 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3375 | SP1PDELAY4 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3376 | SP3PDELAY1 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3377 | SP3PDELAY2 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3378 | SP3PDELAY3 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3379 | SP3PDELAY4 | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3380 | SYNCMANCLS | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3381 | VUBSLIVE | R/W | P10 | 1 | 1 to 1300 | | sec. | 500 | |
| 3382 | VBUSDEAD | R/W | P10 | 1 | 1 to 1300 | | sec. | 500 | |
| 3383 | VLINELIVE | R/W | P10 | 1 | 1 to 1300 | | sec. | 500 | |
| 3384 | VLINEDEAD | R/W | P10 | 1 | 1 to 1300 | | sec. | 500 | |
| 3385 | LBUSDLINE | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3386 | DBUSLLINE | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3387 | DBUSDLINE | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| 3388 | DELTAV | R/W | P10 | 1 | 1 to 300 | | V | 100 | |
| 3389 | DELTAVBLK | R/W | Unsigned Int | 1 | 0=No, 1=Yes | | - | 0 | |
| **PROTECTION SETTINGS: NON-CRITICAL ALARMS** | | | | | | | | | |
| 3390 | NCAIN1 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 48 | |
| 3391 | NCAIN2 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 49 | |
| 3392 | NCAIN3 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 50 | |
| 3393 | NCAIN4 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 51 | |
| 3394 | NCAIN5 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | - |
| 3395 | NCAIN6 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | - |
| 3396 | NCAIN7 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | - |
| 3397 | NCAIN8 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | - |
| **PROTECTION SETTINGS: OUTPUTS** | | | | | | | | | |
| 3398 | T1 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 33 | |
| 3399 | T2 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 33 | |
| 3400 | T3 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 33 | |
| 3401 | T4 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 33 | |
| 3402 | T5 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 34 | |
| 3403 | T6 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 34 | |
| 3404 | A1 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 58 | |
| 3405 | A2 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 59 | |
| 3406 | A3 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 33 | |
| 3407 | A4 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 33 | |
| 3408 | A5 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 37 | |
| 3409 | A6 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 37 | |

[1, 2, 3, 4, 5, 6, 7, 8]   See page B–14 for footnote explanations.

**B**

**Table B–4: MODBUS MEMORY MAP (Sheet 10 of 10)**

| ALPS REGISTER | CONTENTS | TYPE | FORMAT | NO. OF REGS. | RANGE 1 A | RANGE 5 A | UNITS | DEFAULT 1 A | DEFAULT 5 A |
|---|---|---|---|---|---|---|---|---|---|
| 3410 | A7 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 38 | |
| 3411 | A8 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 45 | |
| 3412 | A9 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | |
| 3413 | A10 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | |
| 3414 | A11 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | |
| 3415 | A12 | R/W | Unsigned Int | 1 | 0 to 256 | | - | - | |
| 3416 | C1 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 52 | |
| 3417 | C2 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 115 | |
| 3418 | KT1 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 39 | |
| 3419 | KT2 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 40 | |
| 3420 | KT3 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 39 | |
| 3421 | KT4 | R/W | Unsigned Int | 1 | 0 to 256 | | - | 40 | |
| 3422 | CONFTRIP | R/W | Unsigned Int | 1 | 0 to 40 | 0 to 256 | - | - | - |
| 3423 | CONFOSC | R/W | Unsigned Int | 1 | 0 to 40 | 0 to 256 | - | - | - |
| 3424 | Reserved | RO | - | - | - | - | - | - | - |
| ↓ | ↓ | RO | - | - | - | - | - | - | - |
| 3499 | Reserved | RO | - | - | - | - | - | - | - |
| **SETTINGS REGISTERS GROUP 2** | | | | | | | | | |
| 3500 ↓ 3799 | Settings address equivalent to SETTINGS REGISTERS GROUP 1 plus 300. See registers 3200 to 3499 for details of the individual registers. | | | | | | | | |
| **SETTINGS REGISTERS GROUP 3** | | | | | | | | | |
| 3800 ↓ 4099 | Settings address equivalent to SETTINGS REGISTERS GROUP 1 plus 600. See registers 3200 to 3499 for details of the individual registers | | | | | | | | |
| **SETTINGS REGISTERS GROUP 4** | | | | | | | | | |
| 4100 ↓ 4399 | Settings address equivalent to SETTINGS REGISTERS GROUP 1 plus 900. See registers 3200 to 3499 for details of the individual registers | | | | | | | | |
| **REPORT CONTROL REGISTERS** | | | | | | | | | |
| 4400 | Report Control Register | R/W | Integer | 1 | *XXYY*, where X=0 (none – default) or 2 (Fault Report); *Y*=01 to 36 (fault index, dependent on NUMFLTS setting) | | | | |

1, 2, 3, 4, 5, 6, 7, 8   See page B–14 for footnote explanations.

**MEMORY MAP FOOTNOTES:**

1. Valid for single-pole models only.

2. Valid only when blocking scheme is selected.

3. Valid only for models with recloser.

4. Specific to each serial interface.

5. Valid for models with rear serial port only.

6. Valid for single-pole and LPS models only.

7. Valid for models with series compensation only.

8. Valid for models with positive-sequence overvoltage only.

9. Valid for three-pole models only

**Table B–5: DATA FORMATS (Sheet 1 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F1 | **32 bits** | **DATE (32 bits) MM/DD/YYYY** |
| | 8 bits | Month = 1 (Jan), 2 (Feb), etc. |
| | 8 bits | Day (1 to 31) |
| | 16 bits | Year 0...80 (2000...2080), 81...99 (1981...1999) or 1981...2080 |
| F2 | **32 bits** | **TIME HH:MM:SS.sss** |
| | 8 bits | Hours (0 to 23) |
| | 8 bits | Minutes (0 to 59) |
| | 16 bits | Seconds (0 = 00.000s, 1 = 00.001s,..., 59999 = 59.999 s) |
| F3 | **2 bytes** | **Breaker Indication** |
| | 0 | Open |
| | 1 | Close |
| F4 | **2 bytes** | **ON/OFF Indication** |
| | 0 | ON |
| | 1 | OFF |
| F5 | **2 bytes** | **Reclose State** |
| | 0 | None |
| | 1 | Reclose |
| | 2 | Process |
| | 3 | Lockout |
| | 4 | Manual Lockout |
| | 5 | Off |
| F6 | **16 bits** | **SYS_960STAT1** |
| | bit 0 | FLASH self test error in 960 card |
| | bit 1 | startup RAM self test error in 960 |
| | bit 2 | CRC RAM self test error |
| | bit 3 | DPRAM self test error |
| | bit 4 | Interrupt self-test error |
| | bit 5 | Timer self test error |
| | bit 6 | EEPROM self test error |
| | bit 7 | CAPACITOR RAM self test error |
| | bit 8 | RTC failure |
| | bit 9 | Watchdog Timer failure |
| | bit 10 | N/A |
| | bit 11 | N/A |
| | bit 12 | Version Error |
| | bit 13 | SYSTEM processor in RESET |
| | bit 14 | DO h/w disable flag |
| | bit 15 | N/A |

**Table B–5: DATA FORMATS (Sheet 2 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F7 | **16 bits** | **SYS_960STAT2** |
| | bit 0 | N/A |
| | bit 1 | Digital output self test error |
| | bit 2 | LCD display self test error |
| | bit 3 | IRIG-B self test error |
| | bit 4 | Rear port 1 present/absent |
| | bit 5 | Rear port 2 present/absent |
| | bit 6 | Voltage cct # 1 continuity error |
| | bit 7 | Voltage cct # 2 continuity error |
| | bit 8 | Voltage cct # 3 continuity error |
| | bit 9 | Voltage cct # 4 continuity error |
| | bit 10 | Voltage cct # 5 continuity error |
| | bit 11 | Voltage cct # 6 continuity error |
| | bit 15 | Hardware configuration mismatch |
| F8 | **16 bits** | **SYS_ANISTAT** |
| | bit 0 | A/D controller self test error |
| | bit 1 | A/D serial NVM self test error |
| | bit 2 | A/D reference self test error |
| | bit 3 | Zero crossing self test error |
| | bit 4 | A/D ref self test error corrected |
| | bit 5 | No ANI/DMA interrupt self test error |
| | bit 6 | Digital Input Error |
| | bit 7 | Digital Input Error Corrects |
| | bit 8 | N/A |
| | bit 9 | MAG serial NVM self test error |
| | bit 10 | Serial Port#1 Error |
| | bit 11 | Serial Port#2 Error |
| | bit 12 | Serial Port#3 Error |
| | bit 13 | Parallel Port Error |
| | bit 15 | Power frequency Error |
| F9 | **16 bits** | **SYS_DSPSTAT** |
| | bit 0 | PROM self test error in DSP card |
| | bit 1 | startup RAM self test error in DSP |
| | bit 2 | CRC RAM self test error in DSP |
| | bit 3 | Shared RAM self test error |
| | bit 4 | Interrupt self test error |
| | bit 5 | Shared RAM checksum error |
| | bits 6 to 12 | N/A |
| | bit 13 | DSP processor in RESET |
| | bit 14 | DSP version error |
| | bit 15 | DSP processor in SHUTDOWN |

**B**

**B**

**Table B–5: DATA FORMATS (Sheet 3 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F10 | 16 bits | SYS_MISCSTAT1 |
|  | bit 0 | Protection disabled flag |
|  | bit 1 | N/A |
|  | bit 2 | Continuous monitor alarm error |
|  | bit 3 | Unbalanced system detection error |
|  | bit 4 | Fuse failure error |
|  | bit 5 | Trip bus check error |
|  | bits 6 to 11 | N/A |
|  | bit 12 | Time strobe fail (to be looked into) |
|  | bit 13 | Jumper (remote manual trip/close) |
|  | bit 14 | Jumper (Remote change settings/ Soft DO enable/disable) |
|  | bit 15 | Jumper (keypad enabled/disabled) |
| F11 | 16 bits | SYS_MISCSTAT2 (16 bits) |
|  | bit 0 | Group selection through contact converters |
|  | bit 1 | Relay test |
|  | bit 2 | Digital output test |
|  | bit 3 | Channel test |
|  | bit 4 | Playback |
|  | bit 5 | MMI passwords enabled/disabled |
|  | bit 6 | Logon failure through front port |
|  | bit 7 | Logon failure through Rear port#1 |
|  | bit 8 | Logon failure through Rear port#2 |
|  | bit 9 | D.O. software disable flag |
|  | bit 10 | Comm. access level - low bit |
|  | bit 11 | Comm. access level - high bit |
|  | bit 12 | Factory Setting access level |
|  | bit 13 | Active setting group - low bit |
|  | bit 14 | Active setting group - high bit |
|  | bit 15 | N/A |
| F12 | Integer | Comm Port 1 Settings (xxyz) |
|  | F56 | Baud Rate (xx) |
|  | F57 | Parity (y) |
|  | F58 | Stop Bits (z) |
| F13 | Integer | Comm Port 2 Settings (ixxyz) |
|  | F59 | Interface (i) |
|  | F56 | Baud Rate (xx) |
|  | F57 | Parity (y) |
|  | F58 | Stop Bits (z) |
| F14 | 2 bytes | Fault Data |
|  | F18 | Fault Type (Lower byte) |
|  | F17 | Trip Type (Upper byte) |

**Table B–5: DATA FORMATS (Sheet 4 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F17 | 2 bytes | Trip Types |
|  | 0 | No trip available |
|  | 1 | Z1 |
|  | 2 | Z2 |
|  | 3 | Z3 |
|  | 4 | Z4 |
|  | 5 | PLT |
|  | 6 | 50G |
|  | 7 | 50P |
|  | 8 | 51G |
|  | 9 | LPU |
|  | 10 | REM |
|  | 11 | WI |
|  | 12 | OSC |
|  | 13 | SZ1 |
|  | 14 | SZ2 |
|  | 15 | SP1 |
|  | 16 | SWI |
|  | 17 | CTB |
|  | 255 | Undefined |
| F18 | 2 bytes | Fault Types |
|  | 1 | AG_-phase A to Ground |
|  | 2 | BG_-phase B to Ground |
|  | 3 | CG_-phase C to Ground |
|  | 4 | ABG-phase A to phase B to Ground |
|  | 5 | BCG-phase B to phase C to Ground |
|  | 6 | CAG-phase C to phase A to Ground |
|  | 7 | AB_-phase A to phase B |
|  | 8 | BC_-phase B to phase C |
|  | 9 | CA_-phase C to phase A |
|  | 10 | 3PH-phase A to phase B to phase C |
|  | 255 | Undefined |
| F20 | 2 bytes | Download Status |
|  | 0 | OK |
|  | 1 | Erasing Flash RAM |
|  | 2 | Communication Error |
|  | 3 | Code CRC Error |
|  | 4 | Flash Write Error |
|  | 5 | Flash Erase Error |
|  | 6 | Incorrect Application Error |
|  | 7 | Incorrect Size |
|  | 8 | Computing application code CRC |

**Table B–5: DATA FORMATS (Sheet 5 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F22 | 2 bytes | **Digital Test Number** |
| | 0 | END OF TEST |
| | 1 | T1 |
| | 2 | T2 |
| | 3 | T3 |
| | 4 | T4 |
| | 5 | T5 (1-phase tripping model only) |
| | 6 | T6 (1-phase tripping model only) |
| | 7 | A1 |
| | 8 | A2 |
| | 9 | A3 |
| | 10 | A4 |
| | 11 | A5 |
| | 12 | A6 |
| | 13 | A7 |
| | 14 | A8 |
| | 15 | A9 (1-phase tripping model only) |
| | 16 | A10 (1-phase tripping model only) |
| | 17 | A11 (1-phase tripping model only) |
| | 18 | A12 (1-phase tripping model only) |
| | 19 | KT1 |
| | 20 | KT2 |
| | 21 | KT3 |
| | 22 | KT4 |
| | 23 | C1A/C1B |
| | 24 | C2A/C2B |
| | 25 | CA-A/B (Critical Alarm) |
| F26 | 2 bytes | **Output Mode** |
| | 0 | output enabled |
| | 1 | Output disabled |
| F27 | 2 bytes | **Contact Converter Status Bits (0=not activated, 1=activated)** |
| | bit 0 | Status for CC1 |
| | bit1 | Status for CC2 |
| | bit 2 | Status for CC3 |
| | bit 3 | Status for CC4 |
| | bit 4 | Status for CC5 |
| | bit 5 | Status for CC6 |
| | bit 6 | Status for CC7 |
| | bit 7 | Status for CC8 |
| | bit 8 | Status for CC9 (1-phase model) |
| | bit 9 | Status for CC10 (1-phase model) |
| | bit 10 | Status for CC11 (1-phase model) |
| | bit 11 | Status for CC12 (1-phase model) |

**Table B–5: DATA FORMATS (Sheet 6 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F28 | 2 bytes | **Output Contact Status Bits (0=not activated, 1=activated)** |
| | bit 0 | status for T1 |
| | bit 1 | status for T2 |
| | bit 2 | status for T3 |
| | bit 3 | status for T4 |
| | bit 4 | status for T5 (1-phase model) |
| | bit 5 | status for T6 (1-phase model) |
| | bit 6 | status for A1 |
| | bit 7 | status for A2 |
| | bit 8 | status for A3 |
| | bit 9 | status for A4 |
| | bit 10 | status for A5 |
| | bit 11 | status for A6 |
| | bit 12 | status for A7 |
| | bit 13 | status for A8 |
| | bit 14 | status for A9 (1-phase model) |
| | bit 15 | status for A10 (1-phase model) |
| | bit 16 | status for A11 (1-phase model) |
| | bit 17 | status for A12 (1-phase model) |
| | bit 18 | status for KT1 |
| | bit 19 | status for KT2 |
| | bit 20 | status for KT3 |
| | bit 21 | status for KT4 |
| | bit 22 | status for C1 |
| | bit 23 | status for C2 |
| | bit 24 | status for CA-A/B (Critical Alarm) |
| F43 | 2 bytes | **Reset Type** |
| | 0 | Fault report and oscillography data |
| | 1 | Event Data |
| | 2 | OST Data |
| | 3 | Breaker Health |
| | 4 | Reset Target LEDs, Clear Warn and Fail and Trip Message from Display and EEPROM |
| F48 | 2 bytes | **Breaker Duty** |
| | 0 to 9999 | Actual Value |
| | 10000 to 19999 | $\dfrac{Value - 10000}{10} \times 10^3$ |
| | 20000 to 29999 | $\dfrac{Value - 20000}{10} \times 10^6$ |
| F49 | 2 bytes | **Multiplier** |
| | 0 | M - Millions |
| | 1 | K - Thousands |
| | 2 | Actual Value |
| F52 | 2 bytes | **PHASEROTATE value** |
| | 0 | ABC |
| | 1 | ACB |

**B**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F56 | 2 bytes | Baud Rate |
| | 03 | 300 |
| | 12 | 1200 |
| | 24 | 2400 |
| | 48 | 4800 |
| | 96 | 9600 |
| | 19 | 19200 |
| F57 | 2 bytes | Parity |
| | 0 | no parity |
| | 1 | odd parity |
| | 2 | even parity |
| F58 | 2 bytes | Stop bits |
| | 1 | 1 |
| | 2 | 2 |
| F59 | 2 bytes | Interface |
| | 0 | RS-232 |
| | 1 | RS-485 |
| F60 | 2 bytes | DISPLAYVAL value |
| | 0 | Primary |
| | 1 | Secondary |
| F61 | 2 bytes | Event Codes |
| | 000 | FAIL-CPU BOARD SRAM |
| | 001 | FAIL-960 ACCESS TO DPRAM |
| | 002 | FAIL-EEPROM |
| | 003 | FAIL-DIGITAL OUTPUT TEST |
| | 004 | FAIL-INTERRUPT TEST |
| | 005 | FAIL-ANI ADC CONTROL LOGIC |
| | 006 | FAIL-ANI REFERENCE CHANNEL TEST |
| | 007 | FAIL-DMA INTERRUPT |
| | 008 | FAIL-ANI BOARD TIMER |
| | 009 | FAIL-ANI BOARD SERIAL EEPROM TEST |
| | 010 | FAIL-MAG MODULE SERIAL EEPROM TEST |
| | 011 | FAIL-DIG OUTPUT SERIAL EEPROM TEST |
| | 012 | FAIL-DTA SERIAL EEPROM TEST |
| | 013 | FAIL-DSP PROM |
| | 014 | FAIL-DSP INTERNAL RAM |
| | 015 | FAIL-DSP INTERNAL RAM CHECKSUM ERROR |
| | 016 | FAIL-DSP ACCESS TO DPRAM |
| | 017 | FAIL-DSP INTERRUPT |
| | 018 | FAIL-DIGITAL INPUT TEST |
| | 019 | FAIL-MODEL NUMBER |
| | 020 | FAIL-MAG MODULE CONFIG MISMATCH |

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| F61 ctd | 021 | FAIL-ANI MODULE CONFIG MISMATCH |
| | 022 | FAIL-DIG INPUT MODULE CONFIG MISMATCH |
| | 023 | FAIL-DIG OUTPUT MODULE CONFIG MISMATCH |
| | 024 | FAIL-TRIP CIRCUIT#1 CONTINUITY MONITOR |
| | 025 | FAIL-TRIP CIRCUIT#2 CONTINUITY MONITOR |
| | 026 | FAIL-TRIP CIRCUIT#3 CONTINUITY MONITOR |
| | 027 | FAIL-TRIP CIRCUIT#4 CONTINUITY MONITOR |
| | 028 | FAIL-TRIP CIRCUIT#5 CONTINUITY MONITOR |
| | 029 | FAIL-TRIP CIRCUIT#6 CONTINUITY MONITOR |
| | 030 | FAIL-SOFTWARE VERSION ERROR |
| | 031 | FAIL-DSP SOFTWARE VERSION ERROR |
| | 032 | FAIL-FIVE RESTARTS IN AN HOUR |
| | 033 | FAIL-i960-DSP INTERFACE (DPRAM) |
| | 034 | RUNTIME FLASH TEST CRC CHECK FAIL |
| | 035 | i960 INSTRUCTION FAULT OCCURRED |
| | 036 | i960 ARITHMETIC INSTRUCTION FAULT |
| | 037 | TOO MANY BOGUS INTERRUPTS |
| | 038 | FAIL-DSP DPRAM CHECKSUM |
| | 039 to 42 | NONE |
| | 043 | WARN-CPU BOARD TIMER TEST |
| | 044 | WARN-ZERO CROSSING LOGIC |
| | 045 | WARN-CAPRAM FAILURE |
| | 046 | WARN-RTC TEST FAILURE |
| | 047 | WARN-COMM FRONT PORT FAILURE |
| | 048 | WARN-COMM REAR PORT 1 FAILURE |
| | 049 | WARN-COMM REAR PORT 2 FAILURE |
| | 050 | WARN-WATCHDOG TIMER FAILED |
| | 051 | WARN-LCD DISPLAY FAILURE |
| | 052 | WARN - IRIGB FAILED |
| | 053 | WARN - H/W MISMATCH - REAR PORT2 ABSENT |
| | 054 | WARN- NON CRIT FIELD IN MODEL NUM ERROR |
| | 055 | WARN - CAPRAM SIZE MISMATCH |

**Table B–5: DATA FORMATS (Sheet 9 of 12)**

| TYPE | VALUE/BITMASK | DESCRIPTION |
|------|---------------|-------------|
| F61 ctd | 056 | WARN - FREQUENCY OUT OF RANGE |
| | 057 | WARN - WARM RESTART |
| | 058 | NONE |
| | 059 | NONE |
| | 060 | NONE |
| | 061 | NONE |
| | 062 | ANI REFERENCE CORRECTED |
| | 063 | DIGITAL INPUT ERROR CORRECTED |
| | 064 | MAG MODULE ERROR CORRECTED |
| | 065 | ANI MODULE ERROR CORRECTED |
| | 066 | LCD DISPLAY ERROR CORRETCED |
| | 067 | NONE |
| | 068 | NONE |
| | 069 | NONE |
| | 070 | NONE |
| | 071 | NONE |
| | 072 | NONE |
| | 073 | NONE |
| | 074 | NONE |
| | 075 | NONE |
| | 076 | NONE |
| | 077 | LOGIN FAILED |
| | 078 | PASSWORD CHANGE |
| | 079 | ENABLE OUTPUTS |
| | 080 | DISABLE OUTPUTS |
| | 081 | MANUAL TRIP |
| | 082 | MANUAL CLOSE |
| | 083 | ATTEMPTED MANUAL TRIP FAILED |
| | 084 | ATTEMPTED MANUAL CLOSE FAILED |
| | 085 | MANUAL RECLOSER RESET |
| | 086 | SETTINGS CHANGE STARTED |
| | 087 | SETTINGS CHANGE DONE |
| | 088 | PROTECTION TURNED OFF |
| | 089 | PROTECTION TURNED ON |
| | 090 | FAULTS RESET |
| | 091 | EVENTS RESET |
| | 092 | OST OSCILLOGRAPHY RESET |
| | 093 | EQUIPMENT DUTY RESET |
| | 094 | ACTIVE SETTING GROUP CHANGED |
| | 095 | PROTECTION REINITIALIZATION SERVICED |
| | 096 | PROTECTION REINIT NOT SERVICED |

**Table B–5: DATA FORMATS (Sheet 10 of 12)**

| TYPE | VALUE/BITMASK | DESCRIPTION |
|------|---------------|-------------|
| F61 ctd | 097 | FACTORY SETTING DONE |
| | 098 | ERR - CONSTANTS USED FOR PROT |
| | 099 | ERR- CONFIG LOGIC CODE AREA |
| | 100 | INTIALIZED,ALPS INITIALIZED |
| | 101 | NONE |
| | 102 | NONE |
| | 103 | NONE |
| | 104 | NONE |
| | 105 | TRIP SIGNALS ON |
| | 106 | TRIP SIGNALS RESET |
| | 107 | TRIP A SIGNAL ON |
| | 108 | TRIP A SIGNAL RESET |
| | 109 | TRIP B SIGNAL ON |
| | 110 | TRIP B SIGNAL RESET |
| | 111 | TRIP C SIGNAL ON |
| | 112 | TRIP C SIGNAL RESET |
| | 113 | OUT OF STEP BLOCK ON |
| | 114 | OUT OF STEP BLOCK OFF |
| | 115 | BREAKER #1 OPEN |
| | 116 | BREAKER #1 CLOSED |
| | 117 | BREAKER #2 OPEN |
| | 118 | BREAKER #2 CLOSED |
| | 119 | FUSE FAILURE ALARM ON |
| | 120 | FUSE FAILURE ALARM OFF |
| | 121 | RECEIVE CARRIER ON |
| | 122 | RECEIVE CARRIER OFF |
| | 123 | KEY TRANSMITTER ON |
| | 124 | KEY TRANSMITTER OFF |
| | 125 | TRIP CIRCUIT #1 ENERGIZED |
| | 126 | TRIP CIRCUIT #2 ENERGIZED |
| | 127 | TRIP CIRCUIT #3 ENERGIZED |
| | 128 | TRIP CIRCUIT #4 ENERGIZED |
| | 129 | TRIP CIRCUIT #5 ENERGIZED |
| | 130 | TRIP CIRCUIT #6 ENERGIZED |
| | 131 | LINE OVERLOAD ALARM ON |
| | 132 | LINE OVERLOAD ALARM OFF |
| | 133 | TRIP CIRCUIT #1 MONITOR ALARM ON |
| | 134 | TRIP CIRCUIT #1 MONITOR ALARM OFF |
| | 135 | TRIP CIRCUIT #2 MONITOR ALARM ON |
| | 136 | TRIP CIRCUIT #2 MONITOR ALARM OFF |
| | 137 | TRIP CIRCUIT #3 MONITOR ALARM ON |
| | 138 | TRIP CIRCUIT #3 MONITOR ALARM OFF |

**B**

**B**

**Table B–5: DATA FORMATS (Sheet 11 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| **F61 ctd** | 139 | TRIP CIRCUIT #4 MONITOR ALARM ON |
| | 140 | TRIP CIRCUIT #4 MONITOR ALARM OFF |
| | 141 | TRIP CIRCUIT #5 MONITOR ALARM ON |
| | 142 | TRIP CIRCUIT #5 MONITOR ALARM OFF |
| | 143 | TRIP CIRCUIT #6 MONITOR ALARM ON |
| | 144 | TRIP CIRCUIT #6 MONITOR ALARM OFF |
| | 145 | PILOT PROTECTION ON |
| | 146 | PILOT PROTECTION OFF |
| | 147 | OSCILLOGRAPHY TRIGGERED |
| | 148 | FAIL-TRIP BUS CHECK |
| | 149 | UNBALANCED SYSTEM DETECTION ALARM ON |
| | 150 | UNBALANCED SYSTEM DETECTION ALARM OFF |
| | 151 | ZONE MEASUREMENT UNITS ALARM ON |
| | 152 | ZONE MEASUREMENT UNITS ALARM OFF |
| | 153 | OVERCURRENT MONITOR ALARM ON |
| | 154 | OVERCURRENT MONITOR ALARM OFF |
| | 155 | TRIP CIRCUIT #1 NOT ENERGIZED |
| | 156 | TRIP CIRCUIT #2 NOT ENERGIZED |
| | 157 | TRIP CIRCUIT #3 NOT ENERGIZED |
| | 158 | TRIP CIRCUIT #4 NOT ENERGIZED |
| | 159 | TRIP CIRCUIT #5 NOT ENERGIZED |
| | 160 | TRIP CIRCUIT #6 NOT ENERGIZED |
| | 161 | Recloser in Reset |
| | 162 | Reclose In Progress - Start |
| | 163 | Reclose In Progress - End |
| | 164 | Single Pole Reclose - Shot1 |
| | 165 | Single Pole Reclose - Shot2 |
| | 166 | Single Pole Reclose - Shot3 |
| | 167 | Single Pole Reclose - Shot4 |
| | 168 | Three Pole Reclose - Shot1 |
| | 169 | Three Pole Reclose - Shot2 |
| | 170 | Three Pole Reclose - Shot3 |
| | 171 | Three Pole Reclose - Shot4 |
| | 172 | OUT OF STEP TRIP ON |
| | 173 | OUT OF STEP TRIP OFF |

**Table B–5: DATA FORMATS (Sheet 12 of 12)**

| TYPE | VALUE/ BITMASK | DESCRIPTION |
|---|---|---|
| **F61 ctd** | 174 | RUNTIME ANI CONTROL ERROR |
| | 175 | RUNTIME ANI REFERENCE ERROR |
| | 176 | TOC Curve Changed |
| | 177 | Run time DSP handshake |
| | 178 | Run time DSP PROGRAM ROM |
| | 179 | Run time DSP STATIC RAM |
| | 180 | Run time DSP CRC STATIC RAM |
| | 181 | Run time DSP DPRAM |
| | 182 | Run time DSP DPRAM CHECKSUM |
| | 183 | Run time NO DMA interrupt |
| | 184 | EEPROM CRC Recalculated |
| | 185 | Max Breaker operations exceeded |
| | 186 | Max I2T exceeded |
| | 187 | No Sync Check |
| | 188 | Recloser in Lockout - No Inhibit Input |
| | 189 | Recloser in Lockout - Breaker open |
| | 190 | Recloser in Lockout - Reclose Unsuccessful |
| | 191 | Recloser in Lockout - Reclose Cancel |
| | 192 | Recloser in Lockout - Breaker Fail to open |
| | 193 | Recloser in Lockout - Maximum Shots |
| | 194 | Recloser in Lockout - Invalid Reclose Type |
| | 195 | Reclose - Output Issued |
| | 196 | Recloser in Lockout - Manual Lockout |
| **F69** | **2 bytes** | **Event Source** |
| | 0 | Port PL1 |
| | 1 | Port PL2 |
| | 2 | Port PL3 |
| | 3 | LUI |
| | 4 | Protection |
| | 5 | Self Test |
| | 6 | Start Up |
| **P10** | **2 bytes** | **Integer Fixed Point, 1 Decimal** |
| | | Field Value is multiplied by 10 |
| **P100** | **2 bytes** | **Integer Fixed Point, 2 Decimals** |
| | | Field Value is multiplied by 100 |

> **The DNP Protocol is only available on ALPS Rev. A versions V0004.04AA23 or higher and Rev. B. versions V0005.01AA02 or higher.**
>
> **NOTE**

This appendix contains information for using DNP with the ALPS for users familiar with the DNP protocol. Since DNP is a complex protocol, it is not within the scope of this manual to provide a complete description of its operation in the detail required for communication with the ALPS. It is strongly recommended that interested users contact the DNP Users Group at www.dnp.org to obtain further information. Members of the DNP Users group are eligible to receive complete descriptions of all aspects of the protocol.

### C.1.2 MODIFYING SETTINGS USING DNP

**C**

ALPS settings can be read using Function Code 1 to read the Analog Output Object Points. Settings can only be modified using Function Codes 5 or 6 to Direct Operate the Analog Output Object Points. Since there are eight groups of settings for most of the Settings categories, the Settings group of interest must be selected before reading or writing any of the Analog Output Points. Analog Output Point #0 gives the currently active settings group being used by the DNP application in the device. Note that this is not necessarily same as the currently active settings group of the device. On power-up or any device restart, this point is set to the active settings group of the device, but this can later be changed using DNP functions and can be different from the active settings group in the device.

Binary Output #13, Start Settings Change must be activated before starting any settings changes using function codes 5 or 6 to Analog Output points. Any changes to the Analog output points are only done in the local copy of the DNP application and are not written to the Non-Volatile memory section of the device where settings are stored till Binary Output #14, End Settings Change is activated. This procedure is summarized in the following steps.

1.  Start Settings change by activating Binary Output #13 (using function code 5 or 6)

2.  Select the settings group by writing the appropriate value in Analog Output point #0
    (using function code 5 or 6).

3.  Modify the required settings by writing to the corresponding Analog Output points
    (using function code 5 or 6).

4.  End Settings change by activating Binary Output #14 (using function code 5 or 6). When this is done, the new settings are saved in Non-Volatile memory and the device is restarted if any of the critical settings are modified. Refer to the Instruction Book for details on the Critical settings.

**C**

| **DNP 3.0**<br>**DEVICE PROFILE DOCUMENT** | |
|---|---|
| **Vendor Name**: General Electric Power Management Inc. | |
| **Device Name**: ALPS Advanced Line Protection System | |

| **Highest DNP Level Supported:** | **Device Function:** |
|---|---|
| For Requests: Level 2<br>For Responses: Level 2 | ☐ Master    ☒ Slave |

**Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):**

Binary Input (Object 1, Variations 1 and 2)
Binary Output (Object 10, Variation 2)
Binary Counter (Object 20, Variations 5 and 6)
Frozen Counter (Object 21, Variations 5 and 6)
Analog Input (Object 30, Variations 1, 2, 3 and 4)
Analog Input Change (Object 32, Variations 1, 2, 3 and 4)
Analog Output (Object 40, Variations 1 and 2)
Analog Output Block (Object 41, Variation 1)
Warm Restart (Function code 14)

| **Maximum Data Link Frame Size (octets):** | **Maximum Application Fragment Size (octets):** |
|---|---|
| Transmitted: 292<br>Received: 292 | Transmitted: 2048<br>Received: 2048 |

| **Maximum Data Link Re-tries:** | **Maximum Application Layer Re-tries:** |
|---|---|
| ☒ None<br>☐ Fixed<br>☐ Configurable | ☒ None<br>☐ Configurable |

**Requires Data Link Layer Confirmation:**

☒ Never
☐ Always
☐ Sometimes
☐ Configurable

**Requires Application Layer Confirmation:**

☐ Never
☐ Always
☐ When reporting Event Data
☒ When sending multi-fragment responses
☐ Sometimes
☐ Configurable

**Timeouts while waiting for:**

| | | | | |
|---|---|---|---|---|
| Data Link Confirm | ☒ None | ☐ Fixed | ☐ Variable | ☐ Configurable |
| Complete Appl. Fragment | ☒ None | ☐ Fixed | ☐ Variable | ☐ Configurable |
| Application Confirm | ☐ None | ☒ Fixed at 5000 ms | ☐ Variable | ☐ Configurable |
| Complete Appl. Response | ☒ None | ☐ Fixed | ☐ Variable | ☐ Configurable |
| Others: | (None) | | | |

**DNP 3.0**
**DEVICE PROFILE DOCUMENT (CONTINUED)**

**Sends/Executes Control Operations:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| WRITE Binary Outputs | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |
| SELECT/OPERATE | ☐ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |
| DIRECT OPERATE | ☐ Never | ☒ Always | ☐ Sometimes | ☐ Configurable |
| DIRECT OPERATE - NO ACK | ☐ Never | ☒ Always | ☐ Sometimes | ☐ Configurable |
| Count > 1 | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |
| Pulse On | ☐ Never | ☒ Always | ☐ Sometimes | ☐ Configurable |
| Pulse Off | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |
| Latch On | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |
| Latch Off | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |

   (For an explanation of the above, refer to the discussion accompanying the Binary Output/Control Relay Output point list)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Queue | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |
| Clear Queue | ☒ Never | ☐ Always | ☐ Sometimes | ☐ Configurable |

| **Reports Binary Input Change Events when no specific variations requested:** | **Reports time-tagged Binary Input Change Events when no specific variation requested:** |
|---|---|
| ☐ Never | ☐ Never |
| ☒ Only time-tagged | ☒ Binary Input Change With Time |
| ☐ Only non-time-tagged | ☐ Binary Input Change With Relative Time |
| ☐ Configurable to send both, one or the other | ☐ Configurable |

| **Sends Unsolicited Responses:** | **Sends Static Data in Unsolicited Responses:** |
|---|---|
| ☒ Never | ☒ Never |
| ☐ Configurable | ☐ When Device Restarts |
| ☐ Only certain objects | ☐ When Status Flags Change |
| ☐ Sometimes | |
| ☐ ENABLE/DISABLE UNSOLICITED Function codes supported | |

| **Default Counter Object/Variation:** | **Counters Roll Over at:** |
|---|---|
| ☐ No Counters Reported | ☐ No Counters Reported |
| ☐ Configurable | ☐ Configurable |
| ☒ Default Object: 20  Default Variation: 6 | ☐ 16 Bits |
| | ☐ 32 Bits |
| ☐ Point-by-point list attached | ☐ Other Value |
| | ☒ Point-by-point list attached |

**Sends Multi-Fragment Responses**:      ☐ Yes      ☒ No

**C**

The implementation table gives a list of all objects recognized and returned by the ALPS device. Additional information detailing a list of default variations returned for each object and lists of defined point numbers for each object is provided on the following pages.

**Table C–1: IMPLEMENTATION TABLE**

| OBJECT | | | REQUEST | | RESPONSE | |
|---|---|---|---|---|---|---|
| **OBJ** | **VAR** | **DESCRIPTION** | **FUNC CODES (DEC)** | **QUAL CODES (HEX)** | **FUNC CODES (DEC)** | **QUAL CODES (HEX)** |
| 1 | 0 | Binary Input – All Variations | 1 | 06 | | |
| 1 | 1 | Binary Input | 1 | 00, 01, 06 | 129 | 00, 01 |
| 1 | 2 | Binary Input With Status | 1 | 00, 01, 06 | 129 | 00, 01 |
| 2 | 0 | Binary Input Change – All Variations | 1 | 06, 07, 08 | | |
| 2 | 1 | Binary Input Change Without Time | 1 | 06, 07, 08 | 129 | 17, 28 |
| 2 | 2 | Binary Input Change With Time | 1 | 06, 07, 08 | 129 | 17, 28 |
| 10 | 0 | Binary Output –　All Variations | 1 | 06 | | |
| 10 | 2 | Binary Output Status | 1 | 00, 01, 06 | 129 | 00, 01 |
| 12 | 1 | Control Relay Output Block | 5, 6 | 17, 28 | 129 | 17, 28 |
| 20 | 0 | Binary Counter – All Variations | 1, 7, 8, 9, 10 | 06 | 129 | 00, 01 |
| 20 | 5 | 32-Bit Binary Counter without Flag | 1, 7, 8, 9, 10 | 06 | 129 | 00, 01 |
| 20 | 6 | 16-Bit Binary Counter without Flag | 1, 7, 8, 9, 10 | 06 | 129 | 00, 01 |
| 21 | 0 | Frozen Counter – All Variations | 1 | 06 | 129 | 00, 01 |
| 21 | 9 | 32-Bit Frozen Counter without Flag | 1 | 06 | 129 | 00, 01 |
| 21 | 10 | 16-Bit Frozen Counter without Flag | 1 | 06 | 129 | 00, 01 |
| 30 | 0 | Analog Input – All Variations | 1 | 06 | | |
| 30 | 1 | 32-Bit Analog Input with Flag | 1 | 00, 01, 06 | 129 | 00, 01 |
| 30 | 2 | 16-Bit Analog Input with Flag | 1 | 00, 01, 06 | 129 | 00, 01 |
| 30 | 3 | 32-Bit Analog Input without Flag | 1 | 00, 01, 06 | 129 | 00, 01 |
| 30 | 4 | 16-Bit Analog Input without Flag | 1 | 00, 01, 06 | 129 | 00, 01 |
| 32 | 0 | Analog Change Event – All Variations | 1 | 06, 07, 08 | | |
| 32 | 1 | 32-Bit Analog Change Event without Time | 1 | 06, 07, 08 | 129 | 17, 28 |
| 32 | 2 | 16-Bit Analog Change Event without Time | 1 | 06, 07, 08 | 129 | 17, 28 |
| 32 | 3 | 32-Bit Analog Change Event with Time | 1 | 06, 07, 08 | 129 | 17, 28 |
| 32 | 4 | 16-Bit Analog Change Event with Time | 1 | 06, 07, 08 | 129 | 17, 28 |
| 40 | 0 | Analog Output Status – All Variations | 1 | 06 | | |
| 40 | 1 | 32-Bit Analog Output Status | 1 | 00, 01, 06 | 129 | 00, 01 |
| 40 | 2 | 16-Bit Analog Output Status | 1 | 00, 01, 06 | 129 | 00, 01 |
| 41 | 1 | 32-Bit Analog Output Block | 5, 6 | 17, 28 | 129 | 17, 28 |
| 41 | 2 | 16-Bit Analog Output Block | 5, 6 | 17, 28 | 129 | 17, 28 |
| 50 | 1 | Time And Date | 1, 2 | 07 [1] | 129 | 07 |
| 60 | 1 | Class 0 Data [2] | 1 | 06 | | |
| 60 | 2 | Class 1 Data [3] | 1 | 06, 07,. 08 | 129 | |
| 60 | 3 | Class 2 Data [3] | 1 | 06, 07, 08 | 129 | |
| 60 | 4 | Class 3 Data [3] | 1 | 06, 07, 08 | 129 | |
| 80 | 1 | Internal Indications | 2 | 00 [4] | 129 | |
| No Object (Cold Start Command) | | | 13 | | | |
| No Object (Warm Start Command) [5] | | | 14 | | | |
| No Object (Delay Measurement Command) [6] | | | 23 | | | |

[1], [2], [3], [4], [5], [6] See IMPLEMENTATION TABLE NOTES section on the following page

**C.2.3 IMPLEMENTATION TABLE NOTES**

1.  For this object, the quantity specified in the request must be exactly '1' as there is only one instance of this object defined in the relay.

2.  All Static Data known to the relay is returned in response to a request for Class 0. This includes all objects of type 1 (Binary Input), type 10 (Binary Output), type 30 (Analog Input) and type 40 (Analog Output).

3.  The point tables for Binary Input and Analog Input objects contain a field that defines to which event class the corresponding static data has been assigned.

4.  or this object, the qualifier code must specify an index of 7 only.

5.  Warm Restart (Function Code 14) is supported although it is not required by the DNP L2 specification.

6.  Delay Measurement (Function Code 23) is supported although it should be noted that the relay would never set the "Time Synchronization Required" Internal Indication bit.

**C**

**C.2.4 DEFAULT VARIATIONS**

The following table specifies the default variation for all objects returned by the relay. These variations will be returned for the object in a response when no specific variation is specified in a request.

**Table C–2: DEFAULT VARIATIONS**

| DEFAULT VARIATIONS | | |
|---|---|---|
| **OBJECT** | **DESCRIPTION** | **DEFAULT VARIATION** |
| 1 | Binary Input | 1 |
| 2 | Binary Input Change with Time | 2 |
| 10 | Binary Output Status | 2 |
| 20 | 16-Bit Binary Counter without Flag | 6 |
| 21 | 16-Bit Frozen Counter without Flag | 10 |
| 30 | 16-Bit Analog Input without Flag | 4 |
| 32 | 16-Bit Analog Input Change without Time | 2 |
| 40 | 16-Bit Analog Output Status | 2 |

The following tables give a list of data points defined for each object in the relay.

**Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 1 of 5)**

| BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02) | | | |
|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **REMARKS** |
| 0 | Relay In Service | Class 1 | |
| 1 | Critical Failure | Class 1 | |
| 2 | Non-Critical Failure | Class 1 | |
| 3 | Warm Restart | Class 1 | |
| 4 | Settings Group 1 Active | Class 1 | |
| 5 | Settings Group 2 Active | Class 1 | |
| 6 | Settings Group 3 Active | Class 1 | |
| 7 | Settings Group 4 Active | Class 1 | |
| 8 | Recloser Disabled | Class 1 | |
| 9 | Recloser in Reset | Class 1 | |
| 10 | Recloser in Progress | Class 1 | |
| 11 | Recloser in Lockout | Class 1 | |
| 12 | Breaker #1 / Breaker #1 Phase A is Open | Class 1 | |
| 13 | Breaker #1 Phase B is Open | Class 1 | |
| 14 | Breaker #1 Phase C is Open | Class 1 | |
| 15 | Breaker #1 / Breaker #1 Phase A is Closed | Class 1 | |
| 16 | Breaker #1 Phase B is Closed | Class 1 | |
| 17 | Breaker #1 Phase C is Closed | Class 1 | |
| 18 | Breaker #2 / Breaker #2 Phase A is Open | Class 1 | |
| 19 | Breaker #2 Phase B is Open | Class 1 | |
| 20 | Breaker #2 Phase C is Open | Class 1 | |
| 21 | Breaker #2 / Breaker #2 Phase A is Closed | Class 1 | |
| 22 | Breaker #2 Phase B is Closed | Class 1 | |
| 23 | Breaker #2 Phase C is Closed | Class 1 | |
| 24 | DO – Phase A Trip Bus | Class 1 | |
| 25 | DO – Phase B Trip Bus | Class 1 | |
| 26 | DO – Phase C Trip Bus | Class 1 | |
| 27 | DO – Single Pole Reclose Initiate | Class 1 | |
| 28 | DO – Three Pole Reclose Initiate | Class 1 | |
| 29 | DO – Reclose Cancel | Class 1 | |
| 30 | DO – Key Transmitter 1/Carrier Start | Class 1 | |
| 31 | DO – Key Transmitter 2/Carrier Stop | Class 1 | |
| 32 | DO – Three Phase Trip Enable | Class 1 | |
| 33 | …Reserved… | | |
| 34 | …Reserved… | | |
| 35 | DO – Reclose In Progress | Class 1 | |
| 36 | DO – Line Overload Alarm | Class 1 | |
| 37 | DO – Recloser in Lockout Alarm | Class 1 | |
| 38 | DO – Trip Circuit Alarm | Class 1 | |

**Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 2 of 5)**

| BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02) | | | |
|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **REMARKS** |
| 39 | DO – Zone Flags ON Alarm | Class 1 | |
| 40 | DO – Over Current Alarm | Class 1 | |
| 41 | DO – Unbalanced Alarm | Class 1 | |
| 42 | DO – Key Transmitter 3 | Class 1 | |
| 43 | DO – Key Transmitter 4 | Class 1 | |
| 44 | DO – Manual Open Breaker 1 | Class 1 | |
| 45 | DO – Manual Open Breaker 2 | Class 1 | |
| 46 | DO – Manual Close Breaker 1 | Class 1 | |
| 47 | DO – Manual Close Breaker 2 | Class 1 | |
| 48 | DO – Fault ID Phase A | Class 1 | |
| 49 | DO – Fault ID Phase B | Class 1 | |
| 50 | DO – Fault ID Phase C | Class 1 | |
| 51 | DO – Fault ID Neutral | Class 1 | |
| 52 | Zone 1 AB Distance Function | Class 1 | |
| 53 | Zone 1 BC Distance Function | Class1 | |
| 54 | Zone 1 CA Distance Function | Class1 | |
| 55 | Zone 2 AB Distance Function | Class 1 | |
| 56 | Zone 2 BC Distance Function | Class1 | |
| 57 | Zone 2 CA Distance Function | Class1 | |
| 58 | Zone 3 AB Distance Function | Class 1 | |
| 59 | Zone 3 BC Distance Function | Class1 | |
| 60 | Zone 3 CA Distance Function | Class1 | |
| 61 | Zone 4 AB Distance Function | Class 1 | |
| 62 | Zone 4 BC Distance Function | Class1 | |
| 63 | Zone 4 CA Distance Function | Class1 | |
| 64 | Any Z1 Phase Distance Function | Class 1 | |
| 65 | Any Z2 Phase Distance Function | Class 1 | |
| 66 | Any Z3 Phase Distance Function | Class 1 | |
| 67 | Any Z4 Phase Distance Function | Class 1 | |
| 68 | Zone 1 AG Distance Function | Class 1 | |
| 69 | Zone 1 BG Distance Function | Class 1 | |
| 70 | Zone 1 CG Distance Function | Class 1 | |
| 71 | Zone 2 AG Distance Function | Class 1 | |
| 72 | Zone 2 BG Distance Function | Class 1 | |
| 73 | Zone 2 CG Distance Function | Class 1 | |
| 74 | Zone 3 AG Distance Function | Class 1 | |
| 75 | Zone 3 BG Distance Function | Class 1 | |
| 76 | Zone 3 CG Distance Function | Class 1 | |
| 77 | Zone 4 AG Distance Function | Class 1 | |
| 78 | Zone 4 BG Distance Function | Class 1 | |
| 79 | Zone 4 CG Distance Function | Class 1 | |
| 80 | Any Z1 Ground Distance Function | Class 1 | |
| 81 | Any Z2 Ground Distance Function | Class 1 | |
| 82 | Any Z3 Ground Distance Function | Class 1 | |
| 83 | Any Z4 Ground Distance Function | Class 1 | |

**C**

**Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 3 of 5)**

| BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02) | | | |
|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **REMARKS** |
| 84 | Any Phase Under Voltage | Class 1 | |
| 85 | All Voltages High | Class 1 | |
| 86 | Fault Detector | Class 1 | |
| 87 | TL1 Timer Output | Class 1 | |
| 88 | IT Detector | Class 1 | |
| 89 | IB Detector | Class 1 | |
| 90 | IPT Detector | Class 1 | |
| 91 | IPB Detector | Class 1 | |
| 92 | Remote Breaker Open Detector | Class 1 | |
| 93 | Ground Directional Trip | Class 1 | |
| 94 | Ground Directional Block | Class 1 | |
| 95 | Line Pickup | Class 1 | |
| 96 | Fuse Failure | Class 1 | |
| 97 | Instantaneous Phase Over Current | Class 1 | |
| 98 | Instantaneous Ground Over Current | Class 1 | |
| 99 | Ground Time Over Current Pickup | Class 1 | |
| 100 | Ground Time Over Current Trip | Class 1 | |
| 101 | Out of Step Blocking | Class 1 | |
| 102 | Out of Step Trip | Class 1 | |
| 103 | Configurable Trip Bus Input | Class 1 | |
| 104 | Configurable Oscillography Trigger | Class 1 | |
| 105 | TL16 Timer Output | Class 1 | |
| 106 | TL24 Timer Output | Class 1 | |
| 107 | Ground Forward Flag | Class 1 | |
| 108 | Ground Reverse Flag | Class 1 | |
| 109 | TL25 Timer Output | Class 1 | |
| 110 | Z2 Ground Timer | Class 1 | |
| 111 | Z3 Ground Timer | Class 1 | |
| 112 | Z4 Ground Timer | Class 1 | |
| 113 | Z2 Phase Timer | Class 1 | |
| 114 | Z3 Phase Timer | Class 1 | |
| 115 | Z4 Phase Timer | Class 1 | |
| 116 | Any Trip Bus | Class 1 | |
| 117 | Weak Infeed Trip | Class 1 | |
| 118 | Synch Check Output | Class 1 | |
| 119 | Any Phase Over Voltage Pickup | Class 1 | |
| 120 | Positive Sequence Over Voltage Pickup | Class 1 | |
| 121 | Compensated Positive Sequence Overvoltage Pickup | Class 1 | |
| 122 | Phase A Over Voltage | Class 1 | |
| 123 | Phase B Over Voltage | Class 1 | |
| 124 | Phase C Over Voltage | Class 1 | |
| 125 | Instantaneous Positive Sequence Over Voltage | Class 1 | |
| 126 | Time Delayed Positive Sequence Over Voltage | Class 1 | |
| 127 | Instantaneous Compensated Positive Sequence Overvoltage | Class 1 | |
| 128 | Time Delayed Compensated Positive Sequence Overvoltage | Class 1 | |

**Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 4 of 5)**

| BINARY INPUT (OBJECT 01)<br>BINARY INPUT CHANGE (OBJECT 02) | | | |
|------|-------------|--------------------------|---------|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **REMARKS** |
| 129 | Any Phase Overvoltage | Class 1 | |
| 130 | I1 Line Pickup | Class 1 | |
| 131 | Manual Close Requested | Class 1 | |
| 132 | CC Input – 52b Breaker #1 Phase A | Class 1 | |
| 133 | CC Input – 52b Breaker #1 Phase B | Class 1 | |
| 134 | CC Input – 52b Breaker #1 Phase C | Class 1 | |
| 135 | CC Input – 52b Breaker #2 Phase A | Class 1 | |
| 136 | CC Input – 52b Breaker #2 Phase B | Class 1 | |
| 137 | CC Input – 52b Breaker #2 Phase C | Class 1 | |
| 138 | CC Input – Enable 3-Phase Tripping | Class 1 | |
| 139 | CC Input – Change Setting Group Input Bit 0 | Class 1 | |
| 140 | CC Input – Change Setting Group Input Bit 1 | Class 1 | |
| 141 | CC Input – Stop Carrier / Receiver 3 | Class 1 | |
| 142 | CC Input – Block Pilot Tripping /Receiver 4 | Class 1 | |
| 143 | CC Input – Receiver 1 | Class 1 | |
| 144 | CC Input – Receiver 2 | Class 1 | |
| 145 | CC Input – Single Pole Reclose Initiate | Class 1 | |
| 146 | CC Input – Three Pole Reclose Initiate | Class 1 | |
| 147 | CC Input – Reclose Inhibit | Class 1 | |
| 148 | CC Input – Reclose Cancel | Class 1 | |
| 149 | CC Input – Reclose Reset | Class 1 | |
| 150 | CC Input – Manual Close | Class 1 | |
| 151 | CC Input – Target Reset | Class 1 | |
| 152 | CC Input – Disable Protection | Class 1 | |
| 153 | CC Input – Disable Outputs | Class 1 | |
| 154 | CC Input – Oscillography Trigger | Class 1 | |
| 155 | CC Input – Manual Lockout | Class 1 | |
| 156 | CC Input – Configurable Input 1 | Class 1 | |
| 157 | CC Input – Configurable Input 2 | Class 1 | |
| 158 | CC Input – Configurable Input 3 | Class 1 | |
| 159 | CC Input – Configurable Input 4 | Class 1 | |
| 160 | CC Input – Configurable Input 5 | Class 1 | |
| 161 | CC Input – Configurable Input 6 | Class 1 | |
| 162 | CC Input – Configurable Input 7 | Class 1 | |
| 163 | CC Input – Configurable Input 8 | Class 1 | |
| 164 | CC Input #1 Closed | Class 1 | |
| 165 | CC Input #2 Closed | Class 1 | |
| 166 | CC Input #3 Closed | Class 1 | |
| 167 | CC Input #4 Closed | Class 1 | |
| 168 | CC Input #5 Closed | Class 1 | |
| 169 | CC Input #6 Closed | Class 1 | |
| 170 | CC Input #7 Closed | Class 1 | |
| 171 | CC Input #8 Closed | Class 1 | |
| 172 | CC Input #9 Closed | Class 1 | |
| 173 | CC Input #10 Closed | Class 1 | |

**C**

**Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 5 of 5)**

| BINARY INPUT (OBJECT 01)<br>BINARY INPUT CHANGE (OBJECT 02) | | | |
|---|---|---|---|
| INDEX | DESCRIPTION | EVENT CLASS ASSIGNED TO | REMARKS |
| 174 | CC Input #11 Closed | Class 1 | |
| 175 | CC Input #12 Closed | Class 1 | |
| 176 | Output T1 Closed | Class 1 | |
| 177 | Output T2 Closed | Class 1 | |
| 178 | Output T3 Closed | Class 1 | |
| 179 | Output T4 Closed | Class 1 | |
| 180 | Output T5 Closed | Class 1 | |
| 181 | Output T6 Closed | Class 1 | |
| 182 | Output A1 Closed | Class 1 | |
| 183 | Output A2 Closed | Class 1 | |
| 184 | Output A3 Closed | Class 1 | |
| 185 | Output A4 Closed | Class 1 | |
| 186 | Output A5 Closed | Class 1 | |
| 187 | Output A6 Closed | Class 1 | |
| 188 | Output A7 Closed | Class 1 | |
| 189 | Output A8 Closed | Class 1 | |
| 190 | Output A9 Closed | Class 1 | |
| 191 | Output A10 Closed | Class 1 | |
| 192 | Output A11 Closed | Class 1 | |
| 193 | Output A12 Closed | Class 1 | |
| 194 | Output KT1 Closed | Class 1 | |
| 195 | Output KT2 Closed | Class 1 | |
| 196 | Output KT3 Closed | Class 1 | |
| 197 | Output KT4 Closed | Class 1 | |
| 198 | Output C1 Closed | Class 1 | |
| 199 | Output C2 Closed | Class 1 | |
| 200 | Fault Target - Phase A | Class 1 | |
| 201 | Fault Target - Phase B | Class 1 | |
| 202 | Fault Target - Phase C | Class 1 | |
| 203 | Fault Target - Ground | Class 1 | |
| 204 | | | |

**C.3.3 BINARY OUTPUT, CONTROL RELAY OUTPUT BLOCK**

**Table C–4: POINT LIST: OBJECTS 10 & 12**

| BINARY OUTPUT (OBJECT 10) CONTROL RELAY OUTPUT BLOCK (OBJECT 12) | |
|---|---|
| **INDEX** | **DESCRIPTION** |
| 0 | Open Breaker #1 |
| 1 | Close Breaker #1 |
| 2 | Open Breaker #2 |
| 3 | Close Breaker #2 |
| 4 | Enable Outputs |
| 5 | Disable Outputs |
| 6 | Trigger Oscillography |
| 7 | Reset Recloser |
| 8 | Lockout Recloser |
| 9 | Reset Event Data |
| 10 | Reset Fault Data |
| 11 | Reset OST Data |
| 12 | Reset Breaker Duty |
| 13 | Reset Latched Alarms |
| 14 | Start Settings Change |
| 15 | End Settings Change |
| 16 | |

The ALPS uses the following rules when parsing requests for control of Binary Output points using Object 12.

1. The Count field is checked first. If it is zero, the command will be accepted but no action will be taken. If this field is non-zero, the command will be executed once.

2. The Control Code field of Object 12 is then checked:

   • The Queue and Clear sub-field are ignored.

   • For all points, the only valid control is "Close – Pulse On" (0x41). This is used to initiate the function associated with the point.

• Any value in the Control Code field not specified above is invalid and will be rejected.

3. The On Time and Off Time fields are ignored. A "Pulse On" control takes effect immediately when received. Thus, the timing is irrelevant.

4. The Status field in the response will reflect the success or failure of the control attempt as below:

   • A Status of "Request Accepted" (0) will be returned if the command was accepted.

   • A Status of "Request Not Accepted due to Formatting Errors" (3) will be returned if the Control Code field was incorrectly formatted or an invalid code was present in the command.

   • A Status of "Control Operation not Supported for this Point" (4) will be returned if an attempt was made to operate the point and the device, owing to its configuration, does not allow the point to perform its function.

An operate of an Output point may fail even if the command is accepted due to other inputs or conditions existing at the time. To verify the success or failure of an "OPERATE" of an output point, the associated Binary or Analog Input(s) may be examined after the control operation is performed.

When using Object 10 to read the status of any Binary Output, a value of zero will always be returned. This is because all points are "Pulse On" and are deemed normally off.

**Table C–5: POINT LIST: OBJECTS 20 & 21**

| BINARY COUNTER (OBJECT 20) FROZEN COUNTER (OBJECT 21) | | |
|-------|-------------|----------------|
| **INDEX** | **DESCRIPTION** | **ROLLOVER POINT** |
| 0 | Breaker Health Accumulator – Phase A | 4294967295 |
| 1 | Breaker Health Accumulator – Phase B | 4294967295 |
| 2 | Breaker Health Accumulator – Phase C | 4294967295 |
| 3 | Number Of Trips – Phase A | 65535 |
| 4 | Number Of Trips – Phase B | 65535 |
| 5 | Number Of Trips – Phase C | 65535 |

None of the above counters can be cleared with the Freeze/Clear (function code 9) operation. Instead, the control relay output block points can be used to clear groups of counters. There is only one copy of each counter, so clearing a counter from other serial ports or MMI causes the corresponding DNP counter point to be cleared and vice-versa. However, note that counters 2 to 5 cannot be cleared using DNP protocol. The Breaker Health can be set via MMI or from other serial ports using GE_MODEM, MODBUS or ASCII protocols.

**Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 1 of 6)**

| ANALOG INPUT (OBJECT 30)<br>ANALOG INPUT CHANGE (OBJECT 32) | | | | | |
|---|---|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **FORMAT/ UNITS** | | **REMARKS** |
| 0 | Phase A RMS Current | Class 2 | F1 | Amp | Note 2 |
| 1 | Phase B RMS Current | Class 2 | F1 | Amp | Note 2 |
| 2 | Phase C RMS Current | Class 2 | F1 | Amp | Note 2 |
| 3 | Neutral RMS Current | Class 2 | F1 | Amp | Note 2 |
| 4 | Phase A RMS Voltage | Class 2 | F2 | Amp | Note 2 |
| 5 | Phase B RMS Voltage | Class 2 | F2 | Volt | Note 2 |
| 6 | Phase C RMS Voltage | Class 2 | F2 | Volt | Note 2 |
| 7 | Phase A Current Amplitude | Class 2 | F1 | Amp | Note 2 |
| 8 | Phase A Current Angle | Class 2 | F4 | Deg. | Note 2 |
| 9 | Phase B Current Amplitude | Class 2 | F1 | Amp | Note 2 |
| 10 | Phase B Current Angle | Class 2 | F4 | Deg. | Note 2 |
| 11 | Phase C Current Amplitude | Class 2 | F1 | Amp | Note 2 |
| 12 | Phase C Current Angle | Class 2 | F4 | Deg. | Note 2 |
| 13 | Neutral Current Amplitude | Class 2 | F1 | Amp | Note 2 |
| 14 | Neutral Current Angle | Class 2 | F4 | Deg. | Note 2 |
| 15 | Phase A Voltage Amplitude | Class 2 | F2 | Amp | Note 2 |
| 16 | Phase A Voltage Angle | Class 2 | F4 | Deg. | Note 2 |
| 17 | Phase B Voltage Amplitude | Class 2 | F2 | Amp | Note 2 |
| 18 | Phase B Voltage Angle | Class 2 | F4 | Deg. | Note 2 |
| 19 | Phase C Voltage Amplitude | Class 2 | F2 | Amp | Note 2 |
| 20 | Phase C Voltage Angle | Class 2 | F4 | Deg. | Note 2 |
| 21 | Watts | Class 2 | F3 | Watts | Note 2 |
| 22 | Vars | Class 2 | F3 | Vars | Note 2 |
| 23 | Power Factor | Class 2 | F1 | | Note 2 |
| 24 | Frequency | Class 2 | F1 | | |
| 25 | Status – CPU Status Word 1 | Class 2 | F9 | | |
| 26 | Status – CPU Status Word 2 | Class 2 | F9 | | |
| 27 | Status – ANI Status | Class 2 | F10 | | |
| 28 | Status – DSP Status | Class 2 | F11 | | |
| 29 | Status – Misc. Status Word 1 | Class 2 | F12 | | |
| 30 | Status – Misc. Status Word 2 | Class 2 | F12 | | |
| 31 | Fault 1 Date (Lower 16-Bits) | Class 2 | | | |
| 32 | Fault 1 Date (Middle 16-Bits) | Class 2 | | | |
| 33 | Fault 1 Date (Upper 16-Bits) | Class 2 | | | |
| 34 | Fault 1 Type | Class 2 | F5 | | |
| 35 | Fault 1 Trip Type | | F6 | | |
| 36 | Fault 1 Distance | | F2 | | |
| 37 | Fault 1 Relay Operating Time | Class 2 | F4 | | |
| 38 | Fault1 Breaker Operating Time | Class 2 | F4 | | |
| 39 | Fault1 – Phase A Prefault Current | Class 2 | F1 | | |
| 40 | Fault1 – Phase B Prefault Current | | F1 | | |
| 41 | Fault1 – Phase C Prefault Current | | F1 | | |
| 42 | Fault1 – Neutral Prefault Current | | F1 | | |

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

**Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 2 of 6)**

**C**

| INDEX | DESCRIPTION | EVENT CLASS ASSIGNED TO | FORMAT/ UNITS | | REMARKS |
|-------|-------------|------------------------|---------------|--|---------|
| | **ANALOG INPUT (OBJECT 30)** **ANALOG INPUT CHANGE (OBJECT 32)** | | | | |
| 43 | Fault1 – Phase A Fault Current | | F1 | | |
| 44 | Fault1 – Phase B Fault Current | | F1 | | |
| 45 | Fault1 – Phase C Fault Current | | F1 | | |
| 46 | Fault1 – Neutral Fault Current | | F1 | | |
| 47 | Fault1 – Phase A Fault Voltage | | F2 | | |
| 48 | Fault1 – Phase B Fault Voltage | | F2 | | |
| 49 | Fault1 – Phase C Fault Voltage | | F2 | | |
| 50 | Fault 2 Date (Lower 16-Bits) | | | | |
| 51 | Fault 2 Date (Middle 16-Bits) | | | | |
| 52 | Fault 2 Date (Upper 16-Bits) | | | | |
| 53 | Fault 2 Type | | | | |
| 54 | Fault 2 Trip Type | | | | |
| 55 | Fault 2 Distance | | | | |
| 56 | Fault 3 Date (Lower 16-Bits) | | | | |
| 57 | Fault 3 Date (Middle 16-Bits) | | | | |
| 58 | Fault 3 Date (Upper 16-Bits) | | | | |
| 59 | Fault 3 Type | | | | |
| 60 | Fault 3 Trip Type | | | | |
| 61 | Fault 3 Distance | | | | |
| 62 | Fault 4 Date (Lower 16-Bits) | | | | |
| 63 | Fault 4 Date (Middle 16-Bits) | | | | |
| 64 | Fault 4 Date (Upper 16-Bits) | | | | |
| 65 | Fault 4 Type | | | | |
| 66 | Fault 4 Trip Type | | | | |
| 67 | Fault 4 Distance | | | | |
| 68 | Fault 5 Date (Lower 16-Bits) | | | | |
| 69 | Fault 5 Date (Middle 16-Bits) | | | | |
| 70 | Fault 5 Date (Upper 16-Bits) | | | | |
| 71 | Fault 5 Type | | | | |
| 72 | Fault 5 Trip Type | | | | |
| 73 | Fault 5 Distance | | | | |
| 74 | Fault 6 Date (Lower 16-Bits) | | | | |
| 75 | Fault 6 Date (Middle 16-Bits) | | | | |
| 76 | Fault 6 Date (Upper 16-Bits) | | | | |
| 77 | Fault 6 Type | | | | |
| 78 | Fault 6 Trip Type | | | | |
| 79 | Fault 6 Distance | | | | |
| 80 | Fault 7 Date (Lower 16-Bits) | | | | |
| 81 | Fault 7 Date (Middle 16-Bits) | | | | |
| 82 | Fault 7 Date (Upper 16-Bits) | | | | |
| 83 | Fault 7 Type | | | | |
| 84 | Fault 7 Trip Type | | | | |
| 85 | Fault 7 Distance | | | | |
| 86 | Fault 8 Date (Lower 16-Bits) | | | | |

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

**Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 3 of 6)**

| INDEX | DESCRIPTION | EVENT CLASS ASSIGNED TO | FORMAT/ UNITS | | REMARKS |
|-------|-------------|-------------------------|---------------|---|---------|
| — **ANALOG INPUT (OBJECT 30)** **ANALOG INPUT CHANGE (OBJECT 32)** | | | | | |
| 87 | Fault 8 Date (Middle 16-Bits) | | | | |
| 88 | Fault 8 Date (Upper 16-Bits) | | | | |
| 89 | Fault 8 Type | | | | |
| 90 | Fault 8 Trip Type | | | | |
| 91 | Fault 8 Distance | | | | |
| 92 | Fault 9 Date (Lower 16-Bits) | | | | |
| 93 | Fault 9 Date (Middle 16-Bits) | | | | |
| 94 | Fault 9 Date (Upper 16-Bits) | | | | |
| 95 | Fault 9 Type | | | | |
| 96 | Fault 9 Trip Type | | | | |
| 97 | Fault 9 Distance | | | | |
| 98 | Fault 10 Date (Lower 16-Bits) | | | | |
| 99 | Fault 10 Date (Middle 16-Bits) | | | | |
| 100 | Fault 10 Date (Upper 16-Bits) | | | | |
| 101 | Fault 10 Type | | | | |
| 102 | Fault 10 Trip Type | | | | |
| 103 | Fault 10 Distance | | | | |
| 104 | Fault 11 Date (Lower 16-Bits) | | | | |
| 105 | Fault 11 Date (Middle 16-Bits) | | | | |
| 106 | Fault 11 Date (Upper 16-Bits) | | | | |
| 107 | Fault 11 Type | | | | |
| 108 | Fault 11 Trip Type | | | | |
| 109 | Fault 11 Distance | | | | |
| 110 | Fault 12 Date (Lower 16-Bits) | | | | |
| 111 | Fault 12 Date (Middle 16-Bits) | | | | |
| 112 | Fault 12 Date (Upper 16-Bits) | | | | |
| 113 | Fault 12 Type | | | | |
| 114 | Fault 12 Trip Type | | | | |
| 115 | Fault 12 Distance | | | | |
| 116 | Fault 13 Date (Lower 16-Bits) | | | | |
| 117 | Fault 13 Date (Middle 16-Bits) | | | | |
| 118 | Fault 13 Date (Upper 16-Bits) | | | | |
| 119 | Fault 13 Type | | | | |
| 120 | Fault 13 Trip Type | | | | |
| 121 | Fault 13 Distance | | | | |
| 122 | Fault 14 Date (Lower 16-Bits) | | | | |
| 123 | Fault 14 Date (Middle 16-Bits) | | | | |
| 124 | Fault 14 Date (Upper 16-Bits) | | | | |
| 125 | Fault 14 Type | | | | |
| 126 | Fault 14 Trip Type | | | | |
| 127 | Fault 14 Distance | | | | |
| 128 | Fault 15 Date (Lower 16-Bits) | | | | |
| 129 | Fault 15 Date (Middle 16-Bits) | | | | |
| 130 | Fault 15 Date (Upper 16-Bits) | | | | |

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

**C**

**Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 4 of 6)**

**C**

| ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32) | | | | |
|---|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **FORMAT/ UNITS** | **REMARKS** |
| 131 | Fault 15 Type | | | |
| 132 | Fault 15 Trip Type | | | |
| 133 | Fault 15 Distance | | | |
| 134 | Fault 16 Date (Lower 16-Bits) | | | |
| 135 | Fault 16 Date (Middle 16-Bits) | | | |
| 136 | Fault 16 Date (Upper 16-Bits) | | | |
| 137 | Fault 16 Type | | | |
| 138 | Fault 16 Trip Type | | | |
| 139 | Fault 16 Distance | | | |
| 140 | Fault 17 Date (Lower 16-Bits) | | | |
| 141 | Fault 17 Date (Middle 16-Bits) | | | |
| 142 | Fault 17 Date (Upper 16-Bits) | | | |
| 143 | Fault 17 Type | | | |
| 144 | Fault 17 Trip Type | | | |
| 145 | Fault 17 Distance | | | |
| 146 | Fault 18 Date (Lower 16-Bits) | | | |
| 147 | Fault 18 Date (Middle 16-Bits) | | | |
| 148 | Fault 18 Date (Upper 16-Bits) | | | |
| 149 | Fault 18 Type | | | |
| 150 | Fault 18 Trip Type | | | |
| 151 | Fault 18 Distance | | | |
| 152 | Fault 19 Date (Lower 16-Bits) | | | |
| 153 | Fault 19 Date (Middle 16-Bits) | | | |
| 154 | Fault 19 Date (Upper 16-Bits) | | | |
| 155 | Fault 19 Type | | | |
| 156 | Fault 19 Trip Type | | | |
| 157 | Fault 19 Distance | | | |
| 158 | Fault 20 Date (Lower 16-Bits) | | | |
| 159 | Fault 20 Date (Middle 16-Bits) | | | |
| 160 | Fault 20 Date (Upper 16-Bits) | | | |
| 161 | Fault 20 Type | | | |
| 162 | Fault 20 Trip Type | | | |
| 163 | Fault 20 Distance | | | |
| 164 | Fault 21 Date (Lower 16-Bits) | | | |
| 165 | Fault 21 Date (Middle 16-Bits) | | | |
| 166 | Fault 21 Date (Upper 16-Bits) | | | |
| 167 | Fault 21 Type | | | |
| 168 | Fault 21 Trip Type | | | |
| 169 | Fault 21 Distance | | | |
| 170 | Fault 22 Date (Lower 16-Bits) | | | |
| 171 | Fault 22 Date (Middle 16-Bits) | | | |
| 172 | Fault 22 Date (Upper 16-Bits) | | | |
| 173 | Fault 22 Type | | | |
| 174 | Fault 22 Trip Type | | | |

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

**Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 5 of 6)**

| ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32) | | | | | |
|---|---|---|---|---|---|
| INDEX | DESCRIPTION | EVENT CLASS ASSIGNED TO | FORMAT/ UNITS | | REMARKS |
| 175 | Fault 22 Distance | | | | |
| 176 | Fault 23 Date (Lower 16-Bits) | | | | |
| 177 | Fault 23 Date (Middle 16-Bits) | | | | |
| 178 | Fault 23 Date (Upper 16-Bits) | | | | |
| 179 | Fault 23 Type | | | | |
| 180 | Fault 23 Trip Type | | | | |
| 181 | Fault 23 Distance | | | | |
| 182 | Fault 24 Date (Lower 16-Bits) | | | | |
| 183 | Fault 24 Date (Middle 16-Bits) | | | | |
| 184 | Fault 24 Date (Upper 16-Bits) | | | | |
| 185 | Fault 24 Type | | | | |
| 186 | Fault 24 Trip Type | | | | |
| 187 | Fault 24 Distance | | | | |
| 188 | Fault 25 Date (Lower 16-Bits) | | | | |
| 189 | Fault 25 Date (Middle 16-Bits) | | | | |
| 190 | Fault 25 Date (Upper 16-Bits) | | | | |
| 191 | Fault 25 Type | | | | |
| 192 | Fault 25 Trip Type | | | | |
| 193 | Fault 25 Distance | | | | |
| 194 | Fault 26 Date (Lower 16-Bits) | | | | |
| 195 | Fault 26 Date (Middle 16-Bits) | | | | |
| 196 | Fault 26 Date (Upper 16-Bits) | | | | |
| 197 | Fault 26 Type | | | | |
| 198 | Fault 26 Trip Type | | | | |
| 199 | Fault 26 Distance | | | | |
| 200 | Fault 27 Date (Lower 16-Bits) | | | | |
| 201 | Fault 27 Date (Middle 16-Bits) | | | | |
| 202 | Fault 27 Date (Upper 16-Bits) | | | | |
| 203 | Fault 27 Type | | | | |
| 204 | Fault 27 Trip Type | | | | |
| 205 | Fault 27 Distance | | | | |
| 206 | Fault 28 Date (Lower 16-Bits) | | | | |
| 207 | Fault 28 Date (Middle 16-Bits) | | | | |
| 208 | Fault 28 Date (Upper 16-Bits) | | | | |
| 209 | Fault 28 Type | | | | |
| 210 | Fault 28 Trip Type | | | | |
| 211 | Fault 28 Distance | | | | |
| 212 | Fault 29 Date (Lower 16-Bits) | | | | |
| 213 | Fault 29 Date (Middle 16-Bits) | | | | |
| 214 | Fault 29 Date (Upper 16-Bits) | | | | |
| 215 | Fault 29 Type | | | | |
| 216 | Fault 29 Trip Type | | | | |
| 217 | Fault 29 Distance | | | | |
| 218 | Fault 30 Date (Lower 16-Bits) | | | | |

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

**Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 6 of 6)**

| **ANALOG INPUT (OBJECT 30)** **ANALOG INPUT CHANGE (OBJECT 32)** | | | | |
|---|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **EVENT CLASS ASSIGNED TO** | **FORMAT/ UNITS** | **REMARKS** |
| 219 | Fault 30 Date (Middle 16-Bits) | | | |
| 220 | Fault 30 Date (Upper 16-Bits) | | | |
| 221 | Fault 30 Type | | | |
| 222 | Fault 30 Trip Type | | | |
| 223 | Fault 30 Distance | | | |
| 224 | Fault 31 Date (Lower 16-Bits) | | | |
| 225 | Fault 31 Date (Middle 16-Bits) | | | |
| 226 | Fault 31 Date (Upper 16-Bits) | | | |
| 227 | Fault 31 Type | | | |
| 228 | Fault 31 Trip Type | | | |
| 229 | Fault 31 Distance | | | |
| 230 | Fault 32 Date (Lower 16-Bits) | | | |
| 231 | Fault 32 Date (Middle 16-Bits) | | | |
| 232 | Fault 32 Date (Upper 16-Bits) | | | |
| 233 | Fault 32 Type | | | |
| 234 | Fault 32 Trip Type | | | |
| 235 | Fault 32 Distance | | | |
| 236 | Fault 33 Date (Lower 16-Bits) | | | |
| 237 | Fault 33 Date (Middle 16-Bits) | | | |
| 238 | Fault 33 Date (Upper 16-Bits) | | | |
| 239 | Fault 33 Type | | | |
| 240 | Fault 33 Trip Type | | | |
| 241 | Fault 33 Distance | | | |
| 242 | Fault 34 Date (Lower 16-Bits) | | | |
| 243 | Fault 34 Date (Middle 16-Bits) | | | |
| 244 | Fault 34 Date (Upper 16-Bits) | | | |
| 245 | Fault 34 Type | | | |
| 246 | Fault 34 Trip Type | | | |
| 247 | Fault 34 Distance | | | |
| 248 | Fault 35 Date (Lower 16-Bits) | | | |
| 249 | Fault 35 Date (Middle 16-Bits) | | | |
| 250 | Fault 35 Date (Upper 16-Bits) | | | |
| 251 | Fault 35 Type | | | |
| 252 | Fault 35 Trip Type | | | |
| 253 | Fault 35 Distance | | | |
| 254 | Fault 36 Date (Lower 16-Bits) | | | |
| 255 | Fault 36 Date (Middle 16-Bits) | | | |
| 256 | Fault 36 Date (Upper 16-Bits) | | | |
| 257 | Fault 36 Type | | | |
| 258 | Fault 36 Trip Type | | | |
| 259 | Fault 36 Distance | | | |
| 260 | | | | |

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

**TABLE NOTES:**

1. The upper and lower 16-bit portions of all the 32-bit values reported by ALPS are assigned to two separate points. To read a 32-bit value, it is necessary to read both the upper and lower 16-bit portions and concatenate these two values to form a 32-bit value and interpret the result according to the format associated with the value.

2. An event object will be generated for this point if the current value of the point changes by an amount greater than or equal to two percent of its previous value.

3. An event object will be generated if the frequency changes by 0.05 Hz or more from its previous value.

4. An event object will be generated if the current value of a point is in any way changed from its previous value.

5. The Time-Stamp of various Analog Inputs is reported in DNP Time Object format. The 48-bit absolute time is allocated to three separate points that need to be concatenated and interpreted as a DNP Time Object (Variation 1).

6. The units for Fault Location are determined by the value read at the Point corresponding to Fault Location Units. The Fault Location units can be either Miles or Km as per the Fault Location Unit value.

**C**

### C.3.6 ANALOG OUTPUT, ANALOG OUTPUT BLOCK

Refer to Chapter 2 for a detailed description of the setpoints listed in the table below. The formats, ranges and units for various setpoints are as described in the Instruction Book but for the following exceptions in these notes. Refer to Appendix B, for a description of the procedure to View/Change the ALPS setpoints.

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 1 of 8)**

| ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41) | | | |
|---|---|---|---|
| INDEX | DESCRIPTION | FORMAT / UNITS | REMARKS |
| 0 | Edit Settings Group Number | | Note 1 |
| 1 | Z1 Phase Distance | | |
| 2 | Z1 Phase Reach | | |
| 3 | Z1 Phase Level Detector | | |
| 4 | Z1 Ground Distance | | |
| 5 | Z1 Ground Reach | | |
| 6 | Z1 Ground Characteristic | | |
| 7 | Z1 Ground React. Mho Supervision Reach | | |
| 8 | Z1 Ground K0 | | |
| 9 | Z1 Ground Level Detector | | |
| 10 | Z1 Blocking Supervision | | |
| 11 | Z1 Ground Characteristic Angle (ALPSQUAD) …Reserved…(ALPS/LPS) | | |
| 12 | Z1 Right Resistive Ground Blinder (ALPSQUAD) …Reserved….(ALPS/LPS) | | |
| 13 | Z2 Phase Distance | | |
| 14 | Z2 Phase Reach | | |
| 15 | Z2 Phase Characteristic Angle | | |
| 16 | Z2 Ground Distance | | |
| 17 | Z2 Ground Characteristic | | |
| 18 | Z2 Ground Reach | | |
| 19 | Z2 Ground Characteristic Angle | | |
| 20 | Z2 Timers | | |
| 21 | Z2 Phase Timer | | |
| 22 | Z2 Ground Timer | | |
| 23 | Z2 Right Resistive Ground Blinder (ALPSQUAD) …Reserved…(ALPS/LPS) | | |
| 24 | Z3 Phase Distance | | |

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 2 of 8)**

| INDEX | DESCRIPTION | FORMAT / UNITS | | REMARKS |
|-------|-------------|----------------|--|---------|
| **ANALOG OUTPUT (OBJECT 40)** | | | | |
| 25 | Z3 Phase Reach | | | |
| 26 | Z3 Phase Characteristic Angle | | | |
| 27 | Z3 Ground Distance | | | |
| 28 | Z3 Ground Reach | | | |
| 29 | Z3 Ground Characteristic Angle | | | |
| 30 | Z3 Phase Timer | | | |
| 31 | Z3 Ground Timer | | | |
| 32 | Z3 Ground Characteristic (ALPSQUAD) …Reserved…(ALPS/LPS) | | | |
| 33 | Z3 Right Resistive Ground Blinder (ALPSQUAD) …Reserved…(ALPS/LPS) | | | |
| 34 | Z4 Phase Distance | | | |
| 35 | Z4 Phase Reach | | | |
| 36 | Z4 Phase Characteristic Angle | | | |
| 37 | …Reserved… | | | |
| 38 | Z4 Ground Distance | | | |
| 39 | Z4 Ground Reach | | | |
| 40 | Z4 Ground Characteristic Angle | | | |
| 41 | Z4 Direction | | | |
| 42 | Z4 Timers | | | |
| 43 | Z4 Phase Timer | | | |
| 44 | Z4 Ground Timer | | | |
| 45 | Z4 Ground Characteristic (ALPSQUAD) …Reserved…(ALPS/LPS) | | | |
| 46 | Z4 Right Resistive Ground Blinder (ALPSQUAD) …Reserved…(ALPS/LPS) | | | |
| 47 | Trip Supervision Current | | | |
| 48 | Block Supervision Current | | | |
| 49 | GDOC Trip Current | | | |
| 50 | GDOC Block Current | | | |
| 51 | IPB I1 Restraint | | | |
| 52 | NT/NB Offset | | | |
| 53 | Unbalanced Current Alarm | | | |
| 54 | Phase Instantaneous Overcurrent | | | |
| 55 | Directional Control 50 | | | |
| 56 | 50 Pickup Setting | | | |
| 57 | 50 Pickup during Fuse Failure | | | |
| 58 | Ground Instantaneous Overcurrent | | | |
| 59 | Directional Control 50G | | | |
| 60 | 50G Pickup Settings | | | |
| 61 | 50G Pickup during Fuse Failure | | | |
| 62 | 50G Restraint Setting | | | |
| 63 | Ground Time Overcurrent | | | |
| 64 | Directional Control 51G | | | |
| 65 | 51G Pickup Setting | | | |
| 66 | 51G Pickup during Fuse Failure | | | |
| 67 | 51G Curve | | | |

**C**

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 3 of 8)**

| ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41) | | | | |
|---|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **FORMAT / UNITS** | | **REMARKS** |
| 68 | 51G Time Dial | | | |
| 69 | Definite Time Delay | | | |
| 70 | 51G Reset Characteristic | | | |
| 71 | Rated Per Unit Voltage | | | |
| 72 | Select Phase Overvoltage | | | |
| 73 | Phase Overvoltage Pickup | | | |
| 74 | Phase Overvoltage Time Delay | | | |
| 75 | Select Pos. Sequence Overvoltage | | | |
| 76 | Inst. Pos. Sequence Overvoltage Pickup | | | |
| 77 | TOV Pos. Seq. Overvoltage Pickup | | | |
| 78 | Pos. Seq. Overvoltage Time Delay | | | |
| 79 | Compensated Pos. Seq. OV | | | |
| 80 | Compensated Pos. Seq. OV Impedance | | | |
| 81 | Inst. Compensated Pos. Seq. OV Pickup | | | |
| 82 | TOV Compensated Pos. Seq. OV Pickup | | | |
| 83 | Compensated Pos. Seq. OV Time Delay | | | |
| 84 | PTFF Blocking | | | |
| 85 | Block Reclosing for any function | | | |
| 86 | Block for Out of Step | | | |
| 87 | Block for 3-Phase Faults | | | |
| 88 | Block for 50G Trip | | | |
| 89 | Block for Z2 Time Delayed Trip | | | |
| 90 | Block for Z3 Time Delayed Trip | | | |
| 91 | Block for Z4 Time Delayed Trip | | | |
| 92 | Block for any Z1 Phase Fault | | | |
| 93 | Block for any Z2 Phase Fault | | | |
| 94 | Block for Configurable Trip Logic | | | |
| 95 | Select Line Pickup | | | |
| 96 | Bypass Line pickup time delay | | | |
| 97 | I1 Pickup | | | |
| 98 | Select Remote Open Detector | | | |
| 99 | Remote Open Detector Time Delay | | | |
| 100 | Select Line Overload protection | | | |
| 101 | Level 1 Pickup Current | | | |
| 102 | Level 2 Pickup Current | | | |
| 103 | Level 1 Time Delay | | | |
| 104 | Level 2 Time Delay | | | |
| 105 | Select Scheme Logic | | | |
| 106 | Select Number of Receivers | | | |
| 107 | 1-Phase/3-Phase Trip Mode | | | |
| 108 | Select function to use to start carrier in Blocking scheme | | | |
| 109 | Select Weak Infeed tripping for Hybrid Scheme | | | |
| 110 | Trip Integrator | | | |
| 111 | POTT Coord Timer PU | | | |
| 112 | POTT Coord Timer DO | | | |
| 113 | BKR1 b Switch Coord Timer PU | | | |

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 4 of 8)**

| ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41) | | | |
|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **FORMAT / UNITS** | **REMARKS** |
| 114 | BKR1 b Switch Coord Timer DO | | |
| 115 | BKR2 b Switch Coord Timer PU | | |
| 116 | BKR2 b Switch Coord Timer DO | | |
| 117 | Weak Infeed Trip Timer | | |
| 118 | GDOC Blocking Timer | | |
| 119 | Distance Blocking Timer | | |
| 120 | Repeat Delay Timer | | |
| 121 | Pos. Seq. Impedance Angle | | |
| 122 | Zero Seq. Impedance Angle | | |
| 123 | Pos. Seq. Line Impedance in sec. ohms | | |
| 124 | Z0/Z1 Ratio | | |
| 125 | Line Length | | |
| 126 | Units of Length | | |
| 127 | CT Ratio | | |
| 128 | PT Ratio | | |
| 129 | Hold Time | | |
| 130 | Fault Location Reset Time | | |
| 131 | Coordinating Zone | | |
| 132 | MOB Characteristic Angle | | |
| 133 | Block during OS | | |
| 134 | Block all Zone 1 Functions | | |
| 135 | Block all Zone 2 Functions | | |
| 136 | Block all Zone 3 Functions | | |
| 137 | Block all Zone 4 Functions | | |
| 138 | Select OST | | |
| 139 | Select Number of Characteristics | | |
| 140 | Trip Entering or Leaving Inner | | |
| 141 | OST Forward Reach | | |
| 142 | OST Reverse Reach | | |
| 143 | Outer Characteristic Angle | | |
| 144 | Middle Characteristic Angle | | |
| 145 | Inner Characteristic Angle | | |
| 146 | Coordinating Timer 1 Pickup | | |
| 147 | Coordinating Timer 1 Dropout | | |
| 148 | Coordinating Timer 2 Pickup | | |
| 149 | Coordinating Timer 3 Pickup | | |
| 150 | Coordinating Timer 4 Pickup | | |
| 151 | Select Reclosing Option | | |
| 152 | Select Reclosing Type | | |
| 153 | Number of attempts following 1P Trip | | |
| 154 | 1-Pole First Delay | | |
| 155 | 1-Pole Second Delay | | |
| 156 | 1-Pole Third Delay | | |
| 157 | 1-Pole Fourth Delay | | |
| 158 | Number of attempts following 3P Trip | | |
| 159 | 3-Pole First Delay | | |

### Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 5 of 8)

| ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41) | | | | |
|---|---|---|---|---|
| INDEX | DESCRIPTION | FORMAT / UNITS | | REMARKS |
| 160 | 3-Pole Second Delay | | | |
| 161 | 3-Pole Third Delay | | | |
| 162 | 3-Pole Fourth Delay | | | |
| 163 | Reset Time | | | |
| 164 | Contact Dwell Time | | | |
| 165 | Inhibit Hold Select | | | |
| 166 | Inhibit Hold Time | | | |
| 167 | Inhibit Contact Input Sense | | | |
| 168 | Synch. Check Supervision | | | |
| 169 | Closing Angle | | | |
| 170 | Slip Frequency | | | |
| 171 | Bus or Line Voltage | | | |
| 172 | Voltage used by SYNCCHECK | | | |
| 173 | SYNCCHECK Hold Time | | | |
| 174 | Supervise 2$^{nd}$ 3P Reclose after 1P Trip | | | |
| 175 | Supervise 3$^{rd}$ 3P Reclose after 1P Trip | | | |
| 176 | Supervise 4$^{th}$ 3P Reclose after 1P Trip | | | |
| 177 | Supervise 1$^{st}$ 3P Reclose after 3P Trip | | | |
| 178 | Supervise 2$^{nd}$ 3P Reclose after 3P Trip | | | |
| 179 | Supervise 3$^{rd}$ 3P Reclose after 3P Trip | | | |
| 180 | Supervise 4$^{th}$ 3P Reclose after 3P Trip | | | |
| 181 | Supervise Manual Close | | | |
| 182 | Live Bus Voltage | | | |
| 183 | Dead Bus Voltage | | | |
| 184 | Live Line Voltage | | | |
| 185 | Dead Line Voltage | | | |
| 186 | Live Bus Dead Line | | | |
| 187 | Dead Bus Live Line | | | |
| 188 | Dead Bus Dead Line | | | |
| 189 | Voltage Difference | | | |
| 190 | Block Sync. Check by DELTAV | | | |
| 191 | Non-Critical Alarm Input #1 | | | |
| 192 | Non-Critical Alarm Input #2 | | | |
| 193 | Non-Critical Alarm Input #3 | | | |
| 194 | Non-Critical Alarm Input #4 | | | |
| 195 | Non-Critical Alarm Input #5 | | | |
| 196 | Non-Critical Alarm Input #6 | | | |
| 197 | Non-Critical Alarm Input #7 | | | |
| 198 | Non-Critical Alarm Input #8 | | | |
| 199 | T1 Contact | | | |
| 200 | T2 Contact | | | |
| 201 | T3 Contact | | | |
| 202 | T4 Contact | | | |
| 203 | T5 Contact | | | |
| 204 | T6 Contact | | | |

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 6 of 8)**

| ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41) | | | |
|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **FORMAT / UNITS** | **REMARKS** |
| 205 | A1 Contact | | |
| 206 | A2 Contact | | |
| 207 | A3 Contact | | |
| 208 | A4 Contact | | |
| 209 | A5 Contact | | |
| 210 | A6 Contact | | |
| 211 | A7 Contact | | |
| 212 | A8 Contact | | |
| 213 | A9 Contact | | |
| 214 | A10 Contact | | |
| 215 | A11 Contact | | |
| 216 | A12 Contact | | |
| 217 | C1 Contact | | |
| 218 | C2 Contact | | |
| 219 | KT1 Contact | | |
| 220 | KT2 Contact | | |
| 221 | KT3 Contact | | |
| 222 | KT4 Contact | | |
| 223 | Configurable 3P Trip | | |
| 224 | Configurable Oscillography Capture | | |
| 225 | …Reserved… | | |
| 226 | System Frequency | | |
| 227 | Phase Rotation | | |
| 228 | Time Synch Source | | |
| 229 | Number of Breakers | | |
| 230 | Number of Trip Circuits | | |
| 231 | Number of Trip Circuits Monitors | | |
| 232 | Value Display Mode | | |
| 233 | Language Option | | |
| 234 | System Inputs 1 to 4 (ALPSQUAD) …Reserved…(ALPS/LPS) | | |
| 235 | Comm. Port #1 Baud Rate | | |
| 236 | Comm. Port #1 Parity | | |
| 237 | Comm. Port #1 Stop Bits | | |
| 238 | Comm. Port #2 Baud Rate | | |
| 239 | Comm. Port #2 Parity | | |
| 240 | Comm. Port #2 Stop Bits | | |
| 241 | Comm. Port #3 Baud Rate | | |
| 242 | Comm. Port #3 Parity | | |
| 243 | Comm. Port #3 Stop Bits | | |
| 244 | Comm. Port #1 Protocol | | |
| 245 | Comm. Port #2 Protocol | | |
| 246 | Comm. Port #3 Protocol | | |
| 247 | Number of Fault Records | | |
| 248 | Number of Prefault Cycles | | |
| 249 | Split Fault Record | | |

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 7 of 8)**

| **INDEX** | **DESCRIPTION** | **FORMAT / UNITS** | | **REMARKS** |
|---|---|---|---|---|
| **ANALOG OUTPUT (OBJECT 40)** **ANALOG OUTPUT BLOCK (OBJECT 41)** | | | | |
| 250 | Exponent in $I^*t$ calculation | | | |
| 251 | Maximum number of Breaker Operations | | | |
| 252 | Maximum Breaker Equipment Duty | | | |
| 253 | Accumulated Breaker Duty – Phase A | | | |
| 254 | Accumulated Breaker Duty – Phase B | | | |
| 255 | Accumulated Breaker Duty – Phase C | | | |
| 256 | Present Number of Breaker Operations – Phase A (1 Pole) | | | |
| 257 | Present Number of Breaker Operations – Phase B (1 Pole) | | | |
| 258 | Present Number of Breaker Operations – Phase C (1 Pole) | | | |
| 259 | Present Number of Breaker Operations (3 Pole) | | | |
| 260 | Contact Converter #1 Configuration | | | |
| 261 | Contact Converter #2 Configuration | | | |
| 262 | Contact Converter #3 Configuration | | | |
| 263 | Contact Converter #4 Configuration | | | |
| 264 | Contact Converter #5 Configuration | | | |
| 265 | Contact Converter #6 Configuration | | | |
| 266 | Contact Converter #7 Configuration | | | |
| 267 | Contact Converter #8 Configuration | | | |
| 268 | Contact Converter #9 Configuration | | | |
| 269 | Contact Converter #10 Configuration | | | |
| 270 | Contact Converter #11 Configuration | | | |
| 271 | Contact Converter #12 Configuration | | | |
| 272 | …Reserved… | | | |
| 273 | …Reserved… | | | |
| 274 | …Reserved… | | | |
| 275 | …Reserved… | | | |
| 276 | …Reserved… | | | |
| 277 | …Reserved… | | | |
| 278 | …Reserved… | | | |
| 279 | …Reserved… | | | |
| 280 | …Reserved… | | | |
| 281 | …Reserved… | | | |
| 282 | …Reserved… | | | |
| 283 | …Reserved… | | | |
| 284 | …Reserved… | | | |
| 285 | …Reserved… | | | |
| 286 | …Reserved… | | | |
| 287 | …Reserved… | | | |
| 288 | …Reserved… | | | |
| 289 | …Reserved… | | | |
| 290 | …Reserved… | | | |
| 291 | …Reserved… | | | |
| 292 | …Reserved… | | | |
| 293 | …Reserved… | | | |
| 294 | …Reserved… | | | |
| 295 | …Reserved… | | | |

**Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 8 of 8)**

| ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41) | | | | |
|---|---|---|---|---|
| **INDEX** | **DESCRIPTION** | **FORMAT / UNITS** | | **REMARKS** |
| 296 | …Reserved… | | | |
| 297 | …Reserved… | | | |
| 298 | …Reserved… | | | |
| 299 | …Reserved… | | | |
| 300 | …Reserved… | | | |
| 301 | …Reserved… | | | |
| 302 | …Reserved… | | | |
| 303 | …Reserved… | | | |

**C**

**TABLE NOTES:**

There are four settings groups in ALPS. However, there is only one group of General Settings categories, CONFIGURE, COMMPORTS, OSC_GRAPHY, BRKR_DUTY, and INPUTS, which are represented by Analog Output Points 218 to 261. The other points report the settings from the group selected by the setpoint at Point 0. Note that this only a DNP setpoint, not part of device settings, and is not stored in non-volatile memory. This setpoint points to the active settings group on device boot-up or a warm or cold restart. This can be set to point to any other group desired. The setpoint value ranges from 0 to 3, selecting Settings groups 1 to 4 respectively.

The port settings are not reported as a single Multi-Field number as with other ALPS protocols but are reported as separate setpoints for each of the port parameters. Each port's baud rate, stop bits and parity are assigned to separate points.

The upper and lower 16-bit portions of all 32-bit values reported by ALPS are assigned to two separate points. To read a 32-bit value, it is necessary to read both the upper and lower 16-bit portions and concatenate these two values to form a 32-bit value and interpret the result according to the format associated with the value.

These setpoints are Multi-field value in other communication protocols of ALPS with each bit corresponding to an option/ field. However, in DNP, each of the bits is assigned to a separate point. Note that the interpretation of the bit remains same as in other protocols. If a bit has a value of '0' then the corresponding option is OFF and if that bit has a value of '1', the corresponding option is ON.

Note that there is an overlap of Point Numbers here. The setpoints from 307 are different in ALPS and LPS-D. The remaining setpoints are same. The ALPS has a total of 334 setpoints.

**C.3.7 DATA FORMATS – ANALOG INPUT AND OUTPUT POINTS**

Data formats for Analog Input and Analog Output Points.

F1 – Signed 16-bit integer, 1 decimal place.

e.g. 123.4 is reported as 1234.

F2 – Signed 16-bit integer, 2 decimal places.

e.g. 12.34 is reported as 1234.

F3 – Signed 16-bit integer, 3 decimal places.

e.g. 1.234 is reported as 1234.

F4 - Signed 16-bit integer, no decimal places

F5 - Signed 8-bit integer, No decimal places. Encoded Fault Type.

There are 16 valid fault type codes as given below:

**Table C–8: FAULT TYPE CODES**

| FAULT TYPE CODE | FAULT TYPE |
|---|---|
| 0 | Undetermined |
| 1 | AG |
| 2 | BG |
| 3 | CG |
| 4 | ABG |
| 5 | BCG |
| 6 | CAG |
| 7 | AB |
| 8 | BC |
| 9 | CA |
| 10 | 3PH |
| 11 | A |
| 12 | B |
| 13 | C |
| 14 | G |
| 15 | TRG |

F6 – Unsigned 16-bit integer, No decimal places. Encoded Fault Trip Type. The lower and upper 16-bits of the 32-bit value are assigned to two separate points. To read the trip type the two points need to be read and concatenated to form a 32-bit word.

Each bit of Trip Type indicates a Trip flag that is picked up. The following table lists the mnemonic for each of the bits of Trip Type.

F7 – Unsigned 8-bit integer, No decimal places. Encoded Trip Phase information.

Trip phases is a single byte value with the least significant four bits indicating which of the four phases have a trip fault as shown below:

Trip Phases: xxxxGCBA (binary)
A = '1' then Phase A has a Trip Fault
B = '1' then Phase B has a Trip Fault
C = '1' then Phase C has a Trip Fault
G = '1' then Phase G has a Trip Fault

F8 – Unsigned 16-bit integer, No decimal places. Part of 48-bit DNP Time. This has the same format as the DNP Time object (50), Variation 1, except that it has been assigned to three separate points as shown in the table. After reading the three points they should be concatenated to form a 48-bit value and interpreted as DNP Time Object.

F9 – Unsigned 16-bit integer. No decimal places. Encoded CPU Status information.

F10 – Unsigned 16-bit integer. No decimal places. Encoded ANI Status information.

F11 – Unsigned 16-bit integer. No decimal places. Encoded DSP Status information.

F12 – Unsigned 16-bit integer. No decimal places. Encoded Miscellaneous Status information.

F13 – Unsigned 8-bit integer, No decimal places. Encoded RMS/HiZ Fault Type. There are four valid RMS/HiZ fault type codes as give below.

**Table C–9: RMS / HiZ FAULT TYPE CODES**

| FAULT TYPE CODE | RMS / HIZ FAULT TYPE |
|---|---|
| 0 | Undetermined |
| 1 | HiZ (Downed Conductor) |
| 2 | RC (Arcing) |
| 3 | 2COC" |

F12 – Unsigned 8-bit integer, No decimal places. RMS Pickup phases.

RMS Pickup phases is a single byte value with the least significant four bits indicating which of the four phases have an RMS type fault as shown below:

Trip Phases: xxxxGCBA (binary)

A = '1' then Phase A has an RMS Fault
B = '1' then Phase B has an RMS Fault
C = '1' then Phase C has an RMS Fault
G = '1' then Phase G has an RMS Fault

**SET**

1. Edit Protection Settings
2. Edit General Settings
3. Select Act Settings Group
4. Modify Date/Time

DATE
TIME

SELECT ACT
SETTINGS GROUP
0 to 4

1. CONFIGURE
UNIT ID *(0101)*
SYSFREQ *(0102)*
PHASROTATE *(0103)*
NUM_BRKR *(0105)*
NUM_TC *(0106)*
NUM_MON *(0107)*
DISPLAYVAC *(0108)*
LANGUAGE *(0109)*

2. COMMPORTS
COMPORT1 *(0201)*
COMPORT2 *(0202)*
PROTOCOL1 *(0203)*
PROTOCOL2 *(0204)*

3. OSCGRAPHY
NUMFAULTS *(0301)*
PREFAULTS *(0302)*
SPLITREC *(0303)*

4. BRKR DUTY
EXPONENT *(0401)*
MAX_OP *(0402)*
MAX_IXT *(0403)*
IXTPHASEA *(0404)*
IXTPHASEB *(0405)*
IXTPHASEC *(0406)*
NUM_OP *(0407)*

† ALPS with Single-Pole Tripping Only

5. INPUT
CC1 *(0501)*
CC2 *(0502)*
CC3 *(0503)*
CC4 *(0504)*
CC5 *(0505)*
CC6 *(0506)*
CC7 *(0507)*
CC8 *(0508)*
CC9 *(0509)* †
CC10 *(0510)* †
CC11 *(0511)* †
CC12 *(0512)* †

1. Z1DISTANCE *(0101-0112)*
2. Z2DISTANCE *(0201-0211)*
3. Z3DISTANCE *(0301-0310)*
4. Z1DISTANCE *(0401-0413)*
5. CURVSUPVISN *(0501-0507)*
6. OVERCURRENT *(0601-0617)*
7. VOLTAGE *(0701-0714)*
8. BLKRSCLOS *(0801-0810)*
9. LINEPICKUP *(0901-0903)*
10. REMOTEOPEN *(1001-1002)*
11. LINEOVLRD *(1101-1105)*
12. SCHEME *(1201-1205)*
13. SCHMTIMERS *(1301-1311)*
14. LINEINFO *(1401-1408)*
15. SCADA DATA *(1501-1502)*
16. OSBLOCKING *(1601-1607)*
17. OSTRIPPING *(1701-1713)*
18. RECLOSER *(1801-1840)*
19. NONCRIT_AL *(1901-1908)*
20. OUTPUTS *(2001-2026)*

**D**

**Figure D–1: SET KEYPAD MENU**

**D**

**ACT**

1. Disable Outputs
2. Enable Outputs
3. Trip Breaker
4. Close Breaker
5. Relay Test
6. Channel Test
7. LUI Test
8. Digital Output Test
9. Playback
10. Change Password
11. En/Dis Password
12. Reset Data
13. Reset Recloser
14. Adjust Contrast

1. END
2. FACTORY TEST
3. UPLOADED DATA
4. DATA IN RELAY

1. SETTING
2. CONTROL
3. MASTER

1. FAULTS
2. EVENTS
3. OST OSC
4. EQUIPMENT DUTY

1. CURRENT SETTING
2. FAULT SETTING

1. CURRENT SETTING
2. FAULT SETTING

1. CURR–SELECT
   SETS FAULT #
2. FAULT–SELECT
   SETS FAULT #

† ALPS with Single Phase Tripping only

1. End Channel Test
2. Channel Test

1. DISPLAY
2. LED
3. KEYPAD

1. End Test Mode
2. T1
3. T2
4. T3
5. T4
6. T5 †
7. T6 †
8. A1
9. A2
10. A3
11. A4
12. A5
13. A6
14. A7
15. A8
16. A9 †
17. A10 †
18. A11 †
19. A12 †
20. C1A/C1B
21. C2A/C2B
22. KT1
23. KT2
24. KT3
25. KT4
26. CA-A/B

1. End Test Mode
2. Zone 1 AG
3. Zone 1 BG
4. Zone 1 CG
5. Zone 2 AG
6. Zone 2 BG
7. Zone 2 CG
8. Zone 3 AG
9. Zone 3 BG
10. Zone 3 CG
11. Zone 4 AG
12. Zone 4 BG
13. Zone 4 CG
14. Any Z1 GND
15. Any Z2 GND
16. Any Z3 GND
17. Any Z4 GND
18. Zone 1 AB
19. Zone 1 BC
20. Zone 1 CA
21. Zone 2 AB
22. Zone 2 BC
23. Zone 2 CA
24. Zone 3 AB
25. Zone 3 BC
26. Zone 3 CA
27. Zone 4 AB
28. Zone 4 BC
29. Zone 4 CA
30. Any Z1 Phase
31. Any Z2 Phase
32. Any Z3 Phase
33. Any Z4 Phase
34. IT Detector
35. IB Detector
36. GND Dir Trip
37. GND Dir Block
38. Fault Detector
39. Ren Op Detector
40. Out of Step Blk
41. V1 Detector
42. Line Overload
43. Inst Phase Overload
44. Inst GND Overload
45. GND TOC Pickup
46. Line Pickup
47. Overvoltage
48. Undervoltage
49. Out of Step Trip

**Figure D–2: ACT KEYPAD MENU**

**D**

INF

1. ALPS Status ———————— Status ....................

2. Faults                          Select Fault # ———— Time
                                                       └— Date

3. Present Values ——————————————————————————— Va  Ia  Pf .....

4. CC Status ————————————————————— CC1 to CC12    ├— Vb  Ib  FREQ .....

                                                   └— Vc  Ic  kW .....

5. DO Status ——————————————————————————— T1 to T6, KT1 to KT4

6. Events ———————————— EVENT #1 ———— #150    ├— A1 to A4, C1 to C2

                                              └— A5 to A8, CA

7. Comm Password ——————————— VW, CTL, SET, MAS

8. Station/Line ID ——————————————————————— Station ID
                                             └— Line ID

9. ALPS Model/Version ———— Model  Version

10. OSC Snapshot

**Figure D–3: INF KEYPAD MENU**

**D**

E

**E**

**E**

# GE POWER MANAGEMENT RELAY WARRANTY

General Electric Power Management Inc. (GE Power Management) warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Power Management will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service centre or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay which has been subject to misuse, negligence, accident, incorrect installation or use not in accordance with instructions nor any unit that has been altered outside a GE Power Management authorized factory outlet.

GE Power Management is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Power Management Standard Conditions of Sale.

**F**

**F**

## Numerics

## A

# B

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