Cutler-Hammer Digitrip RMS and Digitrip OPTIM Trip Units with Types DSII and DSLII Low Voltage Power Circuit Breakers

NOTICE

Information in this instruction leaflet also pertains to Types DS and DSL Low Voltage Power Circuit Breakers.

Table of Contents **Page**

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 WITH THE TASK, AND ALWAYS FOLLOW GENERALLY ACCEPTED SAFETY PROCEDURES. CUTLER-HAMMER INC. IS NOT LIABLE FOR THE MISAPPLICATION OR MISINSTALLATION OF ITS PRODUCTS.

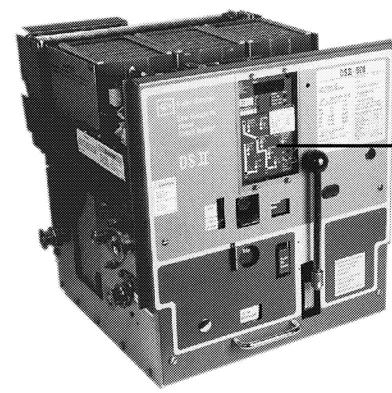


Figure 1 DSII-620 Circuit Breaker with Digitrip RMS Trip Unit Installed

The user is cautioned to observe all recommendations, warnings and cautions relating to the safety of personnel and equipment, as well as all general and local health and safety laws, codes, and procedures.

The recommendations and information contained herein are based on experience and judgment, but should not be considered to be all-inclusive or covering every application or circumstance which may arise. If any questions arise, contact Cutler-Hammer Inc. for further information or instructions.

1.0 SUPPLEMENTARY INFORMATION

The instructions contained in this book supplement the instructions for Low-Voltage AC Power Circuit Breakers, Type DS and DSL covered in I.B. 33-790-1 and Types DSII and DSLII covered in I.B. 694C694.

Section 8 of I.B. 33-790-1 covers the circuit breaker automatic tripping system using Amptector solid-state trip units. Supplement A to I.B. 33-790-1 covers Digitrip RMS models 500, 600, 700 and 800.

2.0 DIGITRIP RMS AND DIGITRIP OPTIM TRIP UNITS

This instruction book specifically covers the application of Digitrip RMS and Digitrip OPTIM Trip Units installed in

Types DSII and DSLII Low-Voltage Power Circuit Breakers (Figure **1**).

Digitrip RMS and Digitrip OPTIM Trip Units are AC devices that employ microprocessor based technology to provide true RMS current sensing for proper correlation with thermal characteristics of conductors and equipment. The primary function of the Digitrip RMS and Digitrip OPTIM Trip Units is overcurrent protection, which is achieved by analyzing the current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuator when pre-determined current levels and time delay settings are exceeded.

The protection section of the Digitrip RMS Trip Unit can be equipped with up to five phase and two ground fault time current adjustments. The short delay and ground fault pick-up adjustments can be arranged for either a flat or I^2t response. The exact selection of the available adjustments must be chosen to satisfy the protection needs of the specific installation.

LEDs provide mode of trip indication for ground fault, overload and short circuit trip operations.

Digitrip RMS Trip Unit types LS and LSG are not equipped with an adjustable instantaneous trip element, but are provided with a making current release (discriminator). A high-level instantaneous override circuit is provided to insure rapid circuit clearing under abnormal fault current conditions.

Digitrip RMS Trip Units are available in four basic models, the Digitrip RMS 510, 610, 810 and 910 (Figure **2a**). Separate instruction leaflets referenced in Section 8.1 cover the features and functions of each model. This instruction book is arranged to describe the unique features of each type as applied in Types DSII and DSLII Low-Voltage AC Power Circuit Breakers. Table 1 presents the available characteristics of each of the four trip unit models.

The Digitrip OPTIM Trip Unit System utilizes two basic trip unit models with the Type DSII Low Voltage AC Power Circuit Breaker, the OPTIM 750 and OPTIM 1050 Trip Units (Figure **2b**). The featured parts of a Digitrip OPTIM Trip Unit System are:

1. OPTIM 750 or 1050 RMS sensing trip units
2. OPTIMizer Hand Held Programmer
3. Breaker Interface Module

The OPTIMizer Hand Held Programmer plugs into the front of OPTIM 750 or 1050 Trip Units to access, display and configure trip unit information, and establish trip unit addresses. The panel mounted Breaker Interface Module provides all the same features and capabilities as the OPTIMizer Hand Held Programmer, plus energy monitoring, local/remote indication, and communications capabilities, except that only the Hand Held Programmer can establish trip unit addresses. Separate instruction manuals, referenced in Section 8.3, cover all the details associated with the OPTIMizer Hand Held Programmer and the Breaker Interface Module.

The following circuit breaker accessories are available to provide supplementary protection, signaling and test functions: (Refer to Section 3.10 of I.B. 694C694 for details)

1. Undervoltage Trip Device
2. Portable Test Kit - See **CAUTION** on page 4.
3. Latch Check Switch
4. Auxiliary Switches
5. Overcurrent Trip Switch

3.0 RATINGS PLUGS

Rating Plugs, as shown in Figure **3**, determine the continuous current rating of the circuit breaker. All protection function settings on the face of the trip unit for the Digitrip RMS 510, 610, 810 and 910 are expressed in per unit multiples of the plug rating (I_n) or the long delay current setting (I_r). The Digitrip OPTIM 750 and 1050 use the same rating plug family as Digitrip RMS. The plug rating (I_n) determines the maximum continuous current rating of the circuit breaker. All the protection function pickup settings are based on the plug rating (I_n). These pickup settings are ultimately loaded into the trip unit in per unit, but are displayed as an ampere value for ease of use by the user.

Available rating plugs are shown in Table **2**. Plugs are suitable for 50 or 60Hz operation, but must be selected to match the desired continuous current rating of the circuit breaker as well as the installed sensor rating.

Rating plugs are equipped with a back-up battery, as shown in Figure **3**, to maintain the trip indication following a circuit breaker tripping operation when external control power is not available. The battery is a long-life lithium type that is replaceable from the front of the trip unit without removing the rating plug. Replacement types and instructions are provided in the Digitrip RMS Trip Unit instruction leaflets referred to in Section 8.1.

Following a trip operation and with no supplementary control power available, the battery would maintain the mode of trip LED for approximately 60 hours.

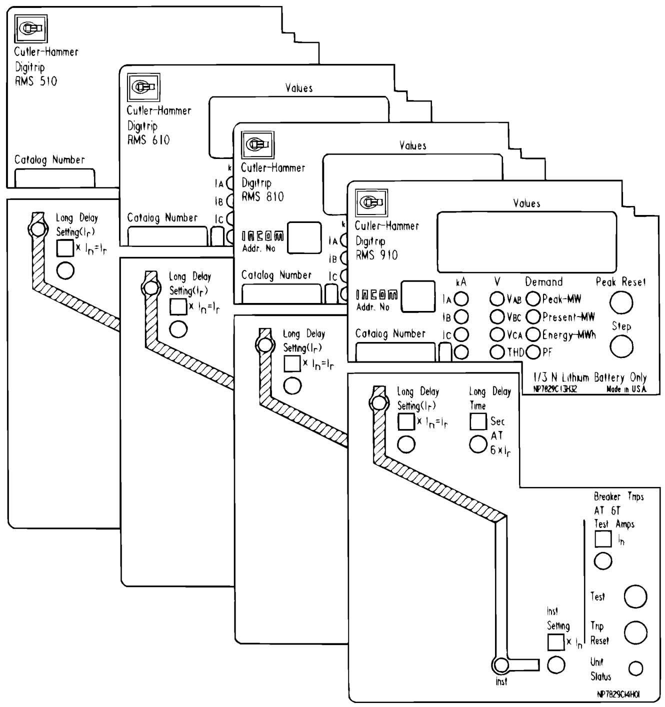


Figure 2a Typical Digitrip RMS Trip Unit Display Panels

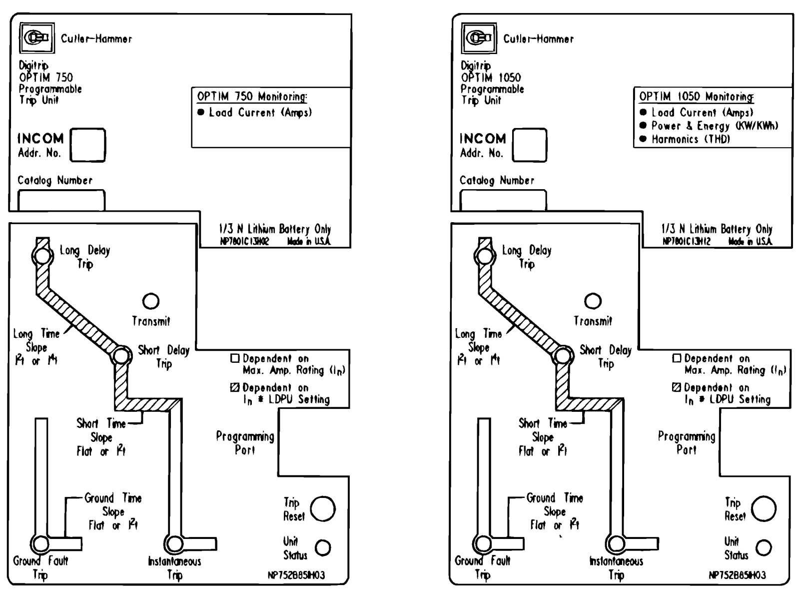


Figure 2b Typical Digitrip OPTIM Trip Unit Display Panels

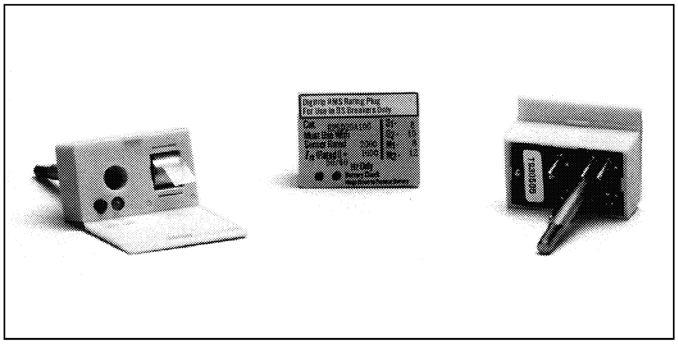


Figure 3 Interchangeable Rating Plugs for Use with Digitrip RMS Trip Units

If the rating plug is removed from the trip unit while the circuit breaker is closed, the circuit breaker may trip. Therefore, the rating plug must be securely tightened before operating the breaker.

4.0 DIGITRIP RMS MODEL CONSIDERATIONS

The trip unit contains a receptacle for use with an Auxiliary Power Module (Cat. No. PRTAAPM). When this module is in place on the trip unit and connected to a 120V 50/60Hz supply, a circuit breaker with a Digitrip RMS Trip Unit assembly installed can be bench tested using the integral test panel. With the circuit breaker in the closed position, it can be “tripped” when the test selector switch is in either the “6T” or “GFT” positions.

With the Auxiliary Power Module installed, the circuit breaker can also be field tested using secondary currents provided by an Amptector Trip Unit test kit as illustrated in I.L. 33-791. Detailed instructions for testing trip units are given in the individual trip unit instruction leaflets referenced in Section 8.1.

CAUTION

ONLY AMPTECTOR TEST KIT STYLES 140D481G02R, 140D481G02RR OR 140D481G03 IN CONJUNCTION WITH A DIGITRIP ADAPTER (STYLE 8779C02G01) SHOULD BE USED. UNMODIFIED AMPTECTOR TEST KITS STYLES 140D481G01 AND 140D481G02 SHOULD NOT BE USED TO TEST BREAKERS WITH DIGITRIP RMS TRIP UNITS AS DAMAGE TO THE TRIP MAY OCCUR.

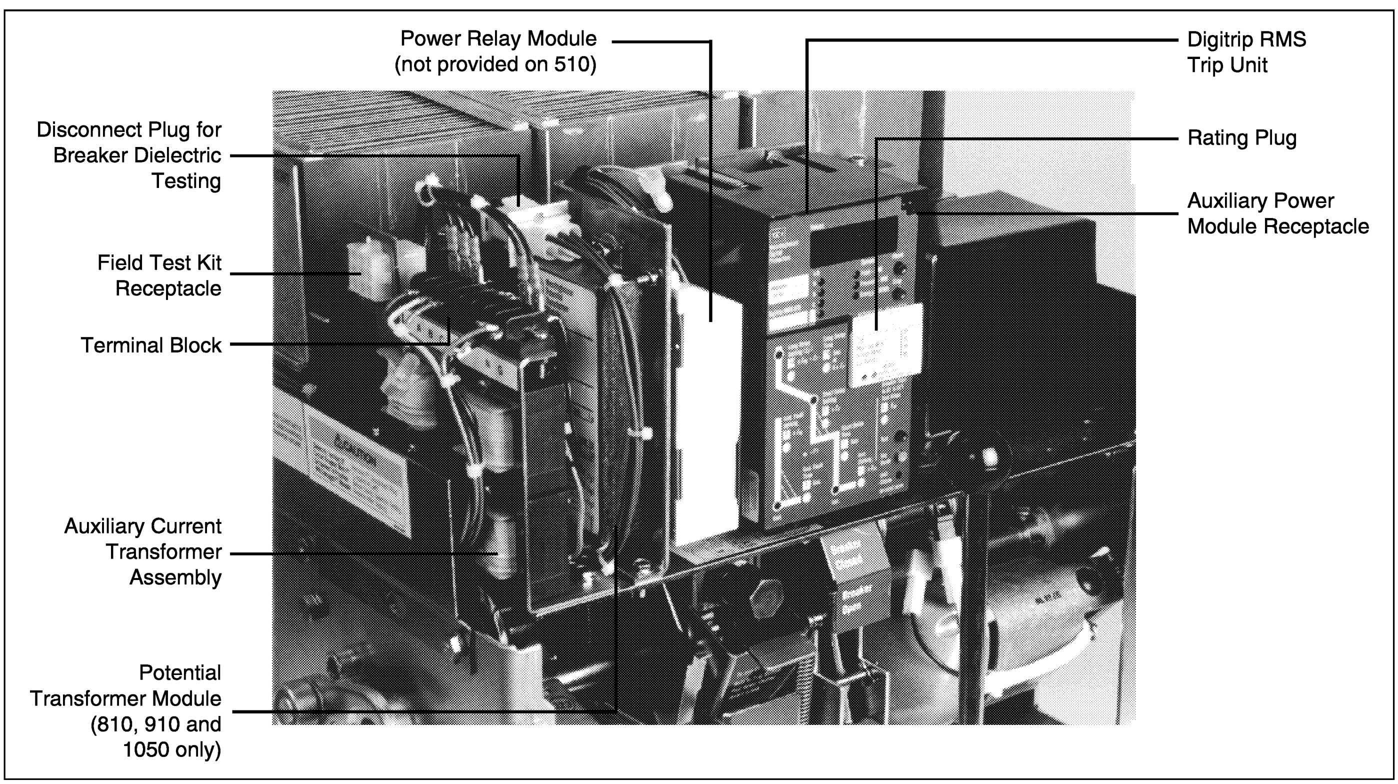


Figure 4 Trip Unit Assembly with Digitrip RMS Trip Unit and Associated Components Installed on Breaker

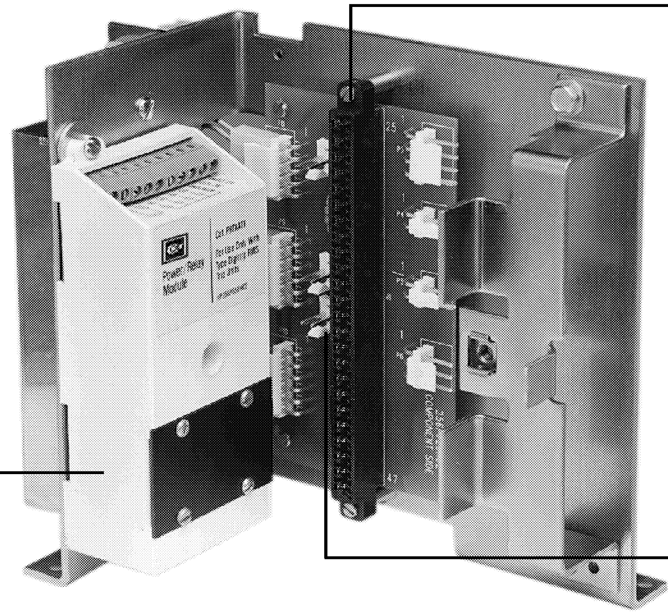


Figure 5 Trip Unit Assembly with Digitrip RMS Trip Unit Removed

CAUTION

TESTING OF A CIRCUIT BREAKER IN THE CELL "CONNECTED" POSITION BY EITHER THE INTEGRAL TEST PROVISIONS IN THE DIGITRIP RMS TRIP UNIT OR BY THE SEPARATE AMPTECTOR TRIP UNIT TEST KIT IS NOT RECOMMENDED.

THE TRIPPING OPERATION OF THE CIRCUIT BREAKER WILL CAUSE DISRUPTION OF SERVICE AND POSSIBLY PERSONAL INJURY RESULTING FROM UNNECESSARY SWITCHING OF CONNECTED EQUIPMENT.

TESTING OF A CIRCUIT BREAKER SHOULD BE DONE ONLY IN THE "TEST," "DISCONNECTED" OR "REMOVE" CELL POSITIONS.

4.1 DIGITRIP RMS 510

The Digitrip RMS 510 Trip Assembly consists of a Digitrip RMS 510 Trip Unit described in I.L. 29-885, auxiliary current transformers (3 or 4), a stab-in trip unit edge connector and a test terminal block with test receptacles for external field testing mounted in the breaker (Figures **4** and **5**).

4.2 DIGITRIP RMS 610

The Digitrip RMS 610 Trip Assembly consists of a Digitrip RMS 610 Trip Unit described in I.L. 29-886, auxiliary current transformers (3 or 4), a stab-in trip unit edge connector, a test terminal block with test receptacles for external field testing and a Power/Relay Module mounted as shown in Figures **4** and **5**. The Digitrip RMS 610 Trip Unit performs all the functions of the Digitrip RMS 510 Trip Unit and, in addition, has a four character display, three phase and one ground (when supplied) current pointer LEDs along with a stepping pushbutton as outlined in Table **1**.

The Power/Relay Module requires a 120 V, 50/60 Hz, 6 Va. control power supply for operating the readout display and internally mounted signal relays. It provides signal contacts for three remote mode of trip indications and a high load remote alarm. The relay contacts are each rated 120 V, 50/60 Hz, 1.0 A.

Table 1 Digitrip Trip Unit Characteristics

	DIGITRIP RMS Type	510	610	810	910	OPTIM 750	OPTIM 1050
	Instruction Leaflet No.	**I.L. 29-885**	**I.L. 29-886**	**I.L. 29-888**	**I.L. 29-889**	**I.L. 29C891**	**I.L. 29C891**
Protection	Long Delay Setting	X	X	X	X	X	X
	Long Delay Time	X	X	X	X	X	X
	Long Time Slope (I^2t - I^4t)					X	X
	Long Time Memory Powered	X	X	X	X	X	X
	Overtemperature	X	X	X	X	X	X
	Short Delay Pick-up	OPT.	OPT.	OPT.	OPT.	X	X
	Short Delay Time	OPT.	OPT.	OPT.	OPT.	X	X
	Flat/I^2T Response	X	X	X	X	X	X
	Zone Interlocking	①	①	①	①	①	①
	Instantaneous Pick-up	OPT.	OPT.	OPT.	OPT.	X	X
	DIScriminator Disable	⑩	⑩	⑩	⑩	X	X
	Ground Fault Pick-up	OPT.	OPT.	OPT.	OPT.	OPT.	OPT.
	Ground Fault Time	OPT.	OPT.	OPT.	OPT.	OPT.	OPT.
	Flat/I^2t Response	X	X	X	X	X	X
	Ground Time Memory	X	X	X	X	X	X
	Zone Interlocking	①	①	①	①	①	①
	Ground Fault Alarm Only					OPT.	OPT.
	Interchangeable Rating Plug	X	X	X	X	X	X
	Auto Lockout After Trip		X	X	X	X	X
Local Trip Indicators	Mode of Trip LEDs	X	X	X	X	X	X
	Battery - for Mode of Trip LEDs	X	X	X	X	X	X
	Battery Status LED (Green)	X	X	X	X	X	X
	Battery Test Pushbutton	X	X	X	X	X	X
Remote Signals	Power/Relay Module		X	X	X	X	X
	Remote Signal Contact						
	High Load Alarm		X	X	X	X	X
	Long Delay Trip		X	X	X	X	X
	Short Circuit Trip		X	X	X	X	X
	Ground Fault Trip		⑥	⑥	⑥	⑥	⑥
	Ground Alarm					⑮	⑮
Test	Integral Test Provisions	X	X	X	X	⑬ ⑭	⑬ ⑭
	Trip Unit Status Indication LED	X	X	X	X	X	X
	Display Message Test			③	③		
Current Metering (Local and Remote)	4 Digit Display		X	X	X		
	IA Current		X	X	X		
	IB Current		X	X	X		
	IC Current		X	X	X		
	IG Ground		⑥	⑥	⑥		
	Display Stepping Pushbutton			X	X	X	
Harmonic Current	Total Harmonic Distortion [THD] LED				X		⑭
	Per Harmonic				X		⑭
	Waveform Capture				④		④
Voltage Metering	4 Digit Display						
	Phase to Phase [VAB] LED					X	
	Phase to Phase [VBC] LED					X	
	Phase to Phase [VCA] LED					X	

X = Standard
OPT = Optional

① Use of zone interlocking is optional with breaker wiring modification.
② Remote location only unless optional AEM local monitor is used.
③ Local on face of trip unit. Remote via INCOM/IMPACC to AEM1 or AEM2 or direct to host computer.
④ Remote only - direct to host computer via INCOM/IMPACC.
⑤ On AEM denoted by absence of response from addressed breaker.
⑥ Supplied only when trip unit is equipped with ground fault protection option.
⑦ Requires spring release or electrical operator option.

	DIGITRIP RMS Type		510	610	810	910	OPTIM 750	OPTIM 1050
	Instruction Leaflet No.		**I.L. 29-885**	**I.L. 29-886**	**I.L. 29-888**	**I.L. 29-889**	**I.L. 29C891**	**I.L. 29C891**
Energy Monitoring	Potential Transformer Module				X	X		X
	PTM Disconnect Plug for Dielectric Testing of Circuit Breaker				X	X		X
	Energy Monitoring: Parameters:							
	System Power Factor LED				④	X		⑭
	Peak Demand LED				X	X		⑭
	Peak Demand Reset				③	③		⑭
	Present Demand LED				X	X		⑭
	Reverse Power Flow				③ ⑪	③ ⑪		⑭
	"NPOW" Message				X ⑫	X ⑫		⑭
	Energy Consumption LED				X	X		⑭
	Forward Energy				④	④		⑭
	Reverse Energy				④	④		⑭
	Energy Reset				④	④		⑭
Transmittable Data	INCOM/IMPACC - (Integrated Communications)				X	X		X
	Address Register				⑧	⑧	⑬	⑬
	Baud Rate Register				⑧	⑧	⑬	⑬
	Transmittable Parameters:							
	Individual Phase Currents				③	③	⑭	⑭
	Ground Currents				③ ⑥	③ ⑥	⑥ ⑭	⑥ ⑭
	Breaker Status:							
	High Load	"HILD"			③	③	⑭	⑭
	Open/Closed/Tripped				③	③	⑭	⑭
	Mode of Trip:							
	Instantaneous	"INST"			③	③	⑭	⑭
	DIScriminator	"DISC"			③	③	⑭	⑭
	Short Time Delay	"SDT"			③	③	⑭	⑭
	Ground Fault	"GNDT"			③ ⑥	③ ⑥	⑭	⑭
	Long Delay	"LDT"			③	③	⑭	⑭
	Overtemperature	"TEMP"			③	③	⑭	⑭
	External Trip	"EXTT"			③	③	⑭	⑭
	Long Time Delay Pickup	"LDPU"			③	③	⑭	⑭
	Over Range Trip	"ORNG"			③	③	⑭	⑭
	Information:							
	Normal	"NORM"			③ ⑭	③ ⑭	⑭	⑭
	Protection Settings				④ ⑭	④ ⑭	⑭	⑭
	Time Stamp Trip Event				④ ⑭	④ ⑭	⑭	⑭
	Trip Event Counter				④ ⑭	④ ⑭	⑭	⑭
	Rating Plug Problem	"PLUG"			③ ⑭	③ ⑭	⑭	⑭
	Communication Failure	"NRES"			② ⑤ ⑭	② ⑤ ⑭	⑭	⑭
Control	Control:							
	INCOM/IMPACC Trip (Open) Command				④	④	④	④
	INCOM/IMPACC Close Command				④ ⑦	④ ⑦	④ ⑦	④ ⑦
	INCOM/IMPACC Trip Reset Command				④	④	④	④

⑧ Configuration of address is programmed on face of unit with pushbuttons.
⑨ Optional APM is available separately.
⑩ Supplied if INST protection is omitted.
⑪ Disabled when "NPOW" message is disabled.
⑫ Can be disabled with jumper on circuit board.
⑬ Via OPTIMizer – test and configuration of address and baud rate.
⑭ BIM (Breaker Interface Module) or direct to host computer.
⑮ Supplied only when trip unit is equipped with ground fault alarm.

Table 2 Catalog Numbers of Available Rating Plugs

Rated Current (Amps In)	Sensor Ratings (Amps)	Catalog Number 50/60Hz
100 200	200	RP6D02A010 RP6D02A020
200 250 300	300	RP6D03A020 RP6D03A025 RP6D03A030
200 250 300 400	400	RP6D04A020 RP6D04A025 RP6D04A030 RP6D04A040
300 400 600	600	RP6D06A030 RP6D06A040 RP6D06A060
400 600 800	800	RP6D08A040 RP6D08A060 RP6D08A080
600 800 1000 1200	1200	RP6D12A060 RP6D12A080 RP6D12A100 RP6D12A120
800 1000 1200 1600	1600	RP6D16A080 RP6D16A100 RP6D16A120 RP6D16A160
1000 1200 1600 2000	2000	RP6D20A100 RP6D20A120 RP6D20A160 RP6D20A200
1600 2000 2400	2400	RP6D24A160 RP6D24A200 RP6D24A240
1600 2000 2400 3000 3200	3200	RP6D32A160 RP6D32A200 RP6D32A240 RP6D32A300 RP6D32A320
2000 2400 3200 4000	4000	RP6D40A200 RP6D40A240 RP6D40A320 RP6D40A400
3200 4000 5000	5000	RP6D50A320 RP6D50A400 RP6D50A500

The Power/Relay Module will maintain the cause of trip history and LED's as long as the control power supply is available. If the control power supply is not available, only the cause of trip LEDs will be maintained by the back-up battery located in the rating plug.

The high-load ("HILD") display code and remote alarm switch are pre-set at 85% of the value of the long delay setting. The high-load relay operates after an approximate 40 second delay when the 85% level is reached to ride through momentary overcurrent conditions without nuisance alarms.

4.3 DIGITRIP RMS 810

The Digitrip RMS 810 Trip Assembly consists of a Digitrip RMS 810 Trip Unit described in I.L. 29-888, auxiliary current transformers (3 or 4), a stab-in trip unit edge connector, a test terminal block with test receptacles for external field testing, a Potential Transformer Module and a Power/Relay Module mounted as shown in Figures **4** and **5**. The Digitrip RMS 810 Trip Unit performs all the functions of the Digitrip RMS 610 Trip Unit with the addition of peak demand, present demand and energy consumed pointer LEDs along with a peak demand reset pushbutton as outlined in Table **1**.

The Trip Assembly provides for both local displays on the face of the trip unit and remote communications via an INCOM/IMPACC communication network signal link as outlined in Table **1**.

An optional Assemblies Electronic Monitor (AEM) II, as described in TD 17-382, may also be installed in the equipment assembly to show the parameters in Table **1** covered under Note 2.

Interconnections for the INCOM/IMPACC circuit must be connected using shielded, twisted pair No. 18 AWG conductors.

The three-digit INCOM/IMPACC address and BAUD rate must be set on each trip unit per instructions given in I.L. 29-888 and TD 17-382. To insure that each circuit breaker in an assembly is properly located after the address is set, the breaker and trip unit should be identified as to its proper cell location. That reference along with the breaker INCOM/ IMPACC address should be written on the face of the trip unit in the spaces provided.

In addition to the communication of breaker data the INCOM/IMPACC module allows for remote tripping and closing of the circuit breaker (spring release option required).

WARNING

CARELESSLY PLANNED OR UNPLANNED AUTOMATIC CIRCUIT BREAKER CLOSING OPERATIONS INITIATED BY INCOM/IMPACC COMMUNICATION SIGNALS DURING MAINTENANCE PERIODS COULD CAUSE SEVERE PERSONAL INJURY OR DEATH.

INSTALL APPROPRIATE PERMISSIVE CONTROL MEANS AS ILLUSTRATED IN CONNECTION DIAGRAM 508B508 TO AVOID UNDESIRED REMOTE CLOSING OPERATIONS DURING MAINTENANCE PERIODS. ALSO PROVIDE ADEQUATE EQUIPMENT WARNINGS FOR NORMAL OPERATION PERIODS.

4.4 DIGITRIP RMS 910

The Digitrip RMS 910 Trip Assembly is similar to the Digitrip RMS 810. It is a communicating trip unit that provides all the functions described in Section 4.3 plus the addition of the following locally displayed and remotely communicated features:

1. Phase to Phase Voltages Vab, Vbc, Vca
2. System Power Factor (PF)
3. Total Harmonic Distortion (THD) for Ia, Ib, Ic

The THD calculation also includes the individual harmonic currents up to the 27th harmonic as a percentage of the fundamental. Also included with the THD are provisions for waveform capture information via a host computer. Detailed information is provided in I.L. 29-889.

4.5 DIGITRIP OPTIM MODEL CONSIDERATIONS

Trip unit testing is carried out by using the OPTIMizer Hand Held Programmer, the Breaker Interface Module, or a remote computer to select values of test current within a range of available settings. Basic protection functions are not affected during test operations. The testing capability is not intended for live primary current interruption. Two types of tests are possible, the “No Trip” and the “Trip” tests. Testing is not permitted to proceed if there is greater than 0.4 per unit of current flowing on a phase circuit or 0.2 per unit of current on a ground circuit. The maximum permitted current value can be determined by multiplying the appropriate per unit value (0.4 or 0.2) times the ampere rating of the installed rating plug. An auxiliary power module (Cat. No. PRTAAPM) can be used to bench test a trip unit when the auxiliary power module is connected to a 120V 50/60Hz supply.

CAUTION

“TRIP” TESTING OF A CIRCUIT BREAKER IN THE CELL “CONNECTED” POSITION IS NOT RECOMMENDED. THE TRIPPING OPERATION OF THE CIRCUIT BREAKER WILL CAUSE SERVICE DISRUPTION AND POSSIBLY PERSONAL INJURY RESULTING FROM UNNECESSARY SWITCHING OF CONNECTED EQUIPMENT. THIS KIND OF TESTING SHOULD ONLY BE CONDUCTED IN THE “TEST,” “DISCONNECTED” OR “REMOVE” CELL POSITIONS.

4.6 DIGITRIP OPTIM 750

Digitrip OPTIM 750 Trip Units provide true rms sensing and utilize a fixed interchangeable rating plug to establish the continuous trip rating of the circuit breaker. Rating plugs are interlocked to prevent use between different circuit breaker types.

Precise system coordination is provided by the following time-current curve shaping adjustments:

1. Long delay pickup
2. Long delay time with selectable I^2t or I^4t curve shaping
3. Short delay pickup
4. Short delay time with selectable flat or I^2t curve shaping
5. Instantaneous pickup
6. Ground fault pickup
7. Ground fault time with selectable flat or I^2t curve shaping

The trip units also have a selectable powered/unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

The trip unit information system utilizes battery backup LEDs to indicate the trip mode following an automatic trip operation. The LEDs are complemented by trip event information that is stored in memory after a trip condition. This trip information can then be accessed via the OPTIMizer Hand Held Programmer, the Breaker Interface Module, or over the IMPACC System. A trip reset pushbutton is provided on the trip unit to turn off the LED indication after an automatic trip. The battery status is also LED indicated through the use of a pushbutton.

Selectable early warning alarms, capable of being indicated locally and remotely, are provided to help keep a system operating and productive.

All OPTIM Trip Units are capable of monitoring the following data:

1. Steady-State value of phase, neutral, and ground currents

2. Minimum and maximum current values

3. Average demand current

4. Cause of trip (Long Delay, Short Delay, Instantaneous or Ground Fault)

5. High load current alarm

6. Magnitude of fault current responsible for an automatic trip operation

Monitoring and Control
Trip units are capable of two way communication via a network twisted pair for remote monitoring and control. The circuit breaker, through the trip unit, is able to respond to open and close commands via the communication network. To close the breaker, an electrical operator or spring release option is required.

All programming, information display and general trip unit access is accomplished through the use of one or more of the following:

1. Hand Held Programmer
2. Breaker Interface Module
3. Remote computer

The breaker tripping system includes a power relay module to provide power for the communication function and relay outputs for alarming (Figure **5**). Refer to I.L. 29C891 for more detailed information on Digitrip OPTIM 750 Trip Units.

4.7 DIGITRIP OPTIM 1050

The OPTIM 1050 Trip Unit provides all the same basic system protection features outlined in Section 4.6 for OPTIM 750. In addition, OPTIM 1050 Trip Units are capable of providing data on power quality and permit energy monitoring.

Energy Monitoring
1. Peak demand (kW)
2. Present demand (kW)
3 Forward energy (kWh)
4. Reverse energy (kWh)
5. Total energy (kWh)
6. Power factor

Power Quality
1. Percentage harmonic content
2. Total harmonic distortion (THD)

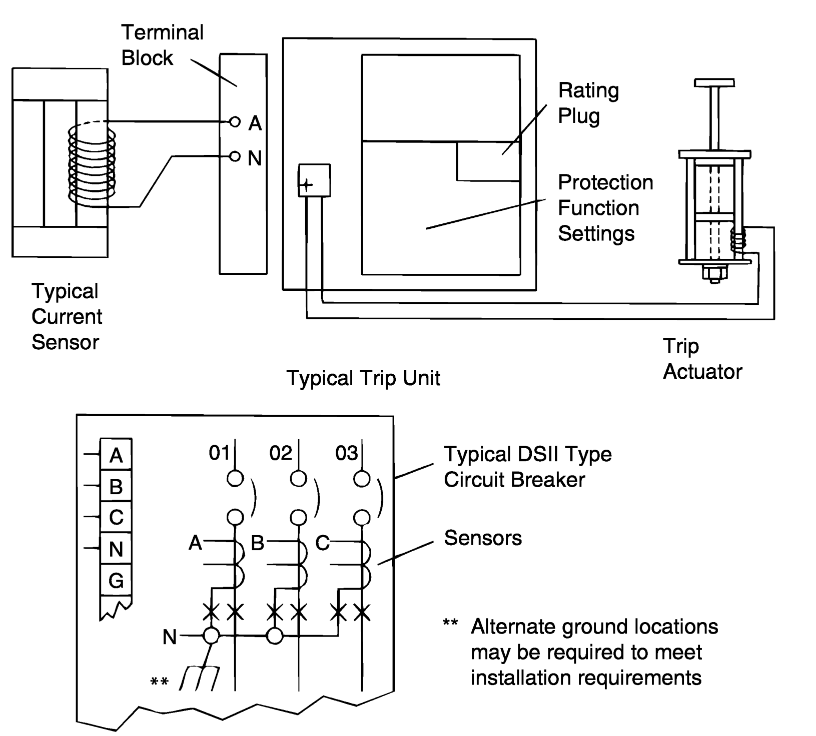


Figure 6 Typical Schematic Diagram of Basic Connections in Tripping System of DSII Circuit Breaker

The breaker tripping system requires a PT Module to provide power and energy monitoring functions via a communications network (Figure **4**). A power relay module is also included to provide power for the communication function and relay outputs for alarming (Figure **5**). Refer to I.L. 29C891 for more detailed information on Digitrip OPTIM 1050 Trip Units.

5.0 PRINCIPLE OF OPERATION

5.1 GENERAL

The circuit breaker is tripped on overload and short circuit conditions by combined action of three components:

1. The sensors which determine the current level.

2. The Trip Assembly, which contains the Trip Unit and provides a tripping signal when pre-determined time-current levels are reached.

3. The actuator which actually trips the circuit breaker.

Schematically, this is represented in Figure **6**. This arrangement provides a very flexible system covering a wide range of tripping characteristics as illustrated by the time-current curves referenced in Section 8.2 of this instruction book. Not only is the Trip Unit adjustable or programmable, but the variety of sensors and rating plugs provides a wide range of current ratings.

The automatic overload and short circuit tripping characteristics for a specific circuit breaker are determined by the ratings of the installed current sensors, rating plugs, and the selected functional protection settings. Specific setting instructions are provided in the applicable trip unit instruction leaflet referenced in Section 8.1.

When the time-current conditions exceed the functional protection settings, the Trip Unit supplies a trip signal to the actuator. Thus all tripping functions are performed by secondary control circuitry, with no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the breaker and with no external control power required.

5.2 DIGITRIP TRIP ASSEMBLY

The basic Digitrip Trip Assembly, as shown in Figures **4** and 5, includes the following which could vary slightly depending upon the exact model of the Digitrip Trip Unit installed:

1. Digitrip Mounting Assembly

2. Digitrip Trip Unit

3. Rating Plug

4. Auxiliary Current Transformer Assembly (3 or 4 current transformers depending upon whether or not ground fault protection is included)

5. Stab-in Edge Connector for Trip Unit

6. Terminal Block equipped with Test Plug Receptacles for use with Portable Test Kit

7. Power/Relay Module (provided on all models except the Digitrip RMS 510)

8. Potential Transformer Module with Dielectric Disconnect Plug (Digitrip RMS 810 and 910, Digitrip OPTIM 1050 only)

As shown in Figures **1** and **4**, the Digitrip Trip Unit assembly mounts on the top front of the circuit breaker.

CAUTION

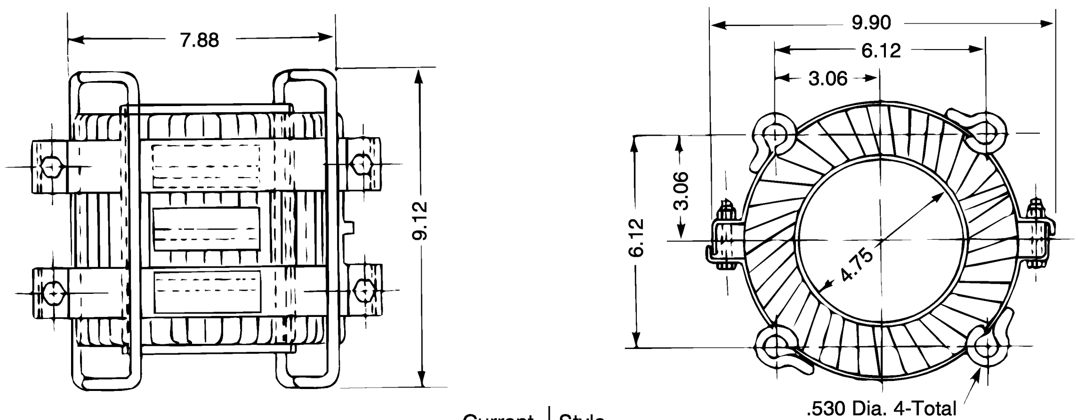
THE ACTUATOR COIL HAS A POLARITY MARKING ON THE POSITIVE LEAD WHICH MUST BE OBSERVED. OTHERWISE THE BREAKER WILL NOT HAVE OVERLOAD OR FAULT PROTECTION WHICH COULD RESULT IN BODILY INJURY AND/OR SERIOUS EQUIPMENT DAMAGE.

5.3 TRIP ACTUATOR

The trip actuator receives a tripping pulse from the Digitrip Trip Assembly, and produces a mechanical force to trip the breaker. Refer to Figure **3-11** in I.B. 694C694 for location and details. The actuator is made up of a permanent magnet, a disc held by the magnet, a rod acted on by a spring, a lever for tripping the breaker, and a lever for mechanically resetting the actuator. The magnet cannot pull and reset the disc against the force of the spring acting on the rod, but can overcome the spring force when the disc is in contact with the magnet pole piece.

A tripping pulse from the Digitrip Trip Assembly counteracts the effect of the permanent magnet, allowing the spring to separate the disc from the magnet pole piece and move the rod to actuate the trip shaft lever. The trip shaft lever then rotates the trip shaft and trips the breaker.

Dimensions (in Inches)



Current Ratio	Style
100/5	592C102G03
50/5	592C102G01

Figure 7 BYZ Zero-Sequence Current Sensor

As the breaker opens, the left pole unit lever pin strikes the spring finger attached to the reset lever; this furnishes the assistance required to move the disc so as to close the air gap between it and the permanent magnet against the spring force.

The device is reset when the disc is in contact with the magnet. If the gap is not fully reset, the trip shaft lever will hold the breaker mechanism in the trip-free condition and the breaker cannot be re-closed.

The trip actuator must be replaced, if it will not stay reset, when the plunger has been moved to the top of its travel.

5.4 GROUND FAULT PROTECTION

When the Digitrip Trip Assembly includes ground fault protection, the distribution system characteristics, i.e., system grounding, number of sources, number and location of ground points, etc. must be considered as well as the manner and location in which the circuit breaker is connected to the system.

If the system neutral is grounded but the neutral is not carried with the phase conductors, the Digitrip Trip Assembly includes all of the equipment necessary for ground fault protection. The basic mode of ground fault sensing employs a residual sensing scheme which vectorially sums the outputs of the individual phase current sensors. As long as the vectorial sum is zero, then no ground fault exists.

If the system neutral is grounded and a neutral conductor is carried with the phase conductors, it is necessary to use an additional sensor for the purpose of canceling out any residual current in the phase conductors. This sensor must be mounted separately and must be located on the neutral conductor at the point where the neutral conductor connects to the neutral bus. These sensors are duplicates of those supplied on the breaker except for the 2400A and 3200A ratings where a modified neutral sensor is required.

The adjustment of the ground fault functional settings is illustrated in the applicable Digitrip RMS and Digitrip OPTIM Trip Unit instruction leaflets referenced in Section 7.1 of this instruction book. Either flat response or I^2t response settings may be selected. The effect of these settings is illustrated in the ground fault time-current curve referenced in Section 8.2 of this instruction book. Applicable residual ground fault settings are given in Table **3** and on the time-current curve.

Depending upon the installation requirements, alternate ground fault sensing schemes may be employed. Two popular methods include: Ground return and zero sequence. Either method can be employed with the Digitrip Trip Unit.

Table 3 Ground Current Pick-up Settings ③

Installed Rating Plug Amperes (I_n)	Pick-up (Dial) Setting Amperes ①							
	A②	B②	C②	D②	E②	F	H	K
100	25	30	35	40	50	60	75	100
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
800	200	240	280	320	400	480	600	800
1000	250	300	350	400	500	600	750	1000
1200	300	360	420	480	600	720	900	1200
1600	400	480	560	640	800	960	1200	1200
2000	500	600	700	800	1000	1200	1200	1200
2400	600	720	840	960	1200	1200	1200	1200
3200	800	960	1120	1200	1200	1200	1200	1200
4000	1000	1200	1200	1200	1200	1200	1200	1200
5000	1200	1200	1200	1200	1200	1200	1200	1200

① Except as noted, tolerances on pick-up levels are ±10% of values shown in chart.

② Ground fault pick-up levels shown are nominal values when tested with external control power present. Without external control power, such as is the case with the Digitrip RMS 510, ground pick-up levels may exceed these values and be as high as the value shown for the "E" setting of that particular rating plug.

③ Not applicable to Digitrip OPTIM. The ground fault pick-up setting is read directly from Digitrip OPTIM. These settings range from 25% to 100% of the rating plug value up to a maximum NEC limitation of 1200 amperes.

For either type application, a ring type current sensor, as illustrated in Figure **7**, is normally employed. For ground return sensing, the sensor is arranged to have the system "main bonding jumper" pass directly through the sensor. For zero sequence sensing methods, all phase and neutral conductors must pass through the sensor.

Where multi-conductor cables are required for a particular circuit and the window opening in a single BYZ sensor is too small to accommodate all cables, separate BYZ sensors may be installed on each set of cables (3 phase, neutral) and the secondaries connected in parallel. (Note: Proper polarity markings must be observed.) The resultant secondary current signal will be equivalent to a single BYZ sensor.

The BYZ current sensor styles shown in Figure **7** are available for all previously mentioned applications. When either style sensor is used, the ground fault values shown in Table **3** are not applicable and the values shown in

Table 4 Approximate Ground Fault Pick-up Amperes Using BYZ (50/5) Sensor and "A" Position Setting on Ground Fault Pick-up ① ② ③

Ratings Plug Amps	Sensor Ratings - Amperes											
	200	300	400	600	800	1200	1600	2000	2400	3200	4000	5000
100	6.3											
200	12.5	8.3	6.3									
250		10.4	7.8									
300		12.5	9.4	6.3								
400			12.5	8.3	6.3							
600				12.5	9.4	6.3						
800					12.5	8.3	6.3					
1000						10.4	7.8	6.3				
1200						12.5	9.4	7.5	6.3			
1600							12.5	10	8.3	6.3		
2000								12.5	10.4	7.8	6.3	
2400									12.5	9.4	7.5	
3200										12.5	10	8.0
4000											12.5	10.0
5000												12.5

① Except as noted, tolerances on pick-up levels are ±10% of values shown in chart.

② Ground fault pick-up levels shown are nominal values when tested with external control power present. Without external control power such as is the case with the Digitrip RMS 510 trip unit, ground pick-up levels can vary between the minimum and maximum values shown for each sensor rating.

③ For BYZ (100/5) sensor, multiply above values by two.

Table **4** should be used. One of the reasons for using the BYZ current sensors is to improve the level of sensitivity. This being the case, then the ground fault functional pick-up setting should be placed on position "A." The sensitivity of the ground element for this kind of arrangement will depend upon the ratio of the BYZ sensor used.

A variety of utilization schemes are available utilizing each of the above methods of ground fault sensing. Therefore, the individual installation requirements must be closely studied to insure proper application.

5.5 CURRENT SENSORS

The three current sensors installed in the circuit breaker are located at the rear of the circuit breaker on the lower studs. The location is shown in Figure **3-1** of I.B. 694C694. They produce an output signal proportional to the load current and furnish the Digitrip Trip Assembly with the intelligence and energy to trip the circuit breaker when the time-current conditions exceed the functional protection settings.

The continuous current rating for any frame size breaker can be changed by changing the rating plug. A complete tabulation of available current sensors and rating plugs is given in Table **2**. In general, plug ratings are available down through 50% of the current sensor rating.

The selection of available current sensors and rating plugs coupled with the wide range of long-delay current pick-up settings available on the Digitrip Trip Unit makes one set of sensors suitable for a number of current ratings. The Digitrip Trip Unit protection function settings are standard, and are usable with standard sensors of any rating, up to the frame rating of the circuit breaker. If sensors are changed because of changing load conditions, etc., it is only necessary to replace the rating plug and readjust the Digitrip Trip Unit protection function settings to the new desired values.

To insure the non-tampering of selected protection settings, a sealable plexiglass cover as shown in Figure **1** is provided. The cover is held in place by four cover screws. The non-tampering feature is insured by the insertion of a standard meter seal through the holes in two of the cover retention screws.

5.6 POTENTIAL TRANSFORMER MODULE

The Potential Transformer Module (PTM) is supplied with the Digitrip RMS 810, 910 and OPTIM 1050 Trip Units. It is mounted on the side of the Trip Assembly as shown in Figures **4** and **5**. The PTM's primary is connected to the circuit breaker's bottom end conductors. This module provides voltage for computing the energy monitoring parameters.

The PTM disconnect plug is mounted above the PTM as shown in Figure **4**. This plug must be disconnected prior to any dielectric testing of the circuit breaker.

WARNING

DO NOT ATTEMPT TO PERFORM DIELECTRIC (OR HIGH POT OR HIGH VOLTAGE) WITHSTAND TESTS ON THE CIRCUIT BREAKER WHILE THE POTENTIAL TRANSFORMER MODULE DISCONNECT PLUG IS CONNECTED. DEATH OR SEVERE PERSONAL INJURY MAY RESULT AND THE POTENTIAL TRANSFORMER MODULE AND TRIP UNIT WILL BE DAMAGED.

REMOVE THE PTM DISCONNECT PLUG PRIOR TO PERFORMING ANY DIELECTRIC (OR HIGH POT OR HIGH VOLTAGE) WITHSTAND TESTS. REPLACE THE PLUG AFTER ALL TESTING IS COMPLETED AND PRIOR TO CLOSING THE BREAKER AS PER THE ESTABLISHED OPERATING PROCEDURES.

6.0 TESTING

6.1 FUNCTIONAL FIELD TESTING

A functional local test of a major portion of the Digitrip's electronic circuitry and breaker's mechanical trip assembly can be verified using the trip unit's test receptacle. The testing can verify the desired trip settings by performing Long Delay, Short Delay and Ground Fault functional tests. The Digitrip model and its associated Test Kit/Auxiliary Power Module requirements are listed in Table **5**.

6.1.1 SECONDARY INJECTION TESTING

The circuit breaker has a field test kit receptacle that can be used for secondary injection testing to test Digitrip RMS or Digitrip OPTIM Trip Units (Figure **4**). With the Auxiliary Power Module installed, the circuit breaker can be tested using secondary currents provided by an Amptector Trip Unit test kit as illustrated in I.L. 33-791. Detailed instructions for testing trip units are given in the individual trip unit instruction manuals referenced in Section 8.1.

Table 5 Digitrip Functional Testing Hardware

Digitrip Model	Testing Hardware
Digitrip RMS 510, 610, 810 and 910	Test Kit (Style No. 140D481G03) Test Kit Adapter (Style No. 8779C02G01) Auxiliary Power Module (Catalog No. PRTAAPM)
Digitrip OPTIM	OPTIMizer Hand Held Programmer (Catalog No. OPTIMIZER) Breaker Interface Module (Catalog No. BIM) Test Kit (Style No. 140D481G03) Test Kit Adapter (Style No. 8779C02G01) Auxiliary Power Module (Catalog No. PRTAAMP)

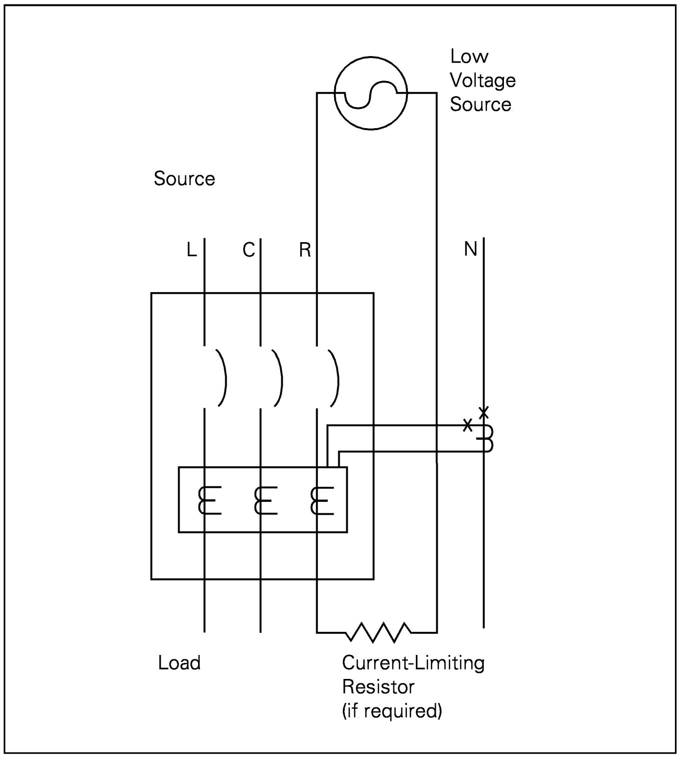


Figure 8a Connections for Ground Fault Trip Test

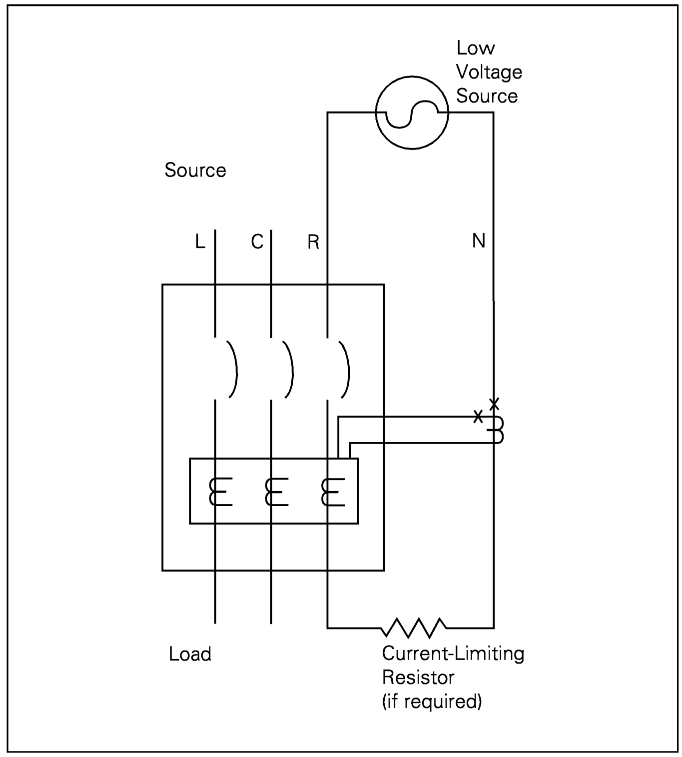


Figure 8b Connections for Ground Fault No-Trip Test, with a Four-Wire System

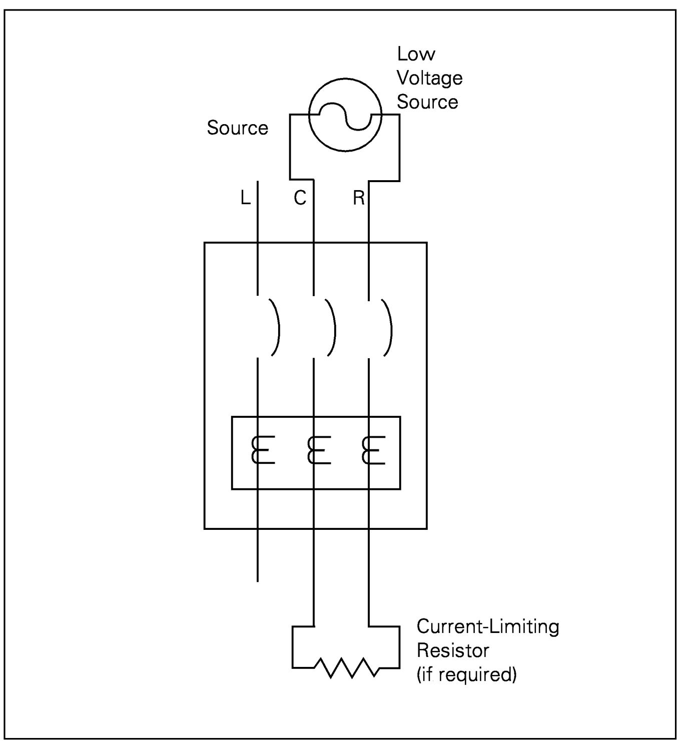


Figure 8c Connections for Ground Fault No-Trip Test, with a Three-Wire System

CAUTION

ONLY AMPTECTOR TEST KIT STYLES 140D481G02R, 140D481G02RR OR 140D481G03 IN CONJUNCTION WITH A DIGITRIP ADAPTER (STYLE 8779C02G01) SHOULD BE USED. UNMODIFIED AMPTECTOR TEST KIT STYLES 140D481G01 AND 140D481G02 SHOULD NOT BE USED TO TEST BREAKERS WITH DIGITRIP TRIP UNITS AS DAMAGE TO THE TRIP UNIT MAY OCCUR.

CAUTION

TESTING OF A CIRCUIT BREAKER IN THE CELL "CONNECTED" POSITION BY EITHER THE INTEGRAL TEST PROVISIONS IN THE DIGITRIP TRIP UNIT OR BY THE SEPARATE AMPTECTOR TRIP UNIT TEST KIT IS NOT RECOMMENDED. THE TRIPPING OPERATION OF THE CIRCUIT BREAKER WILL CAUSE DISRUPTION OF SERVICE AND POSSIBLY PERSONAL INJURY RESULTING FROM UNNECESSARY SWITCHING OF CONNECTED EQUIPMENT.

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

Figure 9 Typical Performance Test Record Form

TESTING OF A CIRCUIT BREAKER SHOULD BE DONE ONLY IN THE "TEST," "DISCONNECTED" OR "REMOVE" CELL POSITIONS.

6.2 PERFORMANCE TESTING FOR GROUND FAULT TRIP UNITS

6.2.1 CODE REQUIREMENTS

The National Electrical Code under Article 230-95-C requires that any ground fault protection system be performance tested when first installed. The test shall be conducted in accordance with approved instructions provided with the equipment. A written record of this test shall be made and shall be available to the authority having inspection jurisdiction.

6.2.2 STANDARDS REQUIREMENTS

As a follow-up to the basic performance requirements stipulated by the N.E.C. in Section 6.2.1, UL Standards No. 1053 requires that certain minimum instructions must accompany each ground fault protection system. The following article plus the test record form illustrated in Figure 9 are intended to satisfy this requirement.

6.2.3 GENERAL TEST INSTRUCTIONS

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

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

The grounding points of the system shall be verified to determine that ground paths do not exist that would bypass the sensors. The use of high voltage testers and resistance bridges may be used.

WARNING

THERE IS A HAZARD OF ELECTRICAL SHOCK OR BURN WHENEVER WORKING IN OR AROUND ELECTRICAL EQUIPMENT. ALWAYS TURN OFF POWER SUPPLYING THE BREAKER BEFORE CONDUCTING TESTS.

Using a low voltage, 0-24 volts, high current, AC source, apply a test current of 125% of the Digitrip Ground Fault Trip Unit pickup setting through one phase of the circuit breaker, as shown in Figure **8a**. This should cause the breaker to trip in less than 1 second, and an alarm indicator should operate, if one is supplied. Reset the breaker and the alarm indicator. Repeat the test on the other two phases.

If the system is a 4-wire system with a neutral current sensor, apply the same current as described above through one phase of the breaker, returning through the neutral sensor, as shown in Figure **8b**. The breaker should not trip, and the alarm indicator, if supplied, should not operate. Repeat the test on the other two phases.

If the system is a 3-wire system with no neutral current sensor, apply the same current as described above through any two phases of the breaker, with the connections exactly as shown in Figure **8c**. The breaker should not trip, and the alarm indicator, if supplied, should not operate. Repeat the test using the other two combinations of breaker phases.

CAUTION

FIELD TESTING SHOULD BE USED FOR FUNCTIONAL TESTING AND NOT FIELD CALIBRATION OF THE DIGITRIP GROUND FAULT TRIP UNIT.

ANY TEMPORARY CONNECTION MADE FOR THE PURPOSE OF CONDUCTING TESTS SHOULD BE RESTORED TO PROPER OPERATING CONDITIONS BEFORE RETURNING THE BREAKER TO SERVICE.

THE RESULTS OF THE TEST ARE TO BE RECORDED ON THE TEST FORM PROVIDED (FIGURE 9).

7.0 RECORD KEEPING

For convenience, a trip function record as shown in Figure **10** is included. This record should be filled in giving the indicated reference information and initial time/current trip function settings. If desirable, a copy could be made and attached to the interior of the breaker cell door or other visible location. Figure **11** is also included as a convenient way of providing 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.

8.0 LOW VOLTAGE POWER CIRCUIT BREAKER REFERENCES

I.B. 694C694	Instructions for Low-Voltage Power Circuit Breakers Types DSII and DSLII
I.B. 33-790-1	Instructions for Low-Voltage Power Circuit Breaker Types DS and DSL
1A33600	Connection Diagram for Type DSII Circuit Breakers
508B508	Connection Diagram for Type DS Circuit Breakers
Supplement A to I.B. 33-790-1	Circuit Breaker Automatic Tripping System When Using Digitrip RMS 500, 600, 700 and 800 Trip Units

8.1 DIGITRIP RMS AND DIGITRIP OPTIM TRIP ASSEMBLY REFERENCES

I.L. 29-885	Instructions for Digitrip RMS 510 Trip Unit
I.L. 29-886	Instructions for Digitrip RMS 610 Trip Unit
I.L. 29-888	Instructions for Digitrip RMS 810 Trip Unit
I.L. 29-889	Instructions for Digitrip RMS 910 Trip Unit
I.L. 29C891	Instructions for Digitrip OPTIM Trip Unit

8.2 TIME-CURRENT CURVES

Refer to the applicable Time-Current Curve details. All protection function time current settings should be made following the recommendations made by the specifying engineer in charge of the installation.

<u>Digitrip RMS Curves</u>

AD 32-870	Typical Time-Current Characteristic Curves for Types DS and DSL Circuit Breakers
SC-5619-93	Instantaneous (I)
SC-5620-93	Long Delay and Short Delay (LS)
SC-5621-93	Ground (G)

<u>Digitrip OPTIM Curves</u>

AD 32-880	Characteristic Curves for Types DSII and DSLII Circuit Breakers with Digitrip OPTIM 750 and 1050 Trip Units
SC-6275-95	Typical Long Delay I^2t, Short Delay I^2t, Types DSII and DSLII rated up to 1200A
SC-6276-95	Typical Long Delay I^2t, Short Flat, Types DSII and DSLII rated up to 1200A
SC-6277-95	Typical Long Delay I^4t, Short Flat, Types DSII and DSLII rated up to 1200A
SC-6278-95	Typical Long Delay I^2t, Short Delay I^2t, Types DSII and DSLII rated 1600A to 5000A
SC-6279-95	Typical Long Delay I^2t, Short Flat, Types DSII and DSLII rated 1600A to 5000A
SC-6280-95	Typical Long Delay I^4t, Short Flat, Types DSII and DSLII rated 1600A to 5000A
SC-6281-96	Typical Instantaneous, Types DSII and DSLII rated up to 1200A
SC-6282-96	Typical Instantaneous, Types DSII and DSLII rated 1600A to 5000A
SC-6283-96	Typical Ground Fault (Trip or Alarm Only), Types DSII and DSLII

<u>DSL Limiter Curves</u>

AD 36-783	Characteristic Curves for Type DSL Limiters
Curve No. 639771	DSL-206 Limiters, Average Melt Time
Curve No. 639431	DSL-416 Limiters, Average Melt Time
Curve No. 705503	DSL-632 and DSL-840, Average Melt Time
Curve No. 639772	DSL-206 Limiters, Let-Through Current Characteristics
Curve No. 639432	DSL-416 Limiters, Let-Through Current Characteristics
Curve No. 705504	DSL-632 and DSL-840 Limiters, Let-Through Current Characteristics

8.3 MISCELLANEOUS REFERENCES

I.L. 33-791	Ampector Trip Unit Test Kit
TD 17-382	Assemblies Electronic Monitor (AEM) II
I.L. 29C892	OPTIMizer Hand Held Programmer
I.L. 29C893	Breaker Interface Module

DIGITRIP TRIP FUNCTION SETTINGS				
Circuit No./Address ________		Breaker Shop Order References ________		
PER UNIT MULTIPLIERS				
Rating Plug Amperes (I_n) ________		I_r Continuous Ampere Rating = LDS x I_n ________		
Trip Function	Per Unit Pick-up Setting	Multi-plier	Ampere Equivalent Setting	Time Delay
Inst.		I_n		
Long Delay		I_n		Sec.
Short Delay		I_r		Sec.
Ground Fault		I_n		Sec.
Date ________		By ________		

Figure 10 Typical Trip Function Record

DIGITRIP AUTOMATIC TRIP OPERATION RECORD				
Circuit No./Address ________	Breaker Shop Order References ________			
	Setting Reference			
Trip Function	Orig. 0	Rev. 1	Rev. 2	Rev. 3
Instantaneous				
Long Delay P/U				
Long Delay Time				
Short Delay P/U				
Short Delay Time				
Ground Fault P/U				
Ground Fault Time				

Date of Trip	Trip Mode Indicated	Per Unit Trip Value Shown	Setting Ref.	Setting Change Made	Investigated By

Figure 11 Automatic Trip Operation Record

Cutler-Hammer
Five Parkway Center
Pittsburgh, PA 15220

Effective 7/97 (ISI)
Style 8700C39H01
Printed in U.S.A.