Instructions for Digitrip Models 1150, 1150*i* and 1150+, 1150+*i* Trip Units for use only in Cutler-Hammer Magnum and Magnum DS Circuit Breakers

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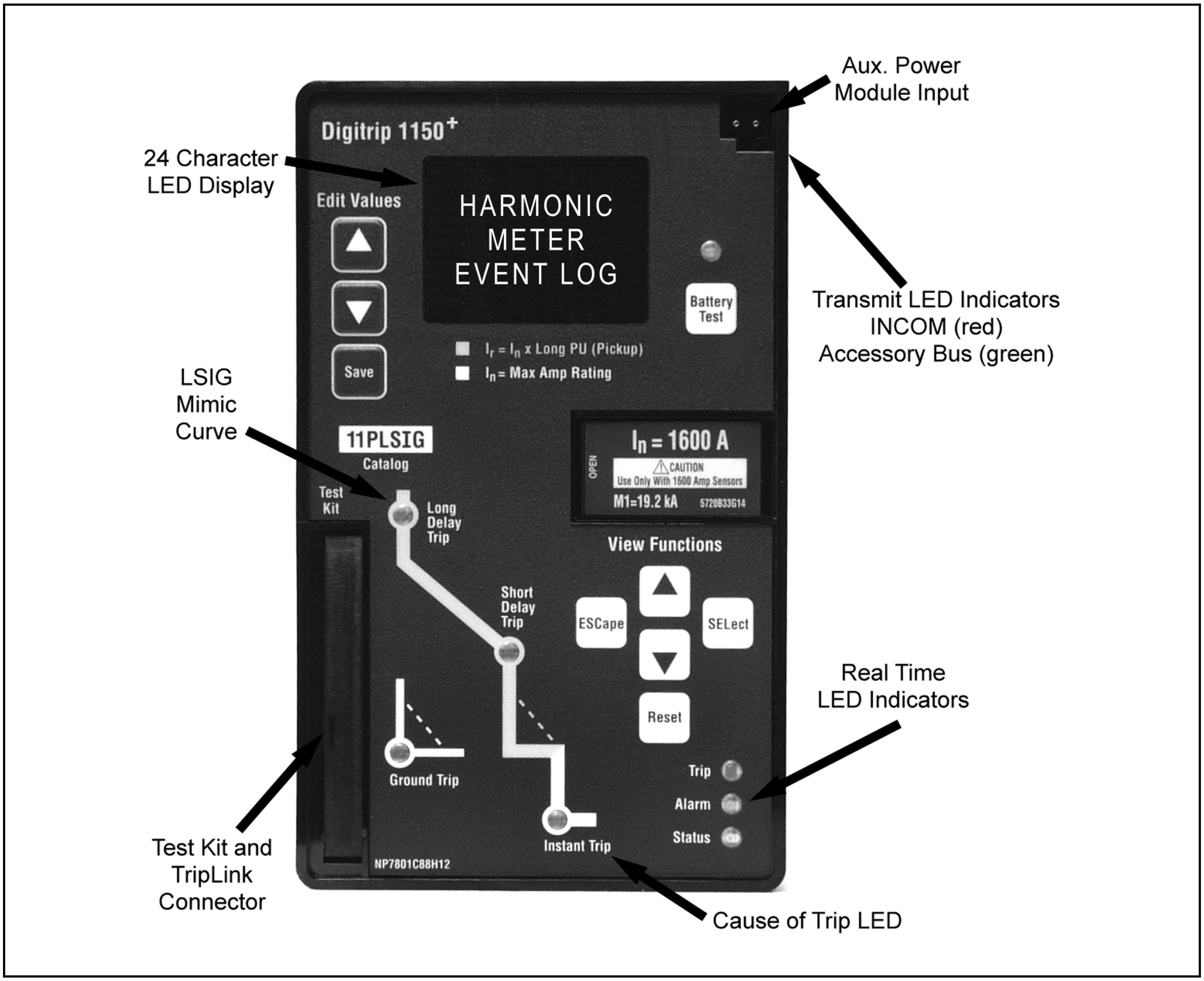


Figure 1.1 Digitrip 1150 Catalog # 11PLSIG Trip Unit with Rating Plug

WARNING

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING. ALWAYS FOLLOW SAFETY PROCEDURES. CUTLER-HAMMER IS NOT LIABLE FOR THE MISAPPLICATION OR MISINSTALLATION OF ITS PRODUCTS.

WARNING

OBSERVE ALL RECOMMENDATIONS, NOTES, CAUTIONS, AND WARNINGS RELATING TO THE SAFETY OF PERSONNEL AND EQUIPMENT. OBSERVE AND COMPLY WITH ALL GENERAL AND LOCAL HEALTH AND SAFETY LAWS, CODES, AND PROCEDURES.

NOTE: The recommendations and information contained herein are based on experience and judgement, but should not be considered to be all inclusive or to cover every application or circumstance which may arise.

Table 1.1a CURRENT Protection Functions for Digitrip 1150/1150i Trip

Trip Unit Type		Digitrip 1150	Digitrip 1150*i*
Ampere Range		100A-6000A	200A-6300A
RMS Sensing		Yes	Yes
Protection and Coordination			
Protection	Ordering Options Catalog #	11LSI, 11LSIG, 11LSIA or 11PLSI, 11PLSIG, 11PLSIA	11IEC, 11IEC-EF or 11PIEC, 11PIECEF
	Fixed Rating Plug (I_n)	Yes	Yes
	OverTEMPerature TRIP	Yes	Yes
	Curve Type	LSI/LSIG, LSIA	LSI/LSIG
	SLOPE	I2T, I4T IEEE[5]	I2T, I4T IEC[5]
Long Delay Protection	LONG delay Pick Up	0.4-1.0 x (I_n)	0.4-1.0 x (I_n)
	LONG delay TIME @ 6 x (I_r) I2T	2-24 seconds	2-24 seconds
	LONG delay TIME @ 6 x (I_r) I4T	1-5 seconds	1-5 seconds
	LONG delay thermal MEMORY	Yes	Yes
Short Delay Protection	SHORT delay Pick Up[3]	150-1000% or 1200% or 1400% x (I_r)	150-1000% or 1200% or 1400% x (I_r)
	SHORT delay TIME @ 8 x (I_r) I2T[4]	0.10-0.50 s	0.10-0.50 s
	SHORT delay TIME FLAT	0.10-0.50 s	0.10-0.50 s
	SHORT delay TIME ZONE INTERLOCK	Yes	Yes
Instan-taneous Protection	INSTantaneous Pick Up	200-1000% x or 1200% or 1400% (I_n)	200-1000% or 1200% or 1400% x (I_n)
	Off setting	Yes	Yes
	Making Current Release	Yes	Yes
Neutral Protection	4th Pole or External Neutral Trip	Yes-CAT # LSI only (50%,100%)	Yes-CAT # IEC only (50%,100%)
Ground (Earth) Fault Protection	GROUND fault option	Yes	Yes
	GROUND fault Pick Up	24-100% x (I_n)[1]	10-100% x (I_n)
	Off Position	No	Yes
	GROUND fault delay @ .625 x (I_n) I2T	0.10-0.50 s	0.10-0.50 s
	GROUND fault delay FLAT	0.10-0.50 s	0.10-0.50 s
	GROUND fault ZONE INTERLOCK	Yes	Yes
	GROUND fault memory	Yes	Yes
Phase Protection			
AMP UNBALANCE		Yes	Yes
PHASE LOSS (current-based)		Yes	Yes
System Diagnostics / Protection Related Alarms			
Status/Long Pick Up LED		Yes	Yes
Cause of Trip LED's		Yes[2]	Yes[2]
HighLOAD ALARM		Yes	Yes
Long Delay Pick Up ALARM		Yes	Yes
GROUND ALARM		Yes-CAT # LSIG	Yes- CAT# IECEF
GROUND ALARM only		Yes –CAT# LSIA	–
NEUTral AMPere ALARM		Yes	Yes
OPeration COUNT ALARM		Yes	Yes
Auxiliary Relay Contacts (Programmable)			
Block Close (1 contact)		Yes	Yes
ALARM/TRIP (2 contacts)		Yes	Yes

Notes:

1. ANSI/UL versions are limited to 1200 Amperes to comply with UL and NEC standards.
2. Four cause of trip LEDs indicate LONG, SHORT, INST or GROUND trip. Making Current Release and the separate High Instantaneous Module are indicated by the Instantaneous LED.
3. An additional setting is marked M1 where:

Standard Circuit Breaker	M1 = 14 x I_n for Plug Amps 100 through 1250A
	M1 = 12 x I_n for Plug Amps 1600, 2000, 2500A
	M1 = 10 x I_n for Plug Amps 3000, 3200A
Double Wide Circuit Breaker	M1 = 14 x I_n for Plug Amps 2000, 2500A
	M1 = 12 x I_n for Plug Amps 3000, 3200, 4000, 5000A (see Section 2.5)
	M1 = 10 x I_n for Plug Amps 6000A, 6300A

4. Only available when Long Time I^2T is selected.
5. Phase protection with 3 TRIP response types *(See Section 4.2.1).*

Table 1.1b Metering Data for Digitrip 1150/1150i Trip Units

Current Metering	Units	Tolerance	Notes
IA, IB, IC, IN,	Amperes	±1% FS	Real time data, FS = In rating
IG	Amperes	±2% FS	Real time data, FS = In rating
IA, IB, IC (AVG)	Amperes		5 MINUTE AVERAGE
IN, IG (AVG)	Amperes		5 MINUTE AVERAGE
			(Tolerance applicable for 5 to 100% of In
IA, IB, IC (Max)	Amperes		and current will start metering @ .02 per unit)
IN, IG (Max)	Amperes		
IA, IB, IC (Min)	Amperes		Group values held until Reset.
IN, IG (Min)	Amperes		Based on approximately 1 second time interval
Voltage Metering			
VAB, VBC, VCA	Volts	±1% FS	FS (Full Scale) = 690 V
Power Metering			
Power	kW	±2% FS	Approximately 1 second update
kVA	kVA	±2% FS	
kvar	kvar	±2% FS	
DEMAND kW	kW	±2% FS	LAST AVG - 5 MIN INTERVAL
DEMAND Max kW	kW	±2% FS	SLIDING or FIXED 15 MIN INTERVAL*
DEMAND kVA	kVA	±2% FS	LAST AVG - 5 MIN INTERVAL
DEMAND Max kVA	kVA	±2% FS	SLIDING or FIXED 15 MIN INTERVAL*
Energy Metering			
ENERGY kWh	kWh	±2% FS	
ENERGY Rev kWh	kWh	±2% FS	
KVAh	kVAh	±2% FS	
Metering Related Alarms			
kVA DEMAND ALARM	KVA	1 to 12500	LAST AVG - 5 min fixed interval
kW DEMAND ALARM	kW	1 to 12500	LAST AVG - 5 min fixed interval
Other			
kVAh PULSE INITIATE	kVAh	See section 4.7	INITIATE is an abbreviation for INITIATOR
kWh PULSE INITIATE	kWh		INITIATE is an abbreviation for INITIATOR

* Only one of DEMAND Max kW or DEMAND Max kVA can be SLIDING INTERVAL

Table 1.1c Power Quality Data for Digitrip 1150/1150i Trip Units

Harmonic	Units	Notes
THD (Total Harmonic Distortion)		
THDA	0 to 99 percent	Phase A current
THDB	0 to 99 percent	Phase B current
THDC	0 to 99 percent	Phase C current
THDN	0 to 99 percent	Neutral current
Per Harmonic Data		Fundamental through 27th
HARMON A	0 to 99 percent	Phase A current
HARMON B	0 to 99 percent	Phase B current
HARMON C	0 to 99 percent	Phase C current
HARMON N	0 to 99 percent	Phase N current
CF (Crest Factor)		
CFA	1.0 to 25.5	Phase A current
CFB	1.0 to 25.5	Phase B current
CFC	1.0 to 25.5	Phase C current
CFN	1.0 to 25.5	Phase N current
Power Factor / Frequency		
PF (Power Factor)	0 to 1.00	Located in METER menu, real time data
PF MIN	0 to 1.00	Value held until Reset
PF MAX	0 to 1.00	Value held until Reset
Hz (Frequency)	Hz	Located in METER menu
Power Quality Related Alarms (Programmable)		
LOW PF ALARM	50 to 95 percent	OFF setting available
THD ALARM	10 to 30 percent	OFF setting available

Table 1.1d VOLTAGE PROTECTION functions for Digitrip 1150/1150i Trip Units

Trip Unit Type	**Digitrip 1150+**		**Digitrip 1150*i*+**
Ordering Catalog Number	11PLSI, 11PLSIG, 11PLSIA		11PIEC, 11PIECEF
SYSTEM Frequency	50 or 60 Hz		50 or 60 Hz
TRIPS			
	RANGE	STEP SIZE	TOLERANCE
UnderVoltage Trip	90 to 670 Volts	1 volt	+/- 7 volts
UnderVoltage Time	1 to 250 seconds	1 second	+2.5s, -0.5s or +2%, -2% whichever is larger
OverVoltage Trip	180 to 720 Volts	1 volt	+/- 7 volts
OverVoltage Time	1 to 250 seconds	1 second	+2.5s, -0.5s or +2%, -2% whichever is larger
UnderFrequency Trip	48 to 52 Hz (50 Hz) 58 to 62 Hz (60Hz)	0.1 Hz	+/- .05 Hz
UnderFrequency Time	0.20 to 5.0 seconds	0.02 seconds	+0.1s/-0s
OverFrequency Trip	48 to 52 Hz (50 Hz) 58 to 62 Hz (60Hz)	0.1 Hz	+/- .05 Hz
OverFrequency Time	0.20 to 5.0 seconds	0.02 seconds	+0.1s/-0s
Voltage Unbalance Trip	5% to 50%	1%	+/-3
Voltage Unbalance Time	1 to 250 seconds	1 second	+2.5s, -0.5s or +2%, -2% whichever is larger
Reverse Power Trip	1 to 65000kW	1 kW	+/- 2% FS
Reverse Power Time	1 to 250 seconds	1 second	0, +2% +3s whichever is larger
ALARMS			
	RANGE	STEP SIZE	TOLERANCE
UnderVoltage Alarm	90 to 670 Volts	1 volt	+/- 7 volts
UnderVoltage AlarmTime	1 to 250 seconds	1 second	+2.5s, -0.5s or +2%, -2% whichever is larger
OverVoltage Alarm	180 to 720 Volts	1 volt	+/- 7 volts
OverVoltage AlarmTime	1 to 250 seconds	1 second	+2.5s, -0.5s or +2%, -2% whichever is larger
UnderFrequency Alarm	48 to 52 Hz (50 Hz) 58 to 62 Hz (60Hz)	0.1 Hz	+/- .05 Hz
UnderFrequency AlarmTime	0.20 to 5.0 seconds	0.02 seconds	+0.1s/-0s
OverFrequency Alarm	48 to 52 Hz (50 Hz) 58 to 62 Hz (60Hz)	0.1 Hz	+/- .05 Hz
OverFrequency AlarmTime	0.20 to 5.0 seconds	0.02 seconds	+0.1s/-0s
Voltage Unbalance Alarm	5% to 50%	1%	+/-3
Voltage Unbalance AlarmTime	1 to 250 seconds	1 second	+2.5s, -0.5s or +2%, -2% whichever is larger
Phase Rotation Alarm	ABC, CBA, OFF	-	-

If you have any questions or need further information or instructions, please contact your local representative or the Cutler Hammer Customer Support Center.

1.0 GENERAL DESCRIPTION OF DIGITRIP TRIP UNITS

The Digitrip Trip Units are circuit breaker subsystems that provide the protective functions of a circuit breaker. The trip unit is in a removable sealed housing, installed in the circuit breaker, and can be replaced in the field by the end user.

This instruction book specifically covers the application of Digitrip Trip Units, as illustrated in Figure 1.1, installed in Magnum and Magnum DS Breakers. Throughout this Instructional Leaflet, the use of the term “Magnum Breakers” refers to both the Magnum and Magnum DS low-voltage, AC power circuit breakers.

The Magnum Digitrip line of trip units consists of the 1150 which conforms to UL standards, and model 1150*i* conforming to IEC standards. Throughout this Instructional Leaflet, the use of the term Digitrip 1150 trip units refers to both models unless otherwise stated.

The Digitrip 1150 trip units may be applied to either 50 or 60 Hz systems.

Digitrip DT1150 family of trip units incorporate two microprocessors in their design. One processor is devoted totally to the task of current protection functions. This processor provides true RMS current sensing for the proper coordination with the thermal characteristics of conductors and equipment. The Digitrip analyzes the secondary current signals from the circuit breaker current sensors and, when preset current levels and time delay settings are exceeded, sends an initiating trip signal to the Trip Actuator of the circuit breaker. The current sensors provide operating power to the trip unit. As current begins to flow through the circuit breaker, the sensors generate a secondary current which powers the trip unit.

The second microprocessor provides the voltage protection display, communications, metering, harmonic calculations, alarming and auxiliary relay functions. These additional features require that auxiliary power be provided to the circuit breaker.

1.1 Protection

Each Digitrip DT1150 Trip Unit is completely self-contained and requires no external control power to operate its basic over current protection functions. It operates from current signal levels derived through current sensors mounted in the circuit breaker. The types of protection available for each model are shown in Table 1.1.

The Digitrip 1150 family of trip units provides five phase and two ground (time-current) curve-shaping adjustments. To satisfy the protection needs of any specific installation, the exact selection of the available protection function is adjustable. The short delay and ground fault adjustments include either a FLAT or I^2T response. A pictorial representation of the applicable time-current curves for the selected protection functions is provided, for user reference, on the face of the trip unit as shown in Figure 1.1.

NOTE: The Digitrip 1150 (11LSI ,11PLSI style) and Digitrip 1150*i* (11IEC, 11PIEC) are the styles that can be used on 3-pole or 4-pole circuit breakers for the protection of the neutral circuit. For a 3-pole circuit breaker an external sensor of the same rating as the phase sensor needs wired to the circuit breaker. Only these styles can provide neutral protection, although all styles can provide neutral metering and alarming (one exception is that there is no metering for source or zero sequence Ground Fault application). These styles also have a protection setting called Neutral Ratio. The 100% setting is the default and is used when phase and neutral conductors are of the same ampacity. The 50% setting is for a half sized neutral conductor and essentually shifts the Long Time thermal curve to the left making it more sensitive. Refer to the National Electric Code (NEC) for the appropriate application for 4-pole circuit breakers.

1.2 Mode of Trip and Status Information

On all DT1150 units, a green light emitting diode (LED), labeled Status, blinks approximately once each second to indicate that the trip unit is operating normally. This Status LED will blink at a faster rate if the Digitrip is in a pick-up, or overload, mode.

Red LEDs on the face of the 1150 family of trip units flash to indicate the cause, or trip mode, for an automatic trip operation (for example, ground fault, overload, or short circuit trip). A battery in the Digitrip unit maintains the trip indication until the Reset button is pushed. The battery is satisfactory if its LED lights green when the Battery Test button is pushed *(See Section 6).*

NOTE: The Digitrip 1150 family provides all protection functions regardless of the status of the battery. The battery is only needed to maintain the automatic trip indication on the mimic curve of the Digitrip when auxiliary power is not available.

1.3 Installation and Removal

1.3.1 Installation of the Trip Unit

Align the Digitrip unit with the molded guide ears on the platform and spring clips of the Magnum Circuit Breaker.

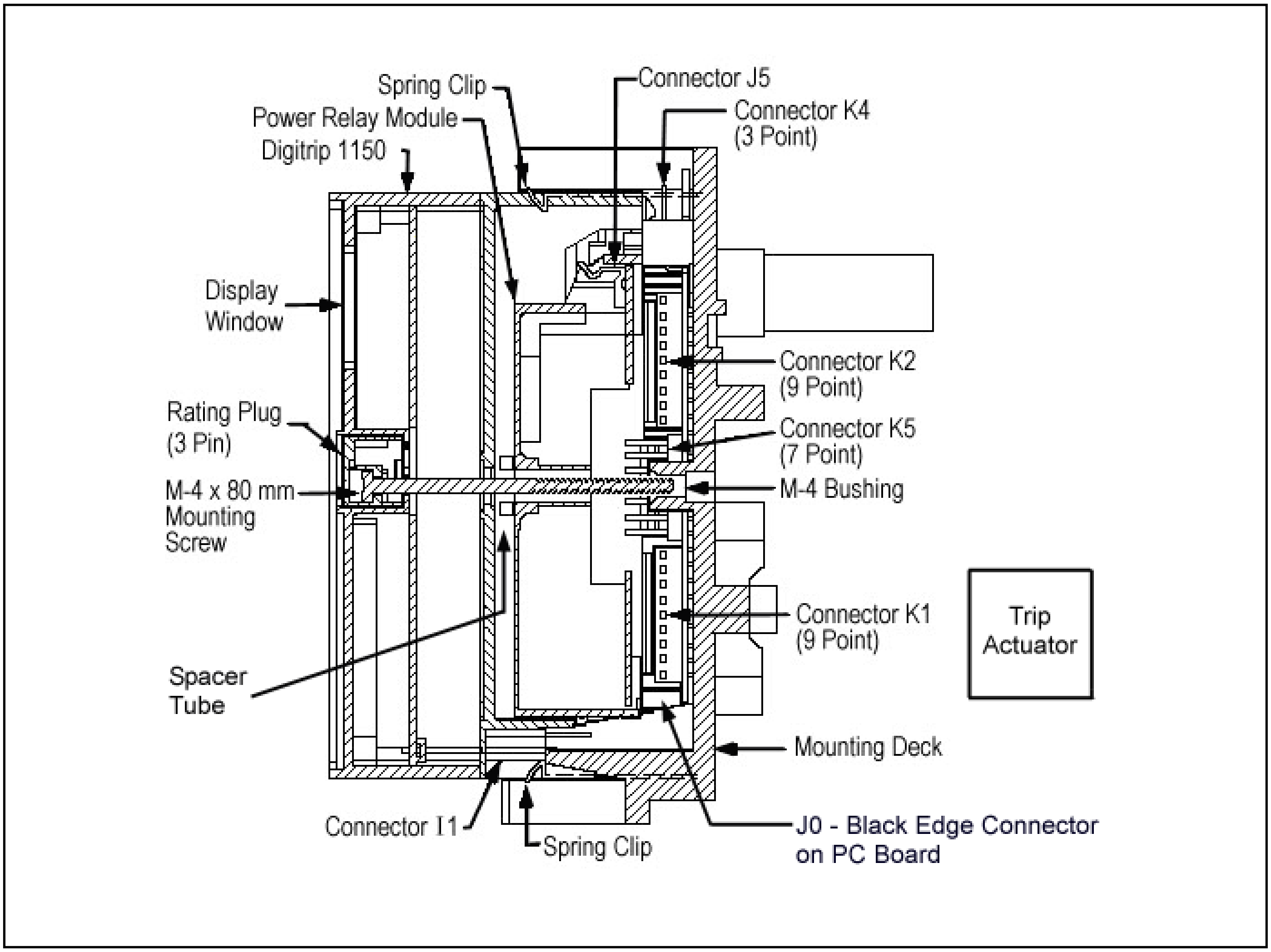


Figure 1.2 Installation of the Digitrip Unit into a Magnum Circuit Breaker (Side View)

Before plugging into the black edge connector, align the long pins on the bottom of the Digitrip into the white, I1, connector *(See Figure 1.2).* Press the unit into circuit breaker until the PC board edge engages into the connector and the spring clips engage over the Digitrip's housing. NOTE: Recheck visually the connector I1 to insure all plugs are engaged properly.

1.3.2 Rating Plug Installation

WARNING

DO NOT ENERGIZE THE MAGNUM CIRCUIT BREAKER WITH THE DIGITRIP REMOVED OR DISCONNECTED FROM ITS CONNECTOR. DAMAGE TO INTERNAL CURRENT TRANSFORMERS MAY OCCUR DUE TO AN OPEN CIRCUIT CONDITION. THERE IS NO PROTECTION FOR THE LOAD CIRCUIT.

CAUTION

IF A RATING PLUG IS NOT INSTALLED IN THE TRIP UNIT, THE UNIT WILL INITIATE A TRIP WHEN IT IS ENERGIZED. IN ADDITION THE INSTANTANEOUS LED WILL LIGHT ON A PLUG TRIP.

Insert the rating plug into the cavity on the right-hand side of the trip unit. Align the three pins on the plug with the sockets in the cavity. The plug should fit with a slight insertion force.

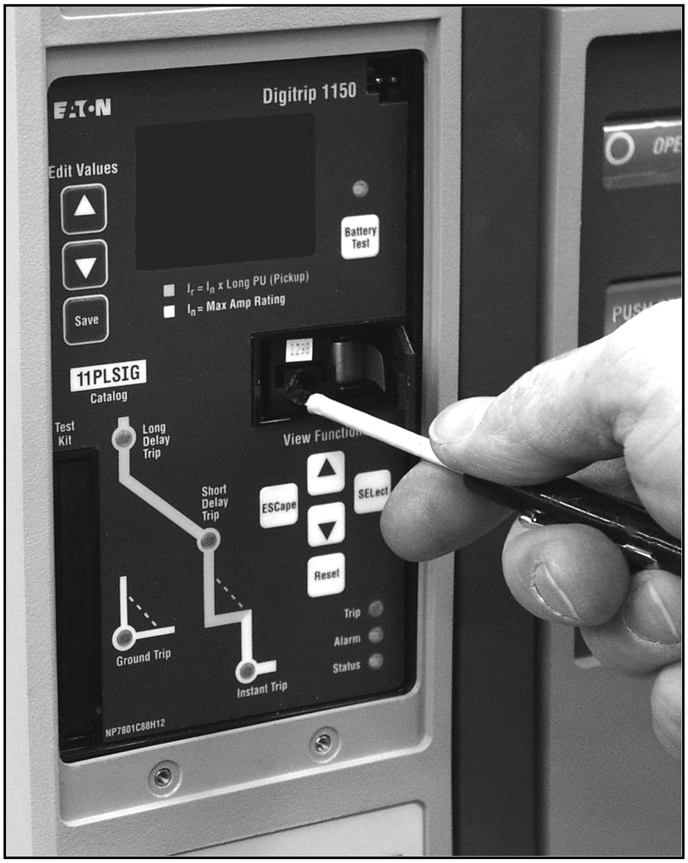


Figure 1.3 Installation of the Rating Plug and Mounting Screw

! CAUTION

DO NOT FORCE THE RATING PLUG INTO THE CAVITY.

Use a 1/8" (3 mm) wide screwdriver to tighten the M4 screw and secure the plug and the trip unit to the circuit breaker *(See Figure 1.3)*. Close the rating plug door.

! CAUTION

THE M4 SCREW SHOULD BE TIGHTENED ONLY UNTIL IT IS SNUG. DO NOT USE A LARGE SCREWDRIVER. A 1/8" (3 mm) WIDE SCREWDRIVER BLADE IS ADEQUATE.

1.3.3 Trip Unit/Rating Plug Removal

To remove the rating plug from the trip unit, open the rating plug door. Use a 1/8" (3 mm) wide screwdriver to loosen the M4 screw. Pull the door to aid in releasing the rating plug from the unit.

To remove the trip unit from the circuit breaker, deflect the top and bottom spring clips to release the unit from the black mounting platform. Pull the unit to disengage the trip unit's printed circuit board connectors J0 & I1 from the circuit breaker *(See Figure 1.2 and Appendix C).*

1.4 Wiring

The internal components of the circuit breaker and their connection points to the secondary contacts, are shown in the breaker master connection diagram provided on page 47 as Appendix C.

1.5 Plexiglass Cover

A clear, tamper-proof plexiglass door sits on the circuit breaker cover. This door, if sealed, allows the settings to be viewed but not changed, except by authorized personnel. The plexiglass cover meets applicable tamper-proof requirements. The cover is held in place by two cover screws. Security is insured by the insertion of a standard meter seal through the holes in both of the cover retention screws. The plexiglass cover has an access cutout for the View Functions group of pushbuttons and the Battery Test pushbutton.

1.6 DT 1150 Power/Relay Module

The Power/Relay Module *(See Figure 1.4)* is a standard device for the Digitrip 1150 model. The module is installed on the molded platform under the trip unit in the Magnum Circuit Breaker. There are four style modules that cover the following input voltage ratings: 120 VAC, 230 VAC, 24-48 VDC and 125 VDC (100-140 VDC operating range). The burden of the Power/Relay Module is 10VA. Check circuit breaker cover label marking for proper trip unit power and voltage rating.

1.6.1 Auxiliary Power

When the module is wired and supplied with proper voltage, it will provide an auxiliary power supply so that the DT 1150's (LED) display will be functional even when the circuit breaker has no load. A Digitrip 1150 unit **without** auxiliary power will not provide voltage, display any data or communicate.

1.6.2 Alarm Contacts

A second function of this module is to provide either a trip or alarm output contact via the two customer programmed relays within the module. An assortment of relay functions can be assigned to these relays. *(See the Aux Relay programming in Appendix D-15 and Appendix G).* Each relay is a normally open contact with a programming identification of RELAY A and RELAY C. On the Breaker Master Connection Diagram (Appendix C) these contacts

Figure 1.4 Power/Relay Module for 1150 Trip Unit

are labeled ATR_Alarm and ATR_latch. The ATR_latch is a latching relay that will hold contact status even if auxiliary power is lost to the circuit breaker. This relay does require auxiliary power for resetting. The resetting of these relays requires depressing the RESET pushbutton on the front panel of the Digitrip 1150.

1.6.2.1 Ground Alarm

A ground fault alarm is one of many possible programmable alarms and can provide an early warning of a ground fault condition in progress via an alarm LED.

In addition, this unit can be programmed to energize an alarm relay upon this condition. The alarm relay will reset automatically if the ground current is less than the ground alarm pickup setting.

On the LSIA style unit, a red ALARM ONLY LED *(See Figure 3.3)* will indicate the presence of ground fault current, when it is in excess of GROUND PICKUP setting. Ground tripping will not occur with the LSIA style unit.

1.6.2.2 Block Close Relay

Also in this module is a relay that can block the remote closing of a circuit breaker after a trip condition. This Block function is enabled by programming the Aux Relay B via the front panel or via PowerNet communication *(See Appendix D-15).* The block close function can be further setup for “AUTO” or “MANUAL” reset via programming (11Pxxx only). This trip condition requires a front panel reset to clear the *Block Close* condition.

1.7 Standards

The Digitrip 1150 Trip Units are listed by the Underwriters Laboratories, Inc.®, UL File E52096, for use in Magnum Circuit Breakers. These devices were tested to the ANSI C37.13 breaker standard and ANSI C37.17 trip unit standard. Additionally, these same units are also listed by the Canadian Standards Association (CSA) under file LR 43556.

All Digitrip units have also passed the IEC 947-2 test program which includes radiated and conducted emissions testing. As a result, all units carry the CE mark.

2.0 DESCRIPTION OF MAGNUM CIRCUIT BREAKERS

2.1 General

Magnum Circuit Breakers are tripped automatically on overload or fault current conditions by the combined action of three components:

1. The Sensors, which measure the current level and provide the energy to trip
2. The Digitrip Trip Unit, which provides a tripping signal to the Trip Actuator when current and time delay settings are exceeded
3. The low-energy Trip Actuator, which actually trips the circuit breaker

Figure 2.1 shows this tripping circuit for a typical Magnum Circuit Breaker. This arrangement provides a very flexible system, covering a wide range of tripping characteristics described by the time-current curves referenced in Section 9.2.

The automatic overload and short circuit tripping characteristics for a specific circuit breaker are determined by the ratings of the installed current sensors with a matching rating plug and the selected functional protection settings. Specific setting instructions are provided in Section 4.

When the functional protection settings are exceeded, the Digitrip unit supplies a trip signal to the Trip Actuator. As a result, all tripping operations initiated by the protection functions of the Digitrip Trip Unit are performed by its internal circuitry. There is no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the circuit breaker, thus external control power is not required for overload or fault current tripping.

WARNING

IMPROPER POLARITY CONNECTIONS ON THE TRIP ACTUATOR COIL WILL DEFEAT THE OVERLOAD AND SHORT CIRCUIT PROTECTION, WHICH COULD RESULT IN PERSONAL INJURY.

OBSERVE POLARITY MARKINGS ON THE TRIP ACTUATOR LEADS AND CONNECT THEM PROPERLY USING THE INSTRUCTIONS PROVIDED.

2.2 Low-Energy Trip Actuator

The mechanical force required to initiate the tripping action of a Magnum Circuit Breaker is provided by a special low-energy Trip Actuator. The Trip Actuator is located under the black molded platform on which the Digitrip unit is supported. The Trip Actuator contains a permanent magnet assembly, moving and stationary core assemblies, a spring and a coil. Nominal coil resistance is 24 ohms and the black lead is positive. The circuit breaker mechanism assembly contains a mechanism-actuated reset lever and a trip lever to actuate the tripping action of the circuit breaker.

When the Trip Actuator is reset by the operating mechanism, the moving core assembly is held in readiness against the force of the compressed spring by the permanent magnet. When a tripping action is initiated, the low-energy Trip Actuator coil receives a tripping pulse from the Digitrip unit. This pulse overcomes the holding effect of the permanent magnet, and the moving core is released to trigger the tripping operation via the trip lever.

2.3 Ground Fault Protection

Only the Digitrip 1150 cat# 11LSIG,11PLSIG and Digitrip 1150*i* cat. # 11IEC-EF,11PIECEF provide ground fault protection.

2.3.1 General

When the Digitrip 1150 family includes ground fault protection features, the distribution system characteristics (for example, system grounding, number of sources, number and location of ground points, and the like) must be considered along with the manner and location in which

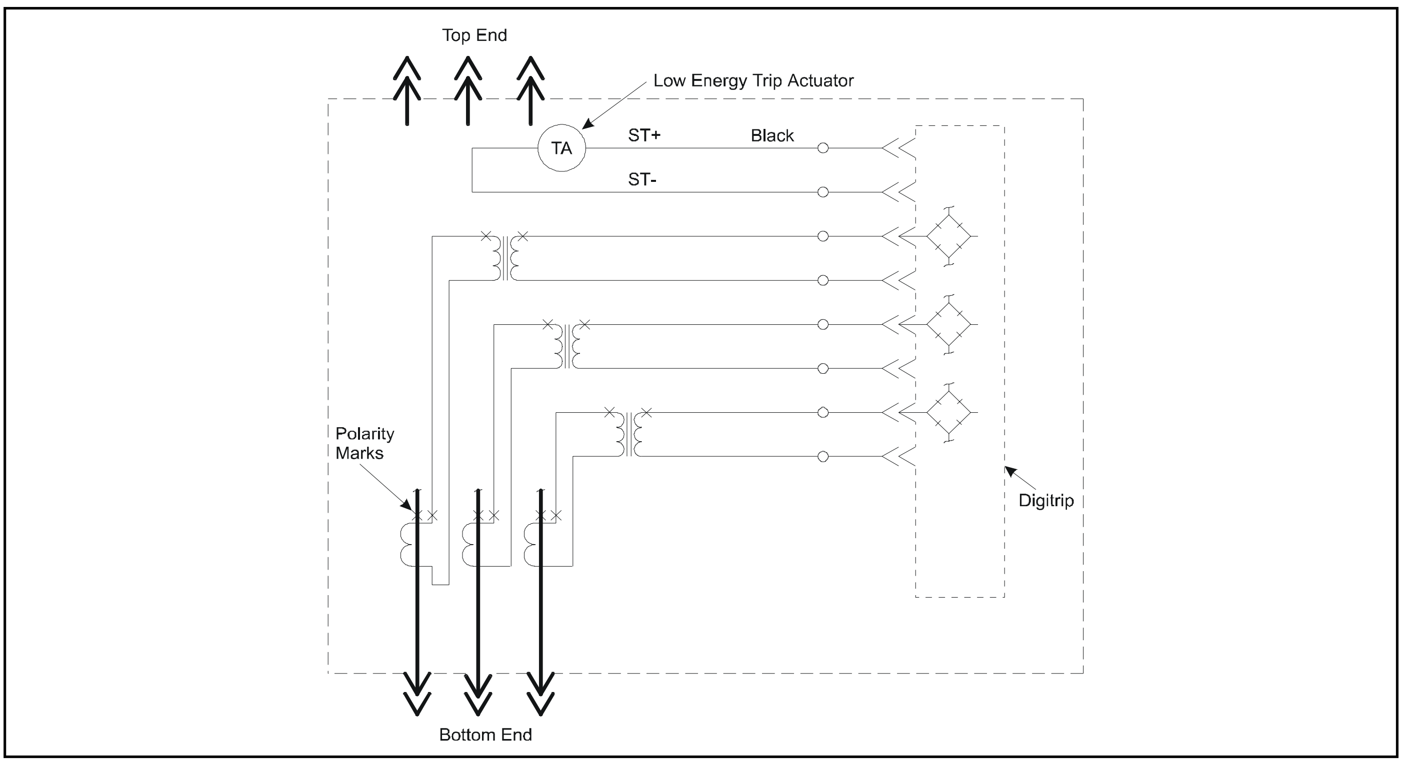


Figure 2.1 Tripping Circuit for a Typical Magnum Circuit Breaker (Partial)

the circuit breaker is applied to the system. These elements are discussed in Sections 2.3.3 through 2.3.6.

The Digitrip 1150 family uses three modes of sensing to detect ground fault currents: residual, source ground, and zero sequence *(See Table 2.1).* The breaker secondary contact inputs B-6 and B-7 are used to configure the trip unit. A jumper from B-6 to B-7 programs the trip unit for either a source ground or zero sequence configuration. Removing the jumper will program the unit for a residual ground fault scheme. This jumper resides on the stationary side of the switchgear assembly. In all three schemes, the proper current sensor input is required on the external sensor input terminals B-4, B-5 of the breaker secondary contacts.

Table 2.1 Digitrip Sensing Modes

Ground (Earth) Fault Sensing Method	Circuit Breaker Secondary Contacts Req'd	Applicable Breakers	Figure Reference	Digitrip GF Sensing Element Used
Residual	No Jumper	3 or 4 pole	2.2, 2.3, 2.5, 2.9	element R5
Source Ground	Jumper B6 to B7	3 pole only	2.7	element R4
Zero Sequence	Jumper B6 to B7	3 pole only	2.8	element R4

Note: This information applies to Trip Units with Ground

2.3.2 Residual Sensing - 3-Wire or 4-Wire

Residual Sensing is the standard mode of ground fault sensing in Magnum Circuit Breakers. This mode utilizes one current sensor on each phase conductor and one on the neutral for a 4-wire system *(Shown in Figures 2.2 and 2.3).* If the system neutral is grounded, and no phase to neutral loads are used (a three wire system), the Digitrip 1150 with ground includes all of the components necessary for ground fault protection. This mode of sensing vectorially sums the outputs of the three individual current sensors. For separately-mounted neutrals, as long as the vectorial sum is zero, then no ground fault exists. The neutral sensor (for a four wire system) must have characteristics and a ratio which matches the three internally-mounted phase current sensors. Available types of neutral sensors are shown in Figure 2.4. Residual ground fault sensing features are adaptable to main and feeder circuit breaker applications.

! CAUTION

IF THE SENSOR CONNECTIONS ARE INCORRECT, A NUISANCE TRIP MAY OCCUR. ALWAYS OBSERVE THE POLARITY MARKINGS ON THE INSTALLATION DRAWINGS. TO INSURE CORRECT GROUND FAULT EQUIPMENT PERFORMANCE, CONDUCT FIELD TESTS TO COMPLY WITH NEC REQUIREMENTS UNDER ARTICLE 230-95(C).

2.3.3 Source Ground Sensing

Depending upon the installation requirements, alternate ground fault sensing schemes may be dictated *(See Figures 2.6 and 2.7).* The ground return method is usually applied when ground fault protection is desired only on the main circuit breaker in a simple radial system. This method is also applicable to double-ended systems where a midpoint grounding electrode is employed. For this mode of sensing, a single current sensor mounted on the equipment-bonding jumper directly measures the total ground current flowing in the grounding electrode conductor and all other equipment-grounding conductors.

In the CURRENT (protection) submenu, there is a setting (EXT GND CT RATIO) that enables the presentation of ground pickup in amperes and the display of ground current in amperes when an External Ground CT is employed. This screen is presented when jumper B-6 to B-7 is present for a trip unit equipped with GROUND. External Ground CT ratios of 10, 25, 50, 100, 200, 400, 800, 1000 A:1 and "none" settings are selectable, with "none" defaulting to the plug (In) rating. With the correct ratio selected the GF pickup settings are adjustable in amperes.

2.3.4 Zero Sequence Sensing

Zero Sequence Sensing, also referred to as vectorial summation *(See Figure 2.8),* is applicable to mains, feeders, and special schemes involving zone protection. Zero Sequence current transformers (4 1/2" x 13 1/2" [114 mm x 342 mm] rectangular inside dimensions) are available with 100:1 and 1000:1 ratios. The EXT GND CT RATIO setting described above is applicable for zero sequence.

2.3.5 Multiple Source/Multiple Ground

A Multiple Source/Multiple Ground scheme is shown in Figure 2.9. In this figure, a ground fault is shown which has two possible return paths, via the neutral, back to its source. The three neutral sensors are interconnected to sense and detect both ground fault and neutral currents.

2.3.6 Ground Fault Settings

The adjustment of the ground fault functional settings and their effect upon the ground fault time-current curve is discussed in Section 4.2.1.8.

2.4 Current Sensors for Standard Breaker

The three (3-pole) or four (4-pole) primary current sensors are located in the circuit breaker on the lower conductors of the breaker. The current sensor rating defines the circuit breaker rating (In). For example, 2000A:1A sensors are used on a 2000A rated circuit breaker. There are also four auxiliary current transformers with a ratio of 10:1 which further step down the rated current to 100 milliamperes, which is equivalent to 100% (In) in the Digitrip 1150.

The primary current sensors produce an output proportional to the load current and furnish the Digitrip 1150 family with the information and energy required to trip the circuit breaker when functional protection settings are exceeded.

WARNING

IF A SET OF CURRENT SENSORS WITH A DIFFERENT RATIO ARE INSTALLED IN THE FIELD, THE RATING PLUG MUST ALSO BE CHANGED. THE ASSOCIATED RATING PLUG MUST MATCH THE CURRENT SENSOR RATING SPECIFIED ON THE PLUG LABEL. THE CURRENT SENSOR RATING CAN BE VIEWED THROUGH OPENINGS IN THE BACK OF THE CIRCUIT BREAKER. ALSO VERIFY DESIRED PROTECTION SETTINGS AFTER THESE COMPONENTS ARE CHANGED.

2.5 Current Sensors for Double Wide Circuit Breakers

The six (3-pole) or eight (4-pole) current sensors installed in the circuit breaker are located on the lower conductors. The poles are paralleled and the corresponding current sensors are also paralleled *(See Figure 2.3).* for example, a 4000A circuit breaker phase rating has two 2000:1 current sensors wired in parallel, which provides an overall ratio of 4000:2. The auxiliary current transformers have a ratio of 20:1 in this size circuit breaker to futher step down the full load current to 100 mA.

3.0 PRINCIPLES OF OPERATION

3.1 General

The Digitrip 1150 family of trip units is designed for industrial circuit breaker environments where the ambient temperatures can range from –20° C to +85° C, but rarely exceed 70° to 75° C. If, however, ambient temperatures exceed this range, the trip unit performance may be degraded. In order to insure that the tripping function is not compromised due to an over-temperature condition, the Digitrip 1150 microcomputer chips have a built-in over-temperature protection feature, factory set to trip the circuit breaker if the chip temperature is excessive. If the unit trips on over-temperature, the red Long Delay Time LED will flash and the OVER TEMP TRIP message will appear on the display.

The Digitrip uses the Cutler-Hammer custom-designed CHip™, an integrated circuit that includes a microcomputer to perform its numeric and logic functions. The principles of operation of the trip unit are shown in Fig. 3.1.

All sensing and tripping power required to operate the protection function is derived from the current sensor secondary currents whenever the circuit breaker is carrying current. These current signals develop analog voltages across the current viewing resistors. The resulting analog voltages are digitized by the CHip™.

The microcomputer continually digitizes these signals. This data is used to calculate true RMS current values, which are then continually compared with the protection function settings and other operating data stored in the memory. The embedded software then determines whether to initiate protection functions, including tripping the circuit breaker through the Trip Actuator. (TA)

3.2 Trip and Operation Indicators

The four cause of trip LEDs on the face of the trip unit, shown in Figures 1.1 and 3.2 to 3.5, flash red to indicate the reason for any automatic trip operation. Each LED is strategically located in the related segment of the time-current curve depicted on the face of the trip unit. The reason for the trip is identified by the segment of the time-current curve where the LED is illuminated. Following an automatic trip operation, the backup battery shown in Figure 3.1 continues to supply power to the LEDs. The LED pulse circuit, also shown in Figure 3.1, is provided to reduce battery burden and will flash the trip LED approximately every 4 seconds. Therefore, it is important to view the unit for at least 5 seconds to detect a flashing trip indicator. Pushing the Reset button extinguishes the LED.

NOTE: A complete reset of the Digitrip 1150 requires the unit to be powered (Status LED flashing) when depressing the Reset pushbutton. Otherwise, a previous trip event may be indicated again by the LED.

3.2.1 Status/Long Pickup LED

The green Status LED will indicate the operational status of the protection CHip A microprocessor of the trip unit. Even with no external power present, if the load current through the circuit breaker exceeds approximately 12 percent (3 phase power) of the current sensor rating, the LED will flash on and off once each second indicating that the trip unit is energized and operating properly *(See Figure 3.1).*

In an overload (Long Pickup) condition this status LED flashes at approximately 4 times per second while the overload persists.

3.2.2 Alarm LED

In addition to the green status LED, a yellow alarm LED is provided to indicate real time alarm conditions existing on the power system. See Appendix D-16 for the programing of these alarms. Also, if an unusual condition is detected within the Digitrip's hardwire or firmware, this LED will light along with an ALARM message.

3.2.3 Trip LED

The trip LED is illuminated upon any trip condition. It is also a real time display and incorporates the circuit breaker's 52b auxiliary switch (also called MCR switch) input for its logic. Pushing the Reset pushbutton or closing the circuit breaker will clear this LED.

3.3 Making Current Release

All Digitrip 1150 Trip Units have a Making Current Release function. This safety feature prevents the circuit breaker from being closed and latched-in on a faulted circuit. This is a nonadjustable sensing circuit. It is preset to trip at an instantaneous current numerically equivalent to 25 x (*I*n). (Note that currents of ~11 x (*I*n) with maximum asymmetry also reach this threshold.)

The Making Current Release is enabled only for the first two cycles following an initial circuit breaker closing operation. The Making Current Release will trip the circuit breaker instantaneously and flash the Instantaneous LED as well as indicating "Making Current Trip" on the display panel.

3.4 Zone Interlocking

! CAUTION

IF ZONE INTERLOCKING IS NOT TO BE USED AND ONLY STANDARD TIME-DELAY COORDINATION IS INTENDED, JUMPER TERMINAL B8 TO B9 ON THE CIRCUIT BREAKER SECONDARY CONNECTOR.

Zone Selective Interlocking (or Zone Interlocking) is available on the Digitrip 1150 for the Short Delay and Ground Fault protection functions *(See Figure 3.1).* The zone interlocking signal is wired via a single set of wireslabeled Zone In (Zin) and Zone Out (Zout) along with a Zone Common wire. The Zone Selective Interlocking function combines the interlocking of Short Delay and Ground Fault. A zone out signal is issued if the ground fault pick-up is exceeded or if the short delay pickup is exceeded or if the value of 2 x (*I*r) is exceeded. Zone Selective Interlocking provides the fastest possible tripping for faults within the zone of protection of the circuit breaker and yet also provides positive coordination among all circuit breakers in the system (mains, ties, feeders, and downstream circuit breakers) to limit a power outage to only the affected parts of the system. When Zone Interlocking is employed, a fault within the zone of protection of the circuit breaker will cause the Digitrip 1150 to:

- Trip the affected circuit breaker immediately and, at the same time,

- Issue a signal to upstream Digitrip units to restrain from tripping immediately. The restraining signal causes the upstream circuit breakers to follow their set coordination times, so that the service is only locally disrupted while the fault is cleared in the shortest time possible.

For an example of how Zone Selective Interlocking may be used, see Appendix A of this Instructional Leaflet.

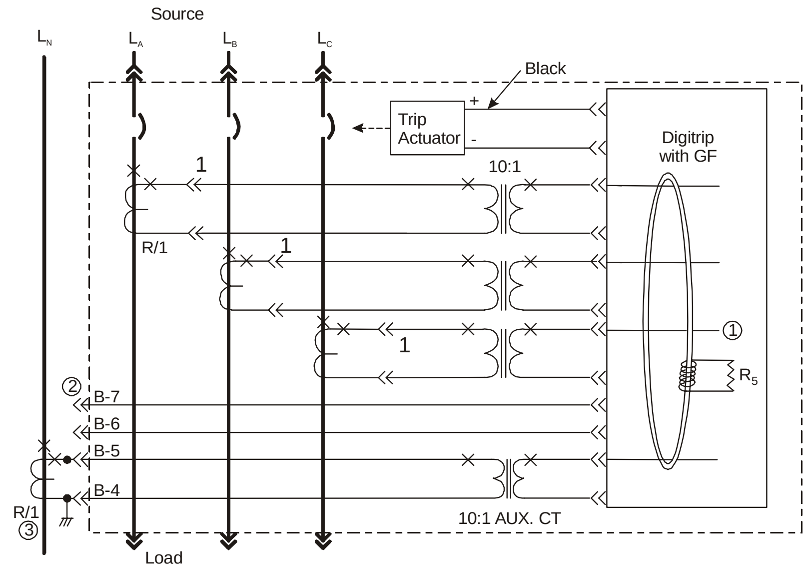
3.5 PT Module

The PT (Potential Transformer) Module *(See Fig. 3.0 and Appendix C)* is internally wired in the circuit breaker to the line side circuit breaker terminals. It provides signal data to calculate voltage, power, energy and related data. The PT module is a three phase, three wire input and three wire output step down transformer with a *wye to wye* hookup.

The power (and energy) metering and protection is calculated with the convention that power flow is from top to bottom through the circuit breaker. This assumes the top side conductor to be the *line* side. If the distribution system is such that the bottom side is the *hot* side, the power values will indicate *Reverse Power*. This reading can be made an absolute value by installing a jumper from B-3 to B-7 of the secondary contacts.

! CAUTION

A DIELECTRIC DISCONNECT PLUG LOCATED ON THE LEFT SIDE OF THE CIRCUIT BREAKER IS PROVIDED WITH THIS MODULE AND IS TO BE REMOVED WHEN DIELECTRIC TESTING OF THE CIRCUIT BREAKER IS CONDUCTED. FAILURE TO REMOVE PLUG WHEN TESTING CAN RESULT IN DAMAGE TO TRIP UNIT AND PT MODULE.



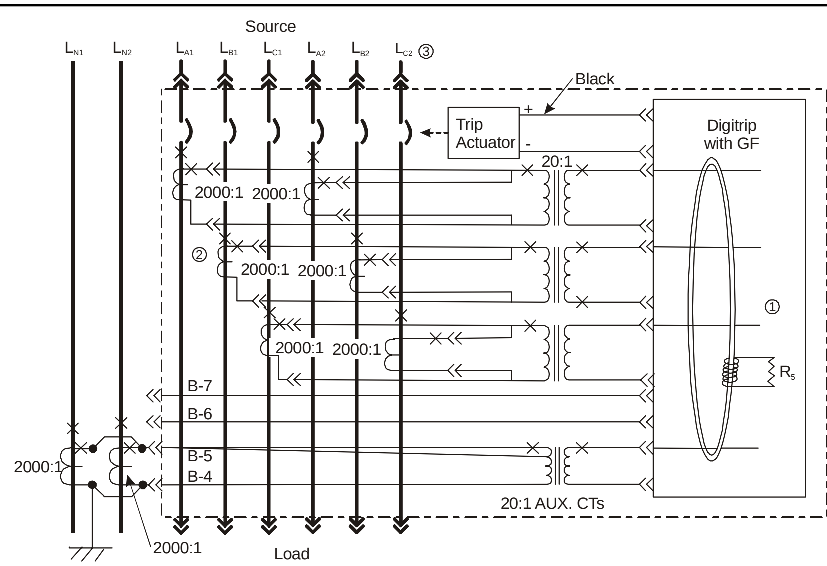
Notes:

① In this scheme, all breaker secondary currents (at the 100mA level) are summed together at the pc board donut transformer to sense ground fault via element R_5.

② No jumper on secondary contacts B-6, B-7.

③ Neutral input (if 4-wire) is via contacts B-4, B-5. Neutral current input to secondary contacts is 1A, equivalent to 1 per unit ground.

Figure 2.2 3-Pole, 4-Wire Circuit Breaker with Neutral Sensor Connections for Standard Circuit Breaker Using Residual GF Sensing



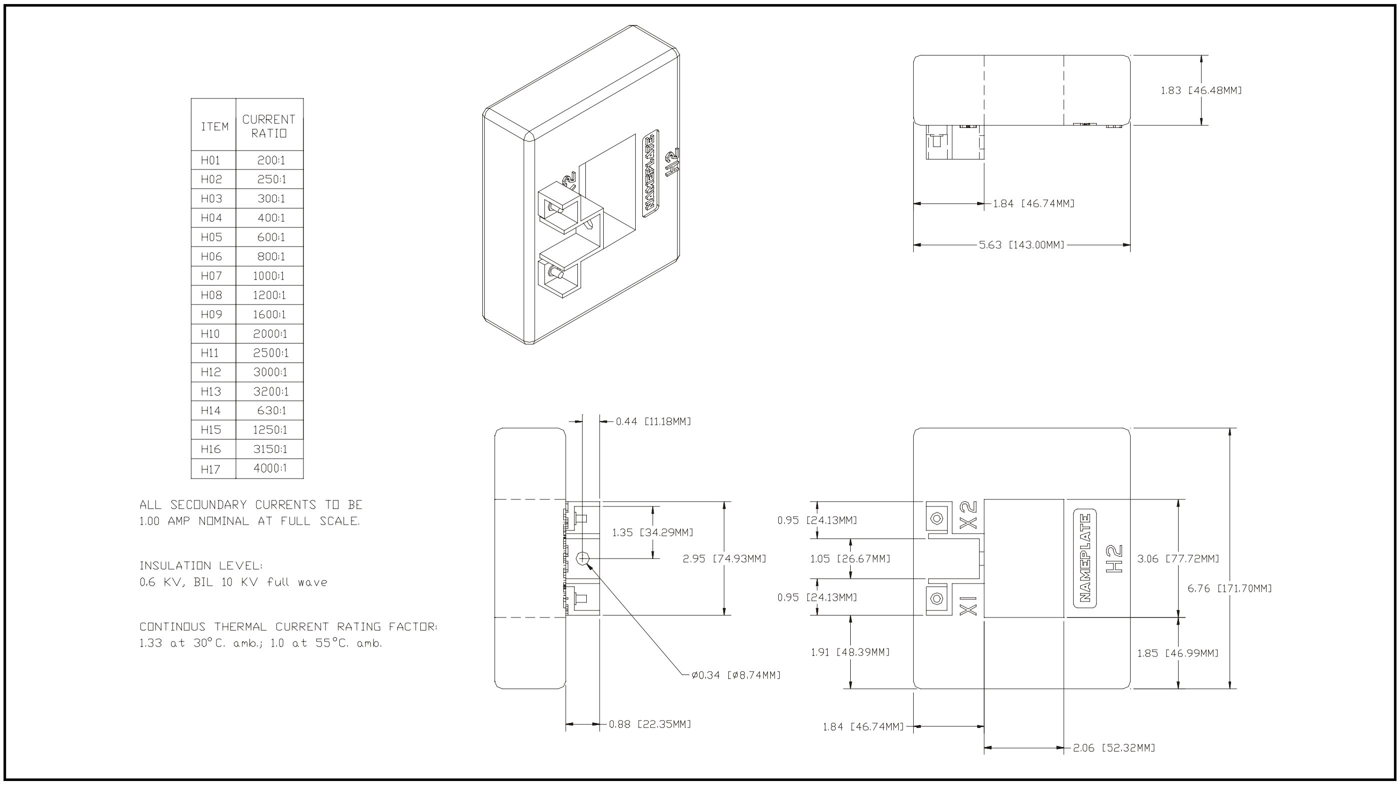
Notes:

① In this scheme, all breaker secondary currents (at the 100mA level) are summed together at the PC board donut transformer to sense ground fault via element R_5.

② In this scheme, the current sensors in the breaker poles are parallel-wired to achieve a 4000 amp breaker rating. Other available ratings in this double-wide configuration are 6300A, 6000A, 5000A, 3200A, 2500A, and 2000A.

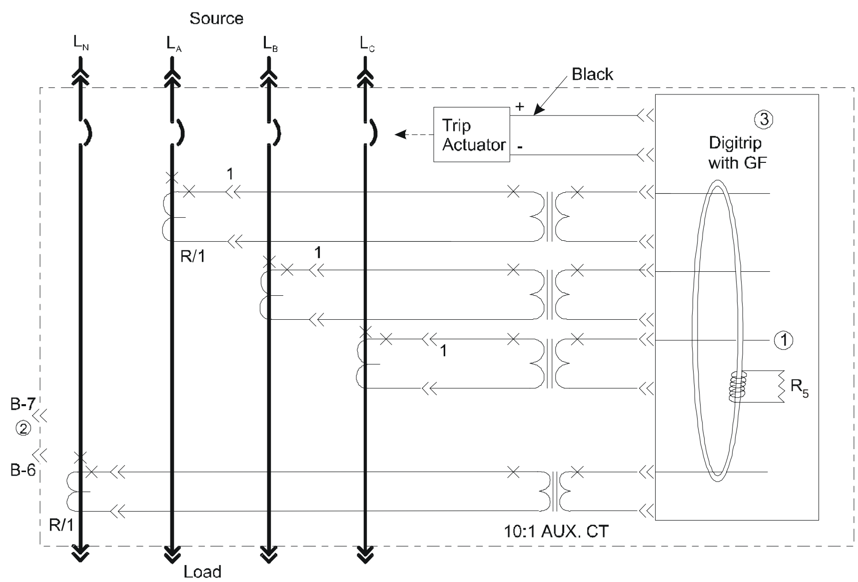
③ Shown is ABCABC bus configuration.

Figure 2.3 Neutral Sensor Connections for Double Wide Circuit Breaker Using Residual Ground Fault Sensing



ITEM	CURRENT RATIO
H01	200:1
H02	250:1
H03	300:1
H04	400:1
H05	600:1
H06	800:1
H07	1000:1
H08	1200:1
H09	1600:1
H10	2000:1
H11	2500:1
H12	3000:1
H13	3200:1
H14	630:1
H15	1250:1
H16	3150:1
H17	4000:1

Figure 2.4 Digitrip Neutral Sensor Types



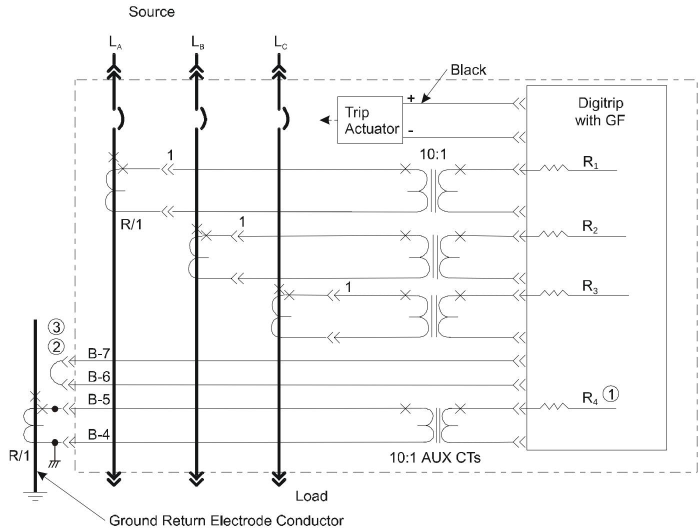
Notes:

① In this scheme, all breaker secondary currents (at the 100 mA level) are summed together at the PC board donut transformer to sense ground fault via element R_5.

② Do not jumper secondary contacts B-6, B-7. **This will defeat all ground fault protection in application for 4 pole breaker.**

③ Ground fault style trip unit is installed.

Figure 2.5 4-Pole-3200A Standard Circuit Breaker Using Residual Ground Fault (Earth-Fault) Sensing



Notes:

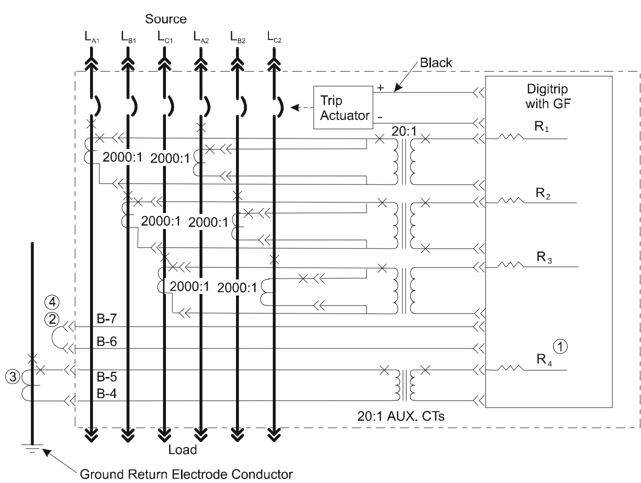
Typical Application - Main

① In this scheme, the residual sensing element R_5 is not used. The ground current is direct true ground current and is sensed directly via element R_4.

② A <u>jumper is required</u> on B-6, B-7 (secondary contacts) to program the Digitrip 1150 to use element R_4 and input on B-4, B-5 directly for source ground sensing.

③ **This scheme is not applicable to 4-pole breakers. No secondary contacts (B-4 and B-5) are available on 4-pole breakers. Do not jumper B-6, B-7 in 4-pole applications.**

Figure 2.6 Source Ground Fault Sensing Scheme for Standard Circuit Breaker



Notes:

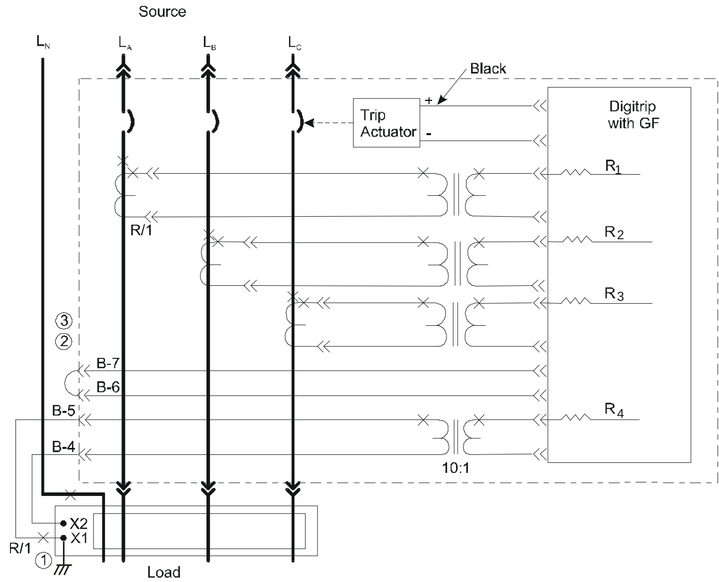
① In this scheme, the current sensors in the circuit breaker poles are parallel-wired to achieve a 4000 Amp circuit breaker rating. The ground fault is sensed directly via element R_4.

② A <u>jumper is required</u> on B-6, B-7 secondary contacts to program the Digitrip 1150 to use element R_4 directly for source ground sensing. If the circuit breaker is removed from the cell (B-6, B-7), jumper disconnected, Residual Ground setting will apply.

③ Source ground sensor input is via B-4, B-5. Source ground current input to secondary contacts is 2A, equivalent to one per unit ground. For example: Applying a 400:1 sensor - Use 800:2 ratio and use 800A value to calculate the ground pickup setting.

④ The scheme is not applicable to 4-pole circuit breakers. No secondary contacts (B-4 & B-5) are available on 4-pole circuit breakers. DO NOT jumper B-6, B-7 in 4-pole applications.

Figure 2.7 Source Ground Fault Sensing Scheme for Double Wide Circuit Breaker



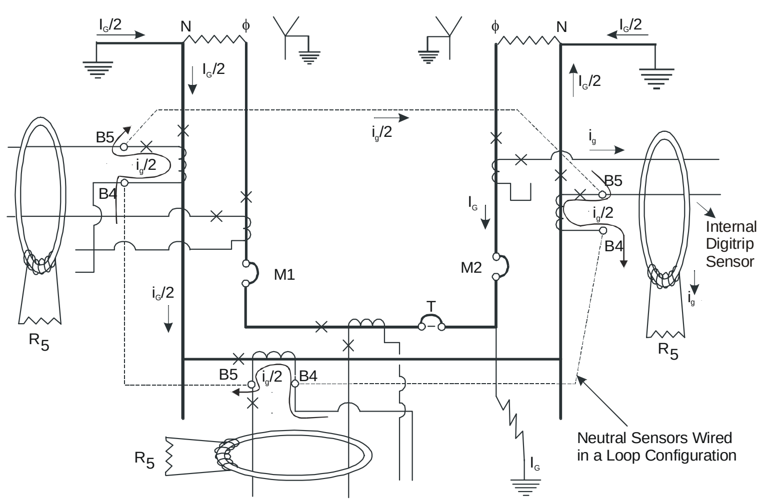
Notes:

① This scheme uses a large zero sequence CT to magnetically sum the currents and the output is sensed via element R_4.

② A jumper is required on B-6, B-7 to program the Digitrip to use element R_4. If the breaker is removed from cell (B-6,B-7) jumper disconnected, Residual Ground settings will apply.

③ The scheme is not applicable to 4-pole breakers.

Figure 2.8 Zero Sequence Sensing Scheme for Standard Circuit Breaker



Notes:

Breaker M2 trips since this is the only breaker seeing the I_G fault via element R_5.

No jumper on B-6, B-7 terminals - all breakers are programmed for standard Residual Ground Fault protection.

AUX CTs not shown. Wiring needed at system level is shown as a dotted line.

Capital letters represent primary current. Lowercase letters represent secondary current.

The three breakers (M1, M2, and T) must all have the same breaker/sensor rating.

Figure 2.9 Multiple Source/Multiple Ground Scheme

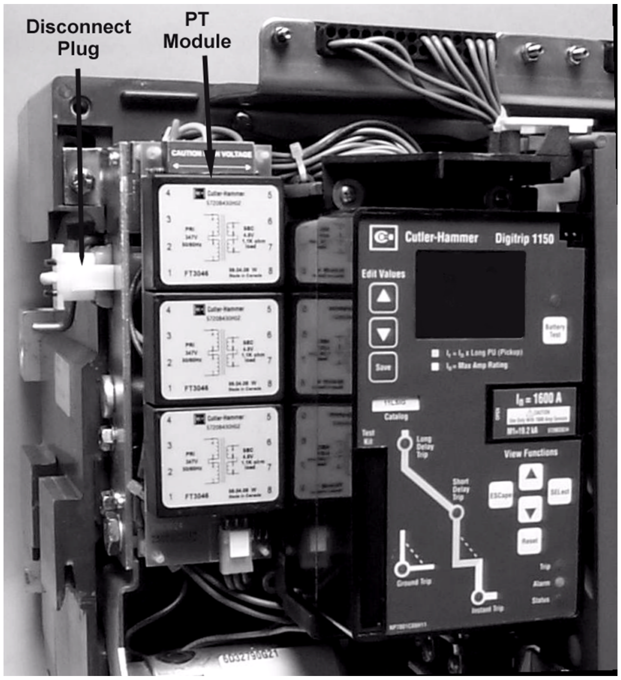


Figure 3.0 PT Module with Dielectric Disconnect Plug

4.0 PROGRAMMING/VIEWING DIGITRIP 1150 *(VIA FRONT PANEL)*

4.1 Main Menu

4.1.1 Power Up Sequence

When the Digitrip 1150/1150i unit is first powered-up, two different display messages are possible. If the Digitrip has been previously commissioned with customer-made settings, the display will alternate between “Customer Settings in Use” and “Eaton-Electrical DT 1150” messages. Following this the display will enter into the main menu *(See Appendix D-1).*

If Digitrip settings have not been saved previously the trip unit is using the factory default values. On power up, the Digitrip will then display “CHANGE FACTORY SETUP?”. This message will stay on the screen until the user presses ESCape or the SELect pushbutton or until an alarm or trip condition is detected.

The ESCape pushbutton action will keep the factory settings and then will enter the main menu. The factory settings are listed in Appendix D-25 and are not valid for most applications. The appropriate settings need to be defined by a qualified application engineer to provide best overall protection and coordination for the power system.

A SELect pushbutton action will provide direct entry into PROGRAM SETTING menu. The first item presented is the Current CURVE type. LSIG or IEEE or (IEC) current curve types are possible selections depending on trip unit style. Pressing SELect again will select the curve presented in the window center and then step into the individual elements that need programmed. The VIEW up and down arrow selects the function while the EDIT up and down arrow changes value. After they are set they need to be saved by depressing the SAVE pushbutton. The saving will place the customer settings in use. Verify the new settings. See Appendix D-13 for program curve and D-19 for saving and D-5 for view setting menu.

4.1.2 Pushbutton Definition

View Functions

The “View Functions” group of pushbuttons is located in the lower right hand side of the unit and includes the View Up (up arrow), View Down (down arrow), ESCape, SELect, and Reset buttons.

View Up / View Down - View Up and View Down allow the user to scroll through any available menu or submenu in the Digitrip 1150 display.

SELect - The SELect pushbutton selects the submenu for the blinking selection located in the middle of the display.

ESCape - The ESCape pushbutton brings the user up to the previous menu in the display. Multiple ESC pushbutton operation will display Main Menu screen.

Reset - The Reset pushbutton will reset LEDs and screen data *(See Reset Sequence).*

Edit Values

The “Edit Values” group located in the upper left hand corner of the Digitrip 1150 unit consists of 3 pushbuttons: Edit Up (indicated by an up arrow), Edit Down (down arrow) and Save. The Edit Values pushbuttons are covered by a Plexiglass cover which can be sealed.

Edit Up / Edit Down - Edit Up and Edit Down allow the user to scroll up or down, respectively, through available setting values while in any Program Settings submenu. In the Test Menu, these buttons will raise or lower the test level when performing a self test.

Save - The Save pushbutton allows the user to save a group of selected programmable settings from any submenu in the PGM SET menu. Save is also used in the

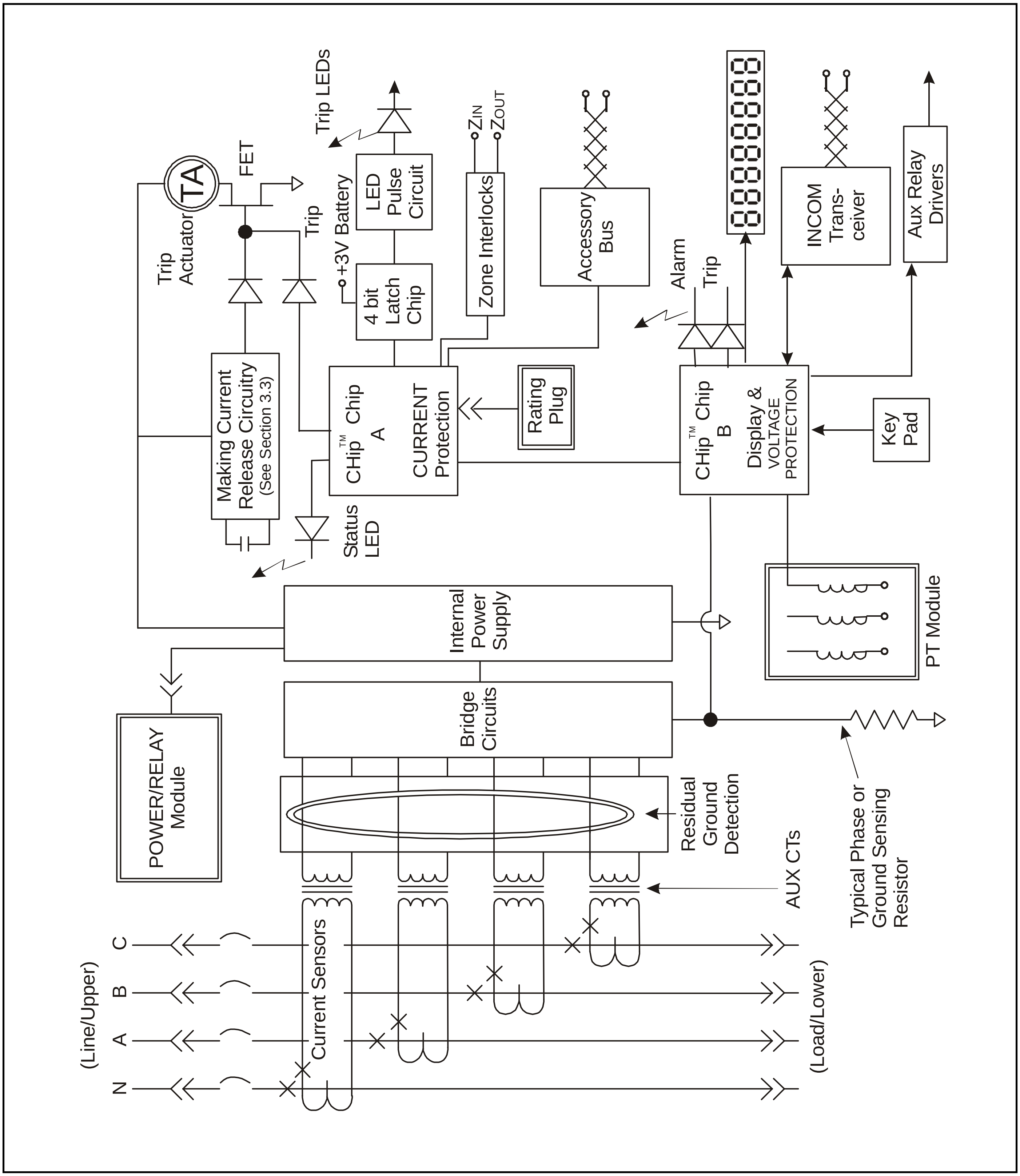


Figure 3.1 Digitrip 1150 Block Diagram with Circuit Breaker Interface

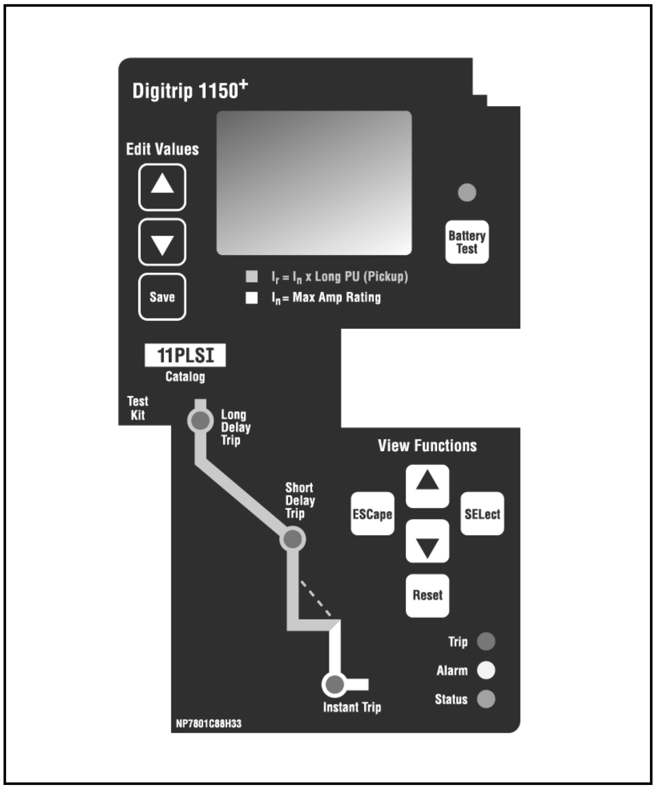


Figure 3.2 Digitrip 1150 LSI

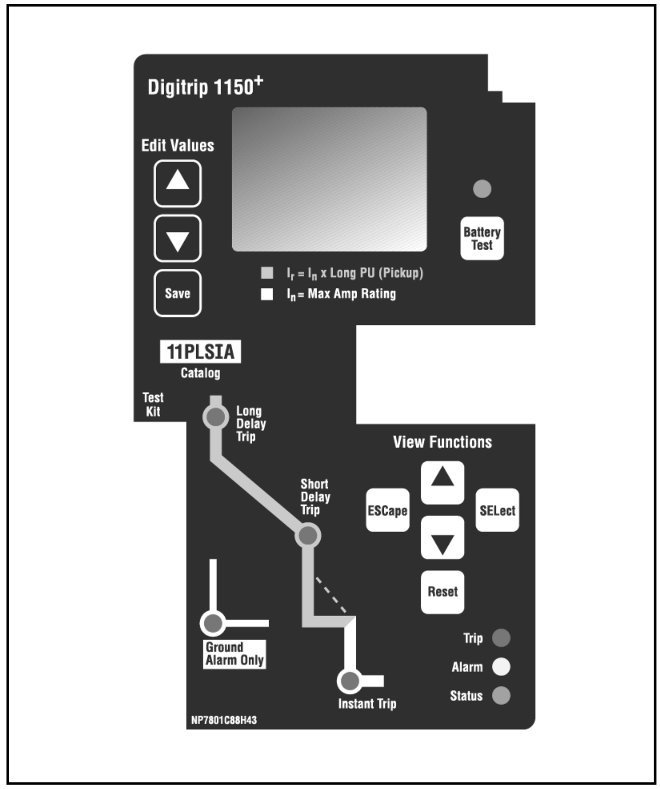


Figure 3.3 Digitrip 1150 LSIA

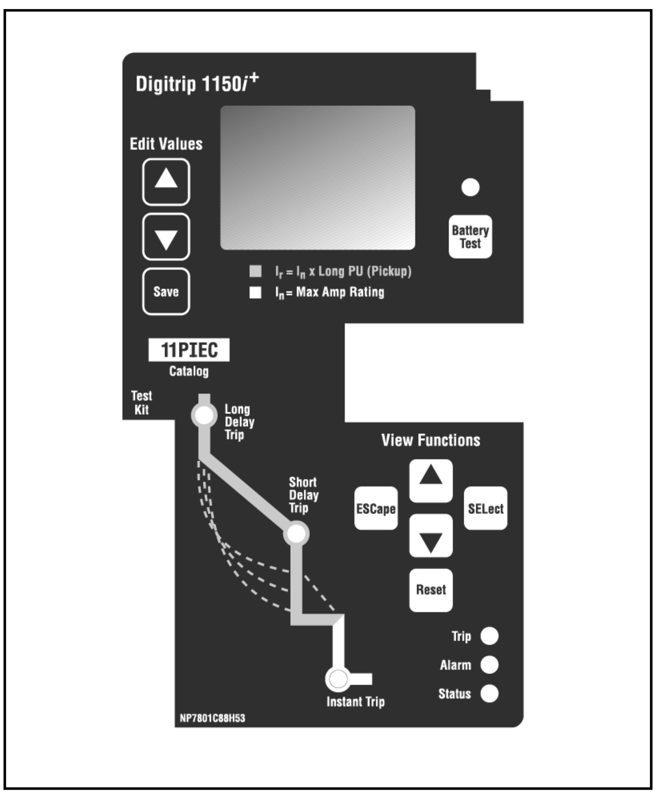


Figure 3.4 Digitrip 1150i IEC

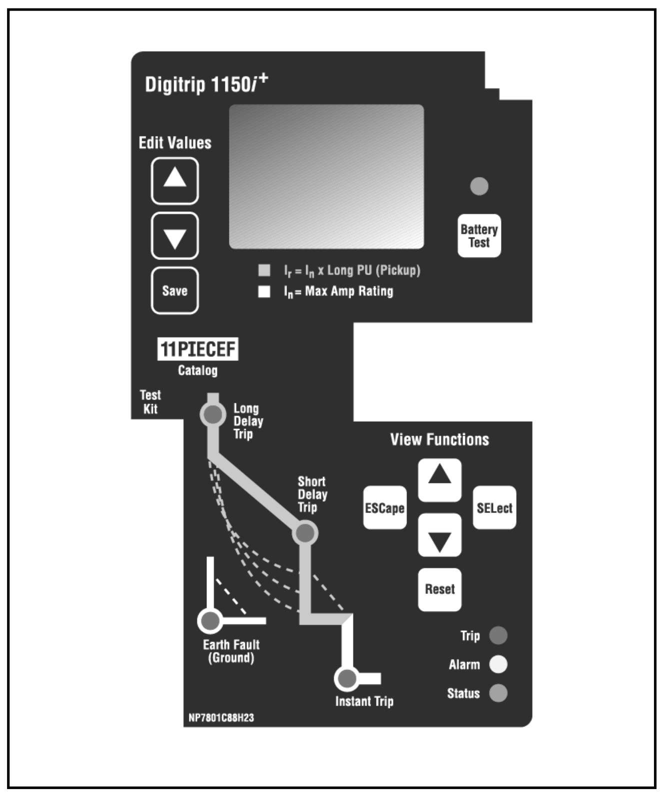


Figure 3.5 Digitrip 1150i IEC-EF

TEST Menu. When prompted, pressing Save will begin the selected test.

Battery Test - The Battery Test pushbutton is located on the right side of the Digitrip 1150 unit, just above the rating plug door. Battery Test will light the green LED located above the pushbutton to ensure proper voltage in the battery.

4.1.3 Blink mode

Middle Blinking - The middle display, if blinking, indicates that the menu item is selectable or that a submenu exists when a selection brings up another menu with middle text blinking.

4.1.4 Programming/Viewing Screens

The View Functions control screen viewing, while Edit Functions apply to programming and storing settings. **ALWAYS VERIFY PROGRAMMED SETTINGS BY ENTERING VIEW SETTINGS AFTER SAVING.**
All screens are viewable depending on the programmed settings and/or Digitrip 1150 model. In particular, the METER submenu may be programmed to include anywhere from one to 22 viewable screens when METER is selected, based on the settings chosen in the PGM SET\DISPLAY screens. Similarly, certain screens are only viewable based on availability. For example, in the PGM SET\AuxRLY menu, the selected relay determines the programmable groups displayed. See Appendix D.

Depending on the Digitrip 1150 model, certain menus or screens are not viewable or programmable. When using the LSI factory style unit, viewing and programming menu screens involving Ground or Earth settings are not accessible. When using the LSIG factory style unit, viewing and programming screens involving Neutral Protection are not displayed.

4.1.5 Reset Pushbutton Operation (After Trip)

4.1.5.1 Trip Events

A Reset pushbutton operation does the following after a trip:

a. Clears the cause of trip flashing LEDs (4) after a trip event
b. Clears the Trip LED
c. Clears Display data

Note: After a Trip Event

1. Observe any Trip LED flashing on Mimic Curve.
2. Observe message on LED display.
3. Push View Down pushbutton to observe timestamp of event and view down to observe trip current data. This data, along with timestamp will also be stored in Event Log. The maximum trip current value that can be displayed is 65535 A.
4. After any trip condition, the trip unit should be reset by pressing the Reset Pushbutton. *(See section 4.1.4.2 on pending Alarm Events)*
5. Reclose circuit breaker as desired.

See Appendix D-4 for possible Trip Events and screen data displayed after a trip by using the View Down (down arrow) pushbutton.

4.1.5.2 Alarm Events

Alarms are tracked in real time and a Reset pushbutton may momentarily clear the alarm but the Alarm LED and Alarm message will reappear if condition is still present.

The ESCape pushbutton activation will remove the alarm message from the display and return to normal menu viewing mode, but the yellow alarm LED will remain lit, as the alarm is in the system *(See Appendix D-22).*

Note: A way to clear an alarm if desired, after reviewing the alarm and its associated data, is to enter the PGM SET Menu followed by the ALARM submenu. The user can then revise or turn off the associated alarm set point value.

See Appendix D-4 for possible Alarm Events and D-22 for multiple Alarm conditions.

4.1.5.3 Data resets in Meter screen

A Reset pushbutton operation will reset data values or group of values if the Reset pushbutton is depressed when screen value is displayed *(See Appendix D-3 Meter Menu).*

4.2 Program Settings PGM SET

4.2.1 Current Curve Type Selection and Pickup/Time Settings

4.2.1.1 General

Before placing any circuit breaker in operation, set each trip unit protection setting to the values specified by the engineer responsible for the installation. Each setting is programmed using the front panel pushbuttons and Save when the desired settings are selected. A few settings are interdependent (the LONG PU (*I*r) rating will indirectly affect the SHORT PU value). **Therefore, always verify these settings after programming by entering View Settings Menu.**

The installed rating plug must match the current sensors which establish the maximum continuous current rating of the circuit breaker (*I*n). Instantaneous and ground current settings are defined in multiples of (*I*n).

To illustrate the effect of each protection setting, simulated time-current curves are pictured on the face of the trip unit. Should an automatic trip occur (as a result of the current exceeding the pre-selected value), the LED in the appropriate segment of the simulated time-current curve will flash red, indicating the reason for the trip.

All Digitrip 1150 and Digitrip 1150*i* offer the LSI(G) curve as the standard factory default. The five segment straight line curve of LONG PU and Time, SHORT PU and Time, and INSTantaneous PU are depicted on the nameplate of the product. The GROUND (EARTH) element is shown also on styles with Ground Fault Protection. The LSIA style has Ground Alarm Only function *(See Appendix D12-D13).*

A second curve selection is also possible for UL/ANSI styles. An IEEE curve that accurately follows the Inverse-Time characteristic equations can be selected (IEEE draft PC37.112-11/95). Curve shapes of MODerately INVerse, VERY INVerse or EXTremely INVerse are available under PHASE SLOPE. Each of these curve shapes have a PICKUP and TimeDIAL selection to position the curve. The short delay function is included as part of IEEE curve.

For the Digitrip 1150*i*, a second curve type is also possible for the international styles. An IEC curve type that accurately follows the IEC255 curve equations can be selected. The curve shapes of IEC-A (normal inverse), IEC-B (very inverse) and IEC-C (extremely inverse) are available under PHASE SLOPE. Each of these curve shapes have a PICKUP and TimeDIAL selection to position the curve. The short delay function is included as part of IEC curve.

The available settings, for the LSIG standard curve along with the effects of changing the settings, are described below and in Figures 4.1 through 4.8. Sample settings are represented in boxes (e.g. ☐)

4.2.1.2 LONG SLOPE Setting

There is a I^2t or I^4t curve shape selection possible for LONG SLOPE.

4.2.1.3 LONG PU Setting

There are thirteen available Long Delay Settings as illustrated in Fig. 4.1. Each setting, called (*I*r), is expressed as a multiple (ranging from .4 to 1) of *the current (I*n).

NOTE: (*I*r) is also the basis for the Short Delay Current Setting *(See Section 4.4).*

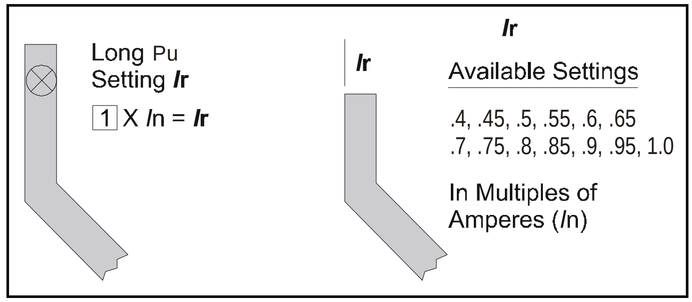


Figure 4.1 Long PU Settings

4.2.1.4 LongTIME Setting

There are forty five available Long Delay Time Settings I^2T, as illustrated in Figure 4.2, ranging from 2 to 24 seconds. For the I^4t slope there are nine settings ranging from 1 to 5 seconds. These settings represent the total clearing times when the current value equals six times (*I*r).

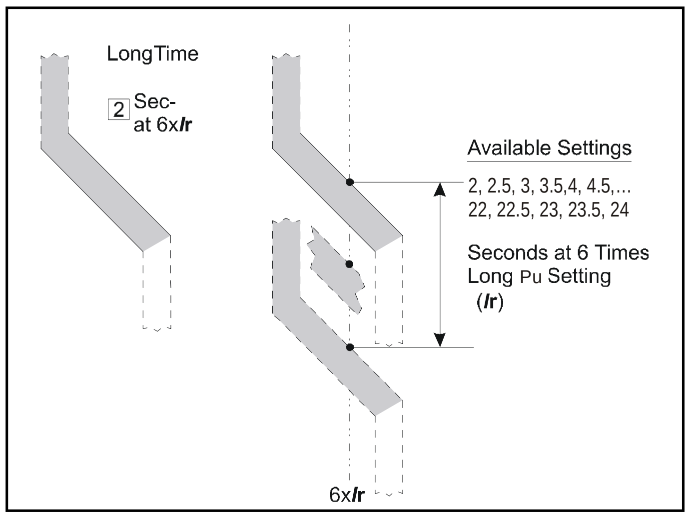


Figure 4.2 Long Delay Time Settings

NOTE: In addition to the standard Long Delay Protection Element, the Digitrip 1150 trip units using LONG SLOPE settings of I^2t or I^4t also have a Long Time Memory (LTM) function, which protects load circuits from the effects of repeated overload conditions. If a circuit breaker is closed soon after a Long Delay Trip, and the current again exceeds the Long Delay Setting, (*I*r), the LTM automatically reduces the time to trip to allow for the fact that the load circuit temperature is already higher than normal because of the prior overload condition. Each time the overload condition is repeated, the LTM causes the circuit breaker to trip in a progressively shorter time. When the load current returns to normal, the LTM begins to reset; after about 10 minutes it will have reset fully, so the next Long Delay trip time will again correspond to the Setting value.

NOTE: In certain applications and field testing, it may be desirable to disable the LTM function by disabling this function in Program Settings.

The action of the LTM must be considered when performing multiple Long Delay Time tests *(See Section 5.4).*

4.2.1.5 SHORT PU Setting

There are at least nineteen available Short Delay Current Settings, as illustrated in Figure 4.3. Eighteen settings are in the range from 1.5 to 10 times (*I*r). ***REMEMBER:*** (*I*r) *is the Long PU Current Setting.* The maximum value M1 depends on the sensor rating of the circuit breaker and is listed in Note 3 of Table 1.1.

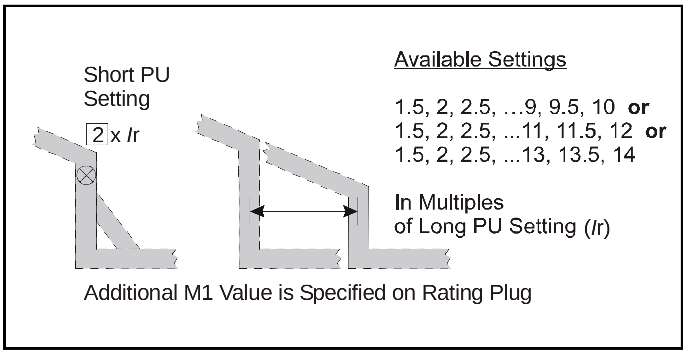


Figure 4.3 Short Delay Current Settings

4.2.1.6 SHORT TIME Setting

As illustrated in Figure 4.4, there are two different Short Delay Slopes: fixed and I^2t. The shape selected depends on the type of selective coordination chosen. The I^2t response curve will provide a longer time delay for current below 8 x *I*r than will the FLAT response curve.

NOTE: The I^2t response for Short Time is not available if LongTime is set for I^4t, IEEE or IEC curve.

Nine FLAT and nine I^2t response time delay settings are available. The I^2t response is applicable to currents less than 8 times the ampere rating of the installed rating plug (*I*r). For currents greater than 8 x (*I*r) the I^2t response reverts to the FLAT response.

NOTE: Also see Section 3.4, Zone Interlocking.

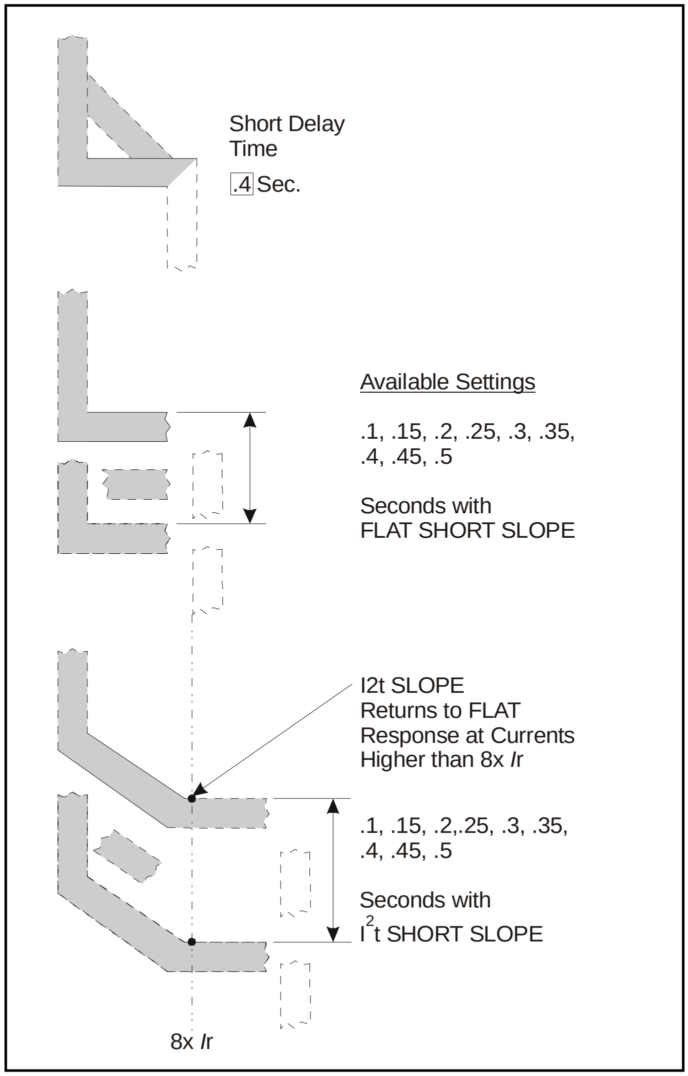


Figure 4.4 Short Time Settings

4.2.1.7 INST PU Setting

There are at least 18 available Instantaneous Current Settings, as illustrated in Figure 4.5. The value that M1 has depends upon the sensor rating of the circuit breaker and is specified both on the rating plug label and on the applicable time-current curves referenced in Section 9.2. The Instantaneous Pickup is based on the plug (*I*n) rating.

4.2.1.8 GND PU Setting

The Ground Fault Current Settings are labeled with values from .24 to 1.0x (*I*n) in 0.01 increments *(See Figure 4.6).* The ANSI/UL models are limited to 1200A, as shown in Table 1.1. The IEC-EF model Earth Pickup range is 0.10 to 1.0x (*I*n) with no 1200A limitation. External control power is required to insure earth fault tripping for fault currents and earth fault setting less than .24 per unit.

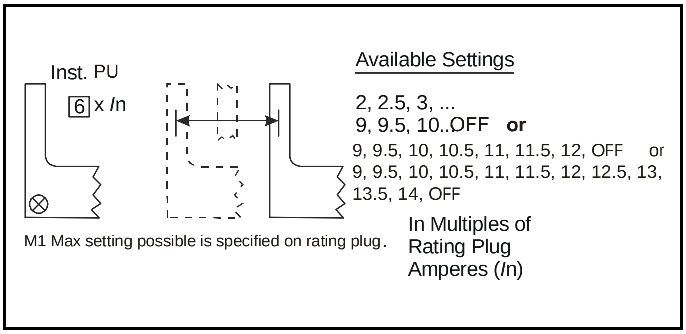


Figure 4.5 Instantaneous Current Settings

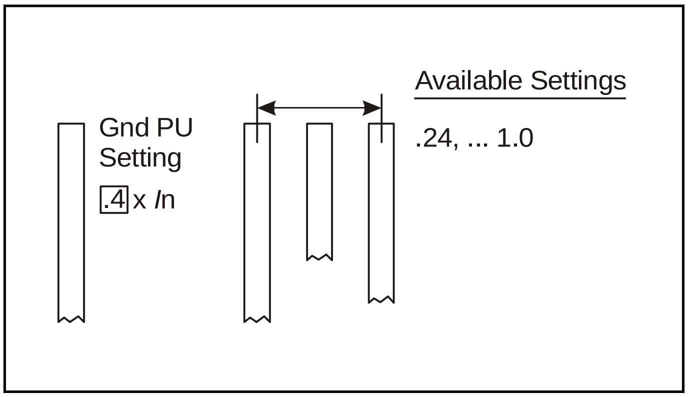


Figure 4.6 Ground Fault Current Settings

4.2.1.9 GROUND TIME Setting

As illustrated in Figure 4.7, there are two different Ground Fault Slopes: fixed time (FLAT) or I^2t response. The shape selected depends on the type of selective coordination chosen. The I^2t response will provide a longer time delay for current below 0.625 x *I*n than will the FLAT response.

Nine Ground Time Settings for both FLAT and I^2t responses for currents less than 0.625 times the ampere rating of the installed rating plug (*I*n). For currents greater than 0.625 x (*I*n) the I^2t response reverts to the FLAT response.

NOTE: Also see Section 3.4, Zone Interlocking.

In addition to standard Ground Fault protection, the Digitrip 1150 Trip Unit also has a GROUND FAULT MEMORY function which serves to protect loads in the event of a sputtering arc to ground. Without this function, the trip unit resets each time the arc sputters, and times out all over again, so that a sputtering fault may not be detected. With the GROUND FAULT MEMORY function, the trip unit "remembers" the sputtering ground current for up to ten (10) times the Ground Fault Time Setting. After that time, it resets automatically. The GROUND FAULT MEMORY function resets quickly; on the 0.1 second setting, for example, the function will reset in 1.0 second.

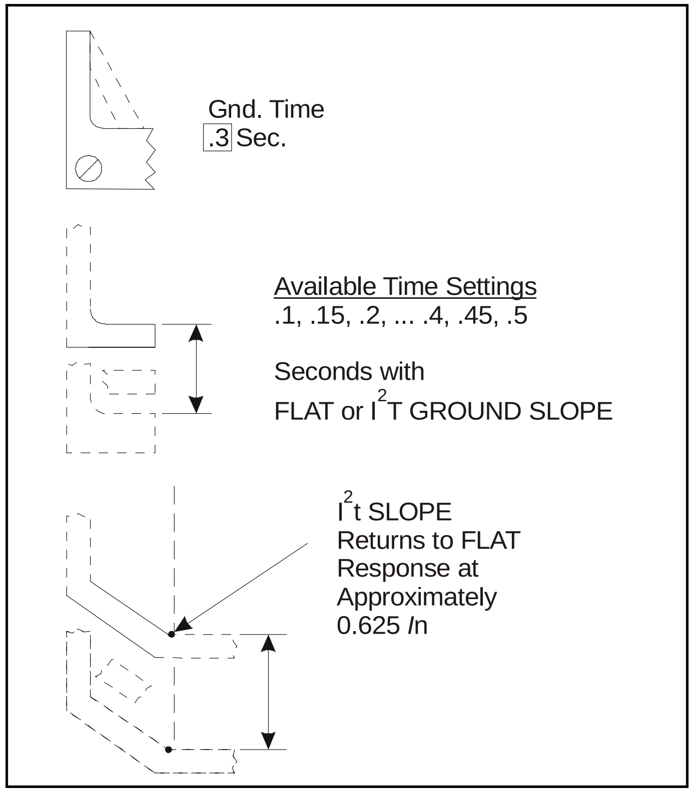


Figure 4.7 Ground Fault Time Delay Settings

4.2.1.10 AMP UNBALANCE, PHASE LOSS

4.2.1.10.1 Amp Unbalance

The Amp Unbalance trip function can be selected in the Program Settings - Program Curve menu *(See Appendix D-12)*. It is set to OFF as a factory default. The pickup unbalance is adjustable from 5% to 25%. Once selected, an associated time delay is adjustable from 0 to 240 seconds with initial factory default of 10 seconds. The setting time tolerance is +/- 3% or +/- 0.3s (whichever is greater). A difference between Max phase and Min phase higher than the Amp Unbalance % settings will cause the breaker to trip with an AMPERES OUT OF BALANCE message and red Trip LED illuminated in the right corner of the Digitrip front panel. **This function does require external auxiliary power to the Digitrip unit.** To avoid unnecessary operation of this function the circuit breaker must be carrying 55% of the *I*r rating on at least one phase before it will trip via Amp Unbalance.

4.2.1.10.2 Phase Loss - (Current Based)

The phase loss trip function can be selected in the Program Settings - Program Curve Menu *(See Appendix D-12).* It is set to OFF initially as a factory default. A Time Delay of 1 to 30 seconds can be selected. If there exists a 75% difference between the Max phase and Min phase currents and if maintained for the selected time delay, the breaker will trip with a PHASE LOSS TRIP message and red Trip LED illuminated in the right corner of the Digitrip front panel. **This function does require auxiliary power to the Digitrip unit.** To avoid unnecessary operation of this function the circuit breaker must be carrying 55% of the *I*r rating on at least one phase before it will trip via Phase Loss.

4.2.2 Voltage - Frequency, Reverse Power

Refer to Table 1.1d for a tabulation of functions available versus the catalog number. Voltage and Frequency and Reverse Power tripping and/or Alarming can be set by entering the VOLTAGE menu under the Program Setting main menu. Please refer to Appendix D-23 for the trip settings available and Appendix D-16 for the Alarm settings available. The Alarms can be mapped to Relay A and the Trips to Relay B and Relay C for desired relay contact action.

The Voltage function (Frequency and Reverse Power included) has a master switch "voltage setting" [enabled/disabled] that can toggle all voltage related trip and alarm settings. The individual selections can, in addition, be enabled or disabled as desired.

NOTE: When programming the Voltage or Frequency setting for Trip or Alarm, there exists a setting interdependancy feature that prevents the user from making an "over-lapping" under and over value combination. When this condition is encountered, change the value or disable the "opposite" setting temporarily to achieve the desired setting.

4.2.2.1 Voltage, Frequency Protection

These functions, unlike the LSIG Current protection functions, do require a reliable source of auxiliary power available on circuit breaker secondary contacts A-14, A-15. If the circuit breaker is equiped with the 24-48VDC Power/Relay Module, the (+) voltage input is terminal A-14.Refer to the breaker information label for proper trip unit power voltage and see also Section 1.6 and Appendix C.

The Voltage is sensed on all three phases. Any phase to phase voltage exceeding the specified setting will activate the protection function. The voltage sensing points are the main conductors at the top of the circuit breaker. This is the factory wired setup. A factory option does exist to enable bottom end of circuit breaker sensing of voltage.

NOTE: Frequency is sensed on phase A voltage input.The Frequency Trip, Voltage Trip or Alarm function will not be active if this voltage falls below 84 volts phase to phase.

4.2.2.2 Voltage, Frequency Trip

Voltage and Frequency Protection Trip functions, if enabled, are active whenever the circuit breaker is closed.These trip functions are made inactive after a trip or when the circuit breaker opens. The function will be rearmed when the circuit breaker is reclosed. Observe the cause of trip message after a trip event then reset the Digitrip by depressing the Reset pushbutton. At this time observe the real time data of the parameter that initiated the trip to see if it is still beyond the specified limit. Voltage and frequency data in the Meter menu is real time data independent of whether the circuit breaker is open or closed. Enter the EventLog menu and observe the event that initiated the trip. When the parameter returns to within its limits, reclose the circuit breaker if desired.

4.2.2.3 Voltage, Frequency Alarms

These alarms can be enabled by the user by entering the Program Settings and then the Alarms submenu.Alarms are real time and are active when the circuit breaker is in either the open, closed or trip state. The alarm LED will light to indicate an alarm condition.

NOTE: If an UnderFrequency or OverFrequency Trip or Alarm is enabled, the following restriction applies: Trip units used on 50 Hz systems have valid frequency sensing range of 43 to 59 Hz. Trip units used on 60 Hz systems have a valid frequency sensing range of 51 to 70 Hz. All trip units leave the factory set for 60 Hz. For frequencies outside the applicable range, the unit will display the alarm message "FREQ OUT OF BOUNDS".

This alarm message also can occur if the system frequency setpoint does not match the nominal power system frequency. If this message is encountered, check or change the frequency setting in the System menu. The FREQ display screen in the Meter sub-menu will display dashes, "-----", instead of a numerical frequency.

The circuit breaker will not initiate a frequency related trip when programmed to provide frequency tripping for frequencies out of bounds. However, the alarm relay Relay A, if programmed for frequency alarming, will operate during an out of bounds condition as well as within the valid frequency range of operation.

EXAMPLE 1 (Assumes line to line voltage > 84V)

ProGRam SETting
SYSTEM FREQ **60Hz**
VOLTAGE VOLTAGE SETTINGS **ENABLED**
UnderFREQ TRIP **58.0Hz**
ALARMS
UndrFREQ ALARM **59.0Hz**
AuxReLaY **A**
RELAY A UF ALARM **ENABLED**

Applied Freq.	TRIP	UF ALARM	FREQ OUT OF BOUNDS ALARM	RELAY A Operation
1 to 50.8	NO	NO	YES	YES
51.1 to 57.95	YES	YES	NO	YES
58.1 to 58.95	NO	YES	NO	YES
59.0 to 69.7	NO	NO	NO	NO
>70	NO	NO	YES	YES

EXAMPLE 2 ProGRam SETting
SYSTEM FREQ **50Hz**
VOLTAGE VOLTAGE SETTINGS **ENABLED**
UnderFREQ **49.8Hz**
OverFREQ **50.2** Hz
ALARMS
UndrFREQ **49.8Hz**
OverFREQ **50.2Hz**
AuxReLaY **A**
RELAY A UF ALARM **ENABLED**
RELAY A OF ALARM **ENABLED**

Applied Freq.	TRIP	UF ALARM	OF ALARM	FREQ OUT OF BOUNDS ALARM	RELAY A Operation
1 to 42.9	NO	NO	NO	YES	YES
43.1 to 49.5	YES	YES	NO	NO	YES
49.85 to 50.15	NO	NO	NO	NO	NO
50.3 to 58.7	YES	NO	YES	NO	YES
>59	NO	NO	NO	YES	YES

Table 4.1 Examples of the Circuit Breaker and Relay A Operation Versus Frequency

The setting range for UnderFrequency or OverFrequency tripping and alarming is 48.0 to 52.0 Hz for a 50 Hz System and 58.0 to 62.0 Hz for a 60 Hz System.

Table 4.1 includes two examples of the circuit breaker and Relay A operation.

Voltage Unbalance is adjustable from 5 to 50% in steps of 1%. A difference between Max Phase and Min Phase higher than the Voltage Unbalance setting, times Min Phase Voltage, will activate the function.

4.2.2.4 Voltage, Frequency Relays A,B,C

Relay A, a normally open contact, can be mapped to an Alarm condition, which can provide a real time contact information of these parameters: UnderVoltage, OverVoltage, UnderFrequency, OverFrequency and Voltage Unbalance. Each alarm setting does have a separate time delay adjustment.

The Phase Rotation Alarm can be set to ABC or CBA or OFF in the Alarm menu. *(See Appendix D-16)* This setting if encountered in application will generate an alarm condition. Phase Rotation Alarm can then be mapped to this Relay A. With this contact an interposing relay with time delay can be employed to provide time delay and contact arrangements to interface with the circuit breaker's closing circuit (spring release coil) to either prevent closing or to open the circuit breaker (Shunt Trip coil). Relay B and Relay C can also be mapped to the Voltage or Frequency TRIP. These include UnderVoltage, OverVoltage, UnderFrequency, OverFrequency and Voltage Unbalance Trip and Reverse Power Trip. In addition Relay B and Relay C together will share a Manual or Auto Reset selection. This is provided in the SYSTEM menu and will provide means to reset the Relay B and Relay C associated contacts. The default setting is MANUAL reset. The resetting of these is accomplished via the Reset pushbutton. The AUTO Reset setting will automatically reset these two relays within five seconds after the trip event.

The Phase Rotation setting should be programmed in the Alarm menu to alarm when the Digitrip encounters this Phase Rotation setting.

4.2.3 INCOM

INCOM programming *(See Appendix D-11)* allows for five different setting options. These include address (001 – FFE in hexadecimal form), baud rate (9600 or 1200), and enabling or disabling external communications trip (EXT COMM OpenTrip) and external communications close (EXT COMM CLOSE). The latter two settings will allow or disallow remote control of the circuit breaker via the computer.

The fifth setting is the DT 910 COMM mode. When enabled, the trip unit will adopt the Digitrip 910 communications protocol. This means that while the trip unit continues to execute all Digitrip 1150 functionality, the unit only transmits those messages pertaining to the Digitrip 910 and will be identified as a 910 unit to a communicating master device.

4.2.3.1 Assemblies Electronic Monitor (AEM II) and Breaker Interface Monitor (BIM) and BIM II

An Assemblies Electronic Monitor (AEM II) can be applied in the same assembly with the circuit breakers or at a location remote from the circuit breakers to monitor the information from any of the Digitrip 1150 Trip Units. The connections in the network are made by twisted pairs of wires. The AEM must use the Digitrip 910 communication setting. Its valid addresses are 001 through 050 decimal.

The Breaker Interface Monitor (BIM) can also be used to monitor the Digitrip 1150 trip unit. However, with BIM must also use “Digitrip 910” setting of the Digitrip 1150 product.

The above two devices mentioned can receive minimum communication from the Digitrip 1150 when set in the DT 910 mode and is not recommended for new installations. The BIM II is the preferred monitoring device to be used with the Digitrip 1150. Its range of acceptable addresses are 001 through 032 hexadecimal.

4.2.3.2 Remote Master Computer and BIM II

When desired, Digitrip 1150 Trip Units can communicate with both an Breaker Interface Monitor (BIM II) and a remote master computer (IBM PC compatible with Cutler Hammer Inc. CONI card or MINT). *(See Figure 4.8)*

4.2.3.3 INCOM Network Interconnections

INCOM sends bursts of data on a 92 to 115.2 kHz carrier at rates up to 9600 baud over twisted pair conductors to interconnect the many devices comprising the network.

The Digitrip 1150 will light the red LED shown in Figure 1.1 when transmitting on INCOM.

Recommended cable specifications:

- Cutler-Hammer Inc. cable catalog #IMPCABLE, Style #2A95705G01
- Belden 9463 cable family
- Identical Commscope or Quabbin cables

These bursts of data can be captured and used in a variety of ways depending upon the manner in which the master computer software program is written. For example, all the settings (protection and alarm) can be programmed and viewed via the master computer. Another example is that the data for the individual phase current values are available on the network, but the software must select the appropriate data, decode it and display it in a useful manner. Following an over-current trip operation, the sequence of coded data varies slightly. The cause of trip and the value and phase (or ground) current responsible for the trip are available on the network.

4.2.4 Aux ReLaY

The programmable Auxiliary Relays in the Digitrip 1150 consist of Relay A (Alarming and Tripping), Relay B (Block Close function), and Relay C (Latch relay). If at least one relay function is enabled, an asterisk will appear beside the relay letter in the menu. More than one relay function can be assigned to a physical relay except for the pulse initiator selection. The selection of Relay A, B or C results in further selection of three “groups” of settings. Relay A, when selected, gives the option to enable or disable the pulse initiator and enable kVAh or kWh settings. When PULSE INITIATE is ENABLED, all groups for Relay A are skipped. When DISABLED, Groups 1, 2 may be programmed and saved for Relay A. Relays B and C do not have a PULSE INITIATE option and are only programmable for Groups 1 and 3. *(See Appendix D-15 and Appendix G.)*

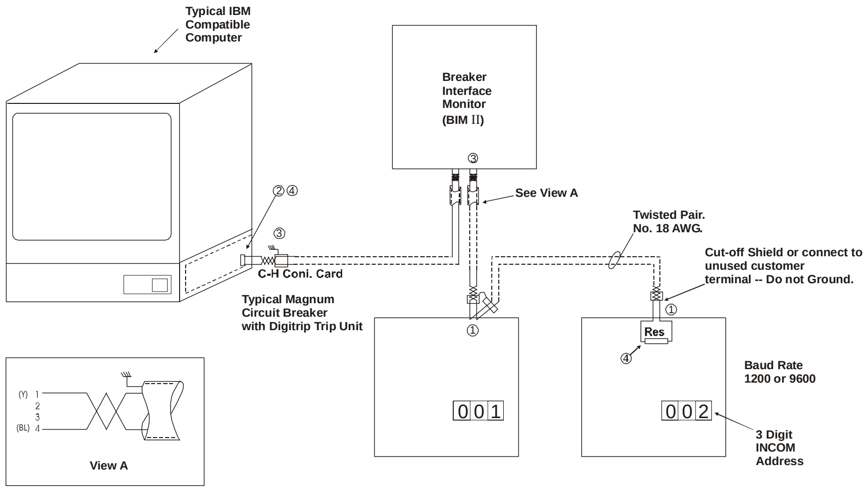
4.2.5 ALARMS

Alarm programming functions the same way as other options. Many alarm settings exist. A listing of these options and their settings can be found in Appendix D-16.

The selection of ALARM TO EventLOG setting will enable both alarm events as well as trip events to be time-stamped and placed in the three-position EventLOG.

4.2.6 Digital Relay Accessory Module

A Digital Relay Accessory Module is a separate device that is programmed via the Digitrip 1150 via ACCBUS menu. Available module addresses are 1 through 4. Each



NOTICE

100 OHM 1/2W terminating resistor required on network even if network is unused

Notes:

① **Refer to Master Circuit Breaker Connection Diagrams in Appendix C.**

② **Modular telephone connector, Type RJ11, supplied by user.**

③ **Ground shielding at computer BIM II as shown. Where devices are daisy-chained, interconnect shielding, but do not ground the connection.**

④ **100 ohm ½ watt carbon resistor required at last breaker. See T.D. 17-513. Also insert 100 ohm resistor to terminator at CONI card (via switch on CONI).**

⑤ **See Appendix D-11 for programming INCOM function.**

⑥ **AEM II is compatible with Digitrip 1150 with AEM II firmware version 7.1and the Digitrip 1150 set in the DT 910 COMM mode. (See page D-11)**

⑦ **Breaker Interface Module (BIM II) Version 3.12 is compatible with Digitrip 1150 Cat # 11****. BIM II version 3.20 or greater is compatible with Digitrip 1150 Cat # 11**** and Cat # 11P****.**

Figure 4.8 INCOM Network with Remote Master Computer BIM II

module has four form C relay contacts numbered 1 through 4. Programmable relay functions (RLY FUNC) for each relay include AUX, ALRM, BELL, DEAD, WATCH, LDT, SDT, INST, GND,HLAlm,GFAlm and OFF. *(See Appendix F for definitions of these settings.)* These options may be saved for any combination of relay functions and addresses. The Digitrip 1150 acts as a master to its Accessory Bus network and will light a green LED located in the upper right corner of the trip unit when transmitting *(See Figure 1.1 and also Appendix H).*

The AUX function can be used as a circuit breaker auxiliary switch in application. BELL will initiate on any “protection” trip and can be used as a circuit breaker bell alarm trip function. The INST function will drive the Accessory Relay when an instantaneous trip is encountered. Similarly LDT function will drive the relay on a circuit breaker Long Time trip and SDT for a Short Time trip. The GFT (Ground Fault) will operate the Accessory Relay on a ground trip. High Load alarm will activate with the HLAlm setting. GFAlm is for a Ground Fault Alarm function. ALRM (alarm) will drive the Digital Relay in the same way as the assignments of Relay A. The one exception is the Accessory Bus relay will not function as a Pulse Initiator. The WATCH (watchdog) function, when programmed, can provide a status monitor of the Digitrip 1150 energizing the programmed relay and will drop out if an abnormal condition exists within the Digitrip or if auxiliary power is low voltage. The DEAD (deadman) function, when programmed, will pick up the relay if the Module is communicating properly with the Digitrip 1150. It will drop out if the Module is not communicating properly. This function should be assigned to the last physical Module in a wiring lineup to verify the integrity of the wiring.

Accessory Bus is not available on PROTECT firmware version 8A.00. The settings of INST, SDT, LDT, GNDT GFAlm and HLAlm will require PROTECT firmware version 8A.05 or higher. Settings OV/UV, OF/UF, RevPwr will require versions PROTECT 8A.09 and DISPLAY 8B.09 or greater.

Figure 4.9 TripLink Transfer

4.2.7 TripLink

TripLink is a means of transferring settings from one circuit breaker to another. TripLink transfers all protection settings and time and date, and the circuit breaker's circuit data. The transfer of these settings may be useful for cloning a lineup of circuit breakers, cloning a circuit breaker's settings for replacing the circuit breaker with its clone for maintenance purposes, or for making common settings for a test program.

All INCOM settings including INCOM ADDRESS is transferred via TripLink. An INCOM network does require a unique address so the address may later have to be changed.

The procedure requires a TripLink cable to provide communication between circuit breakers. The connector with the labeled end must be plugged into the circuit breaker that will receive the settings. This cable must be plugged into the Test Kit pins on the lower left-hand corner on both circuit breakers and both units must be powered up for the setting transfer to be successful. If power is not available, then use separate Auxiliary Power Module Cat. No. #PRTAAPM and energize the unit by plugging keyed connector into upper right corner of the Digitrip 1150 *(See Figures: 1.1 and 4.9).*

NOTE: A TripLink cable when installed will disconnect that unit from the INCOM communication network.

4.2.7.1 Preliminary Requirements

1. Both units must be Digitrip 1150 and both must have the same Catalog (cat.) number, plug ampere rating for a successful transfer.

NOTE: It is recommended that both the sending and receiving units be the same firmware revision. Three cases exist:

a. Units with revision 0 are only compatible with other revision 0 units.

b. Units with revision 9 are only compatible with other revision 9 units.

c. When transferring settings having different firmware revisions will transfer all the protection settings properly. However, the Accessory Bus settings should be verified.

2. To send settings, the receiving circuit breaker must be in open state and without line voltage on the circuit breaker's main terminals.

4.2.7.2 Transfer Procedure

NOTE: It is important to realize that the transfer must be performed from the RECEIVING circuit breaker. (The circuit breaker with the white connector marked "This unit to receive setpoints").

In the Program TripLink menu, if all preliminary requirements are met, the Digitrip 1150 display on the receiving circuit breaker will read "THIS UNIT TO RECEIVE." Otherwise, an error message will appear reading "TripLink CONFIG ERROR" and the display will return to Program Settings menu.

If the circuit breakers meet the preliminary requirements, the user will be prompted to "PRESS SAVE TO LEARN." When Save is pressed, settings will transfer and a "LOADING" message will appear on the display screen. Transfer will be confirmed if successful with a "TripLink TRANSFER COMPLETE" message. Otherwise, "TripLink TRANSFER ERROR" will appear on the display.

In the event of TripLink Configuration Error, check all preliminary requirements as well as the TripLink cable connections. Also ensure that transfer is being initiated and performed on the receiving circuit breaker.

4.2.8 Setting TIME

In the Digitrip 1150, dates are displayed in DD-MmmYY format (for example, 12 Mar 98) and time is displayed in military-style format with hours from 0 to 23. The first screen in PGM SET\TIME is a view-only screen showing the current time setting for the unit. The View Down button changes screens to the DAY programming screen where the two digit date can be adjusted with the Edit Up or Edit Down pushbuttons. View Down then moves through the programmable three-character MONTH abbreviation, two digit YEAR selection, two digit HOURS, and two digit MINUTES which are all programmed with the Edit Up and/or Edit Down pushbuttons. Seconds are not programmable and begin at 00 when time settings are saved. Using View Up in the menu will move the user through the settings in reverse order as described above *(Refer to Appendix D-18).*

4.2.9 Selecting DISPLAYS

Display programming options control the screens displayed in the Meter Menu. Program Display is located in the PGM SET\DISPLAY submenu. This submenu lists twenty-two programmable screens. The first screen sets metering for A, B, and C phase currents to AUTO or MANUAL. The remaining twenty-one screens of various perameters can be set to on or off, depending on user preference. Any settings turned to OFF will not be displayed when METER is selected from the Main Menu *(Refer to Appendix D-14)*.

4.2.10 System Settings

4.2.10.1 Frequency

This setting is to reflect the power system's operating frequency of 50 or 60 Hertz. The factory default is 60Hz.

4.2.10.2 BC Relay Reset

This setting is to define the reset mode of Relay B and Relay C of the Digitrip's Power Relay Module. The selections are AUTO or MANUAL reset *(See Section 4.2.2.4).*

4.2.10.3 Sliding Demand

A sliding demand calculation can be chosen for either the Max kW demand or the Max kVA demand. If neither is required, the user can choose "OFF" by pressing the up/down Edit Value keys.

4.2.10.4 Waveform Capture

The waveform capture function can be enabled on a 1, 5, or 10 minute basis. It can also be disabled by selecting "OFF" with the Edit Value keys. If the THD alarm setting has been enabled in the Alarms menu, the waveform capture function will automatically be set to 1 minute and the waveform capture OFF setting will not be available.

4.3 View Settings (VIEW SET)

The VIEW SET menu will allow the user to view all of the settings presented in the PGM SET menus with the exception of the TripLink function. The user cannot edit or change settings in these menus.

4.3.1 Firmware Menu

The Firmware menu enables the user to view the version and revision of the trip unit firmware. The protection firmware is displayed as PROTECT while DISPLAY firmware can be viewed by pressing the up/down View function keys.

4.4 Meter Menu

The METER menu initially will show six screens of data via the factory display setup. They are phase current, neutral and ground currents (if supplied), phase voltages, forward power, power factor and frequency, and energy values. However, the program DISPLAY menu can be used to present metered data relevant to a specific customer application. There are 22 data screens selectable as listed in Appendix D-14 and D-3.

The Demand and the average, minimum and maximum current screens alternate between the data and additional information concerning the measured parameter. The min and max phase currents are actually reset as a group *(See Appendix D-3)*. The OP COUNT screen displays circuit breaker operation where a open/close is registered as one count. The OP COUNT can be reset also when this screen is active.

4.5 Harmonic Menu

The Digitrip 1150 HARMONIC Menu provides capabilities to calculate and display the Total Harmonic Distortion (THD) for phase currents IA, IB and IC as well as IN if available. The term THD is used to define the amount of harmonic current that the breaker is seeing or the system is experiencing in percentage of the power frequency current. This can be useful in troubleshooting to detect individual circuit breaker current loads that could lead to system problems and early equipment failure. The equation used for calculating THD is:

$$THD = \sqrt{\frac{I_{rms}^2 - I_1^2}{I_1^2}} \times 100\%$$

Where Irms is the rms current of the waveform and I1 is the rms current of the fundamental frequency.

For example, the THD calculation for a load having an equal rms value of the fundamental and third harmonic current would have a THD value of 100 percent. This would be a large value of THD and would not be typical.

In addition to individually displaying the THD for the phase currents, the Digitrip 1150 will also display the individual harmonic currents up through the 27th harmonic.

Local operation on the Digitrip to observe this data is done using the View Down pushbutton of the Digitrip.

By selecting “HARMONIC” from the Main Menu, a waveform capture event and harmonic data calculation is accomplished locally. A second way is to automatically generate waveform capture on a 1 minute, 5 minute, 10 minute, or OFF basis by selecting “GENERAL” in the Program Settings submenu and scrolling to the “WAVEFORM CAPTURE” option. The third way is to remotely trigger the waveform capture via a PowerNet communication command. For these three types of captures the Digitrip 1150 will provide per harmonic data. For trip events and alarm events the per harmonic analysis is not provided. PowerNet software screens are available to show waveform capture oscillographs of each phase as well as bar graphs of the magnitudes and individual harmonics that make up the three-phase currents *(See Section 4.9).*

If less than 15% of the rated current is applied to the circuit breaker, the trip unit will display three dashed lines (‘- - -’) for the THD and Crest Factor values since these cannot accurately be measured.

4.6 Event Log

The Digitrip 1150 trip unit has the ability to record the cause, timestamp and associated current or related data for a maximum of three events. An event is defined as an alarm or trip condition experienced by the circuit breaker. The user has the option to record only trip function events or to record both trip and alarm functions by manipulating the Alarm to EventLOG setpoint located in the Alarms programming menu. The event data is stored in nonvolatile RAM and is maintained on a first-in, first-out basis. In the case where the Alarm to EventLOG setting is enabled, a new alarm event will replace either historic trip or historic alarm condition stored previously *(See Appendix D-3).*

4.7 Power and Energy Parameters

Power has approximately a one second update rate and is shown as Forward or Reverse Power in kW units. The parameters kVA and kvar are also updated in a similar time period. Demand kW is presented as Forward or Reverse in kW units and is based on the last average five minute interval. Demand kVA is also based on the last average five minute interval. These parameters can be reset when this screen is in view and the Reset pushbutton action will start a new five minute period. Programming Alarms (kW or kVA) to exceed a threshold value will produce an Alarm. A timestamp is also provided if the Alarm to EventLOG setting is enabled.

Demand Max kW and Demand Max kVA are peak values that have been encountered since the last Reset of these parameters. A pushbutton Reset or INCOM Reset will start a new fifteen minute interval. As a factory default, both kW and kVA demands are set for a “fixed” fifteen minute window. The update rate for the calculation is fifteen minutes. A “Sliding” window calculation is a possible setting which will calculate a continuous new Demand value and update the value if a new Max is encountered every minute. This SLIDING DEMAND setting is the first item in the SYSTEM (or GENERAL) screen.

The Digitrip 1150 will display locally in kWh units of both Forward and Reverse Energy values. An additional energy parameter is kVAh. The rollover energy value is 9,999,999 for both.

The Auxiliary ReLaY A can be assigned to a Pulse Initiator function for either kVAh or kWh. When this feature is selected, ReLaY A will be dedicated for Pulse Initiator and no other relay function is possible for ReLaY A *(See Appendix D-15).* The Pulse Initiator provides a contact change of state to an external counter device whenever a value is exceeded. This pulse value is based on an ANSI document and is expressed as the general equation:

$$\text{Pulse Value}_{(kVA\ or\ kW)} = .000717 \times I_n\ (\text{plug amperes})$$

4.8 Power Quality

The Digitrip 1150 in a Magnum Circuit Breaker can measure a variety of parameters relating to today's modern Power System. This data can be viewed locally or via a computer remotely in which case the data can be logged.

4.8.1 Power Factor, THD and Crest Factor (CF)

The System Power Factor is a real time measurement with approximately a one second update rate. The tolerance is the value ± 0.02. Max PF and Min PF values are historic values that are held until Reset.

Total Harmonic Distortion (THD) of each phase and neutral (if valid) and corresponding per harmonic data up to the 27th harmonic and Crest Factor are available via a waveform capture trigger. This waveform capture trigger can be done locally by selecting HARMONIC in the Main Menu or by exceeding a THD alarm threshold programmed by the user. See section 4.8.2.

4.8.2 Alarms

Alarming on low power factor can be accomplished by enabling this function in the ALARM programming screen. Any System Power Factor seen by the Digitrip 1150 less than the level programmed will initiate an alarm message on the twenty four character display as well as illuminating the yellow LED and communicating to a host computer. The powerfactor calculation is valid for currents less than the Long Delay Pickup level. The Auxiliary Relay A can be also assigned to the THD alarm.

The THD alarm feature is an alarm setting with a range of 10% to 30% THD that when exceeded will initiate waveform capture and also set the front panel alarm LED. The THD alarm has a 1 minute update rate. The Auxiliary Relay A can also be assigned to a THD alarm.

4.9 Waveform Capture Feature

The Digitrip 1150 can respond to a command from a remote master to perform a waveform capture of phase currents IA, IB and IC, as well as waveform IN (on catalog LSI) or waveform IG (on catalog LSIG employing the source ground configuration). A total of 58 data points per phase per cycle is captured and can be sent to a host computer. From this data, parameters such as [THD], individual harmonics content and waveform are fabricated.

There is a timer in the Digitrip unit that will limit the acceptance of a "WAVEFORM CAPTURE" software command to once per second. Three waveforms are held in a first in, first out manner in the Digitrip's volatile memory.

4.9.1 Six Cycle Waveform Capture on Trip

On Long Time, Short Time, Instantaneous or Ground Fault tripping events, the Digitrip 1150 will capture the curve waveforms to a buffer. The buffer as a waveform can be displayed on the master computer using the PowerNet software screen (Ref. I.L.17384 for protocol and software commands). The six cycle waveform capture will typically contain one cycle of pre-interruption data and five cycles of interruption and post-interruption data for analysis of the power system.

NOTE: The phase loss, phase unbalance, voltage and frequency trips, reverse power trips and alarm events do not produce a waveform capture.

NOTE: PowerNet communications will require hardware and software specified in the Cutler-Hammer PowerNet Operations Manual and also the Digitrip 1150 Firmware must be DISPLAY VERsion 8B, REVision 02 or greater and PROTECT VERsion 8A, REVision 02 or greater *(See Appendix Page D-5).*

4.9.2 One Cycle Waveform Capture

There are two methods of obtaining a one cycle waveform capture from the Digitrip 1150. One method is via the PowerNet software to manually request a waveform capture. The second way is to trigger a waveform capture via an Alarm condition. This is accomplished by entering the PROGRAM - ALARM screen. Enable the ALARM type of interest as well as ALARM TO EventLOG.

The one cycle waveform capture of the currents IA, IB, IC and IN, if applicable, can then be displayed on the master computer for analysis. IG waveform is not displayed for residual ground application *(See Appendix D-16).*

4.10 Health (applicable only to Digitrip 1150+ Rev. E or higher)

The HEALTH menu on the Digitrip 1150 front panel will provide information on the Magnum Circuit Breaker's Health as well as a history of the circuit breaker and circuit it is protecting. This data is useful for planning maintenance and inspection schedules.

The type of data includes the total number of all Instantaneous and Short Delay trips seen by the circuit breaker.

A second counter shows the number of Overloads (LDT) and Ground Faults (GFT) encountered while in service. The OP count provides data on the number of Close Operations experienced by the circuit breaker. The internal TEST function will not increment the INST/SD or the LDT/GFT counters, however, there will be count values in these registers from the factory primary injection testing. Each of these three values can be zeroed by depressing the Reset pushbutton. These counters will roll over at a value of 255.

The last time the circuit breaker was operated (open or closed or tripped) is viewable with time and date displayed. Also included is the maximum temperature in degrees Centigrade as seen by the Digitrip microprocessor CHip. *(For Screen Presentations See Appendix D-24)*

The capture of the data requires external Trip Unit power. This data, once captured, is stored in non volatile memory.

These features are available to PowerNet communications utilizing Digitrip firmware Rev. F or higher.

NOTE: Rev. F firmware permits maximum temperature to be reset.

5.0 TEST PROCEDURES

5.1 General

WARNING

DO NOT ATTEMPT TO INSTALL, TEST, OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH OR SEVERE PERSONAL INJURY CANRESULT FROM CONTACT WITH ENERGIZED EQUIPMENT.

DE-ENERGIZE THE CIRCUIT AND DISCONNECT THE CIRCUIT BREAKER BEFORE PERFORMING MAINTENANCE OR TESTS.

WARNING

ANY TRIPPING OPERATION WILL CAUSE DISRUPTION OF SERVICE AND POSSIBLE PERSONAL INJURY, RESULTING IN THE UNNECESSARY SWITCHING OF CONNECTED EQUIPMENT.

CAUTION

TESTING A CIRCUIT BREAKER WHILE IT IS IN-SERVICE AND CARRYING LOAD CURRENT IS *NOT* RECOMMENDED.

TESTING OF A CIRCUIT BREAKER THAT RESULTS IN THE TRIPPING OF THE CIRCUIT BREAKER SHOULD BE DONE ONLY WITH THE CIRCUIT BREAKER IN THE TEST OR DISCONNECTED CELL POSITIONS OR WHILE THE CIRCUIT BREAKER IS ON A TEST BENCH.

5.2 When to Test

Testing prior to start-up can best be accomplished with the circuit breaker out of its cell or in the Test, Disconnected, or Withdrawn (or Removed) cell positions.

NOTE: Since time-current settings are based on desired system coordination and protection schemes, the protection settings selected and preset in accordance with Section 4 should be reset to their as-found conditions if altered during any routine test sequence.

Enter the Test menu and using the Edit Up/Down pushbuttons, set the desired test current level. A test level chosen above a setting will cause a pickup/trip condition. If a pickup is not exceeded, the unit will remain in a “testing” mode for three hours or until interrupted by a real event or user pushbutton activity. *(See Appendix D-20 for pushbutton sequence to conduct the testing. Press Save twice to initiate the test.)* To conduct this testing as well as viewing setting (if applicable), a small Auxiliary Power Module, Cat. No. #PRTAAPM, is available for these functions. This Module is an intermittent duty device that is powered via 120 VAC, 50/60 Hertz and will plug into the upper right corner of the product *(See Figure 1.1).*

When performing a trip unit self test in TRIP mode, **tripping** of the circuit breaker and **activation** of the associated Alarm or Accessory Bus relays can occur. This is important to consider before initiating a test, since a circuit breaker or relay action can initiate other equipment responses in the system even if the circuit breaker is in test position of a switchgear cell. The one exception to this is the Ground Trip self test function of the LSIA style unit. A Ground TRIP test will not actually trip the circuit breaker but will only provide alarm display information and alarm relay operation (if enabled).

In the NON-TRIP mode of self test, the circuit breaker trip function and any associated relay will not operate when test alarm or test trips occur. The front panel indicating LED will light as well as display alarm/trip cause and trip time information.

5.2.1 Self Testing

Prior to any self testing, the plexiglass cover will need to be removed. The Digitrip 1150 provides means via the TEST selection in the main menu to conduct Phase Current (PH) or Ground Current (GND) (if applicable) type testing in either a TRIP or NON-TRIP mode.

The Self Test function cannot be entered if an alarm is already present. This alarm will need to be cleared before any self testing can be conducted. The self test function will terminate if any of the following conditions occur after the start of testing:

1. Any real Phase current exceeds an alarm setting
2. Any real Ground current exceeds 0.1 per unit.
3. If real Phase current exceeds 1 x (*I*r) while conducting a NON-TRIP test.
4. If real Phase current exceeds 0.5 x (*I*r) while conducting a TRIP test.

5.2.2 Functional Field Testing

CAUTION

PERFORMING TESTS WITHOUT THE CUTLER-HAMMER APPROVED TEST KIT MAY DAMAGE THE DIGITRIP UNIT.

Use the test receptacle to verify a functional load test of a major portion of the electronic circuitry of the Digitrip and the mechanical trip assembly of the circuit breaker. The testing can determine the accuracy of the desired trip settings by performing Long Delay, Short Delay, and Ground Fault functional tests. The Cutler-Hammer-approved test kit is listed below.

Model	Test Kit
Digitrip 1150	Test Kit (140D481G02R, 140D481G02RR, 140D481G03, or G04) with Test Kit Adapter 8779C02G04

The test port is located on the front left-hand corner of the DT1150 units *(See Figure 1.1).* To access the port, remove the plexiglass cover from the front of the circuit breaker. Using a small screwdriver, gently pry up on the test port cover to remove this item.

The test kit authorized by Cutler-Hammer for use with the Digitrip units plugs into the test port of the unit and provides a secondary injection test that simulates currents from the current transformers. Existing test kits, styles 140D481G02R, 140D481G02RR, 140D481G03 or G04, along with the Magnum Test Kit Adapter 8779C02G04, can be used to test the trip unit and circuit breaker.

5.3 Performance Testing for Ground Fault Trip Units

5.3.1 Code Requirements

The NEC, under Article 230-95-C, requires that any ground fault protection system be performance tested when first installed. Conduct tests in accordance with the approved instructions provided with the equipment. Make a written record of this test and make the results available to the authority having inspection jurisdiction.

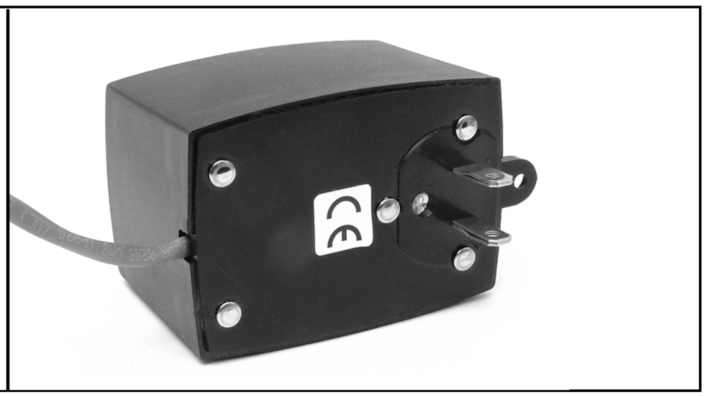


Figure 5.1 Auxiliary Power Module - (Front and Back Views)

5.3.2 Standard Requirements

As a follow-up to the basic performance requirements stipulated by the NEC, UL Standard No. 1053 requires that certain minimum instructions must accompany each ground fault protection system. These statements (Section 5.4.3), plus a copy of the record forms (Figures 8.1, 8.2, and 8.3), are included as part of this Instructional Leaflet.

5.3.3 General Test Instructions

The interconnected system must be evaluated only by qualified personnel and in accordance with the equipment assembler's detailed instructions.

To avoid improper operations following apparently correct simulated test operations, the polarity of the neutral sensor connections (if used) must agree with the equipment assembler's detailed instructions. Where a question exists, consult the specifying engineer and/or equipment assembler.

To avoid improper operations following apparently correct simulated test operations, the polarity of the neutral sensor connections (if used) must agree with the equipment assembler's detailed instructions. Where a question exists, consult the specifying engineer and/or equipment assembler.

WARNING

PERSONAL INJURY CAN OCCUR WHEN WORKING ON POWER SYSTEMS. ALWAYS TURN OFF POWER SUPPLYING CIRCUIT BREAKER BEFORE CONDUCTING TESTS. TEST OUT OF THE CELL, IF POSSIBLE. THERE IS A HAZARD OF ELECTRICAL SHOCK OR BURN WHENEVER WORKING IN OR AROUND ELECTRICAL EQUIPMENT.

Verify the grounding points of the system using high-voltage testers and resistance bridges to ensure that ground paths do not exist that could bypass the sensors.

Use a low-voltage (0 to 24 volt), high-current, AC source to apply a test current of 125 percent of the Digitrip unit ground pick-up setting through one phase of the circuit breaker. This should cause the circuit breaker to trip in less than 1 second and operate the alarm indicator. Reset the Digitrip and then reclose the circuit breaker. Repeat the test on the other two phases *(See Figure 5.2).*

Apply the same current as described above through one phase of the circuit breaker, returning through the neutral sensor. The circuit breaker should not trip, and the alarm indicator should not operate. Repeat the test on the other two phases.

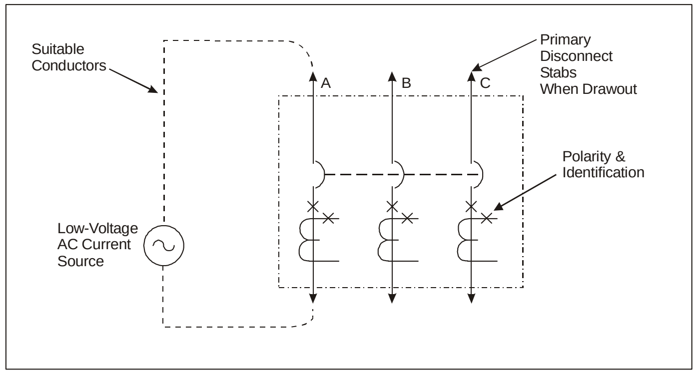


Figure 5.2 Connection Details for Conducting Single Pole,Single Phase Current Tests with the Circuit Breaker Removed from the Cell

Apply the same current as described above through any two phases of the circuit breaker. The circuit breaker should not trip. Repeat the test using the other two combinations of circuit breaker phases *(See Figure 5.3).*

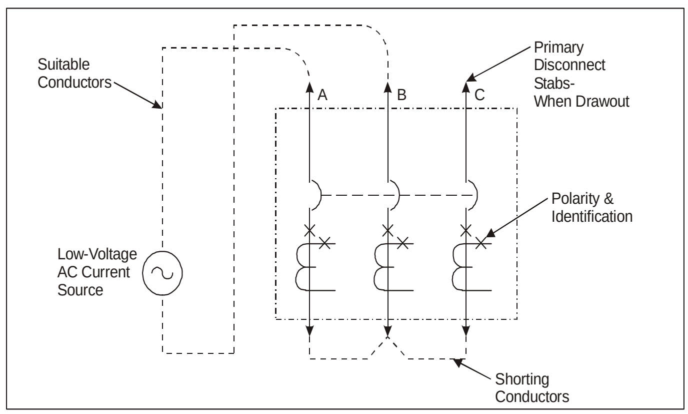


Figure 5.3 Connection Details for Conducting Single Phase Current Tests with the Circuit Breaker Removed from the Cell

An alternative test setup is shown in Fig. 5.4. This three pole hookup should be employed when a low Ground Pickup setting is to be tested like 0.24x and 0.3x and without Aux power present. The Test Circuit does provide a net residual ground current excitation of “1”. Two of the phases cancel each other out as far as ground fault but now the Digitrip is provided with three pole power up current simulating three phase power.

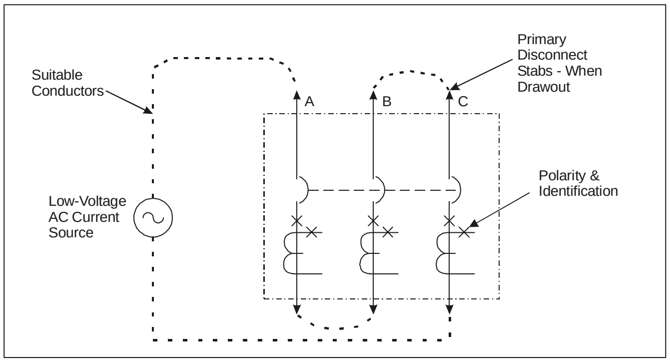


Figure 5.4 Alternate Connection Details using three poles to develop a Ground Fault Condition

CAUTION

RESTORE ALL TEMPORARY CONNECTIONS MADE FOR THE PURPOSE OF CONDUCTING TESTS TO PROPER OPERATING CONDITIONS BEFORE RETURNING THE CIRCUIT BREAKER TO SERVICE.

Record the test results on the test form provided with the equipment *(See Figure 8.3).*

6.0 BATTERY

6.1 General

The battery plays no part in the protection function of the trip unit.

As indicated in Figure 3.1, the battery is provided to flash and power the red LED indication on the mimic curve. The battery is located under the rating plug door. A battery test pushbutton and a green Battery Test LED are also provided.

A second function of the battery is to provide backup power for the clock chip in the unit. The clock is used to timestamp trip and alarm events.

On initial installation of the circuit breaker, pull out the insulating tab with a quick pull *(See Figure 6.1).* This will activate the battery. Check the battery status using the Battery Test pushbutton.

6.2 Battery Test

The battery is a long-life, lithium, camera-type unit. Check the status of the battery at any time by pressing the Battery Test pushbutton and observing the green LED. If the Battery Test LED does not light green, replace the battery. The condition of the battery has no effect on the protection function of the trip unit. Even with the battery removed, the unit will still trip the circuit breaker in accordance with its settings. However, without the battery, the Cause of Trip LED will not be lighted red if auxiliary power is lost to the Digitrip. If the battery is replaced, one or more of the Cause of Trip LEDs may be illuminated. Push the red Reset/Battery Test button to turn off the indicators; the trip unit will be ready to indicate the next cause of trip.

6.3 Battery Installation and Removal

The 3-volt lithium cell battery *(See Figure 6.1)* is easily removed and replaced. The battery is located in the cavity adjacent to the rating plug mounting screw, but is not part of the rating plug. Insert a small screwdriver at the left side of the rating plug, and to the left of the word OPEN, to open the rating plug door. Remove the old battery by pulling up on the removal tab that wraps under the battery cell. When inserting the new cell, pay special attention to ensure that the proper polarity is observed. The main body of the battery is the positive (+) side.

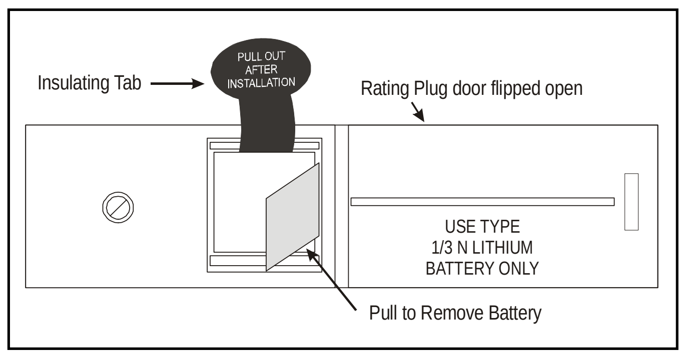


Figure 6.1 Digitrip Battery

NOTE: The battery can be replaced at any time, even while the circuit breaker is in-service, without affecting the operation of the circuit breaker or its protection functions.

CAUTION

EXERCISE CARE WHEN REPLACING THE BATTERY TO ENSURE THAT THE CORRECT POLARITIES ARE OBSERVED. POLARITY MARKINGS ARE SHOWN ON THE RATING PLUG WHEN THE HINGED COVER IS

OPEN. ACCIDENTALLY INSTALLING THE BATTERY IN THE REVERSE DIRECTION WILL NOT HARM EITHER THE TRIP UNIT OR THE BATTERY, BUT WILL DEFEAT THE FUNCTION OF THE BATTERY.

The replacement battery should be the same type as that already in the trip unit or an equivalent. Acceptable 3.0 volt lithium batteries may be obtained from the following companies:

Company	Model
VARTA Batteries, Inc. 300 Elmsford Boulevard Elmsford, N.Y. 10523 USA 1-914-592-2500 (www.varta.com)	CR 1/3N
Duracell, Inc. Berkshire Corporate Park Bethel, CT 06801 USA 1-800-551-2355 (www.duracell.com)	DL 1/3N
Sanyo Energy Corporation 2055 Sanyo Avenue San Ysidro, CA 92173 USA 1-619-661-6620 (www.sanyo.com)	CR 1/3N

7.0 FRAME RATINGS *(SENSOR RATINGS AND RATING PLUGS)*

The frame rating of a circuit breaker is the maximum RMS current it can continuously carry. The maximum short-circuit current rating of the circuit breaker is usually related to the frame rating as well.

A current value, (*I*n), that is less than the full frame rating may be chosen to be the basis for the coordination of the protection function of the circuit breaker without affecting its short-circuit current capability. For the Digitrip 1150, this is implemented by changing the current sensors and the corresponding rating plug. These sensors and rating plugs are available in kit form.

The current sensor rating is the maximum current the circuit breaker can carry with the specified current sensors installed. The sensor rating can be the same or less than the frame rating, but not greater.

This value, (*I*n), is the basis for the trip unit current settings:

1. The Instantaneous and Ground Current Settings (if provided) are multiples of (*I*n) *(See Sections 4.2.1.6 and 4.2.1.7).*

2. The Long Delay Current Setting, (*I*r), is a fractional multiple of (*I*n): Long Delay Current Setting = (*I*r) = LD x (*I*n) *(See Section 4.2.1.2).*

3. The Short Delay Current Setting is a multiple of (*I*r): Short Delay Current Setting = SD x (*I*r) = SD x [LD x (*I*n)] *(See Section 4.2.1.4).*

! CAUTION

BEFORE YOU FIT THE RATING PLUG INTO THE TRIP UNIT, BE SURE TO CHECK THAT THE SENSOR RATING MATCHES THAT PRINTED ON THE RATING PLUG DOOR. INSTALLING A RATING PLUG THAT DOES NOT MATCH THE SENSOR RATING CAN PRODUCE SERIOUS MISCOORDINATION AND/OR FAILURE OF THE PROTECTION SYSTEM.

NOTE: Rating plugs from Digitrip models 210, 500, or 510 **CANNOT** be used with Digitrip 1150 Units.

8.0 RECORD KEEPING

Use the forms shown in Figures 8.1 and 8.2 for record keeping. Fill in these forms, giving the indicated reference information and initial time-current trip function settings. If desired, make a copy of the form and attach it to the interior of the circuit breaker cell door or another visible location. Figure 8.3 provides a place for recording test data and actual trip values.

Ideally, sheets of this type should be used and maintained by those personnel in the user's organization that have the responsibility for protection equipment.

9.0 REFERENCES

9.1 Magnum and Magnum DS Circuit Breakers

I.B. 2C12060	Magnum DS Circuit Breaker Instructions
I.B. 2C13060	Magnum I. Circuit Breaker Instructions
4A36346	Zone Interlocking Application with Non-Magnum Circuit Breakers
I.L 70C1143	Installation Instructions for Digital Relay Accessory Module
I.L. 70C1155	Instruction for TripLink Cable Accessory for Magnum and Magnum DS
I.L. 66A7508	Instructions for mMint Modbus Translator Module

9.2 Time-Current Curves

The Time-Current Curves are listed below for particular trip unit models. All protection function time-current settings should be made following the recommendations of the specifying engineer in charge of the installation.

70C1041	Digitrip 1150/1150*i*	Ground (Earth) Trip
70C1043	Digitrip 1150/1150*i*	Instantaneous Trip
70C1034	Digitrip 1150/1150*i*	I^2t Long Time Trip
70C1035	Digitrip 1150/1150*i*	I^4t Long Time Trip
70C1038	Digitrip 1150 IEEE	Moderately Inverse
70C1039	Digitrip 1150 IEEE	Very Inverse
70C1040	Digitrip 1150 IEEE	Extremely Inverse
70C1031	Digitrip 1150i IEC-A	Normal Inverse
70C1032	Digitrip 1150i IEC-B	Very Inverse
70C1033	Digitrip 1150i IEC-C	Extremely Inverse

DIGITRIP TRIP FUNCTION SETTINGS				
Circuit No./Address ________________		Breaker Shop Order Reference ________________		
PER UNIT MULTIPLIERS				
Rating Plug Amperes (In) ________________		Ir Continuous Ampere Rating = LDS x In ________________		
Trip Function	**Per Unit Setting**	**Multi**	**Ampere Equivalent Setting**	**Time Delay**
Inst.		In		
Long Delay		In		Sec.
Short Delay		Ir		Sec.
Ground Fault		In		Sec.
Date ____________		By ________________		

Figure 8.1 Typical Trip Function Record Nameplate

DIGITRIP AUTOMATIC TRIP OPERATION RECORD				
Circuit No./Address	**Circuit Breaker Shop Order Reference**			
Trip Function	**Settings Reference**			
	Factory	**Rev. 1**	**Rev. 2**	**Rev. 3**
Curve Type	LSIG*			
Slope	I2T			
Ir = Long PU x In	1.0			
Long Time	4s			
Long Memory	ON			
Short Slope	FLAT			
Short PU x Ir	3.0			
Short Time	0.3s			
Inst PU x In	4			
Ground* Slope	FLAT			
Ground* PU x In	0.4 or 0.24			
Ground* Time	0.3s			
* if supplied				

Date of Trip	Trip Mode Indicator	Setting Ref.	Setting Change Made	Investigated By

Figure 8.2 Automatic Trip Operation Record

GROUND FAULT TEST RECORD FORM

Ground Fault Test Record should be retained by those in charge of the building's electrical installation in order to be available to the authority having jurisdiction.

Test Date	Circuit Breaker Number	Results	Tested by

Figure 8.3 Typical Performance Test Record Form

APPENDIX A Zone Interlocking Examples

NOTICE

THE PROVISION FOR ZONE INTERLOCKING IS STANDARD ON CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS FOR SHORT TIME AND GROUND FAULT FUNCTIONS. THE APPROPRIATE JUMPER TO TERMINAL B8 AND B9 MUST BE ADDED ON THE CIRCUIT BREAKER IF ZONE INTERLOCKING IS NOT DESIRED OR IF FIELD TESTING IS DESIRED.

EXAMPLE 1: There is no Zone Selective Interlocking. (Standard time delay coordination is used.)

Assume that a ground fault of 2000 Amperes occurs and refer to Figure A.1.

Fault at location 3
The branch circuit breaker will trip, clearing the fault in 0.1 seconds.

Fault at location 2
The feeder circuit breaker will trip, clearing the fault in 0.3 seconds.

Fault at location 1
The main circuit breaker will trip, clearing the fault in 0.5 seconds.

EXAMPLE 2: There is Zone Selective Interlocking.

Assume a ground fault of 2000 Amperes occurs and refer to Figure A.1.

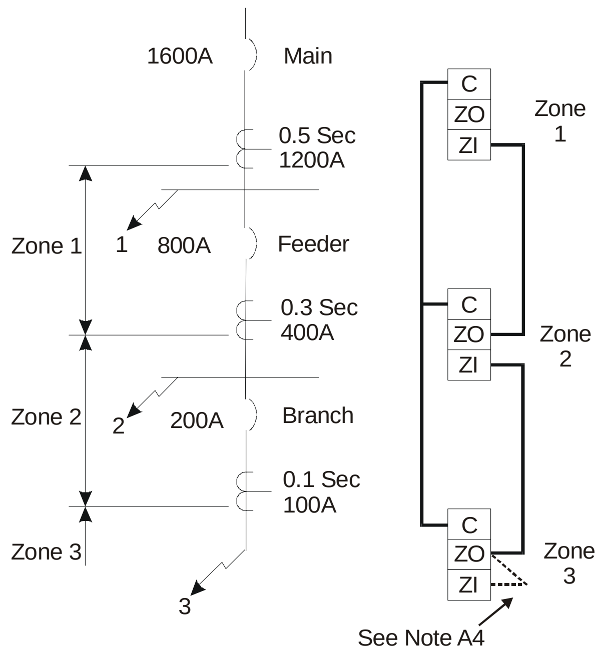
Fault at location 3
The branch circuit breaker trip unit will initiate the trip in 0.045 seconds to clear the fault and the branch will send a restraint signal to the feeder trip unit; the feeder will send a restraint interlocking signal to Z1.

Main and feeder trip units will begin to time out and, in the event that the branch circuit breaker does not clear the fault, the feeder circuit breaker will clear the fault in 0.3 seconds (as above). Similarly, in the event that the feeder circuit breaker does not clear the fault, the main circuit breaker will clear the fault in 0.5 seconds (as above).

Fault at location 2
The feeder circuit breaker trip unit will initiate the trip in 0.045 seconds to clear the fault and will send an interlocking signal to the main trip unit. The main trip unit will begin to time out and, in the event that the feeder circuit breaker Z2 does not clear the fault, the main circuit breaker will clear the fault in 0.5 seconds (as above).

Fault at location 1
There are no interlocking signals. The main circuit breaker trip unit will initiate the trip in 0.045 seconds.

Figure A.2 presents a Zone Selective Interlocking connection diagram for a system with two main circuit breakers from incoming sources and a bus tie circuit breaker. Note that the blocking diode D1 is needed so that the feeder circuit breakers can send interlocking signals to both the main and the tie circuit breakers and prevent the tie breaker from sending an interlocking signal to itself.



Notes:

A1: Wiring to be twisted pair of AWG #14 to #20. Route Zone Interlocking wiring separate from power conductors. DO NOT GROUND any Zone Interlocking wiring.

A2: The maximum distance between two farthest circuit breakers on different zones (from the ZO downstream to ZI upstream terminals) is 250 feet (76m).

A3: A maximum of 20 breakers may be contained in parallel in one zone.

A4: Provide a self interlocking jumper (on Zone 3) if coordination is desired with other downstream circuit breakers.

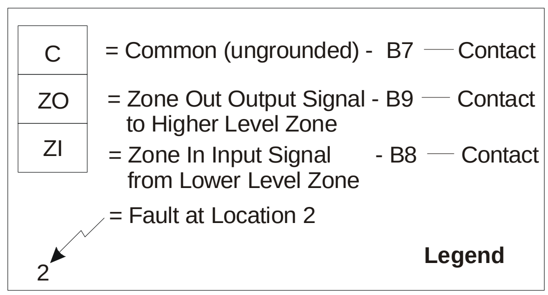


Figure A.1 Typical Zone Interlocking

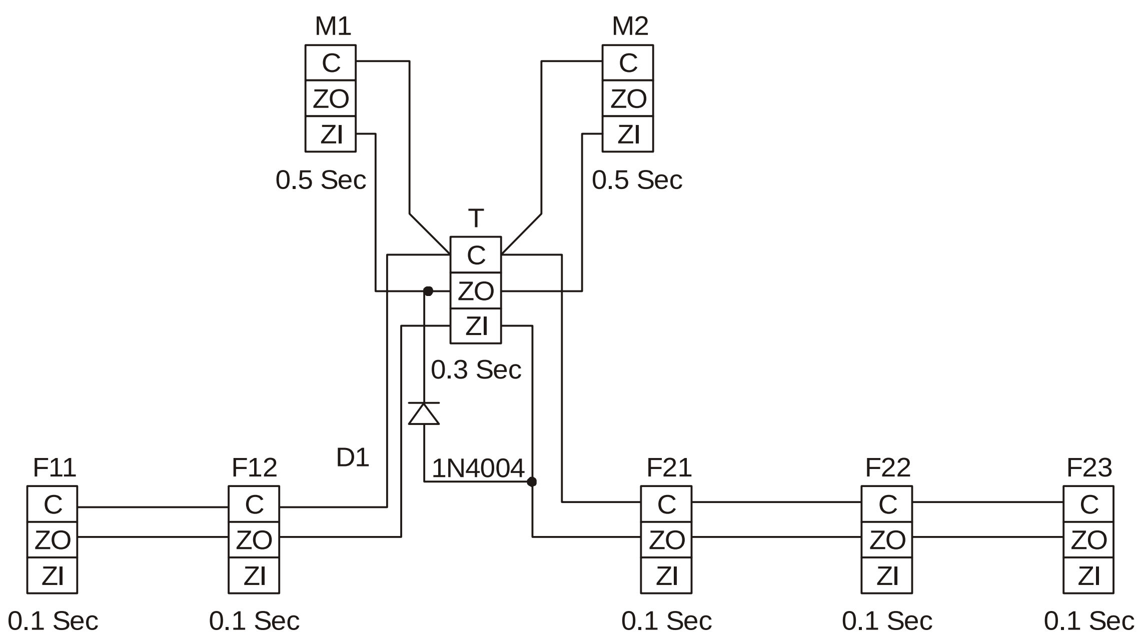


Figure A.2 Typical Zone Interlocking Connections with Two Main Circuit Breakers (M1, M2) and a Tie Circuit Breaker (T)

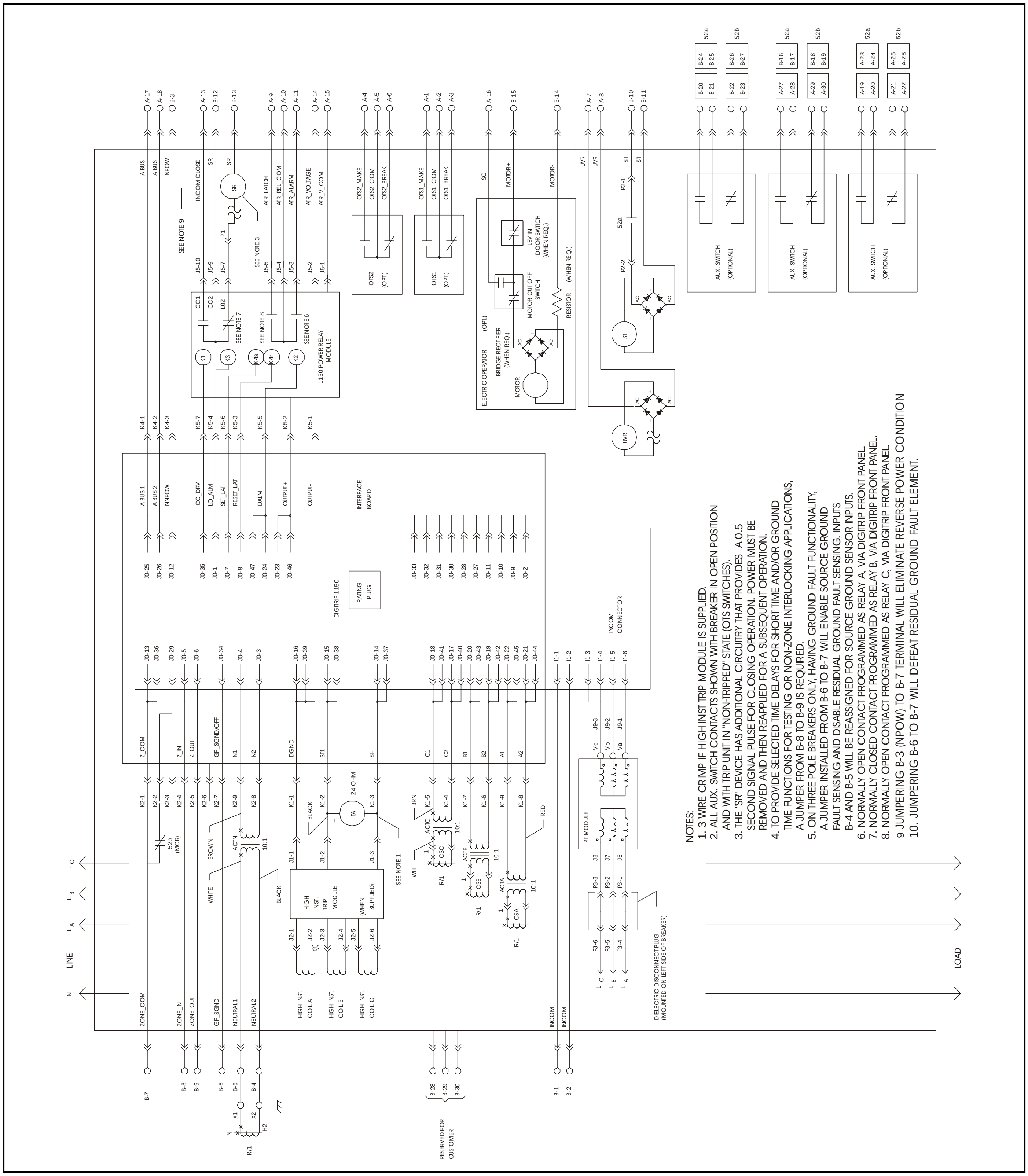
Appendix B Troubleshooting Guide

Symptom	Probable Cause	Possible Solution(s)	Comments
LED display is not energized.	No auxiliary power input.		
	Wrong auxiliary power voltage.	Check voltage input terminals A14-A15.	Refer to Section 1.6.1.
As soon as current starts to flow through the circuit breaker, it trips and the Instantaneous trip LED comes on.	Rating plug is not installed or is loose.	Install rating plug and/or check for loose connections.	
	Rating plug is open internally.	Replace rating plug.	
	Trip unit is malfunctioning.	Replace trip unit.	
LED does not come on when battery check button is pressed.	Battery installed backwards.	Install correctly.	
	Dead battery.	Replace battery.	
	Trip unit is malfunctioning.	Replace trip unit.	
Circuit breaker trips on ground fault.	There actually is a ground fault.	Find location of the fault.	
	On 4-wire residual systems, the neutral current sensor may not have the correct ratio or be properly connected.	Check connections at terminals B4 and B5. Check that the neutral current sensor ratio matches the breaker. Check that the connections from the neutral current sensor to the circuit breaker are not reversed. Check B6, B7 for correct programming of jumper.	See Section 2.3, Notes.
	Trip unit is malfunctioning.	Replace trip unit.	
Circuit breaker trips too rapidly on ground fault or short delay (Zone Selective Interlocking not used).	Connection from Zout to Zin is missing.	Make connections B8 to B9.	Refer to Appendix A.
	Trip unit settings are not correct.	Change settings.	
	Trip unit is malfunctioning.	Replace trip unit.	
Circuit breaker trips too rapidly on long delay.	Long Time Memory selected. Trip unit settings are not correct.	Disable Long Memory. Change settings. Long Time Delay setting is based on 6xIr	
Circuit breaker trips longer than time setting on Short Delay and Ground Fault	The SLOPE setting is set for I^2T response (instead of FLAT)	Determine whether I^2T or FLAT is desired. Check curve for correct time delay if I2T SLOPE is desired.	See Figures 4.5, 4.8 or curve
Circuit breaker trips higher than ground fault setting when field testing using primary injection method	Test Method	1. Apply Aux Power to circuit breaker and repeat test	See also NOTE inI.L. 29-885B Section 4.8
		2. Connect circuit breaker poles in series and repeat test	See Fig 5.4
EEROM ALARM	Non fatal memory error	Note settings via view settings screen. Then enter Program Settings and SAVE CURRENT curve. If setpoint download is successful press Reset. Re-verify settings that you desire.	If alarm reappears after trying the possible solution, replace trip unit at first opportunity.

Appendix B Troubleshooting Guide Continued

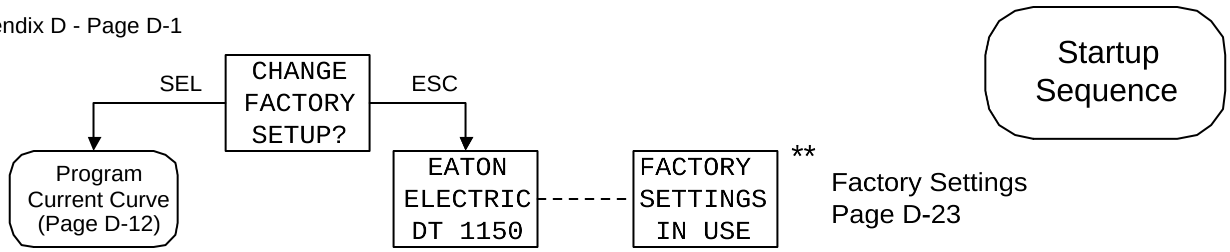
Symptom	Probable Cause	Possible Solution(s)	Comments
SETTINGS ERROR ALARM	Set point mismatch between CHip A and CHip B Microcomputers	Enter Program Settings by using the Esc Button (do not use Reset Button) and SAVE CURRENT curve. If setpoint download is successful press Reset. Re-verify settings that you desire.	If alarm reappears after trying the possible solution, replace trip unit at first opportunity. Ref. Fig. 3.1
SETTINGS ERROR ALARM – or – GROUND FAULT PICKUP TEST INCORRECT	Source Ground configuration jumper disconnected when circuit breaker removed from cell	1. Make temporary secondary connector jumper B-6 to B-7 to duplicate actual field application – or – 2. Place circuit breaker back into test position.	If ground test is to be conducted, apply ground test current into external sensor's primary conductor with secondary leads B-4, B-5 connected to circuit breaker.
WATCHDOG ALARM	Low line Voltage	Check input voltage for Aux Power A14, A15	See Appendix G and H.
	Communication Problem Between CHip A and CHip B Microcomputers	1. Push Reset Button 2. Replace unit if WATCHDOG alarm reappears or if status LED is not flashing.	If alarm persists, protection (CHip A) function may still be present if STATUS LED is flashing. However, its values cannot be communicated properly to the Display. Ref. Fig. 3.1 and Section 3.2.1
CIRCUIT BREAKER DOES NOT COMMUNICATE WITH PowerNet, BIM II	Digitrip 1150 Firmware version 8B must be REV 02 or greater for 1150 mode communication	1. Check for Aux. Power A14, A15. 2. Check address and baud settings. 3. Check status LED and Transmit LED. 4. Check communication wiring B1, B2. 5. Termination resistor missing.	See Appendix G See Section 4.2.3 See Fig. 4.9.
CIRCUIT BREAKER DOES NOT COMMUNICATE WITH AEM II	For communication with AEM II use Digitrip 1150 in the 910 mode.	Same as above.	See Appendix G See Section 4.2.3 Note OK for Ver 6 and Lower
NO VOLTAGE READINGS IN METER MENU	PT dielectric plug removed	1. Circuit breaker is backfed and open. 2. Digitrip is not properly connected/inserted to circuit breaker I1 connector 3. Replace PT Module.	Ref. Section 3.5. Ref. Fig 1.2
VOLTAGE OR CURRENT OR FREQUENCY READINGS APPEAR WRONG OR VARYING (Digitrip Cat 11xxx pre-2003 versions only)	Digitrip METER needs both phase voltages and at least 20% phase A current available initially to lock in frequency	Apply both line voltage and 20% phase A current one time to setup metering.	This situation may occur on initial startup on 50 Hertz applications since circuit breakers are typically tested in the factory at 60 Hz.
Check Aux. Switch (Message on Display)	The MCR Aux. Switch 52b is not operating or is not wired properly	1. Check switch continuity on connector K2-1, K2-2. 2. If secondary injection testing is being done, close circuit breaker and retest.	Refer to Appendix C
RAM ALARM	Memory Error	1. Push Reset Button 2. Replace unit if alarm reappears	Replace Trip Unit at first opportunity.

Appendix C Typical Circuit Breaker Master Connection Diagram

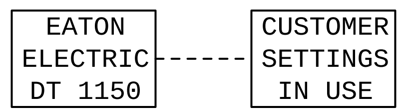


Appendix D - Display Menu Diagrams

Appendix D - Page D-1

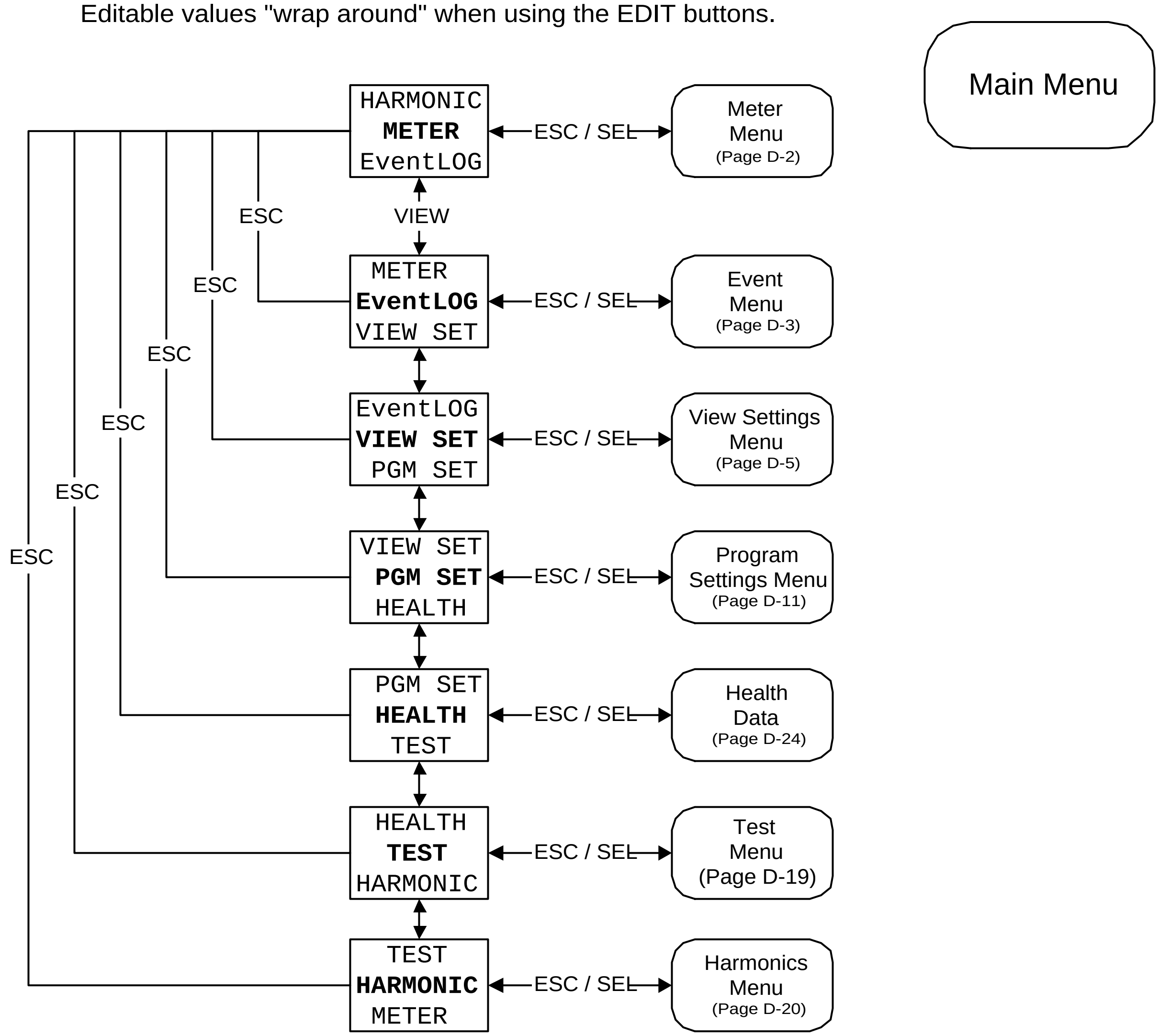


If any current curve setting (shown on pages D-12 and D-13) is changed from the Factory Settings (D-23), the unit will display the following screens on power up.



** Screens will alternate back and forth for 6 seconds and then fall into the Main Menu.

Notes: **BOLDFACE** text is blinking.
Menu screens "wrap around" when using the VIEW buttons.
Editable values "wrap around" when using the EDIT buttons.

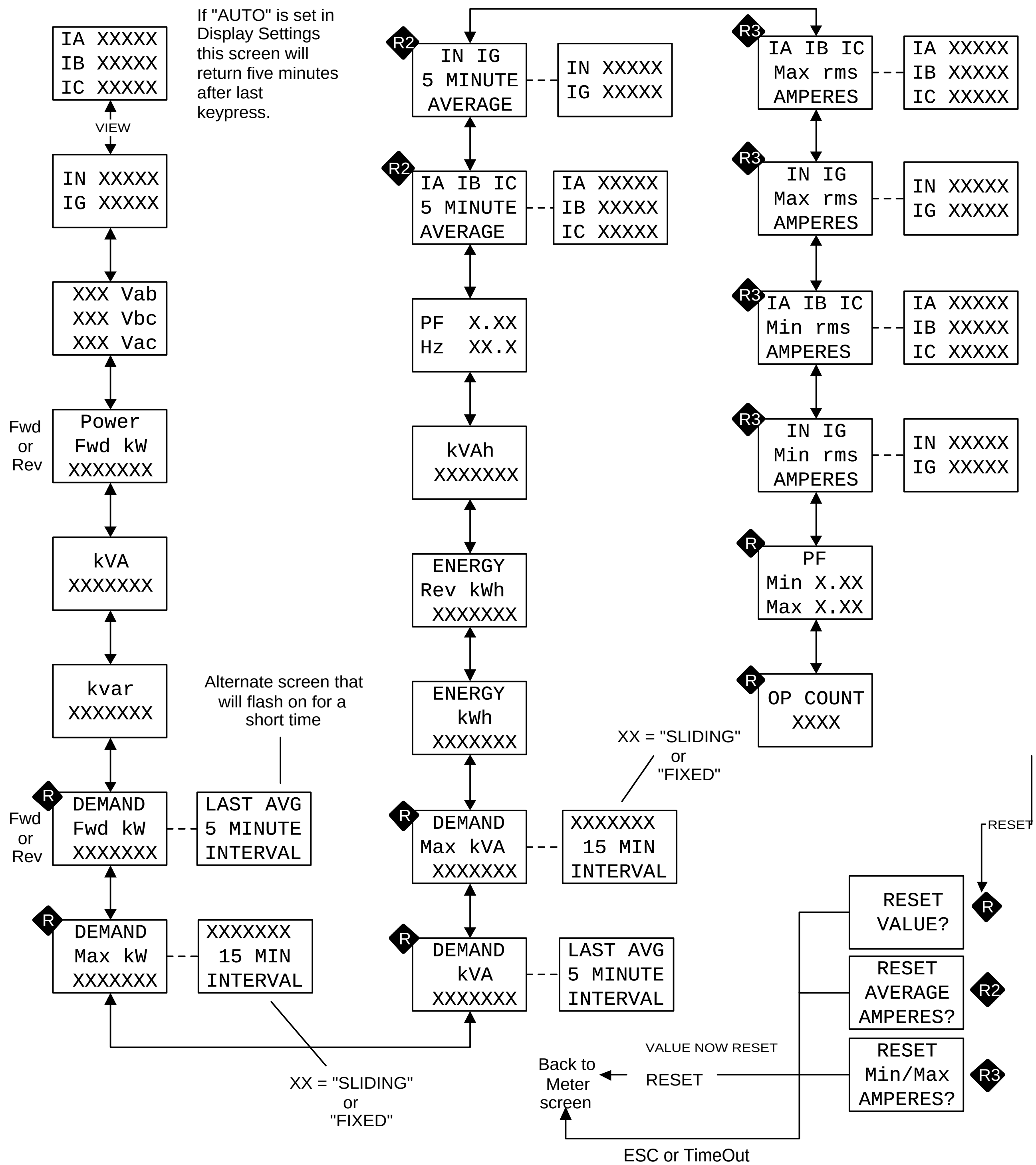


Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-2

Individual screens are only displayed if their Display Setting is set to "ON".

Meter Menu



Appendix D - Display Menu Diagrams Continued

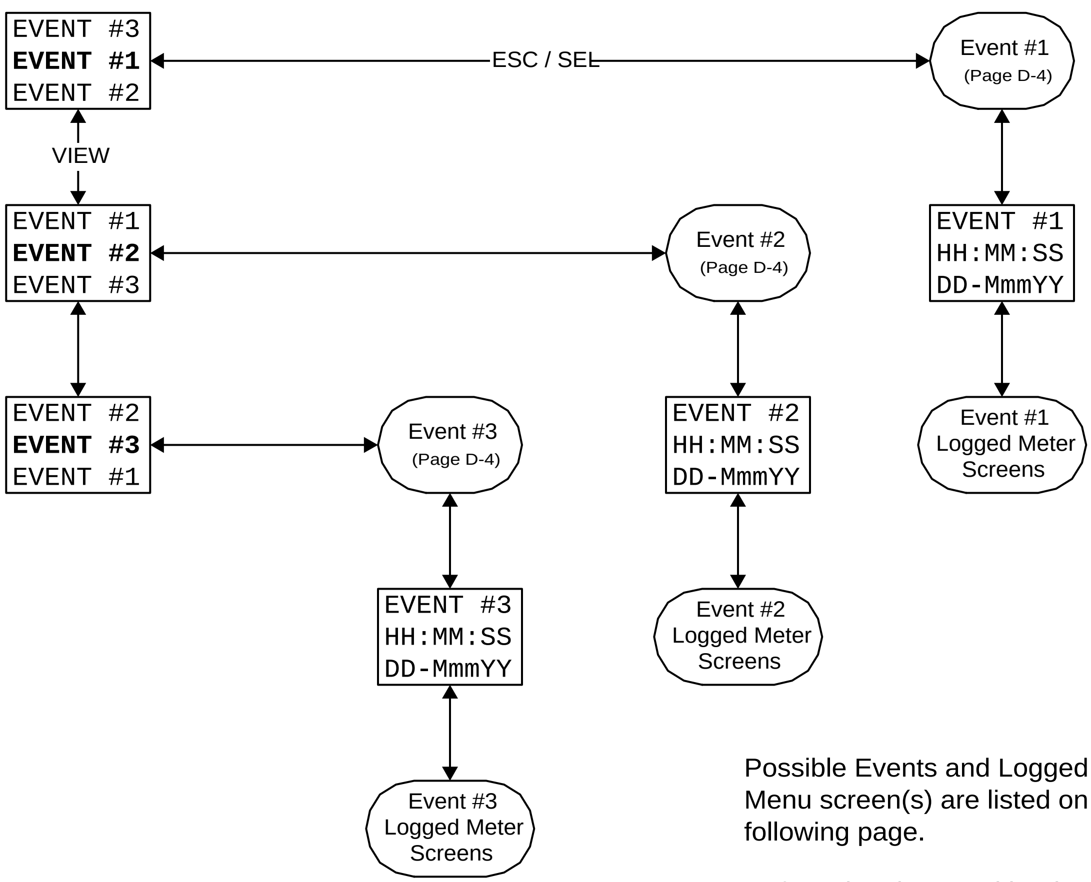
Appendix D - Page D-3

Event Log Menu

When a trip event occurs, data from the appropriate Meter Menu screens is captured and then logged for that event. The event numbering scheme is a first-in, first-out type. However always use the Time Stamp data provided and not the Event # as a chronicle.

An alarm event will be logged if "ALARM TO EventLOG" has been ENABLED (page D-16).

In cases where Trip Unit Power (Aux. power) is lost during or prior to a tripping event, the Time Stamp message will display "No EventLog".



Possible Events and Logged Meter Menu screen(s) are listed on the following page.

Default time is Jan with other values set to 0.

Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-4A

Note: "Meter screens" refer to those on D-2

Possible Events TRIP

Data and Time Stamp logged for each event.

Event	Data
LONG DELAY TRIP	1st & 2nd Meter screens Note 1
SHORT DELAY TRIP	1st & 2nd Meter screens
INST TRIP	1st & 2nd Meter screens Note 2
NEUTRAL TRIP	1st & 2nd Meter screens Note 3
GROUND FAULT TRIP	1st & 2nd Meter screens Note 4
OPEN BY COMM	No data displayed
ACC BUS TRIP	No data displayed
AMPERES OUT OF BALANCE	1st Meter screens
OVER TEMP TRIP	No data displayed
PlugTRIP	No data displayed
MAKING CURRENT TRIP	No data displayed
PHASE LOSS TRIP	3rd Meter screen
HIGH INST TRIP	No data displayed

Additional TRIPs for Digitrips Cat # 11Rxx only

Event	Data
UndrVOLT TRIP	L-L Voltage and FREQ screens displayed. See Note 5
OverVOLT TRIP	L-L Voltage and FREQ screens displayed. See Note 5
UndrFREQ TRIP	L-L Voltage and FREQ screens displayed. See Note 5
OverFREQ TRIP	L-L Voltage and FREQ screens displayed. See Note 5
RevPower TRIP	Power kW screen displayed See Note 5
VOLT UN-BALANCE TRIP	L-L Voltage and FREQ screens displayed. See Note 5

1. LONG DELAY TRIP term is used by LSI, IEEE and IEC curve type indicating an overload trip.

2. INST TRIP values displayed could be less than actual fault levels due to fast response of this element.

3. NEUTRAL TRIP is a Long Delay Trip on Neutral or 4th pole

4. If IEC -EF style, "EARTH" will replace "GROUND"

5. Real Time data is shown for Voltage and Frequency. View EventLog screen for actual TRIP data.

Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-4B

Note: "Meter screens" refer to those on D-2

Possible Events Alarms

Data logged and shown for each event.

Alarm	Data
LOW PF ALARM	PF Meter Screen
GROUND ALARM	1st & 2nd Meter Screens Note 4
NEUTRAL AMPERE ALARM	1st & 2nd Meter Screens
HIGH LOAD ALARM	1st & 2nd Meter Screens
OPCOUNT ALARM	Operate Counter Meter Screen
kW DEMAND ALARM	kW Meter Screen
kVA DEMAND ALARM	kVA Meter Screen
THD ALARM	THD Harmonics Screen

Alarm screens will be real-time messages

LDPU (LONG Pickup) ALARM is setup via CURRENT curve. It is always ON

Alarm	Data
LDPU ALARM	1st & 2nd Meter Screens

These Diagnostic ALARMS are always ON

Alarm	Data
SETTINGS ERROR ALARM	No Data Displayed
WATCHDOG ALARM	No Data Displayed
EEROM ALARM	No Data Displayed

For Cat. # 11PXXX Only

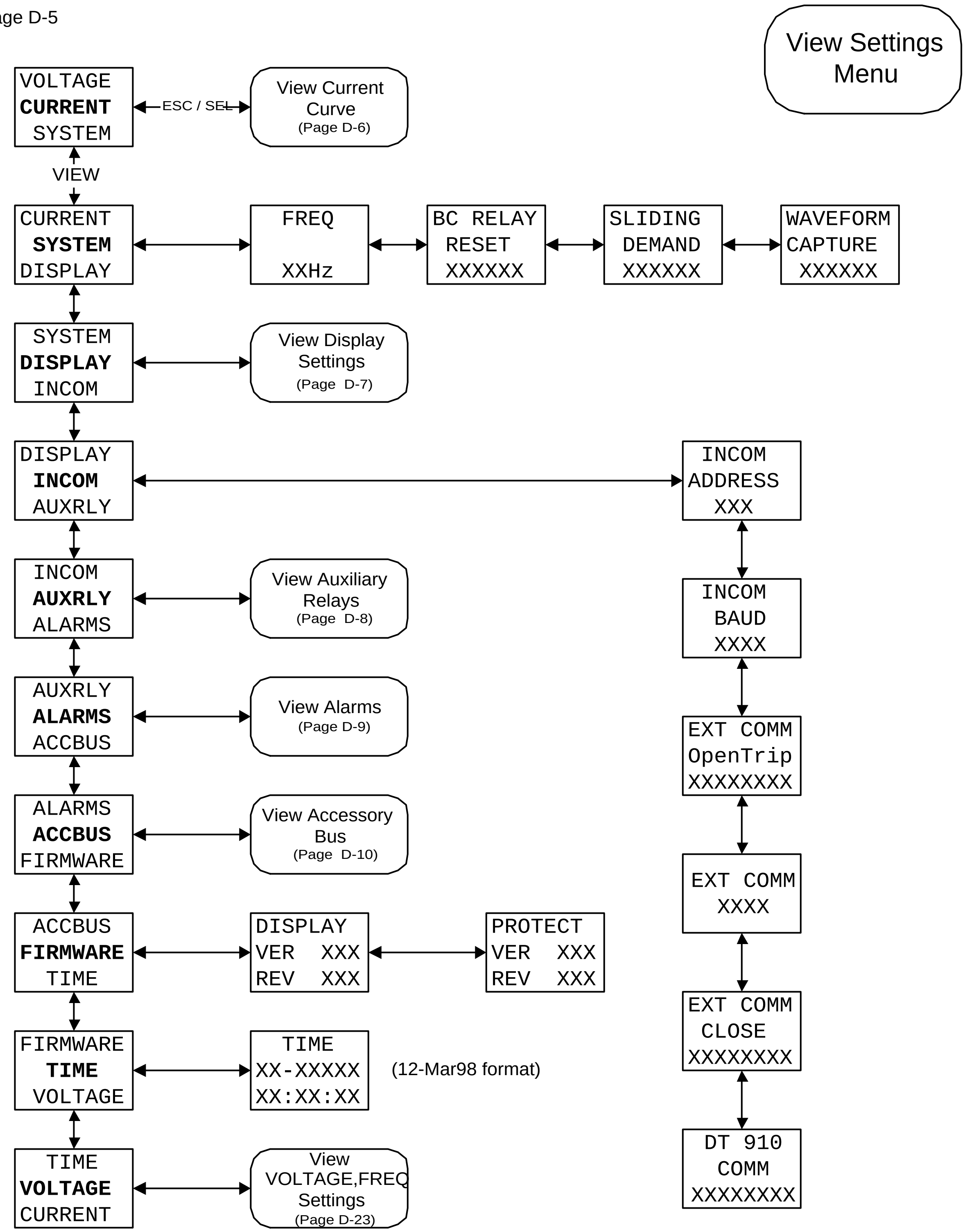
Alarm	Data
FREQ OUT OF BOUNDS	No Data Displayed
CHECK AUX SWITCH	No Data Displayed
RAM ALARM	No Data Displayed

Additional Alarms for Cat # 1 1PXXX only

Alarm	Data
UndrVOLT ALARM	3rd Meter Screen
OverVOLT ALARM	3rd Meter Screen
UndrFREQ ALARM	FREQ Meter Screen
OverFREQ ALARM	FREQ Meter Screen
PHASE ROT ALARM	No Data Displayed
VOLT UN-BALANCE ALARM	3rd Meter Screen

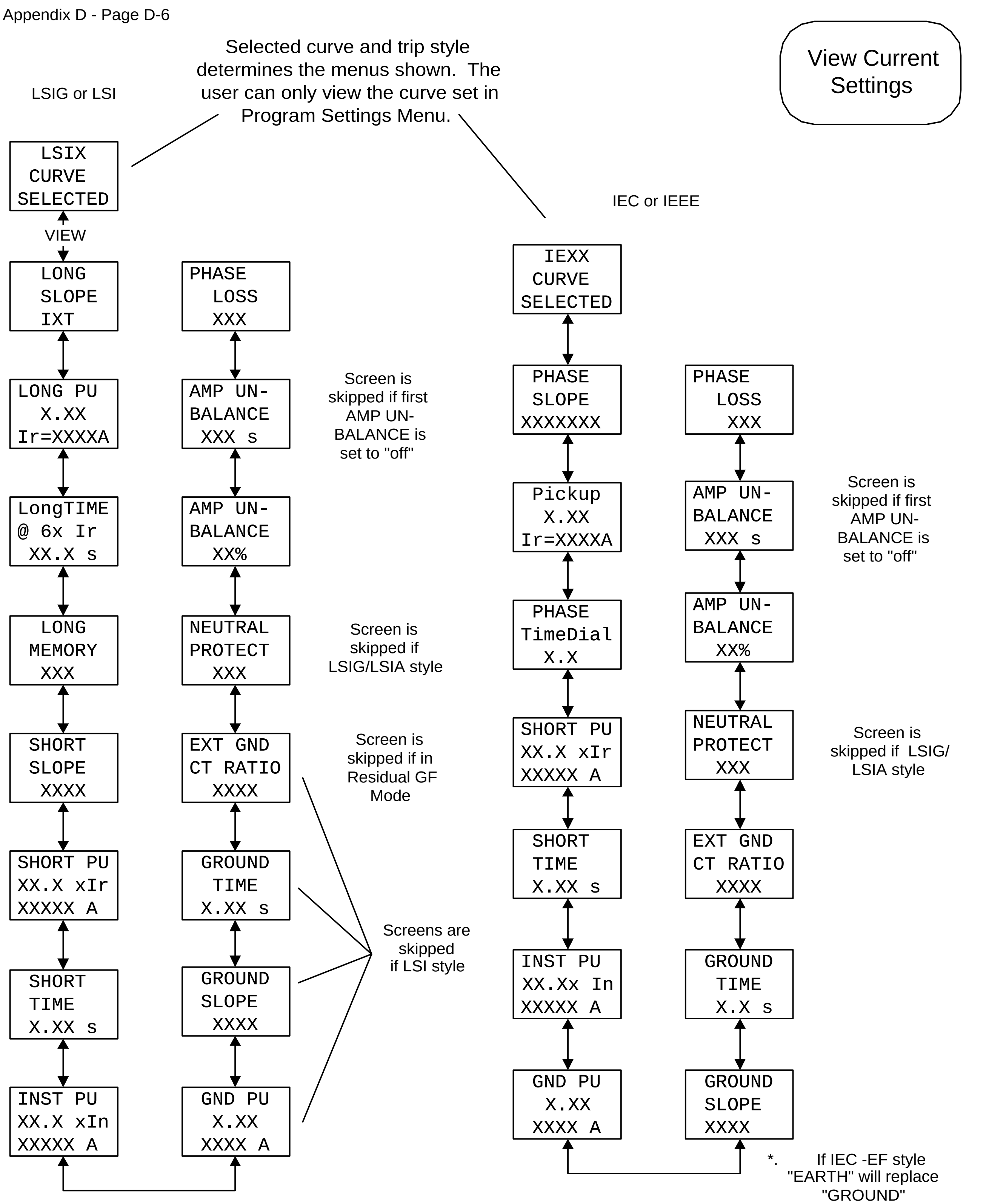
Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-5



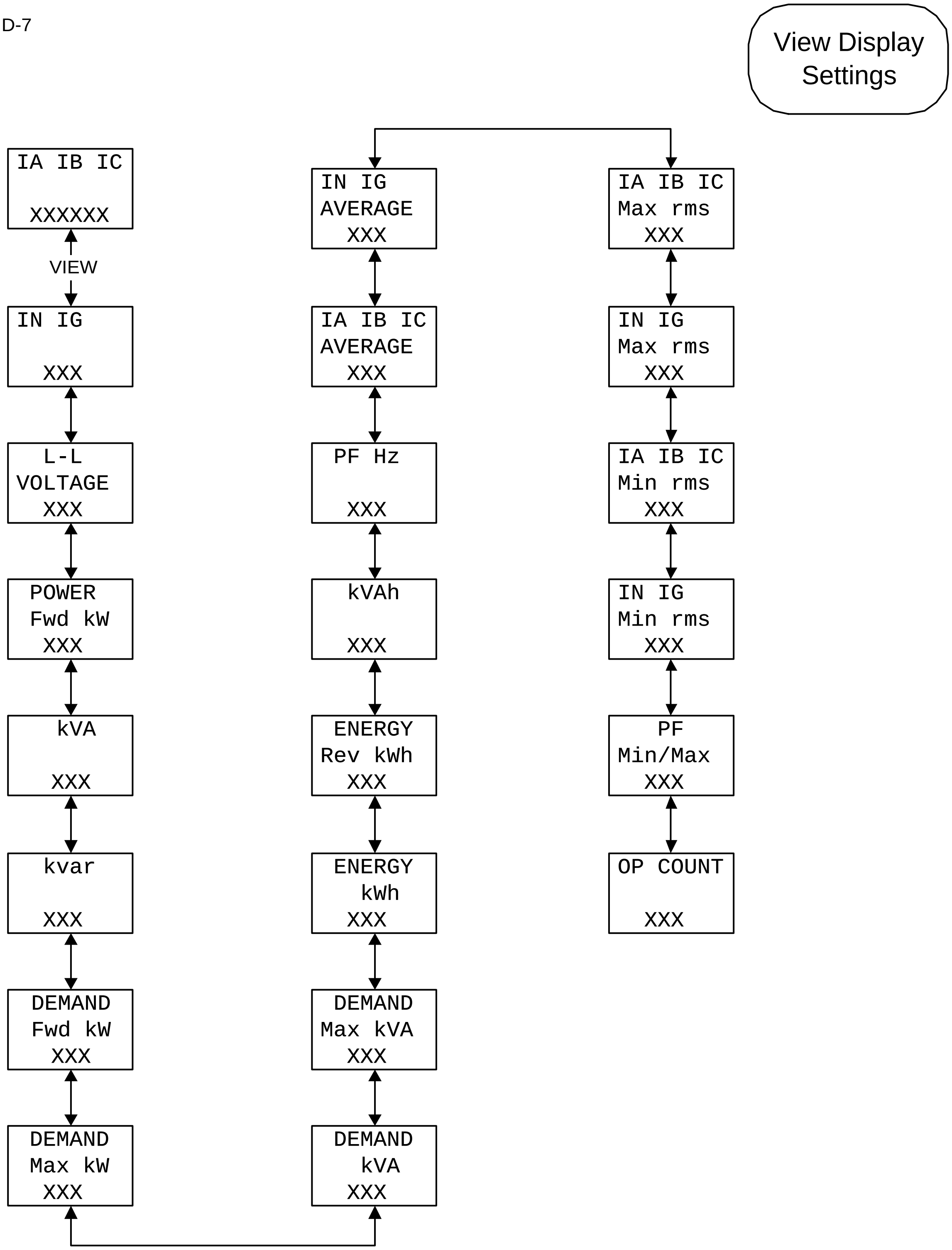
Note: Digitrip 1150 Cat.#11xxx do not have VOLTAGE or SYSTEM main menu. "GENERAL" is used in place of SYSTEM. FREQ selection and EXT COMM OpenTrip are not available.

Appendix D - Display Menu Diagrams Continued



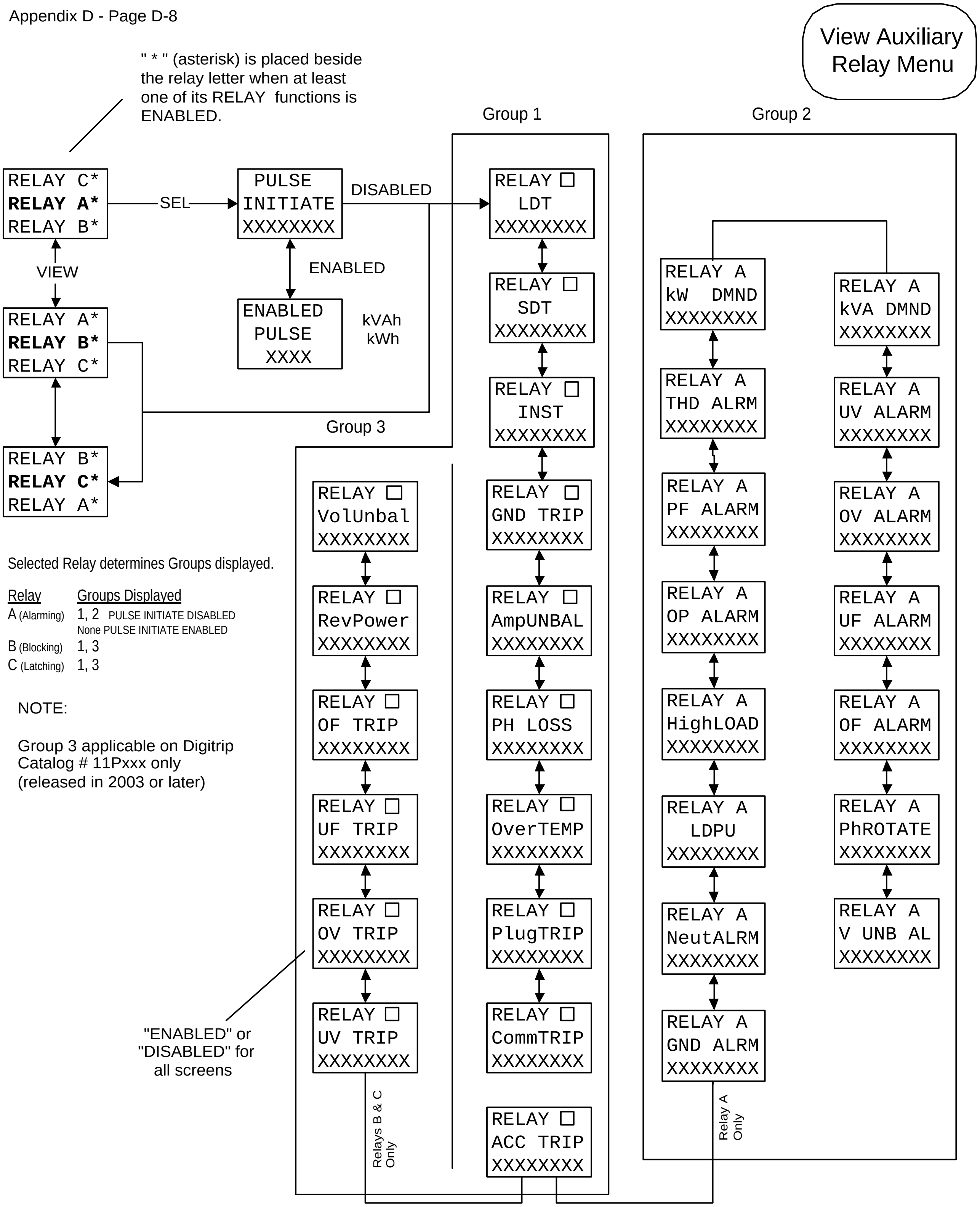
Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-7



Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-8



Selected Relay determines Groups displayed.

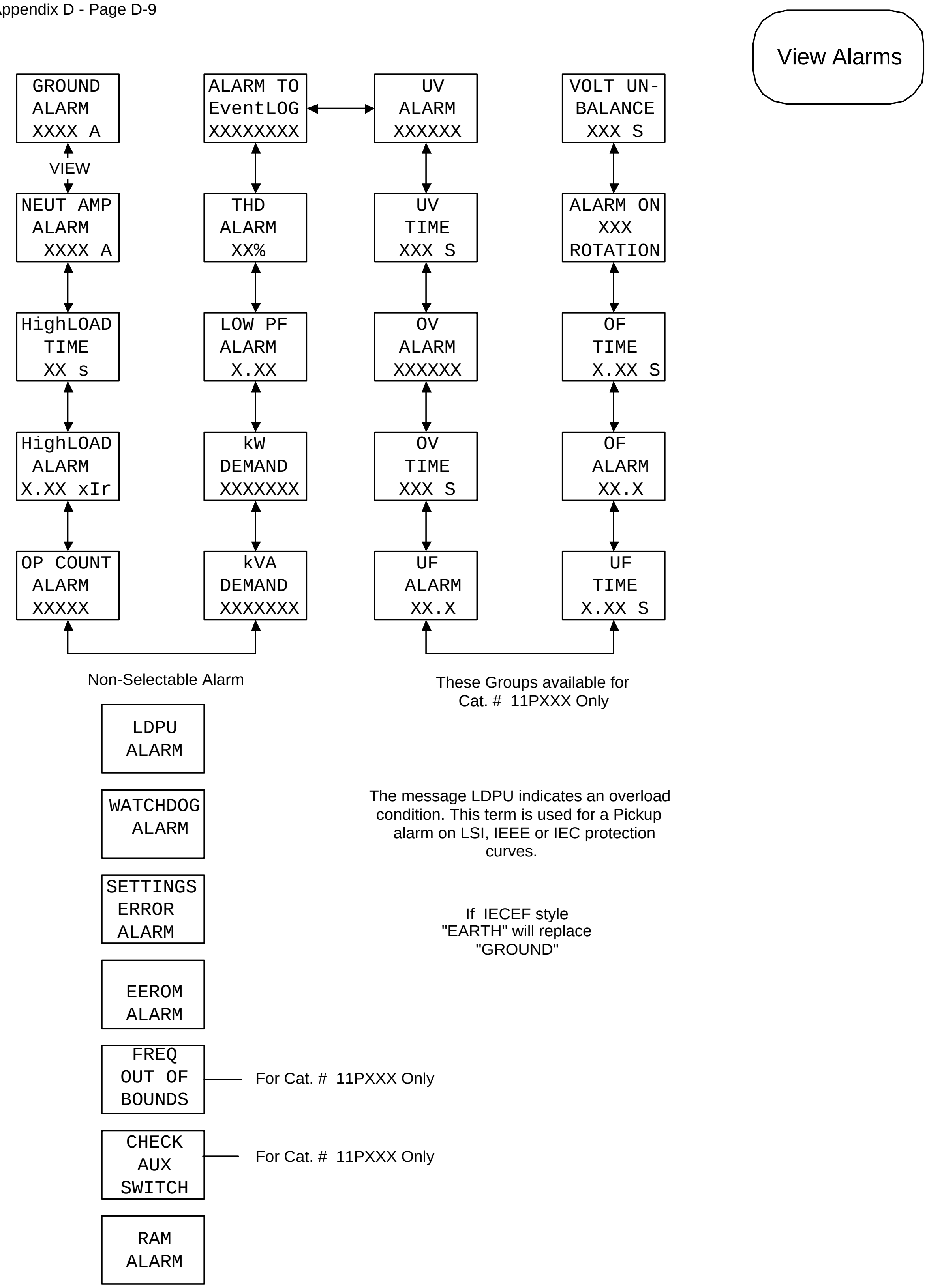
Relay	Groups Displayed
A (Alarming)	1, 2 PULSE INITIATE DISABLED None PULSE INITIATE ENABLED
B (Blocking)	1, 3
C (Latching)	1, 3

NOTE:

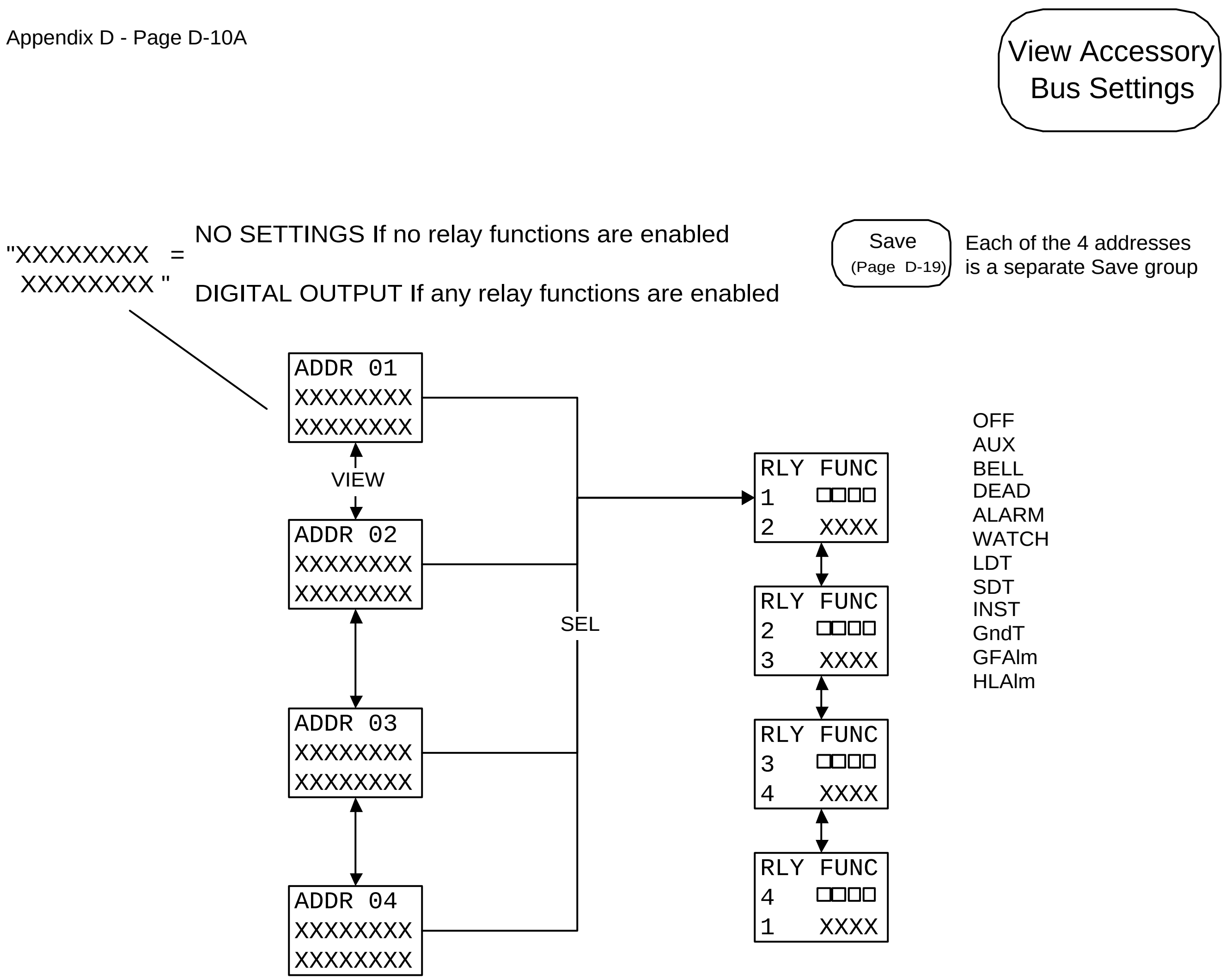
Group 3 applicable on Digitrip Catalog # 11Pxxx only (released in 2003 or later)

Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-9

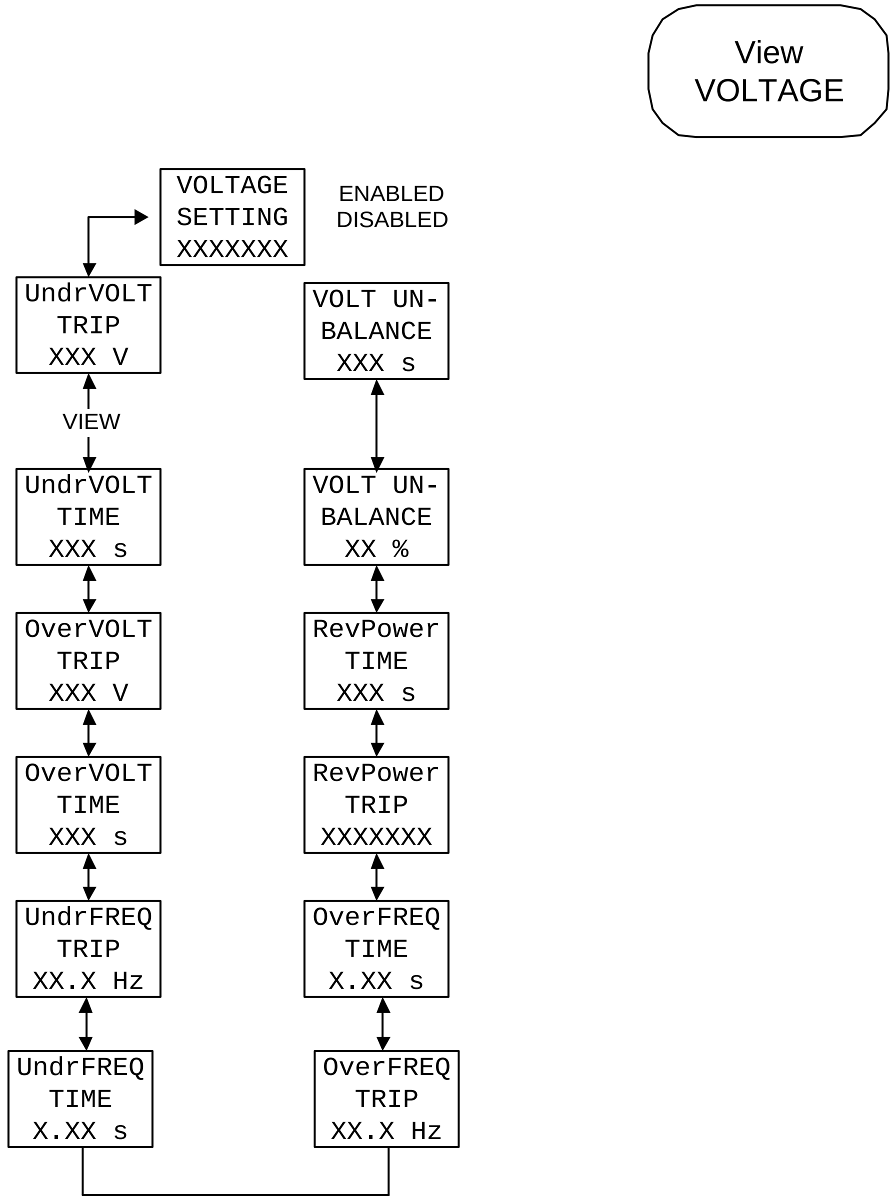


Appendix D - Display Menu Diagrams Continued

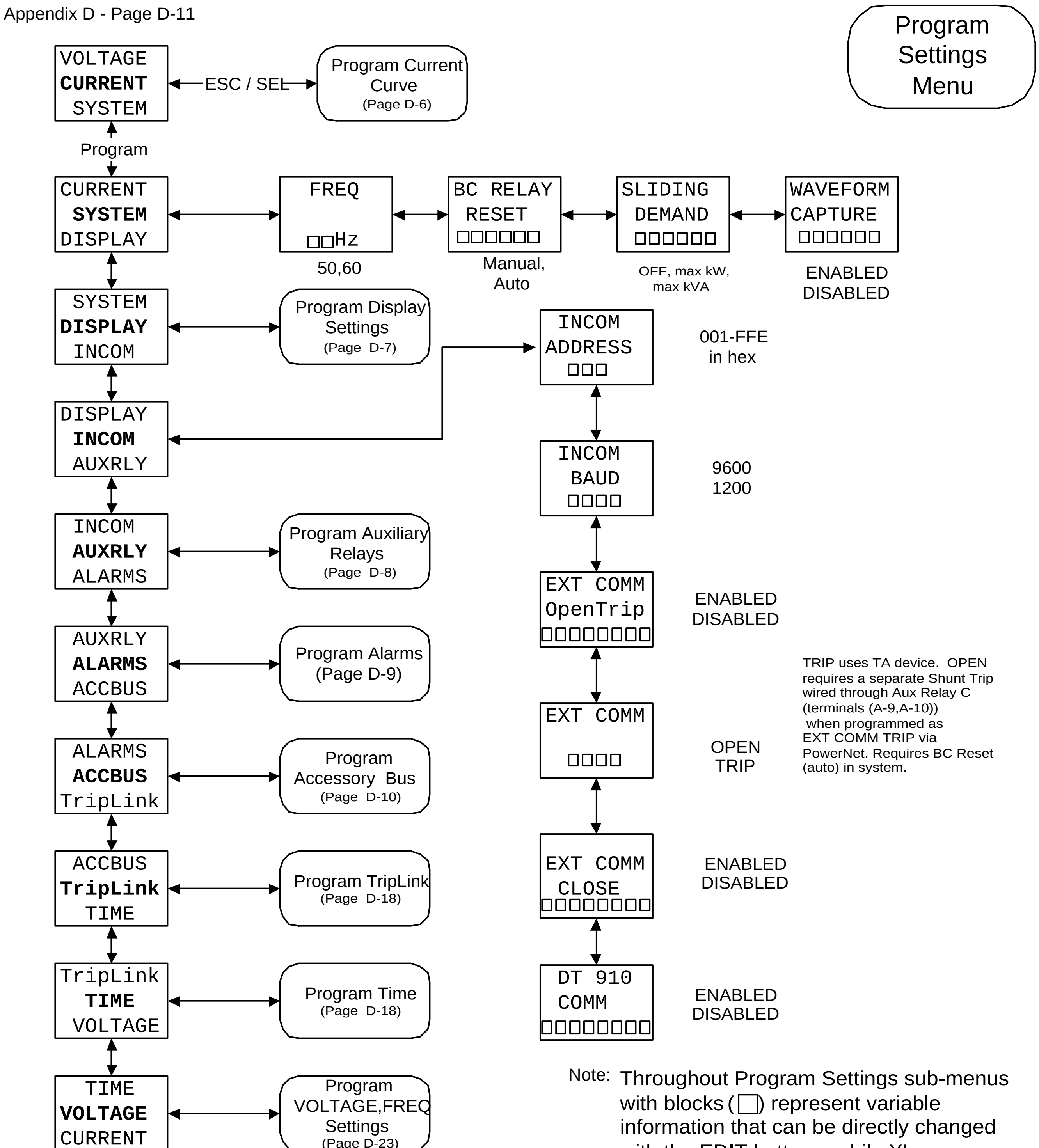


Appendix D - Display Menu Diagrams Continued

Appendix D - Page D -10B



Appendix D - Display Menu Diagrams Continued

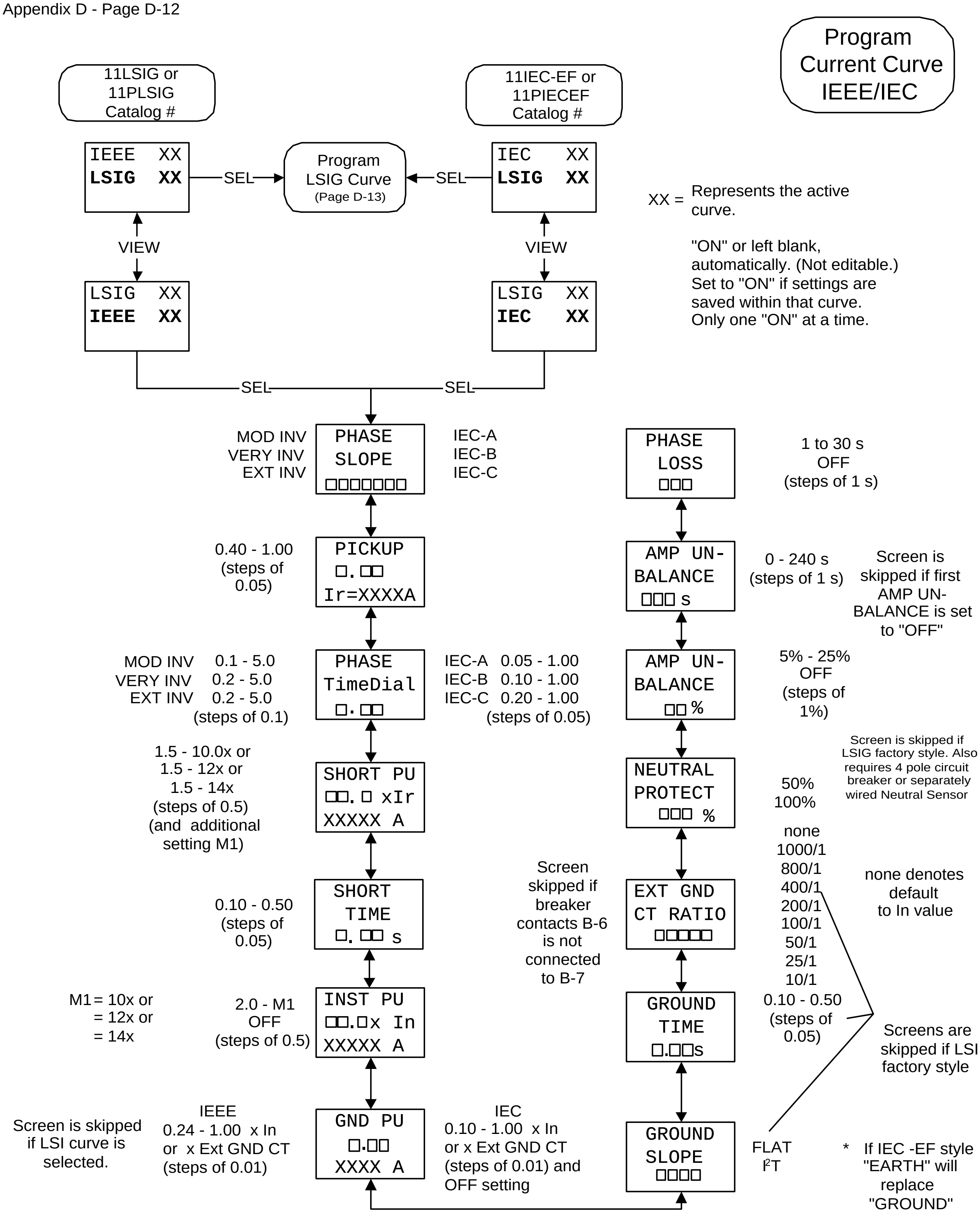


Note: Digitrip 1150 Cat. # 1 1xxx do not have VOLTAGE or SYSTEM main menu. "GENERAL" is used in place of SYSTEM. FREQ selection and EXT COMM OpenTrip are not available.

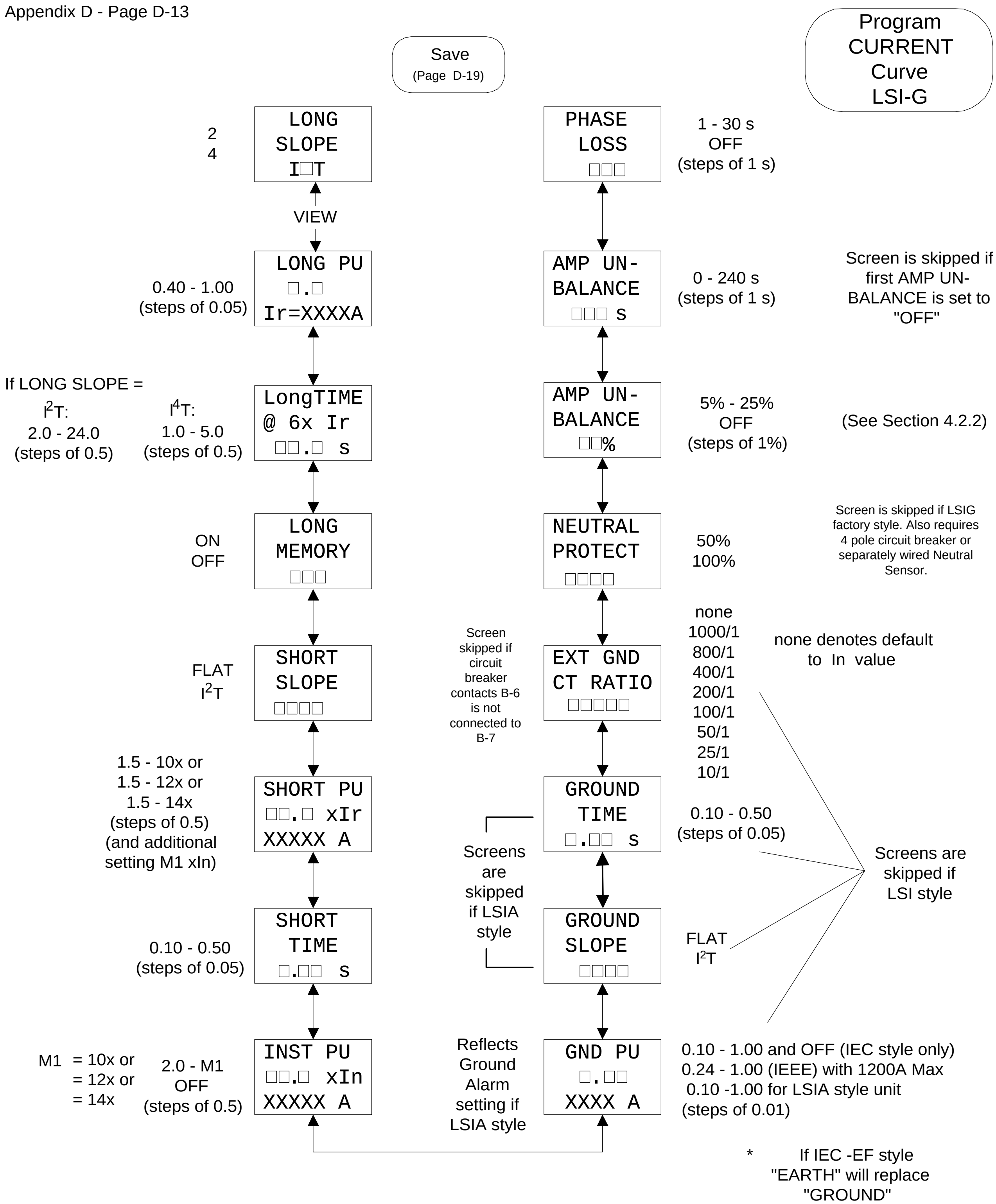
Note: Throughout Program Settings sub-menus with blocks (□) represent variable information that can be directly changed with the EDIT buttons, while X's represent variable information that is viewable.

Appendix D - Display Menu Diagrams Continued

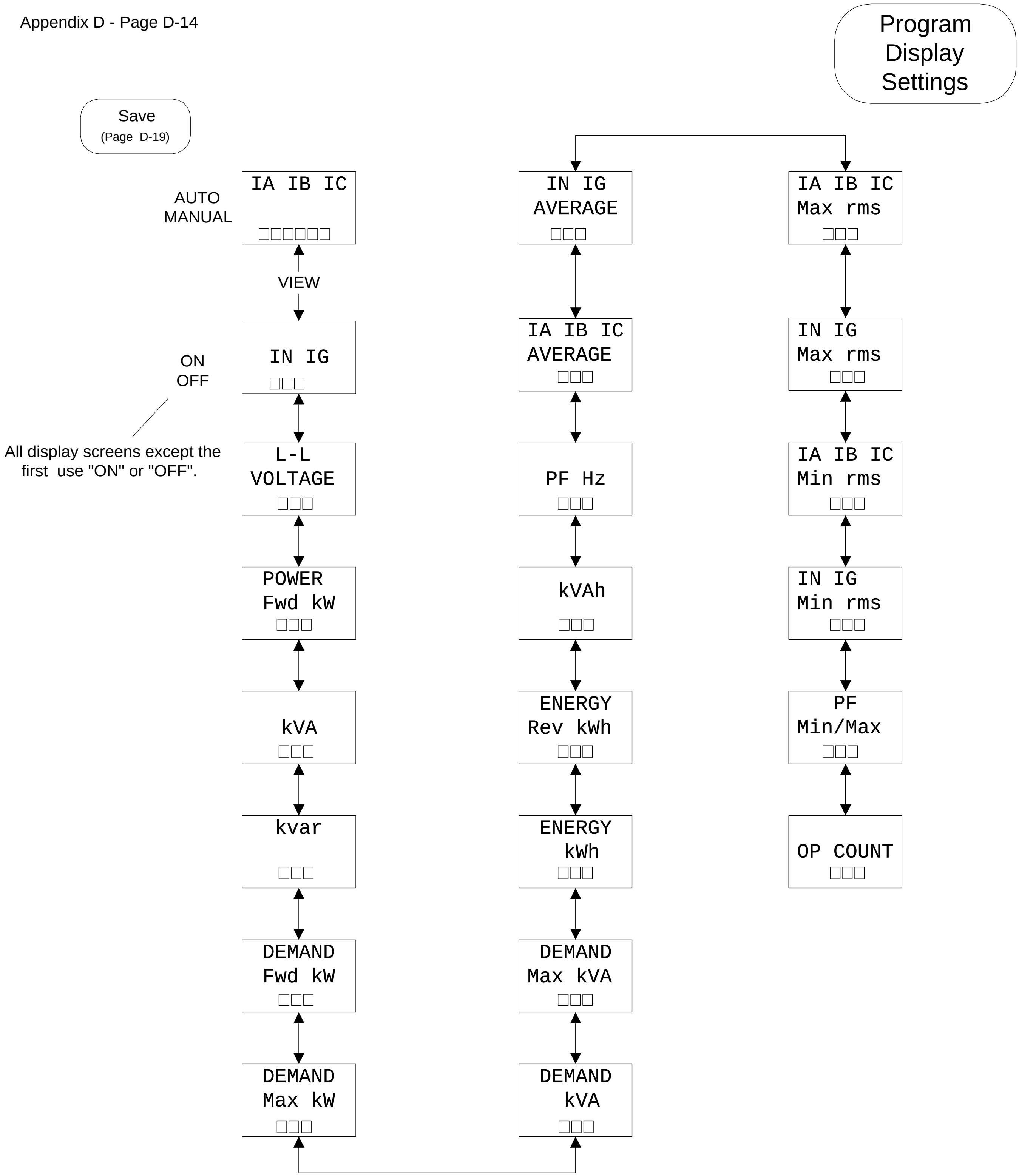
Appendix D - Page D-12



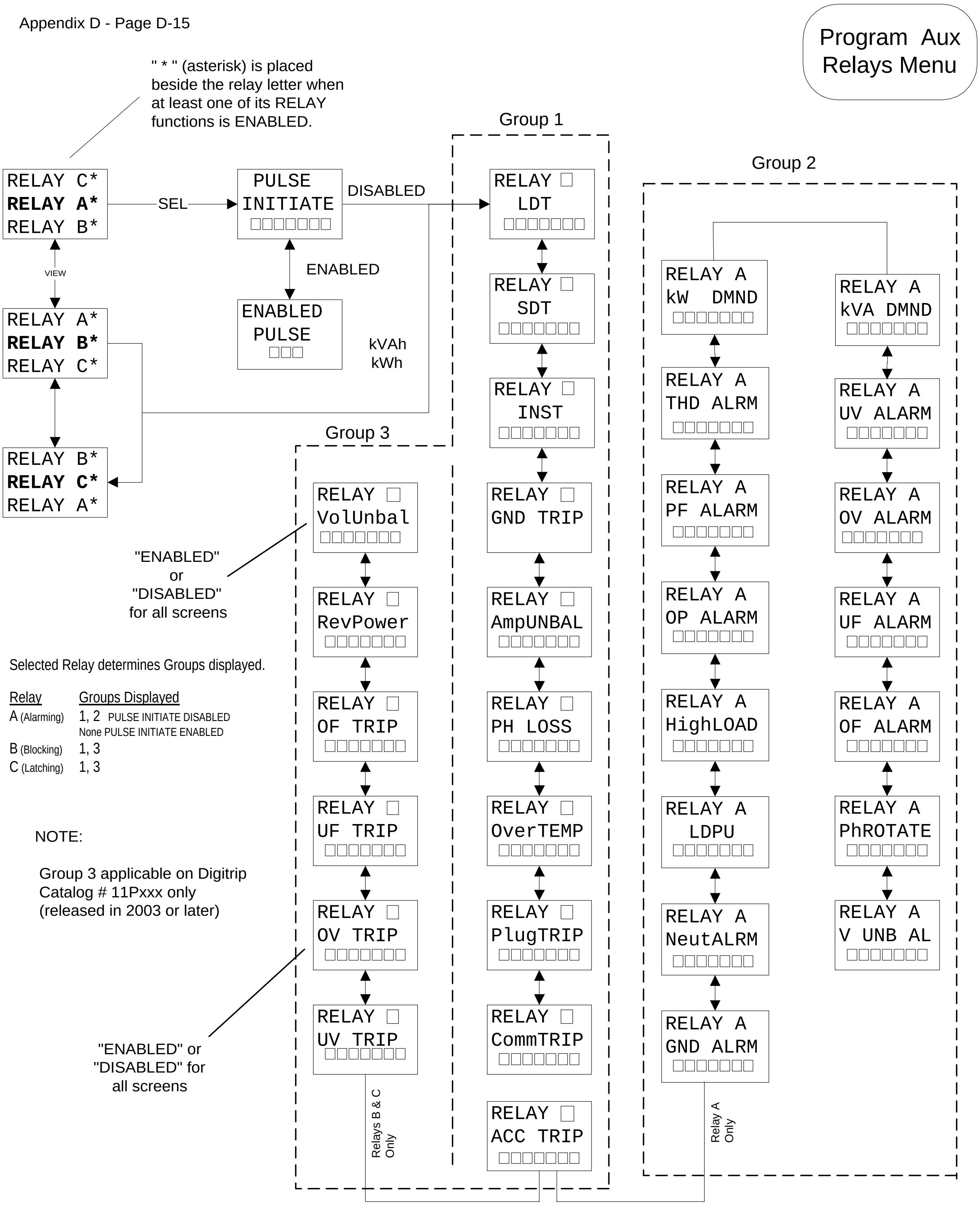
Appendix D - Display Menu Diagrams Continued



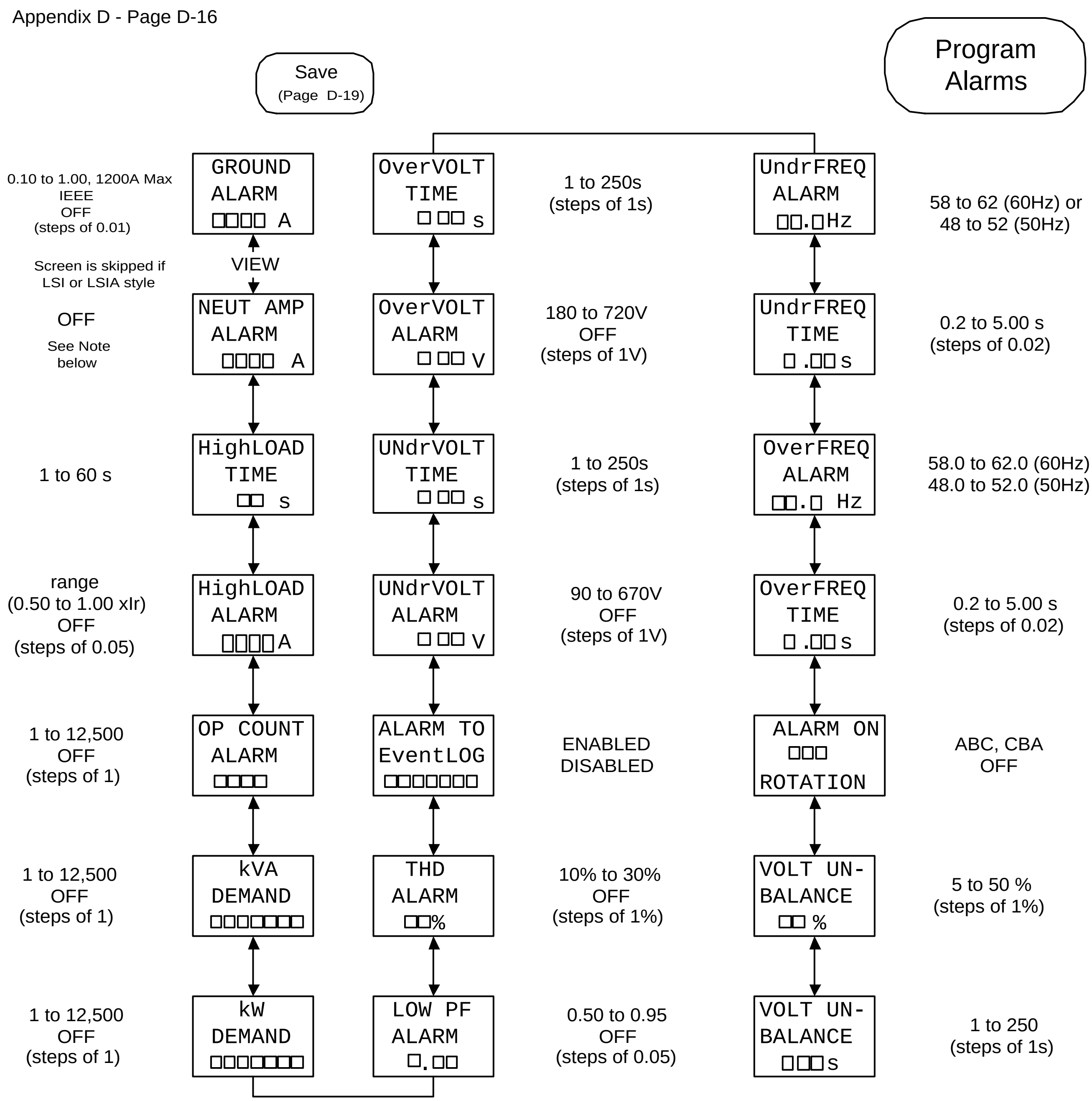
Appendix D - Display Menu Diagrams Continued



Appendix D - Display Menu Diagrams Continued



Appendix D - Display Menu Diagrams Continued



Notes: Front Panel Display of NEUTral AMPere ALARM will be in amperes. Equation used is:

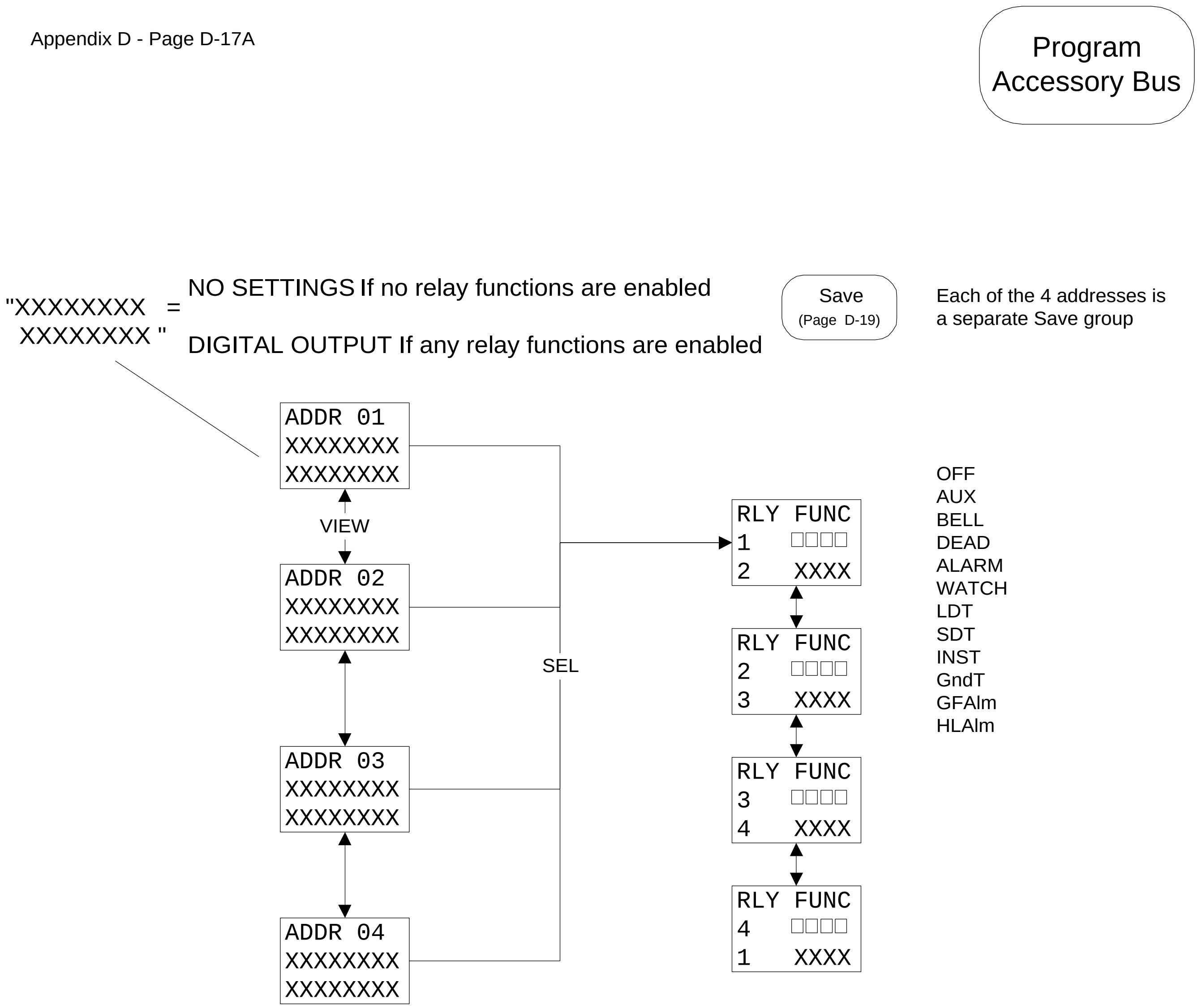
Amperes = In (amperes) x Neutral Alarm Pickup Setting (0.10 to 1.0 x In is range)

The Neutral Alarm (if not set to OFF) will also alarm if Neutral (Long Pickup value) is exceeded. The Neutral alarm function is not possible on breakers used in a Source Ground or Zero Sequence Ground Fault application.

Voltage, Frequency and Phase Rotation alarming requires Digitrip Cat # 11PXXX

* If IEC -EF style "EARTH" will replace "GROUND"

Appendix D - Display Menu Diagrams Continued



Appendix D - Display Menu Diagrams Continued

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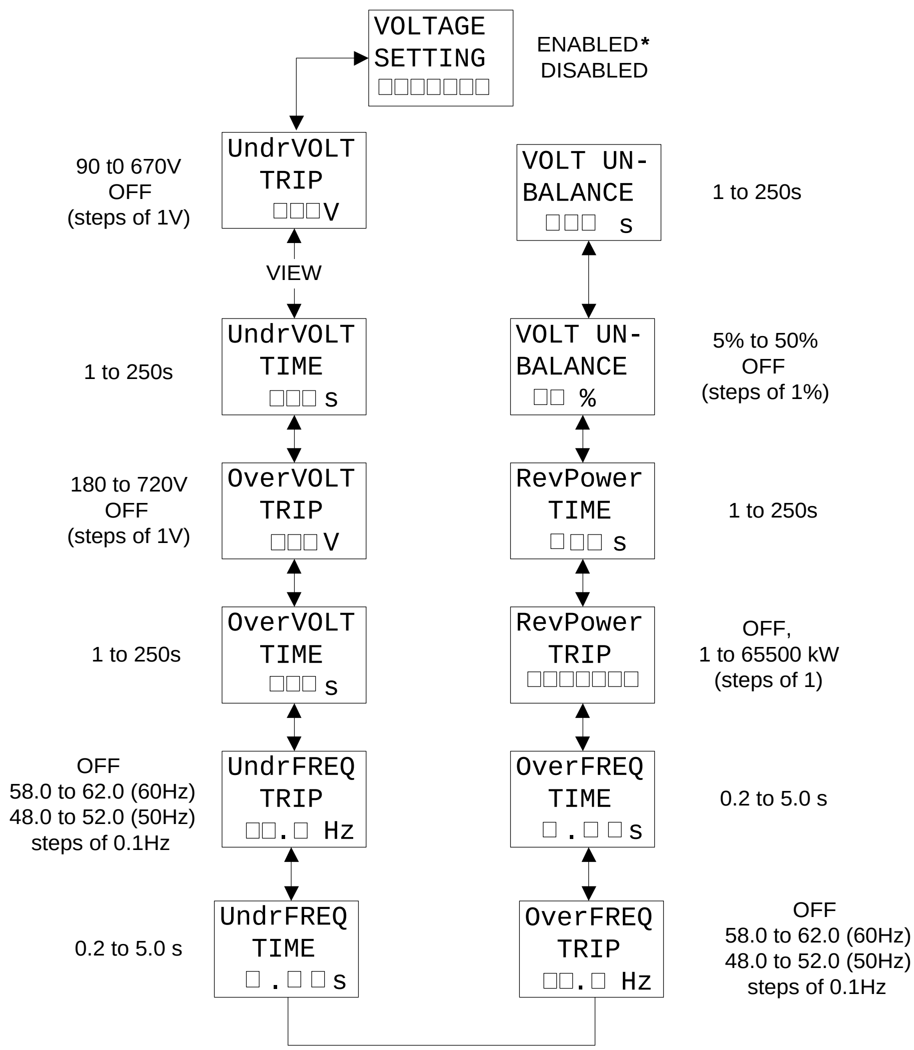
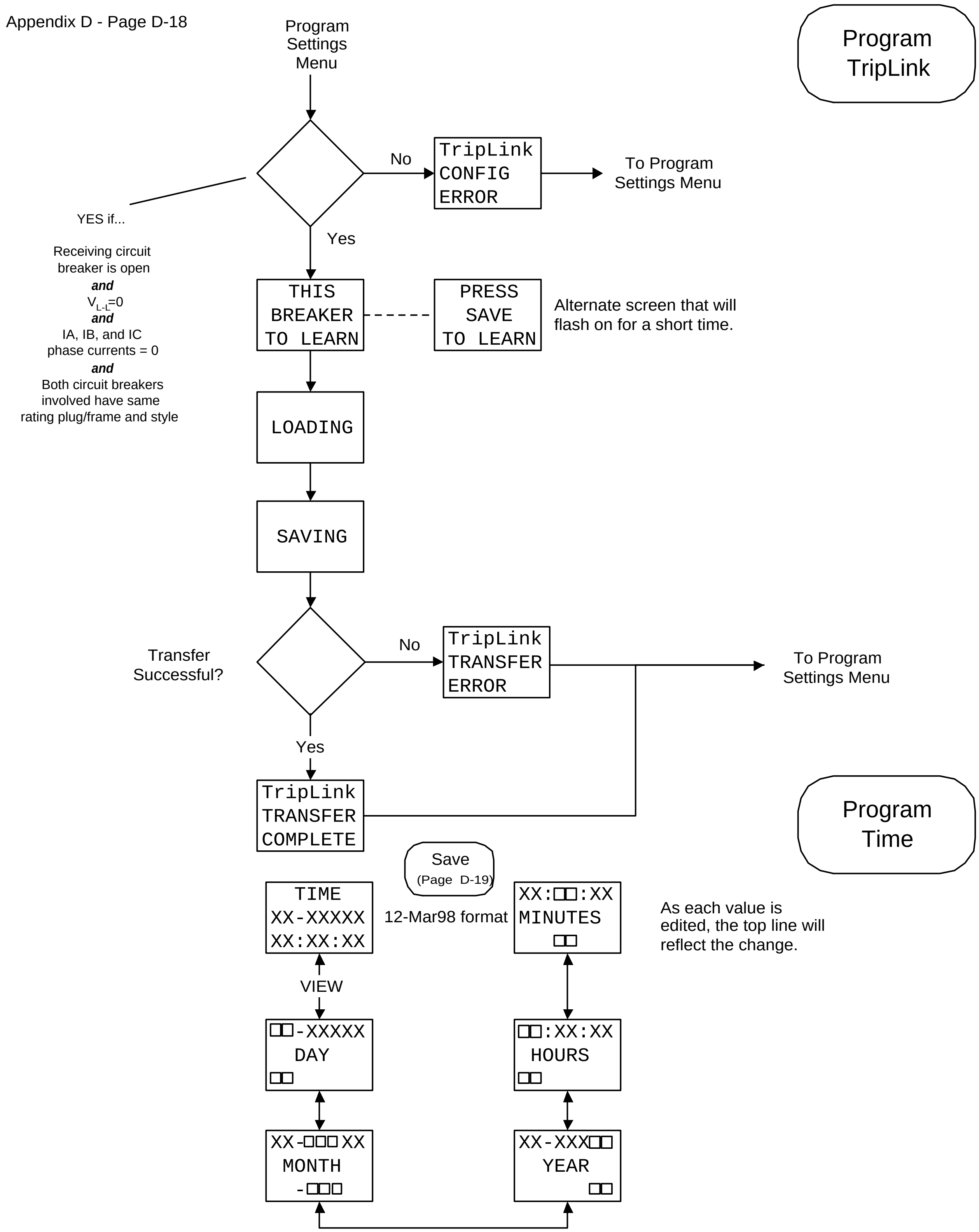
Program VOLTAGE



* This is the Master Setting that will disable (enable) all the following trip functions.
It also disables (enables) the associated voltage alarm functions.

Appendix D - Display Menu Diagrams Continued



Appendix D - Display Menu Diagrams Continued

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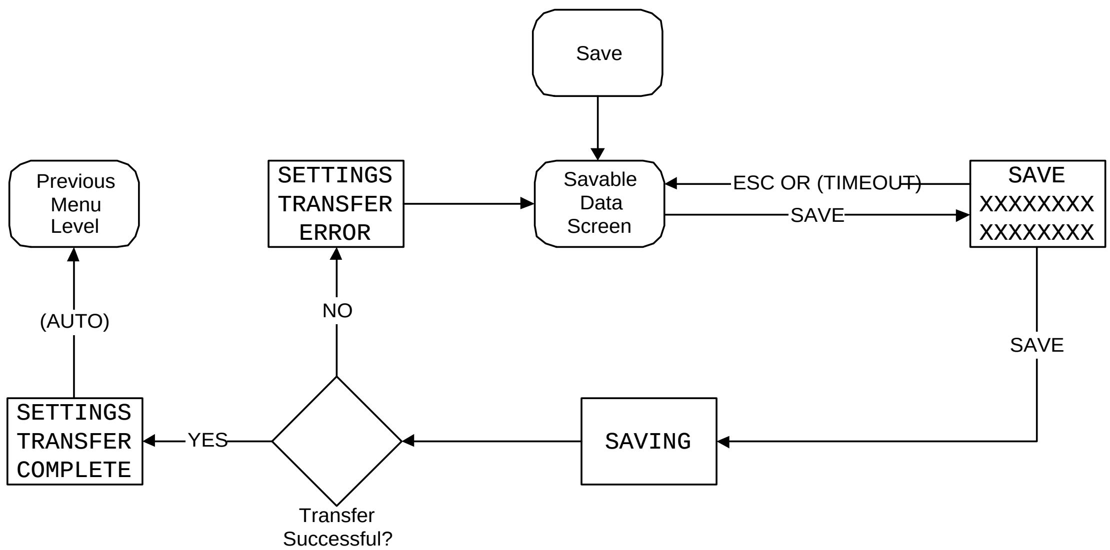
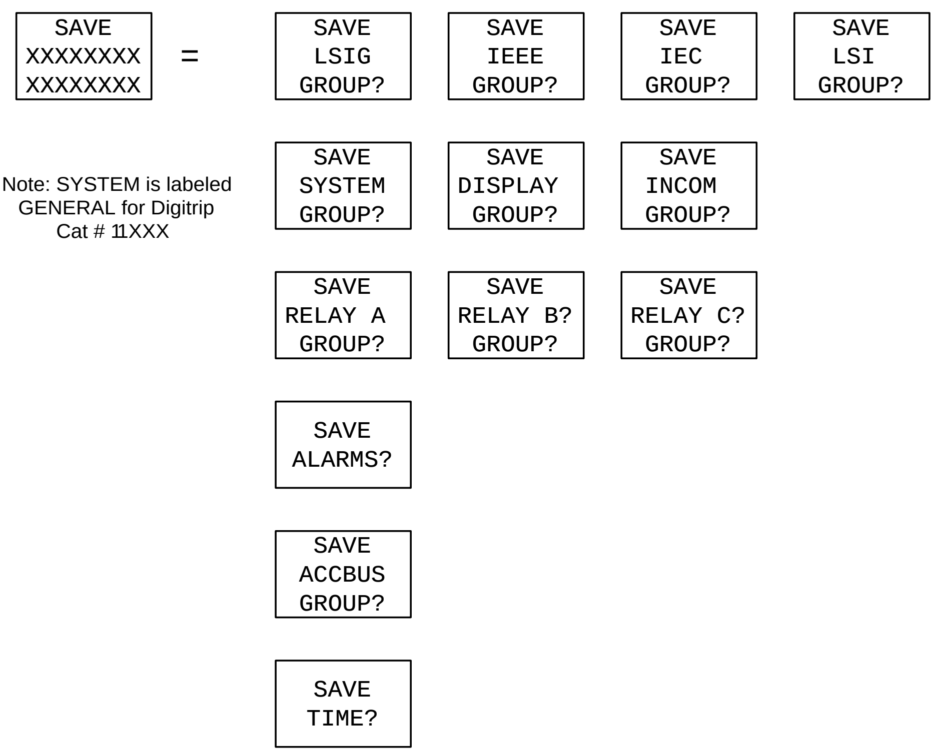
Save





Note: SYSTEM is labeled GENERAL for Digitrip Cat # 11XXX

Appendix D - Display Menu Diagrams Continued

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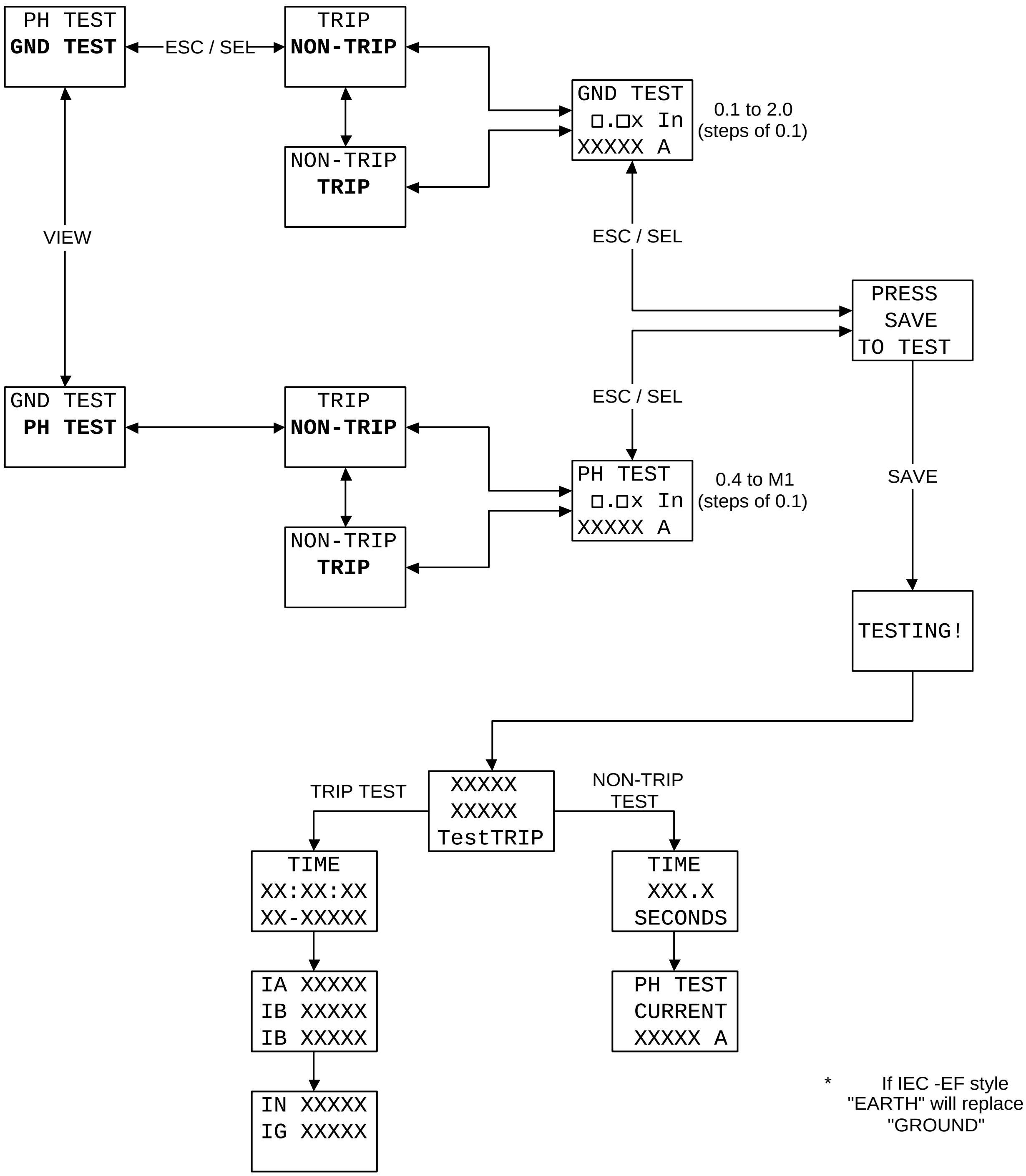
Test Menu

NOTE: If LSI curve is selected, GND TEST will not be available.

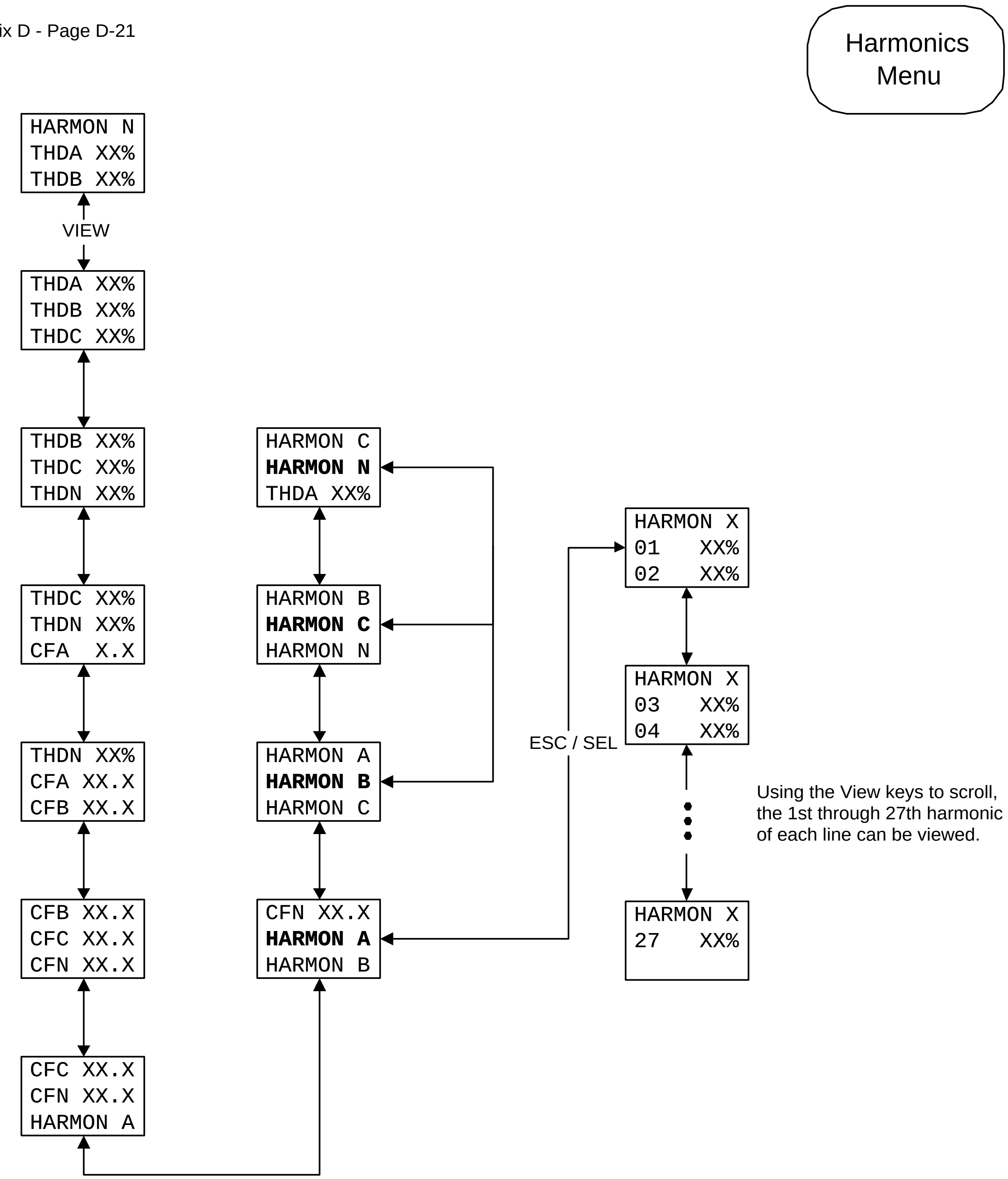
Current Testing



* If IEC -EF style "EARTH" will replace "GROUND"

Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-21



Appendix D - Display Menu Diagrams Continued

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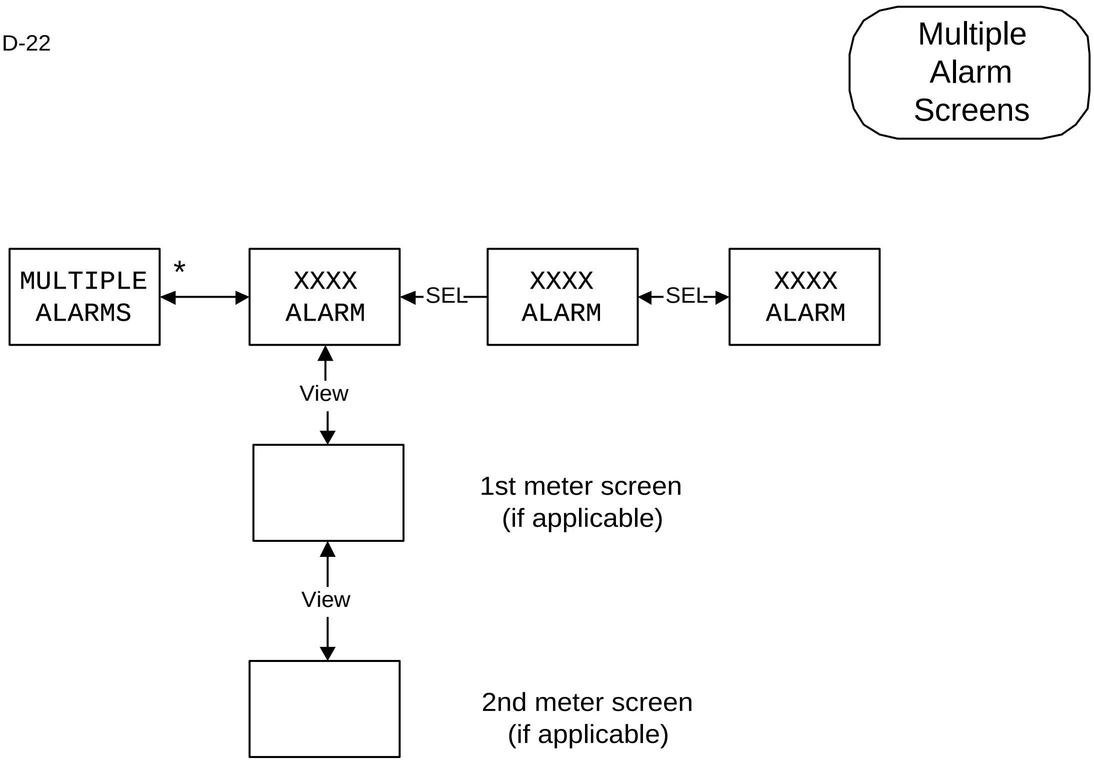

* Note:
If more than one alarm condition exists in the system, the "Mutliple Alarm" screen will be displayed and alternate with one of the alarm causes. Pressing the select pushbutton will display the next alarm condition. Pressing the ESCape will exit out and return to normal menu screen. However, the Alarm LED stays on as a reminder.

Appendix D - Display Menu Diagrams Continued

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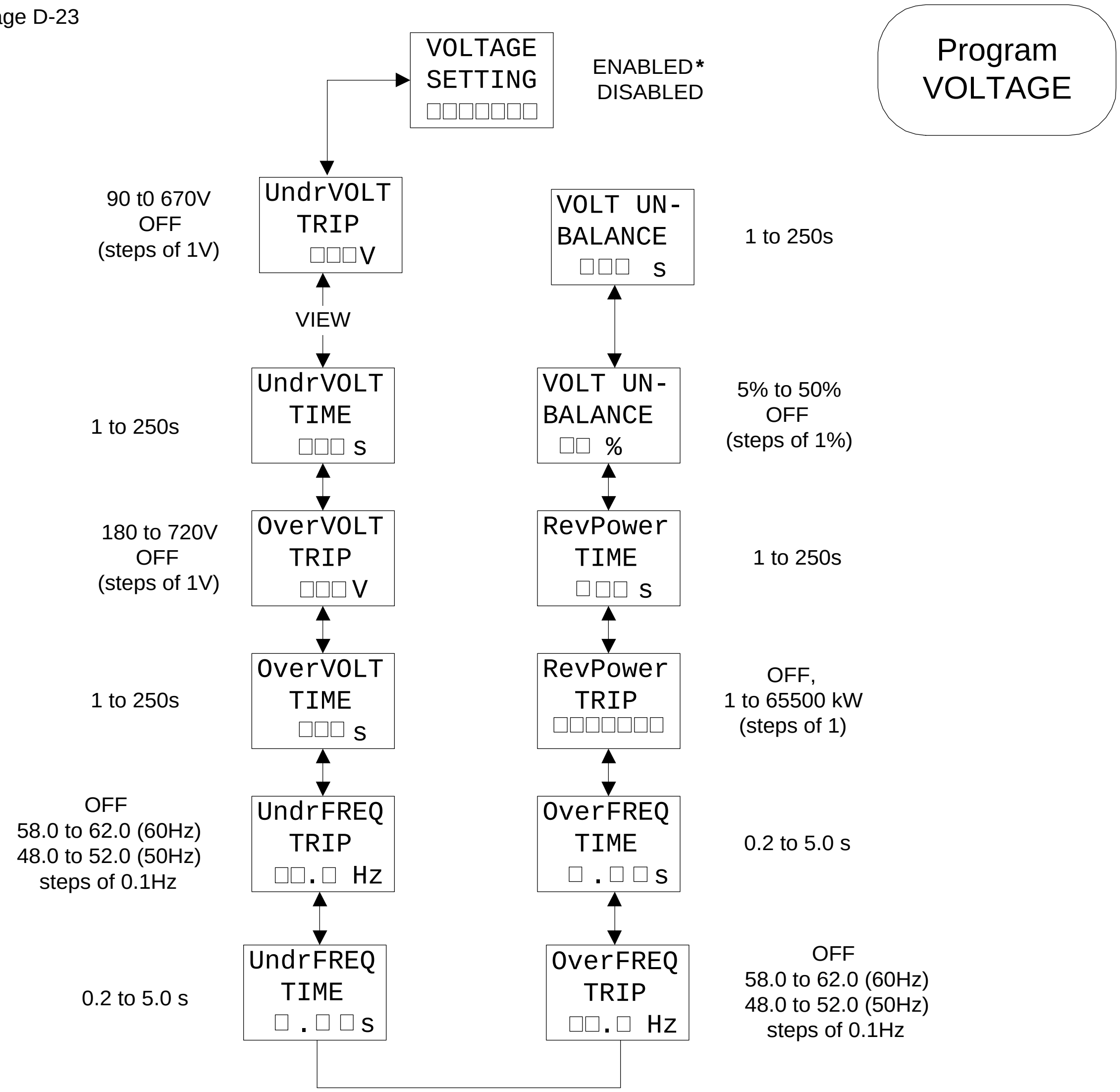

* This is the Master Setting that will disable (enable) all the following trip functions.
It also disables (enables) the associated voltage alarm functions.

Appendix D - Display Menu Diagrams Continued

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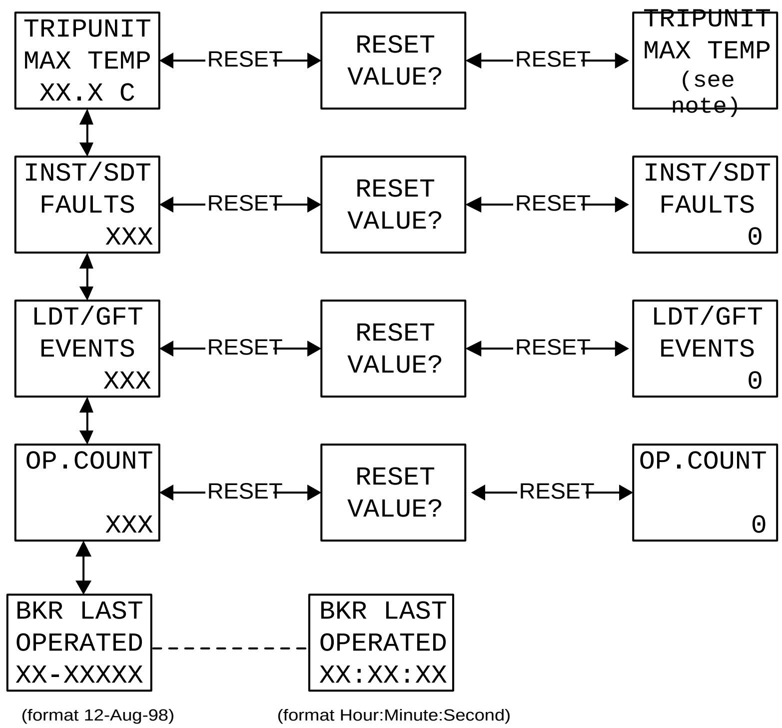
HEALTH



NOTE: The temperature reset is available on Rev. F firmware or higher. After the value has been reset, " - - - -" will be displayed for apprximately three seconds until a new temperatue value has been read.

Appendix D - Display Menu Diagrams Continued

Appendix D - Page D-25

Factory Settings

CURRENT Protection LSIG ON

LSIG Current Curve		IEEE Curve		IEC Curve	
LONG SLOPE	I2T	PHASE SLOPE	MOD INV	PHASE SLOPE	IEC - A
LONG PU	1.00	Pickup	1.00	Pickup	1.00
LONG TIME	4.0 s	PHASE TimeDial	2.0	PHASE TimeDial	0.20
LONG MEMORY	ON	SHORT PU	3.0	SHORT PU	3.0
SHORT SLOPE ***	FLAT	SHORT TIME	0.30 s	SHORT TIME	0.30 s
SHORT PU	3.0	INST PU	4.0	INST PU	4.0
SHORT TIME	0.30 s	GROUND PU**	0.40[2]	EARTH PU**	0.40
INST PU	4.0	GROUND SLOPE****	FLAT	EARTH SLOPE****	FLAT
GROUND PU**	0.40[2]	GROUND TIME****	0.30 s	EARTH TIME****	0.30 s
GROUND SLOPE****	FLAT	EXT GND CT RATIO**	none	EXT EARTH CT RATIO**	none
GROUND TIME****	0.30 s	NEUTRAL PROTECT*	100%	NEUTRAL PROTECT*	100%
EXT GND CT RATIO**	none	AMP UNBALANCE	OFF	AMP UNBALANCE	OFF
NEUTRAL PROTECT*	100%	AMP UNBALANCE (time)	10 s	AMP UNBALANCE (time)	10 s
AMP UNBALANCE	OFF	PHASE LOSS	OFF	PHASE LOSS	OFF
AMP UNBALANCE (time)	10 s				
PHASE LOSS	OFF				

VOLTAGE Protection DISABLED *****

- * Applicable on LSI or IEC factory styles only
- ** Applicable on LSIG, LSIA and IEC-EF
- *** Only available on LSIG, LSI, LSIA Current Curve. On IEEE curve and IEC curve, LONG MEMORY and SHORT SLOPE settings are not available.
- **** Applicable on LSIG, IEC-EF
- ***** VOLTAGE PROT and FREQ settings available on Cat #11PXXXX only.

DISPLAY (6 active)

IA IB IC	AUTO
IN IG	ON
L-L VOLTAGE	ON
FwdPower	ON
PF Hz	ON
ENERGY FWD & REV	ON
(all others)	OFF

AuxReLaYs	All relays DISABLED
ALARMS	All alarms OFF[1]
ACC BUS	Address1 Relay1 is Aux.-Aux Switch All other addresses and relays OFF
SYSTEM	FIXED DEMAND 15 Min window WAVEFORM CAPTURE OFF **FREQ 60Hz** Relay B,C MANUAL

INCOM	
INCOM ADDRESS	100 hex
INCOM BAUD RATE	9600
EXT COMM OpenTrip	ENABLED
EXT COMM	TRIP
EXT COMM CLOSE	ENABLED
DT 910 COMM	DISABLED

TEST	
PH TEST	0.4x In
GND TEST	0.1x In

1. Except LSIA will have Ground Alarm on @ .40x
2. Plug ratings 3200, 4000, 5000, 6300 A are set to .24

Appendix E Display Abbreviations

Glossary
of Terms
A-K

	Abbreviation	Definition	Notes
A	A, AMP	amperes	
	ACC	accessory	
	ACCBUS	accessory bus	
	ADDR	address	
	ALRM	alarm	
	AmpUNBAL	amperes out of balance	
	AUX	auxiliary	
	AuxRLY	auxiliary relay	
	AVG	average	
B	BELL	bell alarm	
C	CF	crest factor	
	COMM	communications	
	CommTRIP	communications trip	
	CT	current transformer	
D	DEAD	deadman alarm	
	DD	day	
	DMND	demand	
	DT	Digitrip	
E	Erth	earth	
	ESC	ESCape pushbutton on Digitrip	
	EVNT	event	
	EXT	external	
F	FREQ	frequency	
	FreqT	Frequency Trip	
	FUNC	function	
	FwdPower	forward power	
G	GFAlm	ground fault alarm	
	GND	ground	
	GroundPU	ground pickup	
H	HARMON	harmonic	
	HH	hours	
	HLAlm	High Load Aarm	
	Hz	hertz	
I	IA	phase A current	
	IB	phase B current	
	IC	phase C current	
	IEC	International Electrotechnical Commission	
	IEC-EF	IEC Earth Fault	
	IEEE	Institute of Electrical and Electronics Engineers	
	IG	ground current	
	IN	neutral current	
	INST	instantaneous	
	INV	inverse	
	In	max continuous current rating	
	Ir	continuous current rating	
J			
K	kVA	kilovolt ampere	
	kVAh	kilovolt ampere hour	
	kvar	kilovolt ampere reactive	
	kW	kilowatt	
	kWh	kilowatt hour	

Glossary of Terms L-Z

	Abbreviation	Definition	Notes
L	L-L	line-to-line	
	LONG PU	long delay pickup	
	LDPU	long delay pickup	
	LDT	long delay trip	
	LSI	Long, Short, Instantaneous Trip	
	LSIA	Long, Short, Instantaneous Trip, Ground Alarm Only	
	LSIG	Long, Short, Instantaneous, Ground Trip	
M	Max	maximum	
	Min	minimum	
	MIN	minute	
	MM	minutes	
	Mmm	month	
N	NEUT	neutral	
	NeutALRM	neutral alarm	
O	OF	Over Frequency	
	OP	operation	
	OV	Over Voltage	
	OverTEMP	over temperature	
P	PF	power factor	
	PGM	program	
	PH	phase	
	phROTATE	phase rotation alarm	
	PICKUP	pickup	Also known as Long PU and LDPU
	PlugTRIP	rating plug trip	
	PROTECT	protection	
	PU	pickup	
Q			
R	REV	revision	
	Rev	reverse	
	RevPower	reverse power	
	RLY	relay	
	rms	root-mean-squared	
	RpwrT	Reverse Power Trip	
S	s	seconds	
	SDT	short delay trip	
	SEL	SELect pushbutton on Digitrip	
	SET	settings	
	SETTINGS	setting	
	SS	seconds	
T	TEMP	temperature	
	THD	total harmonic distortion	
U	UF	Under Frequency	
	UNBAL	unbalance	
	UndrFREQ	Under Frequency	
	UndrVOLT	Under Voltage	
	UV	Under Voltage	
V	V	volts	
	Vab	line voltage from phase A to phase B	
	Vbc	line voltage from phase B to phase C	
	Vca	line voltage from phase C to phase A	
	VER	version	
	Vol Unbal	Voltage Unbalance	
W	WATCH	watchdog alarm	
X			
Y	YY	year	
Z			

Appendix F Digitrip Settings and Descriptions

Digitrip 1150 Settings

Setting	Description
Protection Firmware version	The protection firmware version number, in hexadecimal.
Display Firmware version	The display firmware version number, in hexadecimal.
Curve Type	The curve type: LSI – Long, Short, Instantaneous LSIG – Long, Short, Instantaneous, Ground LSIA – Long, Short, Instantaneous, Alarm on Ground only IEEE – (IEEE Mod. Inv., Very Inv., Extremely Inv.) Short, Instantaneous IEC – (IEC-A, -B, -C) Short, Instantaneous
Rating (In)	Breaker MAX Full Load Current Continuous Rating (In) in Amperes (PLUG RATING).
Frequency	Measured system frequency of voltage.
Ground Current Sensing	Residual or Source ground or Zero Sequence.
Long Delay Pickup = Ir Rating (Ir)	Defines a current level where load current above this setting will cause an eventual trip. The continuous current setting of the circuit breaker.
Long Delay Slope	Shape of the inverse-time-over-current (LongTIME) curve: I^2T I^4T
Long Delay Time	The time delay setting in seconds before tripping @ 6xIr current level.
Short Delay Pickup (a multiple of Ir)	Defines a current setting usually set much higher than continuous current that will initiate timing of this function. When the current reaches and sustains the level of the pickup setting for the period defined by the Short Time setting, the circuit breaker trips.
Short Delay Slope	Shape of the Short Time Curve. FLAT (fixed time) I^2T (applicable with I^2T Long Delay Slope only)
Short Delay Time	The delay time before tripping after short delay is picked up.
Instantaneous Pickup (a multiple of In)	Current above this setting will trip the circuit breaker immediately.
Ground (Earth) Fault Pickup (a multiple of In)	Ground current above this setting will initiate a Ground trip or Ground alarm.
Ground (Earth) Slope	Shape of the Ground Curve: FLAT (fixed time) I^2T
Ground (Earth) Time	The delay time before tripping on Ground.
Pickup Rating (Ir)	Defines a current level where load current above this setting will cause an eventual trip for the IEEE or IEC curve types. The continuous current setting of the circuit breaker.
TimeDial	The TimeDial setting controls the time scale that determines the tripping of the inverse time characteristic for an IEEE or IEC curve.
Amperes Out of Balance Trip % Unbalance	Percent difference setting between the Max and Min phase currents which, when exceeded, will trip the circuit breaker.
Amperes Out of Balance Trip Time	The required duration of the Amperes Out of Balance Trip condition before the circuit breaker trips.
Phase Loss Trip Time	The Phase Loss Time is the duration of a phase loss condition before the circuit breaker trips. This function will trip when a 75% difference between Max phase and the Min phase currents exists.
External Ground Scale Factor	User selectable Ground CT Ratio (when applicable).
Neutral Ratio	User selectable. 50% or 100%. Select 50% for protecting ½ size neutral conductors. (Applicable for non-ground fault units only.)
4^{th} Pole Protection	Neutral or 4^{th} pole protection. (Applicable for non-ground fault style units.)

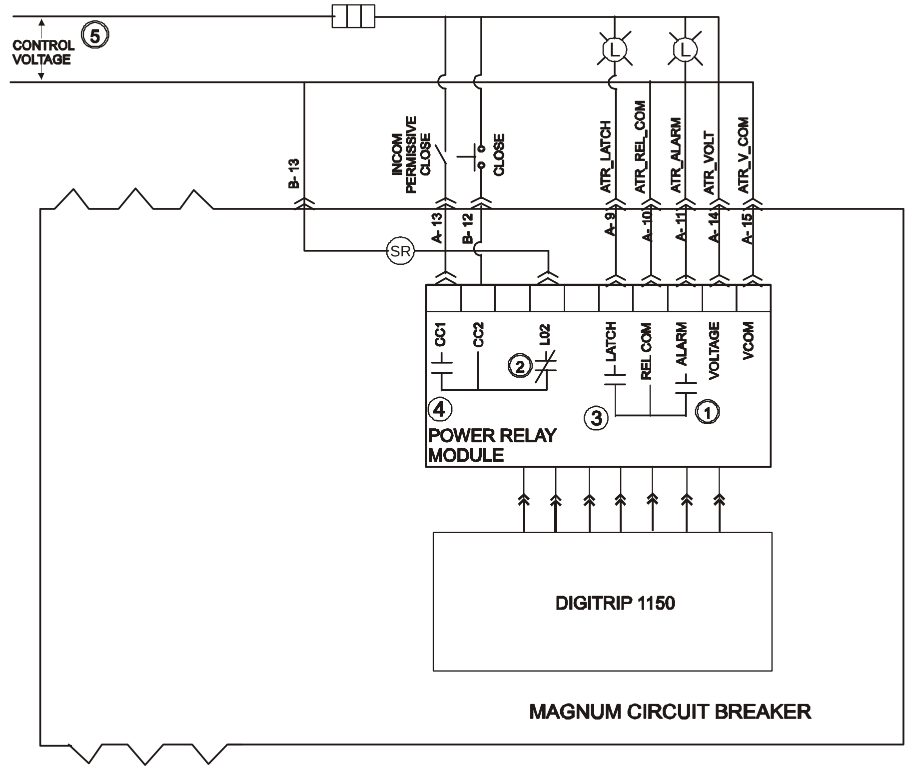
Digitrip 1150 Settings (continued)

Setting	Description
Long Memory (Thermal Memory)	Indicates whether over-current memory function is on or off. (Applicable on LSI, LSIG and LSIA curves only.)
Sliding Window Assignment	Determines if the maximum kW demand or the maximum kVA demand is calculated on a fixed or sliding 15-minute window.
Auto Waveform Capture Interval	The time between auto waveform captures.
High INST Trip	The circuit breaker tripped at a high fault current via separate High INST Module. See Appendix C.
High Load Alarm	When the current reaches the setting, a High Load Alarm occurs.
High Load Time	The circuit breaker waits the duration of the High Load Time before entering into an alarm condition.
Alarm to Event Log	When enabled, alarm events are stored into the Event Log.
Ground Pickup Alarm	When ground current exceeds this setting, a Ground Pickup Alarm occurs (when applicable).
Neutral Pickup Alarm	When neutral current exceeds this setting, a Neutral Pickup Alarm occurs.
Breaker Operations Count Alarm	When circuit breaker operations count exceeds this setting, a circuit Breaker Operations Count Alarm occurs.
Low Power Factor Alarm	When the power factor falls below this setting, a Low Power Factor Alarm occurs.
THD Alarm	When the percent THD exceeds this setting, a THD Alarm occurs.
kW Demand Alarm	When the kW demand reaches this setting, a kW Demand Alarm occurs.
kVA Demand Alarm	When the kVA demand reaches this setting, a kVA Demand Alarm occurs.
Activate Alarm Relay A on Trip	The trip conditions upon which Alarm Relay A is activated: Long Delay Short Delay Instantaneous Ground Fault Ampere Unbalance Phase Loss Over Temperature Rating Plug External Communications Accessory Bus
Pulse Initiate Relay A	The pulse initiator, a means of measuring kWh of kVAh energy, is on or off. If on, no other functions can be assigned to Relay A.
Activate Alarm Relay A on Alarm	The alarm conditions upon which Alarm Relay A is activated: Ground Neutral Amp Long Delay Pickup High Load Operations Count Low Power Factor THD kW Demand kVA Demand Under Voltage Over Voltage Under Frequency Over Frequency Phase Unbalance Phase Rotation

Digitrip 1150 Settings (continued)

Setting	Description
Activate Block Close Relay B on Trip	The trip conditions upon which Block Close Relay B is activated: Long Delay Short Delay Instantaneous Ground Fault Ampere Unbalance Phase Loss Over Temperature Rating Plug External Communications Accessory Bus (when applicable) Under Voltage Over Voltage Under Frequency Over frequency Phase Unbalance
Activate Latch Relay C on Trip	The trip conditions upon which Latch Relay C is activated: Long Delay Short Delay Instantaneous Ground Fault Ampere Unbalance Phase Loss Over Temperature Rating Plug External Communications Accessory Bus (when applicable) Under Voltage Over Voltage Under Frequency Over frequency Phase Unbalance
Return to Metered Current Display	When set to Automatic, returns the trip unit display to the metered phase A, B and C current screen if the unit keypad is idle for 5 minutes.
INCOM Address	Communication address 001 through FFE.

Appendix G Auxiliary Relays

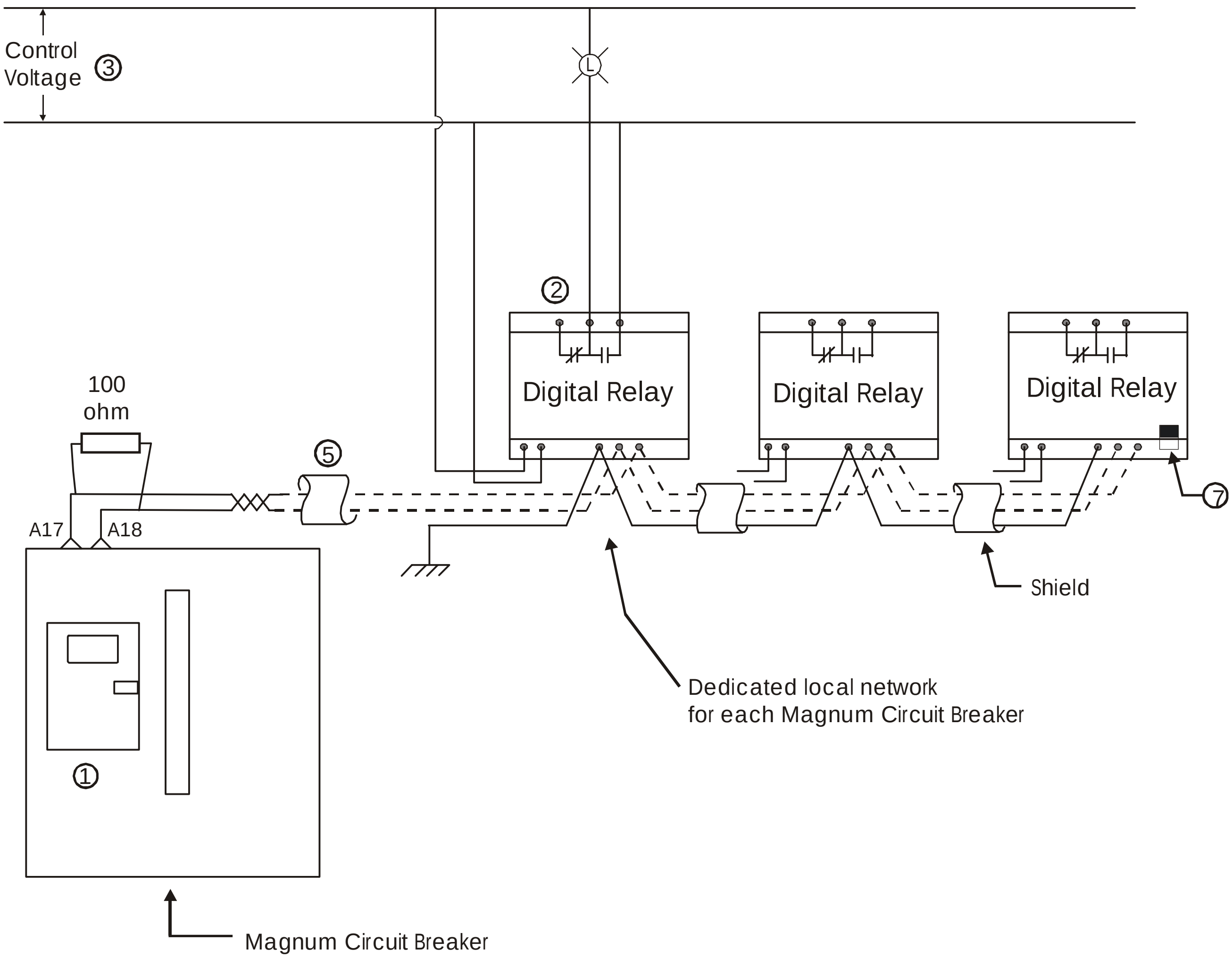


Available Input (5) Voltage for Power / Relay Module	Style Number
120 VAC +/ - 10%	70C1002G01
230 VAC +/ - 10%	70C1002G02
24 - 48 VDC +/ - 10%	70C1005G02
125 VDC (100-140 range)	70C1005G10

Notes:

1. This relay contact is programmed via Digitrip 1150 as Relay A. See Appendix D-15.
2. This relay contact is programmed via Digitrip 1150 as Relay B. Block Close will prohibit the remote closing of the circuit breaker.
3. This relay contact is programmed via Digitrip 1150 as Relay C. This relay will hold contact status on loss of Auxiliary Power.
4. Contact rating (resistive load)
   AC 0.5A @230 VAC
   AC 1A @120 VAC
   DC 1A @48 VDC
   DC 0.35A @125 VDC
5. Verify Input voltage rating before energizing circuit.

Appendix H Digital Relay Accessory Module



Notes:

① The Digitrip 1150 front panel is used to program the external module for any combination of the following: Aux Switch, BELL Alarm, INST ,SDT, LDT GndT or GFAlm, HLAlm, DEADman, WATCHDOG, ALARM, (the Alarm relay tracks the function of the Aux ReLaY A programming).

② Each module has 4 relays. Each relay has a form C contact with each having a rating of 10A max @ 250 VAC.

③ Control voltage is 120 VAC ± 20% or 48 - 125 VDC.

④ Accessory Bus Modules use DIN rail mounting. Connector types are plug-in-Phoenix . Four form C contacts use 12 pin connector part # 1835193. Power is 5 pin part # 1835122.. Communication.. is 3 pin. Part # 1835106.

⑤ Communication Cable is C-H style 2A957805G01 or Belden 9463 cable.

⑥ Set switch to corresponding adress(001 through 004) programmed via the Digitrip front panel. See Appendix D-17.

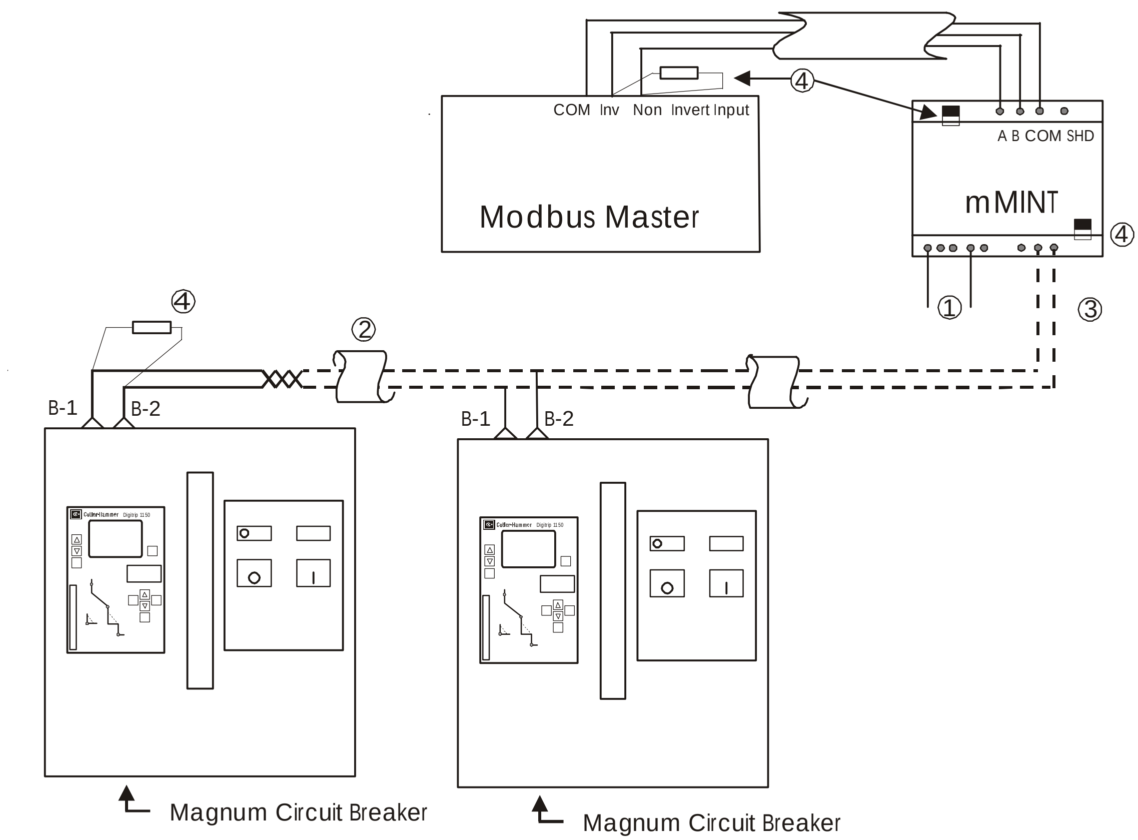
⑦ Set switch up to insert 100 ohm terminating resistor on last relay of network.

Appendix I MODBUS TRANSLATOR Wiring

The Digitrip 1150 in a Magnum Circuit Breaker can communicate its data using Modbus RTU protocol by employing a mMINT device to act as a translator from INCOM communicationto MODBUS communications. A Modbus master device is shown wired to gather data and can provide control logic to open and close circuit breakers.

The mMINT module CAT # mMINT use DIN rail mounting. Connector types are plug-in-Phoenix. . Power is 5 pin. INCOM network uses a 3 pin. The RS-485 MODBUS uses a 4 pin connector which consist of signals A, B, COMmon and SHielD.

Three Baud rates of 1200, 9600 or 19200 are selectable via programming switch for the MODBUS network. The INCOM Baud rate is fixed at 9600 Baud.



Notes:
① Control voltage is 120 VAC ± 20% or 48 - 125VDC.
② Communication Cable is C-H style 2A957805G01 or Belden 9463 cable.
③ The overall network will support up to 32 devices with any addresses from 1 to 247
④ Terminating resistor is 121 ohm 1 watt. Use the mMINT switches to insert these terminators at the mMINT device.

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