Cutler-Hammer

I.B. 29C891B

Instructions for Operation and Maintenance of Digitrip OPTIM Trip Units

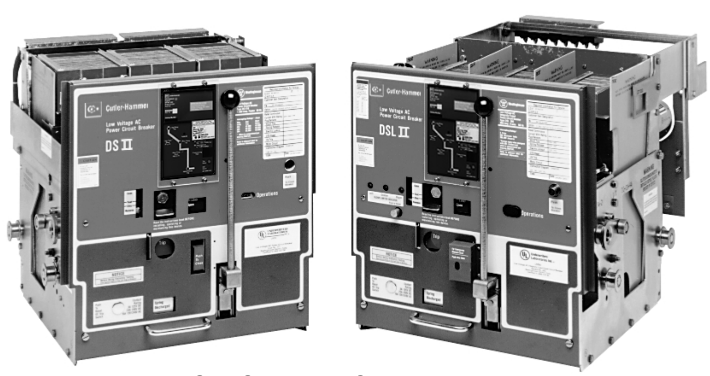
PROTECTION AND COORDINATION

POWER QUALITY

ENERGY MONITORING

Series $\overline{C}$ K, L, N and R Molded Case Circuit Breakers

SPB Systems Pow-R Circuit Breakers



DSII/DSLII Power Circuit Breakers

COMMUNICATIONS SYSTEMS

Effective 11/98 Supersedes I.B. 29C891A dated October 1996

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SECTION 1: INTRODUCTION

1-1 COMMON TERMS

Several commonly used terms or phrases are used throughout this manual. They are defined here to eliminate any confusion that might arise when reading the text.

IMPACC (Integrated Monitoring, Protection and Control Communications) – A family of communicating electrical power distribution protective devices, meters, motor control devices, communications networks and protocols and software packages to provide power distribution monitoring and control.

INCOM (Industrial Communications) – A noise immune communications system designed specifically for power distribution monitoring and control applications.

PONI (Product Operated Network Interface) – A plug-in communications module that enables network communications.

1-2 PRELIMINARY COMMENTS AND SAFETY PRECAUTIONS

This instructional manual is intended to present specific descriptive, operational and maintenance information associated with Digitrip OPTIM Trip Units only. Digitrip OPTIM Trip Units are designed to be used with the Breaker Interface Module and OPTIMizer Hand Held Programmer. For a general overview of the entire Digitrip OPTIM Trip Unit System and certain specific application possibilities, refer to Instruction Book 29C890 entitled “Instructional Overview for Use of the Digitrip OPTIM Trip Unit System.”

Detailed instructional material relative to the installation, use and maintenance of specific devices is included under separate cover by a manual dedicated to each device. A series of four manuals brings together the wide array of capabilities offered by the most advanced programmable trip unit system - Digitrip OPTIM. Refer to Appendix A for all instruction material references.

Please read and understand this manual and all other relevant manuals before proceeding with the installation and operation of any device included in the trip unit system. Pay particular attention to all WARNINGS and CAUTIONS. They are intended to help insure personnel safety and equipment protection. Refer to the WARNING and CAUTION in Paragraph 1-2.1 before proceeding to any other section in this manual or any other manual. If further information is required by the purchaser regarding a particular installation, application or maintenance activity, a Cutler-Hammer representative should be contacted.

1-2.1 SAFETY PRECAUTIONS

All safety codes, safety standards and/or regulations must be strictly observed in the installation, operation and maintenance of any device in this system.

WARNING

THE WARNINGS AND CAUTIONS INCLUDED AS PART OF THE PROCEDURAL STEPS IN THIS DOCUMENT ARE FOR PERSONNEL SAFETY AND PROTECTION OF EQUIPMENT FROM DAMAGE. AN EXAMPLE OF A TYPICAL WARNING LABEL HEADING IS SHOWN ABOVE IN REVERSE TYPE TO FAMILIARIZE PERSONNEL WITH THE STYLE OF PRESENTATION. THIS WILL HELP TO INSURE THAT PERSONNEL ARE ALERT TO WARNINGS, WHICH MAY APPEAR THROUGHOUT THE DOCUMENT. IN ADDITION, CAUTIONS ARE ALL UPPER CASE AND BOLDFACE AS SHOWN BELOW.

CAUTION

COMPLETELY READ AND UNDERSTAND THE MATERIAL PRESENTED IN THIS DOCUMENT BEFORE ATTEMPTING INSTALLATION, OPERATION OR APPLICATION OF THE EQUIPMENT. IN ADDITION, ONLY QUALIFIED PERSONS SHOULD BE PERMITTED TO PERFORM ANY WORK ASSOCIATED WITH THE EQUIPMENT. ANY WIRING INSTRUCTIONS PRESENTED IN THIS DOCUMENT MUST BE FOLLOWED PRECISELY. FAILURE TO DO SO COULD CAUSE PERMANENT EQUIPMENT DAMAGE.

1-3 PRODUCT OVERVIEW

The Digitrip OPTIM Trip Unit is a programmable, communicating, microprocessor-based, low voltage trip unit. Digitrip OPTIM Trip Units are for use with Series C̄ K-Frame, L-Frame, N-Frame and R-Frame Molded Case Circuit Breakers, SPB Systems Pow-R Circuit Breakers, and DSII/DSLII Power Circuit Breakers (Figures **1-1**, **1-2** and **1-3**). These circuit breakers using Digitrip OPTIM Trip Units cover a range of rated currents from 70 amperes to 5000 amperes. The Digitrip OPTIM Trip Unit provides true rms sensing and utilizes a non-adjustable interchangeable rating plug to establish the continuous current rating of the circuit breaker (Figure **1-4**). Rating plugs are interlocked to prevent use between different circuit breaker frames.

The Digitrip OPTIM Trip Unit is an addition to the already expansive family of Digitrip Trip Units (Figure **1-5**). Three different models are available, OPTIM 550, OPTIM 750 and OPTIM 1050. The OPTIM 1050 Trip Unit has all the features of the OPTIM 550 and 750 Trip Units plus several additional features. The OPTIM 1050 Trip Unit's additional features are:

- Monitoring power and energy
- Monitoring current harmonics

Figure 1-1 Series C̄ L-Frame Molded Case Circuit Breaker with OPTIM Trip Unit

Figure 1-2 SPB Systems Pow-R Circuit Breaker with OPTIM Trip Unit

Figure 1-3 DSII Power Circuit Breaker with OPTIM Trip Unit

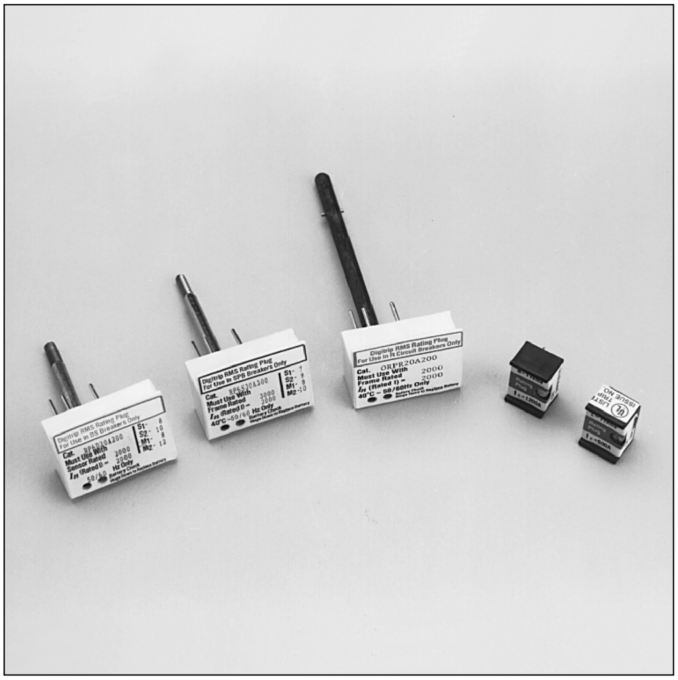


Figure 1-4 Family of Digitrip OPTIM Trip Unit Rating Plugs

Refer to paragraph 1-4 for feature and function details.

A Digitrip OPTIM Trip Unit System can be tailored to meet very precise system requirements. The featured parts of an OPTIM Trip Unit System are:

- OPTIM 550, 750 or OPTIM 1050 Trip Unit
- OPTIMizer Hand Held Programmer
- Breaker Interface Module
- Communications System and Software (IMPACC)

A Digitrip OPTIM Trip Unit System always includes any number of OPTIM 550, 750 or OPTIM 1050 Trip Units with one or more OPTIMizer Hand Held Programmers. The OPTIMizer Hand Held Programmer is required with the trip units to initially:

- Assign unique device addresses
- Select baud rates

In addition, OPTIM Trip Units are compatible with the optional panel mounted Breaker Interface Module and IMPACC software. When used, the Breaker Interface Module and IMPACC software also become integral parts of the overall Digitrip OPTIM Trip Unit System. Together, the OPTIM Trip Units, the required OPTIMizer Hand Held Programmer, the optional Breaker Interface

Applicable Circuit Breaker Types and Trip Unit Type							
K, L, N & R	R, SPB & DSII	K thru DSII	R thru DSII	K thru DSII	R thru DSII	R thru DSII	K thru DSII
RMS 310	RMS 510	OPTIM 550 ①	RMS 610	OPTIM 750	RMS 810	RMS 910	OPTIM 1050
RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing
5 Functions	9 Functions	10 Functions	9 Functions	10 Functions	9 Functions	9 Functions	10 Functions
Front Adjustable	Front Adjustable	Programmable	Front Adjustable	Programmable	Front Adjustable	Front Adjustable	Programmable
			Load Monitoring	Load Monitoring	Load Monitoring	Load Monitoring	Load Monitoring
			Diagnostics	Diagnostics	Diagnostics	Diagnostics	Diagnostics
				Communications	Communications	Communications	Communications
					Power & Energy Monitoring	Power & Energy Monitoring	Power & Energy Monitoring
		① Field Installed communications available				Harmonics	Harmonics

Figure 1-5 Family of Digitrip Trip Units Comparison

Figure 1-6 Hand Held Programmer in Use

Figure 1-7 Breaker Interface Module in Service

Module, and the optional IMPACC software form a system that is capable of:

- Setting trip units
- Configuring systems
- Monitoring/protecting
- Displaying information
- Diagnosing input
- Testing trip units/circuit breakers
- Communicating on sub-networks/networks

Application of low voltage circuit breakers utilizing OPTIM Trip Units generally fall into three primary categories:

Stand Alone Application (Individual Circuit Breakers)

These applications are utilized to take advantage of the superior protection and coordination features of Digitrip OPTIM, and plan to perform monitoring at the circuit breaker itself (Figure **1-6**).

The following would be used:

- OPTIM 550, 750 and/or 1050 Trip Units
- One or more OPTIMizer Hand Held Programmers

Integrated Assembly Applications (Low Voltage Assemblies)

These applications are utilized to provide on-gear or remote monitoring and even testing of compatible devices (Figure **1-7**). Up to 50 OPTIM Trip Units, Digitrip RMS 810/910 Trip Units or IQ Energy Sentinels can communicate with one Breaker Interface Module.

The following would be used:

- OPTIM 550 (if field IMPACC kit installed)
- OPTIM 750 and/or 1050 Trip Units
- Digitrip RMS 810 and/or 910 Trip Units
- IQ Energy Sentinels
- One or more OPTIMizer Hand Held Programmers
- One or more assembly/remotely mounted Breaker Interface Modules

Facility Wide Application (IMPACC System)

These applications are utilized to tie together more than 50 circuit breakers and/or other compatible devices. In addition, this permits taking advantage of PC-based software to improve diagnostics, power quality and energy monitoring, or protective device coordination capabilities. The system would consist of any number of devices and software products, either within a facility or across multiple facilities (Figure **1-8**).

The following would be used:

- OPTIM 550 (if field IMPACC kit installed)
- OPTIM 750 and/or 1050 Trip Units
- Digitrip RMS 810 and/or 910 Trip Units
- Other IMPACC Compatible devices
- One or more OPTIMizer Hand Held Programmers
- One or more assembly/remotely mounted Breaker Interface Modules
- IMPACC software/central PC

Refer to Figure **1-9** for typical system configurations utilizing the OPTIM Trip Unit System and other compatible devices. For additional IMPACC details, refer to Section 3 of Instruction Book 29C890.

1-4 FEATURES AND FUNCTIONS

Digitrip OPTIM 550, 750 and 1050 Trip Units provide a wide range of common protection and coordination features and functions. The Digitrip OPTIM 1050 Trip Unit also provides power quality and energy monitoring capabilities.

Figure 1-8 Monitor and Control from Central PC

1-4.1 COMMON FEATURES OF DIGITRIP OPTIM 550, 750 AND 1050 TRIP UNITS

Precise system coordination is provided by an expansive number of time-current curve shaping adjustments. This is accomplished by the large number of incremental setpoints available for both current pickup and time settings.

Programmable Protection and Coordination Adjustments

- Long delay setting
- Long delay time with selectable I^2t or I^4t slopes
- Short delay setting
- Short delay time with selectable flat or I^2t slopes
- Instantaneous setting
- Ground fault setting
- Ground fault time with selectable flat or I^2t slopes

The trip units also have a selectable powered and 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 LEDs to indicate the trip mode following an automatic trip operation. The LEDs are complemented by trip event information that is stored in non-volatile 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.

Selectable early warning alarms, such as the high load current alarm, are capable of being indicated locally and remotely. They are provided to help keep a system operating and productive.

System Monitoring

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

- Steady-State value of phase and neutral or ground currents ①
- Minimum and maximum current values
- Average demand current
- Cause of trip
- Magnitude of fault current responsible for an automatic trip operation

① LSI version of OPTIM 550 only monitors phase currents

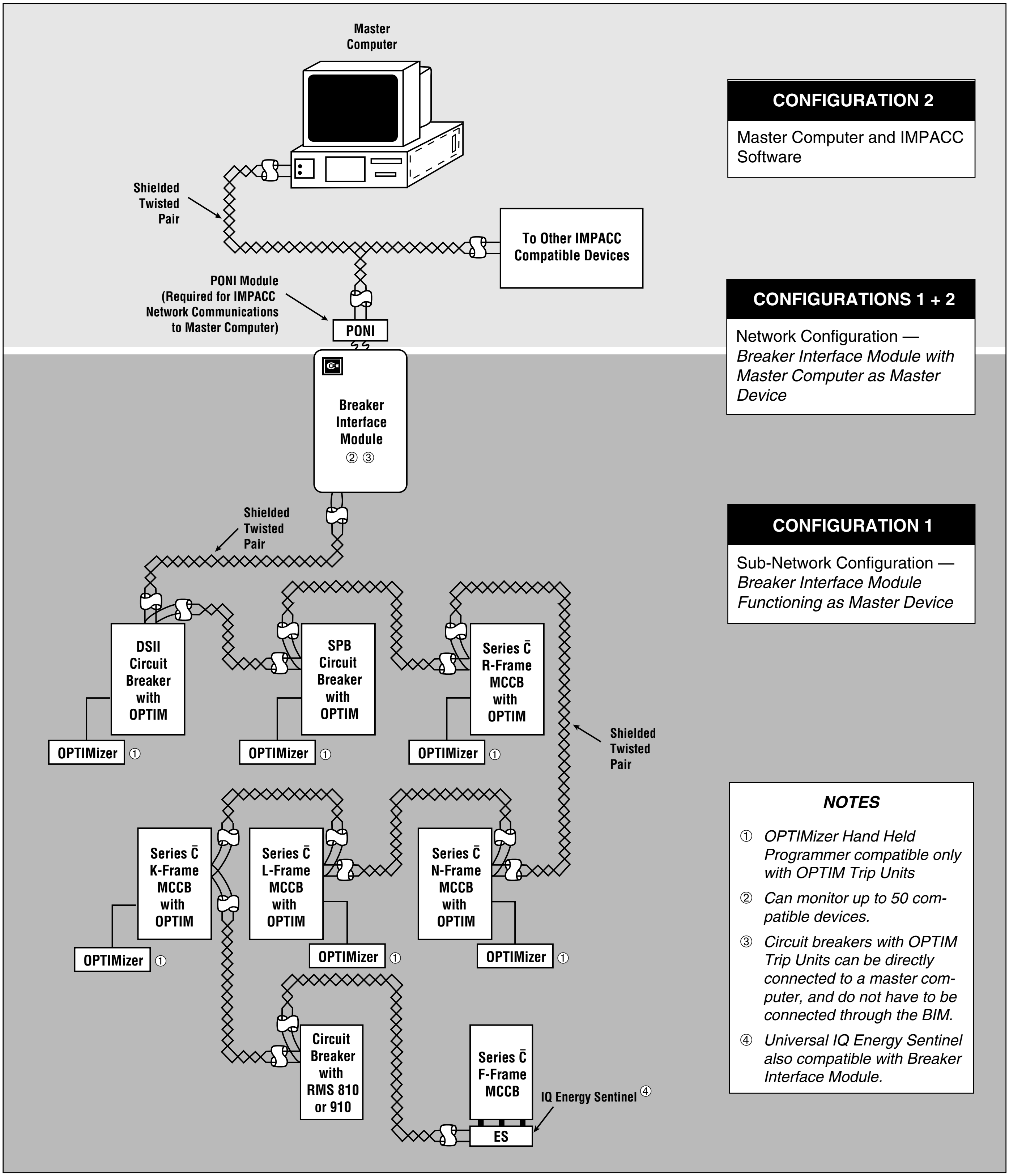


Figure 1-9 Typical System Configurations

Communications

Trip units that are capable of two way communication operate 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, a motor operator accessory is required. Refer to Table **A.1** in Appendix A for motor operator instructional references.

Testing

An integral testing capability is part of all OPTIM Trip Systems. The breaker can be tested in either the “Trip” or “No Trip” Test Mode. System level testing is carried out by using a Hand Held Programmer, a Breaker Interface Module, or a remote computer. Bench level testing requires the Hand Held Programmer only. Trip tests with the Hand Held Programmer require an auxiliary power module to supply the necessary power. Trip units continue to provide protection during test operations.

Data Access

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

- Hand Held Programmer
- Breaker Interface Module ①
- Remote computer ①

1-4.2 ADDITIONAL FEATURES OF DIGITRIP OPTIM 1050 TRIP UNITS

The Digitrip OPTIM 1050 Trip Unit provides all the basic system protection features outlined in Paragraph 1-4.1. In addition, Digitrip OPTIM 1050 Trip Units can provide data on power quality (current harmonics) and permit energy monitoring.

Energy Monitoring

- Peak demand (kW)
- Present demand (kW)
- Forward energy (kWh)
- Reverse energy (kWh)
- Total energy (kWh)
- Power factor

Power Quality

- Percentage harmonic content
- Total harmonic distortion (THD)
- Digitized waveforms (Remote computer only)

① OPTIM 550 trip units must have field IMPACC kit installed for use with BIM or remote computer

SECTION 2: HARDWARE DESCRIPTION AND EQUIPMENT INTERFACES

2-1 GENERAL

The purpose of this section is to familiarize the reader with Digitrip OPTIM Trip Units, their nomenclature, the way trip units are interfaced with specific equipment, and trip unit specifications. The information presented is divided into the following four parts:

- General Trip Unit Details
- Trip Units By Type
- Trip Unit Accessories
- Specification Summary

2-2 GENERAL TRIP UNIT DETAILS

This section describes general trip unit functioning, trip unit hardware, circuit breaker specific details, and required interfaces with other external equipment.

2-2.1 TRIP UNIT CONFIGURATION

A complete OPTIM Trip Unit System consists of current sensors, electronic circuitry and a flux transfer shunt trip device contained inside the circuit breaker (Figure **2-1**). The trip units are completely self-contained and, when the circuit breaker is closed, no external power is required to operate their protective systems. They operate from current signal levels and control power is derived from the current sensors integrally mounted in the circuit breakers.

Circuit protection is achieved by analyzing the secondary current signals received from the circuit breaker current sensors. As signals are received and analyzed, a trip signal to the flux transfer shunt trip is initiated when programmed current levels and time delay settings are exceeded.

2-3 TRIP UNIT PACKAGES

The features associated with the three different OPTIM Trip Unit models (550, 750 and 1050) are outlined in Figure **1-5**.

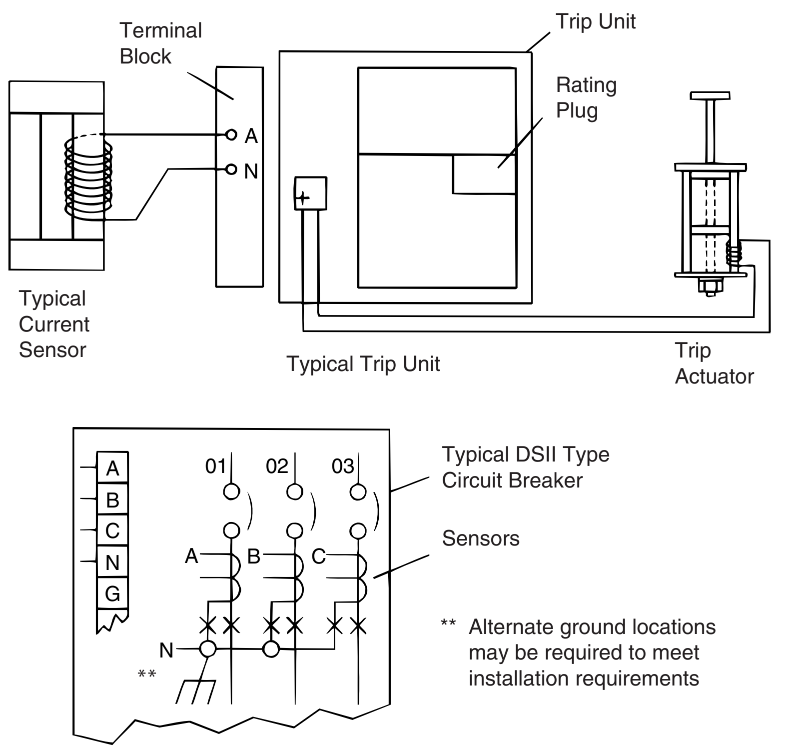


Figure 2-1 Typical OPTIM Trip Unit Circuitry (DSII Type Circuit Breaker Shown)

Models 750 and 1050 on K, L and N-Frame circuit breakers are factory sealed. Model 550 equipped circuit breakers and all R-Frame SPB and DSII circuit breakers can be upgraded in the field.

2-4 SERIES $\overline{C}$ K, L-FRAME AND N-FRAME OPTIM TRIP UNITS

The continuous frame rating of each circuit breaker is selectable via rating plugs over the following range:

- K-Frame (70-400 amperes)
- L-Frame (200-600 amperes)
- N-Frame (400-1200 amperes)

The OPTIM Trip Unit applicable to the Series $\overline{C}$ K and L-Frame molded case circuit breakers extends approximately 0.5 inches beyond the front of the breaker cover (Figure **2-2**). The OPTIM Trip Unit used with the L-Frame is not applicable to any other circuit breaker.

The OPTIM Trip Unit applicable to Series $\overline{C}$ N-Frame molded case circuit breaker is nearly flush mounted to the front of the breaker cover (Figure **2-3**). The OPTIM Trip Unit used with the N-Frame is not applicable to any other circuit breaker.

The side wiring brackets shown in Figures **2-2** and **2-3** are only necessary for Models 750 and 1050 on K, L and N-Frame circuit breakers. Model 550 does not need the bracket on the same frames.

2-4.1 K, L AND N-FRAME OPTIM TRIP UNIT DISPLAYS

Readings are displayed and protective settings established or adjusted through the use of one or more of the following means:

- OPTIMizer Hand Held Programmer
- Breaker Interface Module
- Remote Computer/IMPACC software

OPTIM Trip Units provide the following features (Figure **2-4**):

Push-To-Trip Button

A Push-To-Trip button provides a local manual means for checking the circuit breaker's mechanical tripping function and periodically exercising the operating mechanism. It is located on the front of the trip unit.

Mode of Trip/Alarm Indicators

Four LED type indicators (long delay, short delay, instantaneous and ground fault trip or ground fault alarm) are provided to indicate the mode of trip after an automatic trip. The appropriate LED is lit red when activated.

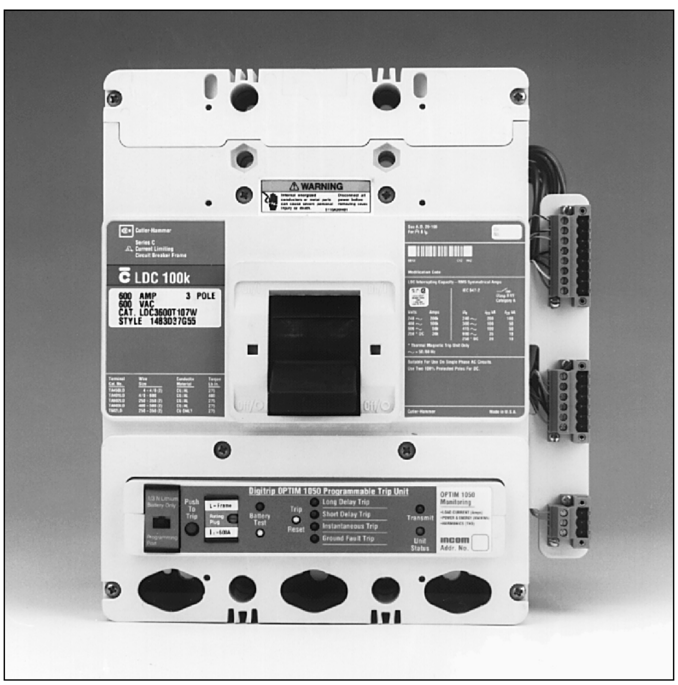


Figure 2-2 OPTIM Trip Unit Mounted in Series $\overline{C}$ L-Frame Circuit Breaker (K-Frame is Similar)

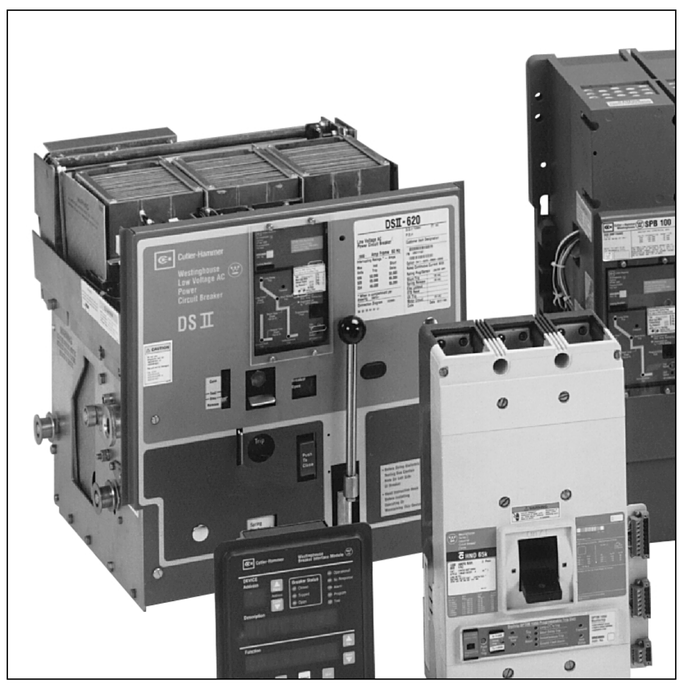
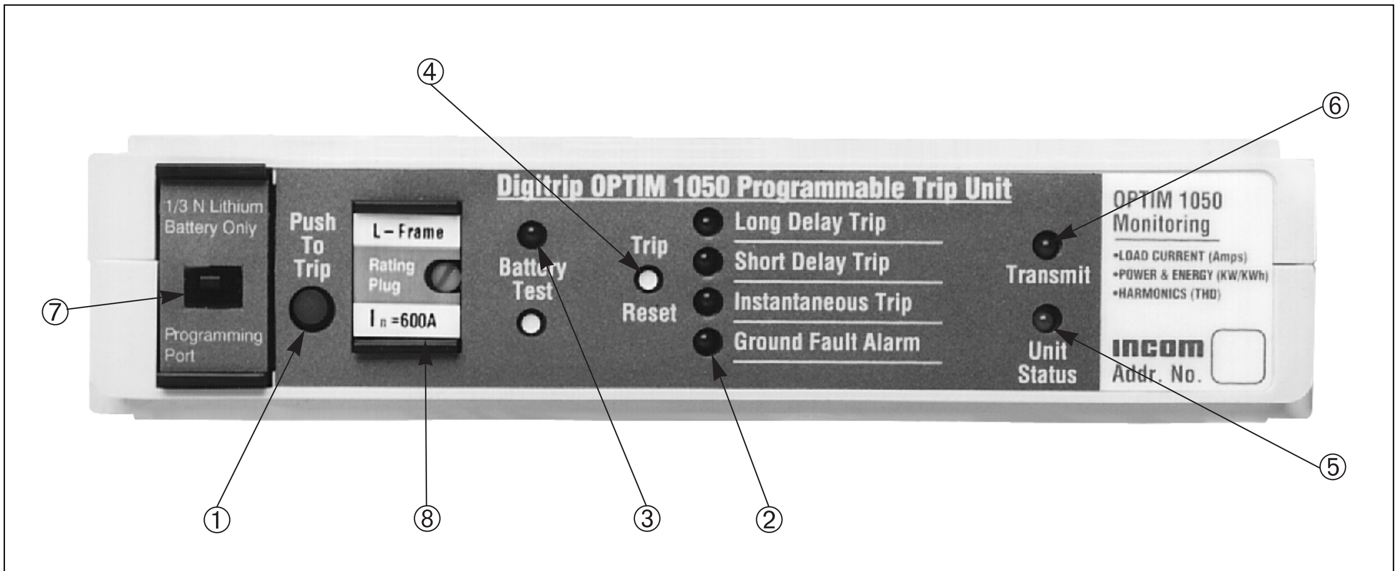


Figure 2-3 OPTIM Trip Unit Mounted in Series $\overline{C}$ N-Frame Circuit Breaker



① Push-to-Trip Button
② Mode of Trip/Alarm LEDs
③ Battery Test Pushbutton/LED
④ Automatic Trip Indicator Reset Pushbutton
⑤ Unit Status LED
⑥ INCOM Transmit LED (Model 550 requires field IMPACC kit)
⑦ Battery Compartment/Pro-gramming Port Access Cover
⑧ Rating Plug

Figure 2-4 Front View of L-Frame Type OPTIM Trip Unit (K and N-Frame Designs are Similar)

Notice: *Trip unit should be powered from an external control power source. If control power is not available the LEDs will temporatily operate off the battery. Refer to the wiring diagrams listed in Appendix A, Table A.1 for control power connections.*

Battery for Trip Indicators

A replaceable 3 volt lithium battery is located behind a small access cover on the left side of the trip unit (Figure **2-5**). A test pushbutton and LED test indicator are also provided. The test pushbutton will energize the LED indicator if the battery is in good working condition. Refer to paragraph 5-4.1 for battery replacement information.

Trip Indicator Reset Pushbutton

A trip reset pushbutton is provided to turn off a mode of trip LED indicator after an automatic trip. The reset pushbutton is located next to the four mode of trip led indicators.

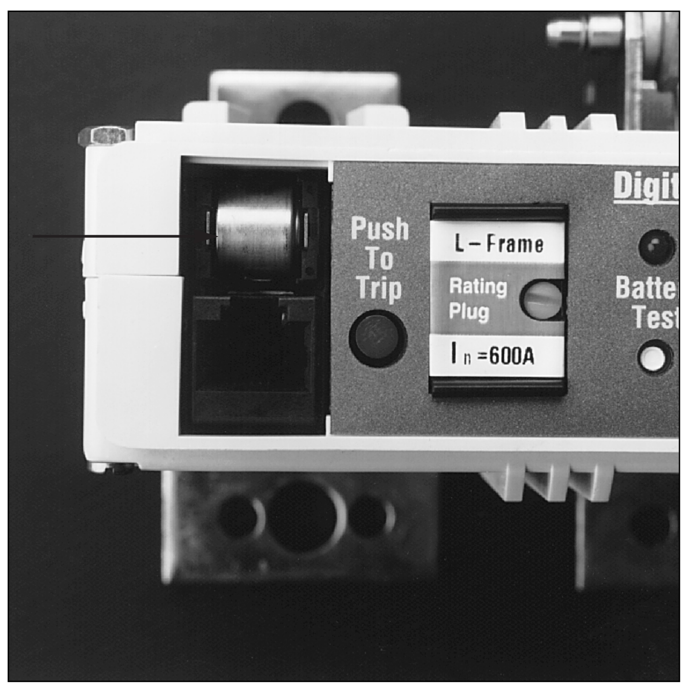


Figure 2-5 K, L and N-Frame Type OPTIM Trip Unit Battery Compartment

Unit Status LED

The green Unit Status LED blinks with a one second on-off duty cycle when power is applied to the trip unit and it is functioning properly.

INCOM Transmit LED

The red transmit LED flashes red when the trip unit is communicating over an INCOM network.

Programming Port

A custom phone type jack programming port is located with the trip indicator battery behind the small access cover. One end of the custom phone type cord provided with the OPTIMizer Hand Held Programmer plugs into the port, and permits direct programming of the trip unit (Figure **2-6**). To access the programming port, remove the access cover by pulling down on the release tab located in the center of the cover while pulling out on the cover. The port will accept either end of the custom phone cord.

Notice: *When the OPTIMizer is plugged into a trip unit, it prevents all remote IMPACC communications (if present) with that trip unit. This action will also cause a No-Response alarm on the Breaker Interface Module and a master network. Refer to Instruction Book 29C892 covering the OPTIMizer Hand Held Programmer for the recommended connection and power application sequence.*

2-5 SERIES $\bar{C}$ R-FRAME, SPB AND DSII/DSLII OPTIM TRIP UNITS

Model 750 and 1050 OPTIM Trip Units used in Series $\bar{C}$ R-Frame, SPB Systems Pow-R and DSII/DSLII circuit breakers are field replaceable. Model 550 is only available on the R-Frame circuit breaker. For each of these circuit breaker types, rating plugs are used to select the continuous ampere rating of the circuit breaker. The rating plugs and circuit breakers are keyed with a mechanical interlock to prevent incorrect installation. The continuous ampere rating of each of these circuit breakers is adjustable via the rating plugs as follows:

- Series C R-Frame (800-2500 amperes) (Figure **2-7**)
- SPB Pow-R (200-5000 amperes) (Figure **2-8**)
- DSII/DSLII (100-5000 amperes) (Figure **2-9**)

Refer to Table **2.1** for the available rating plug values by circuit breaker type.

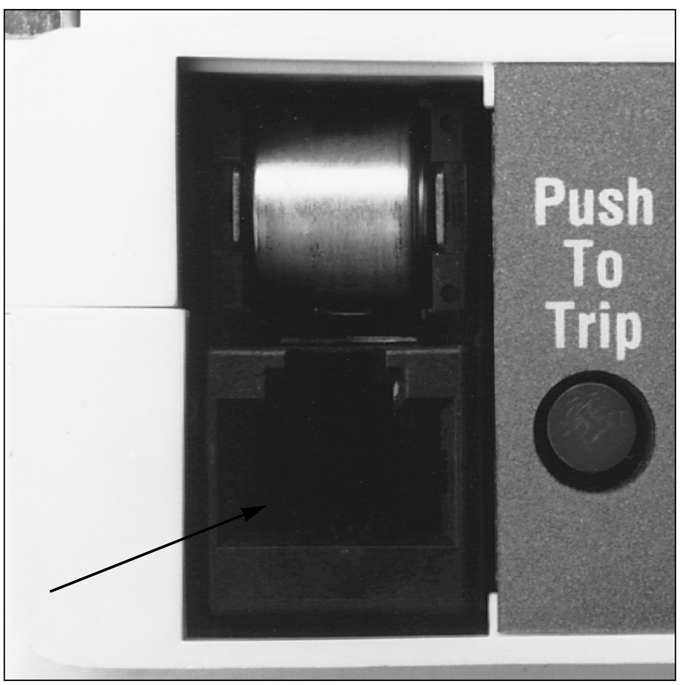


Figure 2-6 K, L and N-Frame Type OPTIM Trip Unit Programming Port

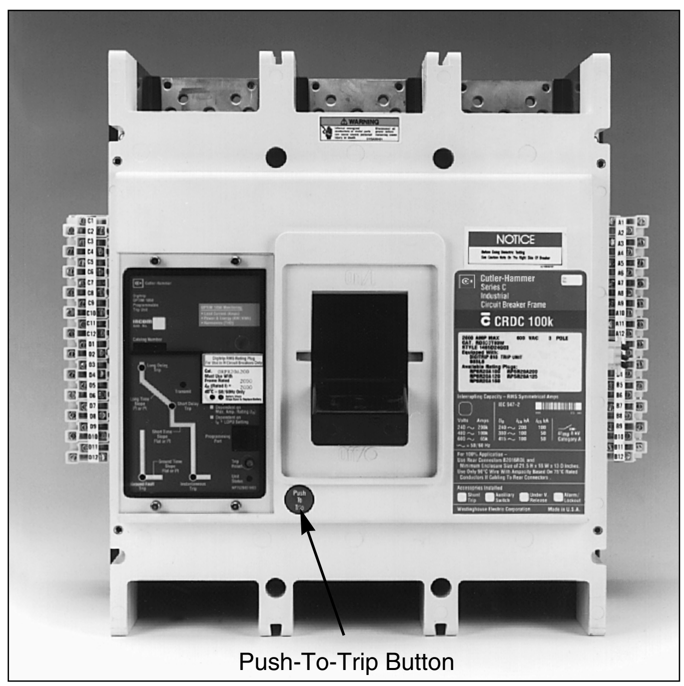


Figure 2-7 OPTIM Trip Unit Mounted in Series $\bar{C}$ R-Frame Circuit Breaker

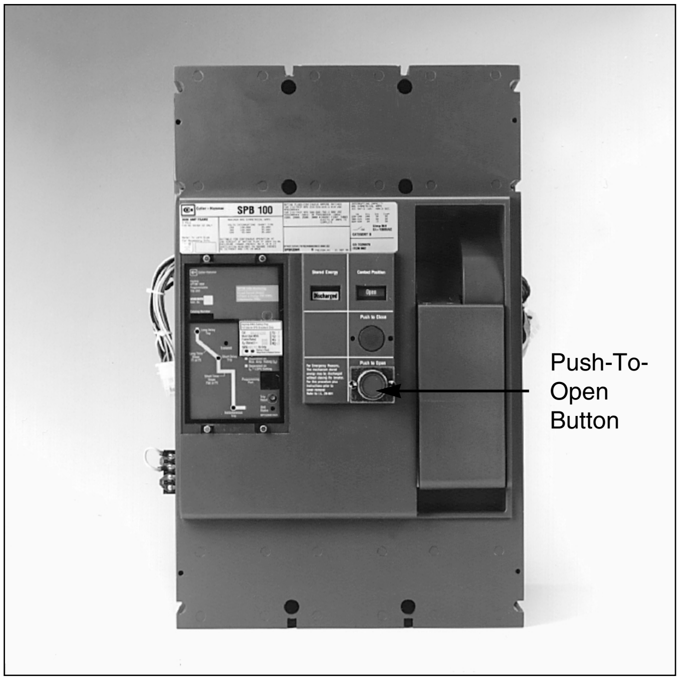


Figure 2-8 OPTIM Trip Unit Mounted in SPB Circuit Breaker

Figure 2-9 OPTIM Trip Unit Mounted in DSII Circuit Breaker

2-5.1 R-FRAME, SPB AND DSII/DSLII OPTIM TRIP UNIT DISPLAYS

Readings are not displayed and protective settings are not established or adjusted from the front of Digitrip OPTIM Trip Units. These functions are carried out through the use of one or more of the following means:

- OPTIMizer Hand Held Programmer
- Breaker Interface Module
- Remote Computer/IMPACC software

The R-Frame, SPB and DSII/DSLII OPTIM Trip Unit displays all provide the following features (Figure **2-10**):

Push-To-Trip Button

A Push-To-Trip (Push-To-Open on SPB) button provides a local manual means for checking the circuit breaker's mechanical tripping function and periodically exercising the operating mechanism. This pushbutton is accessible from the front of the R-Frame, SPB and DSII/DSLII circuit breakers.

Mode of Trip/Alarm Indicators

Four LED type indicators (long delay, short delay, instantaneous and ground fault trip or ground fault alarm) are provided to indicate the mode of trip after an automatic trip. The appropriate LED is lit red when activated. The LEDs are presented in the form of a mimic time-current curve on the front of the OPTIM Trip Unit.

Notice: *Trip unit indicators should be powered from a control power source wired externally to the circuit breaker or alternatively via battery located in the trip unit. For connection to an external control power source, refer to the wiring diagrams listed in Appendix A, Table A.1.*

Battery for Trip Indicators

A replaceable 3 volt lithium battery is located behind the hinged cover of the rating plug (Figure **2-11**). A test pushbutton and LED test indicator are also provided. The test pushbutton will energize the LED indicator if the battery is in good working condition. Refer to paragraph 5-4.1 for battery replacement information.

Trip Indicator Reset Pushbutton

A trip reset pushbutton is provided to turn off a mode of trip LED indicator after an automatic trip. The reset pushbutton is located directly under the programming port.

Notice: *For SPB and DSII/DSLII circuit breakers, this pushbutton also functions as a trip lockout reset. It must be pressed after an automatic trip to reset the trip unit.*

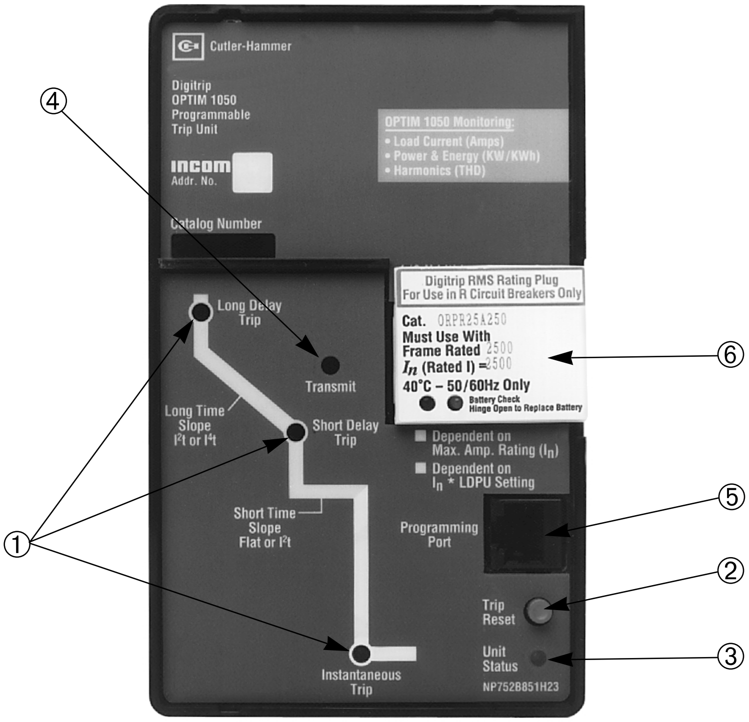


Figure 2-10 Front View of R-Frame, SPB and DSII/DSLII Type OPTIM Model 1050 Trip Unit with R-Frame Rating Plug Installed

Unit Status LED

The green ***Unit Status*** LED blinks with a one second on-off duty cycle when power is applied to the trip unit and it is functioning properly.

INCOM Transmit LED

The red transmit LED flashes red when the trip unit is communicating over an INCOM network. Model 550 requires the field IMPACC kit for communications.

Programming Port

A custom phone type jack programming port is located just under the rating plug. One end of the custom phone type cord provided with the OPTIMizer Hand Held Programmer plugs into the port, and permits direct programming of the trip unit (Figure **2-12**). The port will accept either end of the custom phone cord.

Notice: *When the OPTIMizer is plugged into a trip unit, it prevents all remote IMPACC communications with that trip unit. This action will also cause a No-Response alarm on the Breaker Interface Module and a master network. Refer to Instruction Book 29C892 covering the*

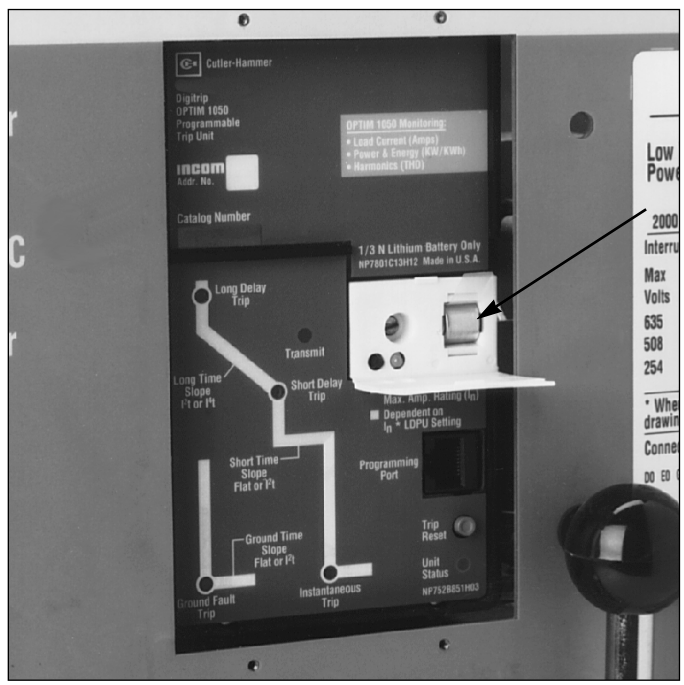


Figure 2-11 R-Frame, SPB and DSII/DSLII Type OPTIM Trip Unit Battery Compartment

OPTIMizer Hand Held Programmer for the recommended connection and power application sequence.

2-6 OPTIM TRIP UNIT RATING PLUG

The rating plug value (I_n) determines the maximum continuous current rating of the circuit breaker. All the protection function settings are based on multiples of the plug rating. These settings are displayed as actual ampere values for ease of use.

Notice: *The primary current conductors (cable or bus) must have ampacity ratings equal to the rating plug value per NEC Section 240-6(b).*

OPTIM Trip Units use interchangeable rating plugs (Figure **2-13**). Rating plugs are designed for use with one specific circuit breaker type. The circuit breaker type is indicated on the rating plug. Rating plugs are suitable for both 50 and 60Hz operation. A rating plug must be selected to match the desired continuous current rating of the circuit breaker as well as the installed sensor rating. The available rating plugs are shown in Table **2.1**.

Figure 2-12 OPTIMizer Shown Connected to Programming Port of DSII Type Circuit Breaker

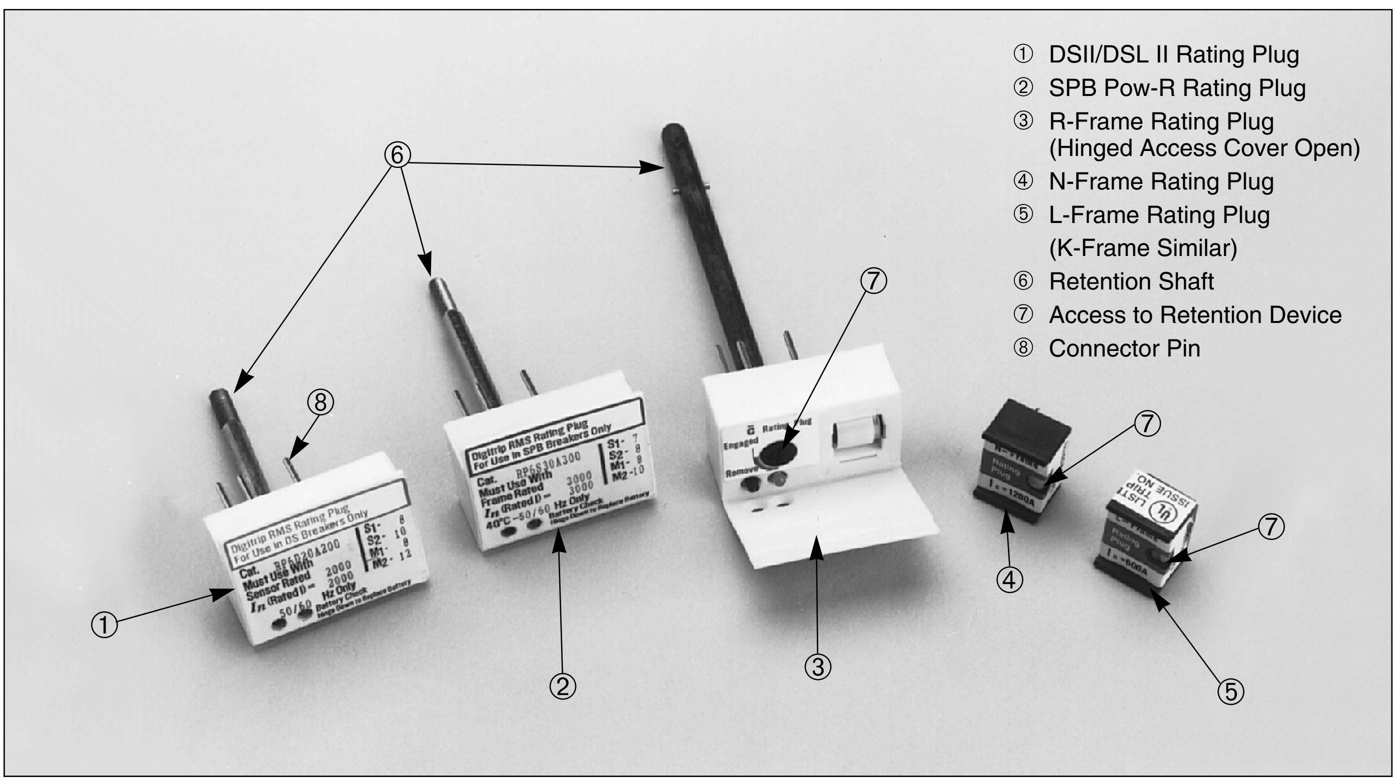


Figure 2-13 Family of OPTIM Trip Unit Rating Plugs

All rating plugs are designed with a rejection feature to prevent interchanging between different circuit breaker types. In addition, the circuit breaker will trip if a rating plug is removed with the trip unit energized.

⚠ WARNING

BEFORE A RATING PLUG IS INSTALLED INTO THE TRIP UNIT, BE CERTAIN TO CHECK THAT THE BREAKER TYPE AND FRAME RATING (OR SENSOR RATING IF APPLICABLE) MATCH THOSE PRINTED ON THE RATING PLUG COVER. INSTALLING A RATING PLUG THAT DOES NOT MATCH THE BREAKER TYPE AND FRAME RATING (OR SENSOR RATING IF APPLICABLE) CAN PRODUCE SERIOUS MISCOORDINATION AND/OR FAILURE OF THE PROTECTION SYSTEM.

IN ADDITION, IT IS IMPORTANT TO MAKE SURE THAT A RATING PLUG IS PROPERLY INSTALLED AND SECURED TO ENSURE PROPER FUNCTIONING OF THE CIRCUIT BREAKER.

2-7 EXTERNAL OPTIM TRIP UNIT ACCESSORIES

Digitrip OPTIM Trip Units for K, L, and N-Frame circuit breakers utilize a number of accessory items mounted outside the circuit breaker (Figure **2-14**). R-Frame, SPB and DSII circuit breakers have these devices already installed internally. Refer to Table **2.2** for specific accessory details, catalog numbers and/or approved accessory items.

Control Power Source

K, L, and N-Frame circuit breakers with OPTIM Model 750 or 1050 Trip Units utilize 24 Vdc control power from an external source for IMPACC communications. The power supply needs to be a high quality, "isolated" type for best performance.

Potential Transformer Module (PTM)

All Digitrip OPTIM 1050 Trip Units require a potential transformer module to provide voltage for power and energy monitoring, and the power factor display. K, L and N-Frame circuit breakers utilize an externally mounted potential transformer module, which can feed up to 16 circuit breakers (Figure **2-15**).

Ground Fault Alarm Indicator

K, L and N-Frame circuit breakers with OPTIM 750/1050 Trip Units utilize a remotely mounted ground fault alarm indicator (Figure **2-16**). This unit provides an indicator light and relay contacts to operate other warning devices when a ground fault condition occurs. Model 550 OPTIM does not support this feature.

2-8 SPECIFICATION AND PROTECTIVE RANGE SUMMARIES

Refer to Tables **2.2, 2.3, 3.2** and **3.3** for trip unit/accessory specification details and trip unit protective ranges.

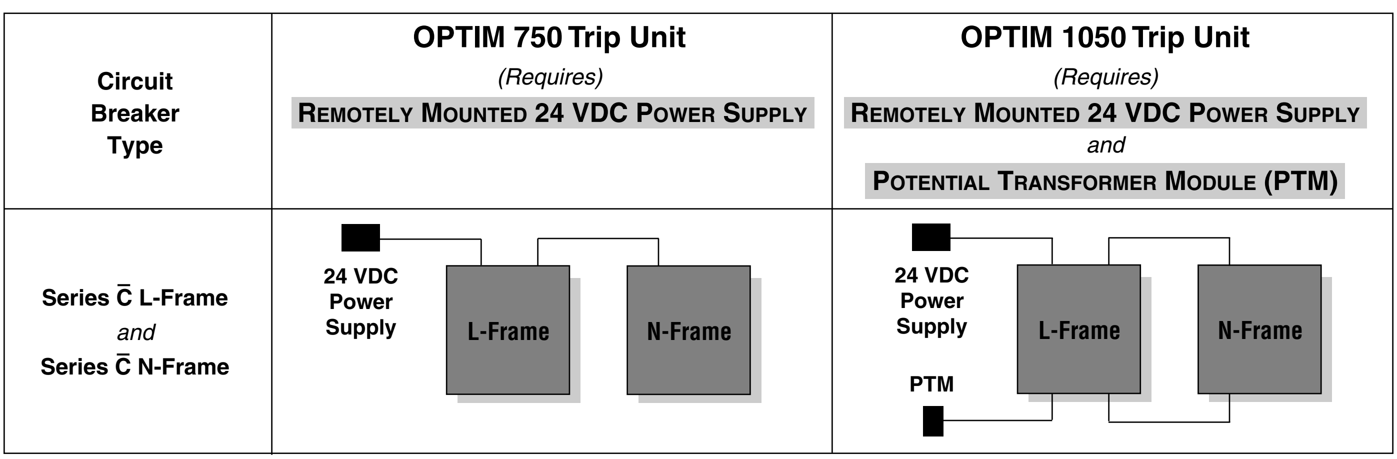


Figure 2-14 Power Accessory Requirements for K, L and N-Frame Circuit Breakers

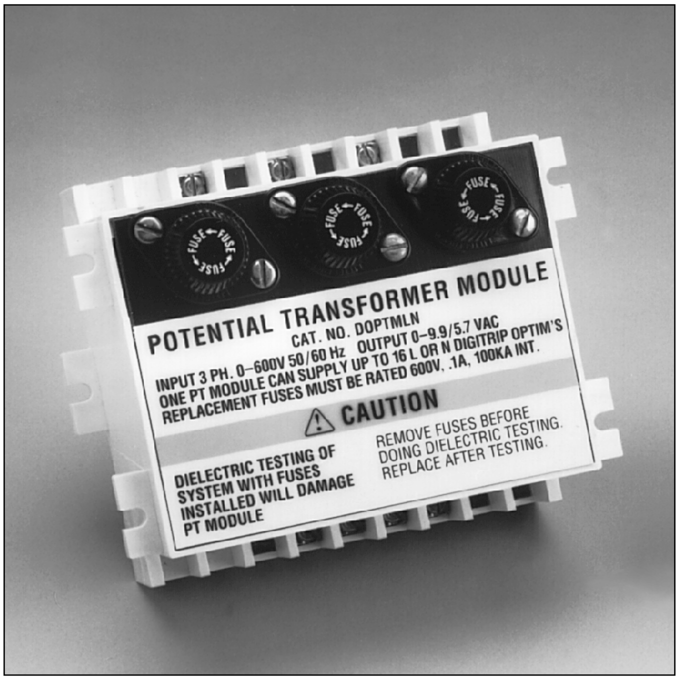


Figure 2-15 Externally Mounted Potential Transformer Module (necessary for K, L and N-Frame only)

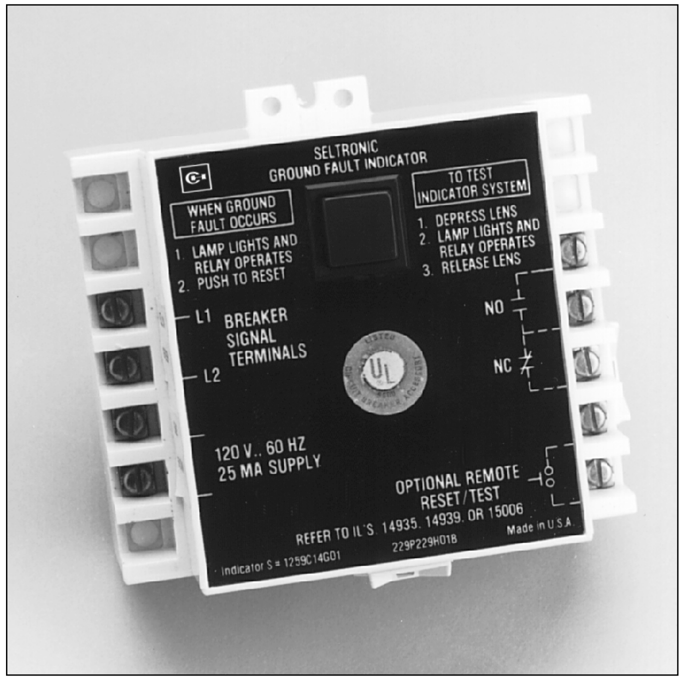


Figure 2-16 Ground Fault Alarm Indicator (necessary for K, L and N-Frame only)

Table 2.1 Rating Plugs Applicable to All OPTIM Trip Units

Series C̄ K-Frame Breaker		Series C̄ L-Frame Breaker		Series C̄ N-Frame Breaker		Series C̄ R-Frame Breaker		SPB Systems Pow-R Breakers		DSII/DSLII Breakers	
Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)	Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)	Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)	Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)	Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)	Rating Plug (I_n) (Amperes)	Sensor Rating (Amperes)
63	125	①	125	400	800	800	1600	200	400	100	200
70		63		450		1000		250		200	
90		70		500		1200		300		200	300
100		90		550		1600		400		250	
110		100		600		1000	2000	400	800	300	
125		110		700		1200		600		200	400
125	250	125		800		1600		800		250	
150		①	250	600	1200	2000		600	1200	300	
175		125		700		1600	2500	800		400	
200		150		800		2000		1000		300	600
225		175		1000		2500		1200		400	
250		200		1200				800	1600	600	
200	400	225						1000		400	800
225		250						1200		600	
250		200	400					1600		800	
300		225						1000	2000C	600	1200
350		250						1200		800	
400		300						1600		1000	
		350						2000		1200	
		400						1600	2000	800	1600
		300	600					2000		1000	
		350						1600	2500	1200	
		400						2000		1600	
		500						2500		1000	2000
		600						1600	3000	1200	
								2000		1600	
								2500		2000	
								3000		1600	2400
								2000	4000	2000	
								2500		2400	
								3000		1600	3200
								3200		2000	
								4000		2400	
								3000	5000	3000	
								3200		3200	
								4000		2000	4000
								5000		2400	
										3200	
										4000	
										3200	5000
										4000	
										5000	

① Not available on Model 550

Table 2.2 OPTIM Trip Unit/Accessory Specifications

TRIP UNITS	
Environment:	
• Operating Temperature	-20°C to 85°C
• Storage Temperature	-30°C to 85°C
• Operating Humidity	0 to 95% Relative Humidity (non-condensing)
Frequency	50/60Hz
Protective Settings	Refer to Table **3.1**
Zone Selective Interlocking	• Short Delay • Ground Fault
Metering Tolerance	Refer to Table **2.3**
ACCESSORIES	
Auxiliary Switch/Bell Alarm	
• Contact Ratings	• AC - 6A @ 600 Vac • DC - 0.5A @ 125 Vdc 0.25A @ 250 Vdc
Ground Fault Indicator (Style 1259C14G01)	• AC Contact Ratings - 5A @ 240 Vac - 1/6 HP @ 120 Vac - 1/3 HP @ 240 Vac • DC Contact Ratings - 5A @ 28 Vdc - 0.5A @ Vdc • Power Source - 120 Vac - 50/60 Hz • Dimensions (inches) - 4.75 x 3.94 x 3.00

Potential Transformer Module (PTM) (Catalog DOPTMLN, Style 7801C54G01)	
• Input voltage terminals	LA, LB and LC
• Rated input voltage	0 to 600 volts line to line
• Input volt amps	1 VA per phase
• Output voltage terminals	A, B, C and N
• Ratio ± 2%	(Input) (Output) 240V L-L 2.25V L-N 480V L-L 4.50V L-N 600V L-L 5.53V L-N
• Dimensions (inches)	4.75 x 5.75 x 3.28
• One PTM	Can supply up to 16 L or N-Frame Circuit Breakers
Power Supply Optim Trip Units impsoe a load of 45ma at 24 Vdc. The power supply should be a high quality, isolated unit with both UL (UR) and CE labels.	
Cause of Trip Battery	
• Type	Lithium, 3 volt
• Acceptable Replacement	• Varta Batteries, Inc. 150 Clarbrook Road Elmsford, NY 10523 **Type CR 1/3N** • Duracell South Broadway Tarrytown, NY 10591 **Type DL 1/3N** • Sanyo Electric, Inc. Battery Div. 200 Riser Road Little Ferry, NJ 07643 **Type CR 1/3N**

Table 2.3 OPTIM Trip Unit Metering Tolerances ①

Parameter	Circuit Breaker Type	Accuracy	Range/Assumptions
Phase Current	K, L, N R, SPB DSII, DSLII	±2% Frame Current Rating ±2% Frame Current Rating ±2% Sensor Current Rating	5% to 100% Frame Rating 5% to 100% (Current) Sensor Rating
Ground Current	K, L, N R, SPB DSII, DSLII	±5% Frame Current Rating ±5% Frame Current Rating ±5% Sensor Current Rating	10% to 100% Frame 10% to 100% Frame 10% to 100% Current Sensor
Power and Peak Demand	K, L, N R, SPB DSII, DSLII	±4% of (Frame Current Rating x 600V) x $\sqrt{3}$ ±4% of (Frame Current Rating x 600V) x $\sqrt{3}$ ±4% of (Current Sensor Rating x 600V) x $\sqrt{3}$	~ 1 sec. sampling window - Current @ 5% to 175% of frame or sensor rating
System Power Factor	K, L, N R, SPB DSII, DSLII	±0.02 ±0.02 ±0.02	Balanced three Phase Load per ANSI Std. C12.1-1988
Energy	K, L, N R, SPB DSII, DSLII	±5% of (Frame Current Rating x 600V x time) x $\sqrt{3}$ ±5% of (Frame Current Rating x 600V x time) x $\sqrt{3}$ ±5% of (Current Sensor Rating x 600V x time) x $\sqrt{3}$	5% to 175% of Plug Rating I_n

Notes:

① Metered values are displayed via:
1. OPTIMizer Hand Held Programmer
2. Breaker Interface Module
3. Remote PC via IMPACC

SECTION 3: OPERATION AND FUNCTIONALITY

3-1 GENERAL

This section describes the details associated with the operation and functional use of Digitrip OPTIM Trip Units in terms four main categories:

- Protection and Coordination
- System Monitoring
  - Load Current Monitoring
  - Power and Energy Monitoring
  - Power Quality Monitoring
- Communications
- Testing

Four quick reference overviews outlining the features available with the Digitrip OPTIM Trip Unit System, and specifically OPTIM Trip Units, are provided in Tables **3.1, 3.2 , 3.3** and **3.4**.

OPTIM Trip Units provide true RMS current sensing for proper correlation with thermal characteristics of conductors and equipment. The rating plug (I_n) determines the continuous current rating of the circuit breaker.

3-2 PROTECTION AND COORDINATION

The Digitrip OPTIM Trip Unit provides circuit breakers with an extensive degree of selective coordination potential, and permits curve shaping over a wide range of current settings. Pickup settings, delay time settings and slope selections are addressed here with respect to their effect on the resultant characteristic curve.

Table 3.1 Digitrip OPTIM 550, 750 and 1050 Trip Unit Capabilities

Capability	OPTIM 550	OPTIM 750	OPTIM 1050
Protection and Coordination	Yes (10 functions)	Yes (10 functions)	Yes (10 functions)
IMPACC Communications	Field Upgradeable	Yes	Yes
Ground Alarm Contact	No	Yes①	Yes①
Zone Selective Interlocking	No	Yes	Yes
Power Quality	No	No	Yes
Energy Monitoring	No	No	Yes①

① Requires external module on K, L and N-Frame breakers

3-2.1 OVER-TEMPERATURE TRIP

The OPTIM Trip Unit is designed for use in environments where the ambient temperatures range from -20°C to +85°C. If, however, temperatures around the trip unit exceed this range, the trip unit performance may be degraded. To insure that the tripping function is not compromised due to an over-temperature condition, the OPTIM microcomputer chip has a built-in over- temperature protection feature. This protective feature is factory set to trip the circuit breaker if the chip temperature exceeds 85°C ± 10°C.

3-2.2 CHARACTERISTIC CURVE REVIEW

As a review, certain aspects of a circuit breaker's characteristic curve are discussed here to simplify the understanding of later material.

The operating response of the trip unit is graphically represented by time-current characteristic curves. These curves show how and when a particular trip unit will act for given values of time and current. The more versatile the trip unit, the easier it is to accomplish close coordination and achieve optimum protection.

A characteristic curve is represented by a band created by a minimum and maximum value of time or current (Figure **3-1**). Minimum and maximum values are generally the result of tolerances introduced by the manufacturing process for components and factory calibration efforts. The tolerances are usually stated as the trip unit's accuracy and specified on the time-current curves. This accuracy is stated in terms of a plus or minus percentage and represents a permitted fluctuation on either side of a selected nominal setting point for a trip unit. OPTIM Trip Unit accuracies are specified for each protective function (long delay, short delay instantaneous and ground fault) and the type of circuit breaker in which the trip unit is installed. Refer to the applicable OPTIM time-current curves outlined in Table **A.1** of Appendix A for specific accuracies.

The programmable or adjustable features of a trip unit permit movement of its characteristic curve or parts of the curve. This movement can be done in both a horizontal and vertical direction on the time-current grid (Figure **3-2**).

The actual shape of the curve can be changed by selecting the slope, such as Flat, I^2t and I^4t (Figure **3-3**). An I^2t slope selection is used for an inverse curve, an I^4t slope selection for an extremely inverse curve, and a Flat selection for a definite or fixed time curve.

Before discussing protection functions individually, keep in mind that combining functional capabilities, such as long, short and instantaneous, is a coordination activity. The effects of one set of settings on another set should be carefully evaluated to determine if the results for all possible circumstances are acceptable.

Example:

- Consider programming the protective functions of a 400 ampere Series $\overline{C}$ L-Frame circuit breaker with an installed 200 ampere rating plug value (I_n). OPTIM trips are set up with actual values of current instead of per unit settings.
- The Long Delay Setting (I_r) is to be 100 amperes and the Short Delay Pickup is to be 200 amperes.
- The Long Delay Setting (I_r) is programmable from 0.4 - 1.0 times the rating plug value (I_n) for the L-Frame. For this example, the Long Delay Setting (I_r) is programmed to 0.5 (I_n) = 0.5 (200) = 100 amperes, the required Long Delay Setting (I_r).
- The Short Delay Pickup is programmable from 1.5 - 8.0 times the Long Delay Setting (I_r) for the L-Frame. For this example, the Short Delay Pickup is programmed to 2.0 (I_r) = 2.0 (100) = 200 amperes, the required Short Delay Pickup.

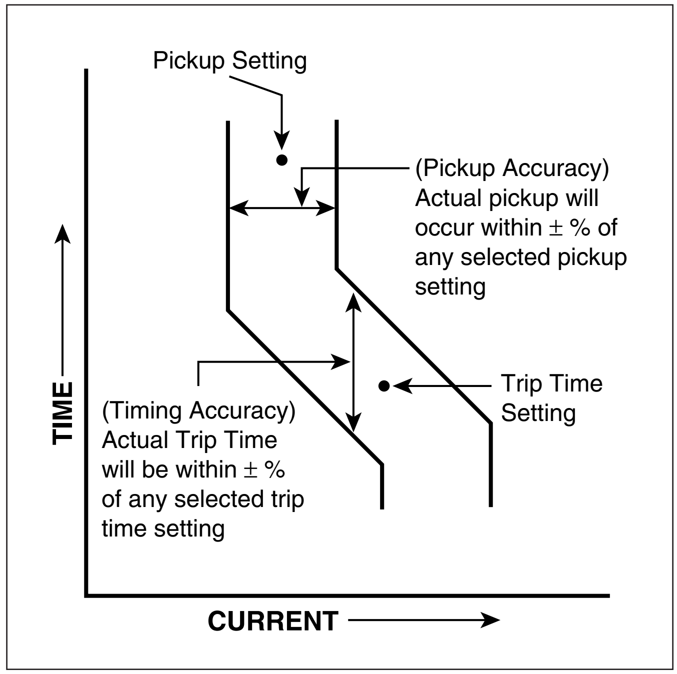


Figure 3-1 Sample of Partial Time-Current Trip Curve

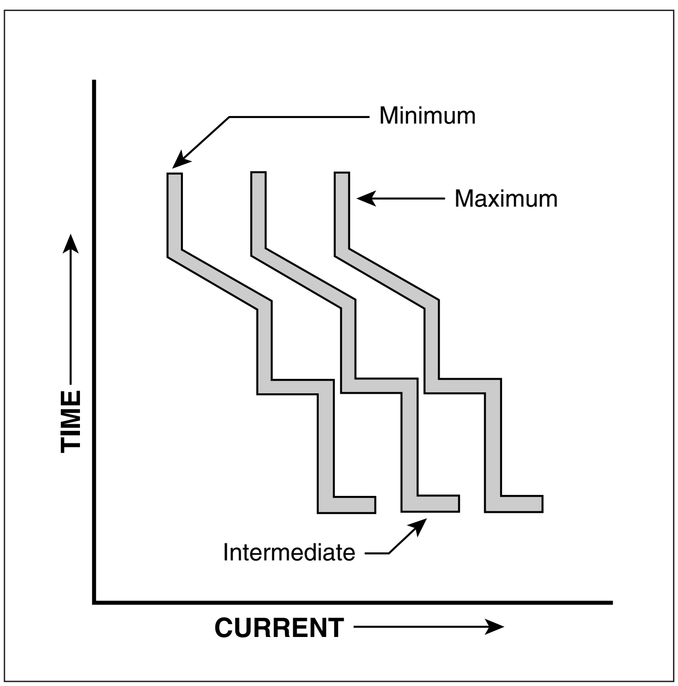


Figure 3-2 Typical Trip Curve Horizontal Movement

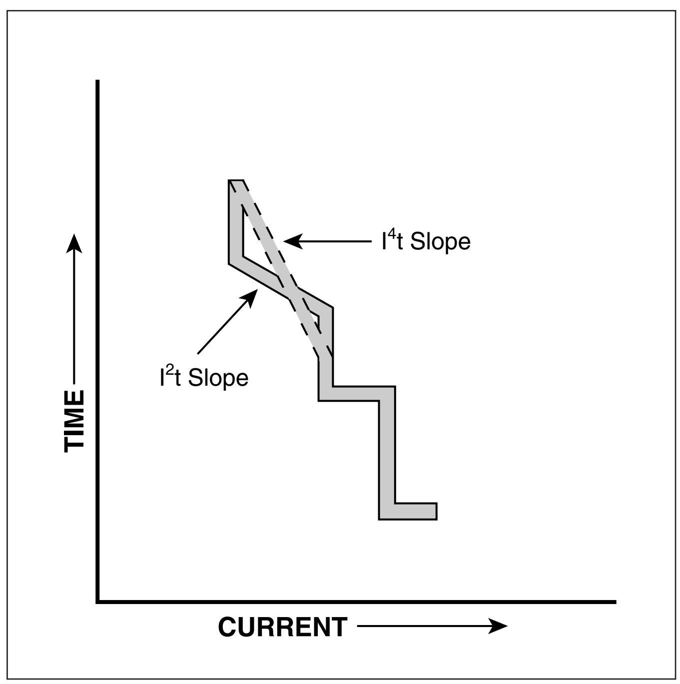


Figure 3-3 Typical Long Delay Time Slope Adjustment

Table 3.2 Digitrip OPTIM 550 Trip Unit System Capabilities Overview

TRIP UNIT TYPE	DIGITRIP OPTIM 550	
RMS Sensing	Yes	
Programmable	Yes	
CIRCUIT BREAKERS		
Types	Series C̄ K, L and N-Frames	Series C̄ R-Frames
Ampere Range	70 - 1200A	800 - 2500A
Interrupting Rating @ 480V	30 thru 100KA	65 thru 100KA
TRIP UNIT ORDERING OPTIONS		
LSI ① ②	Yes	Yes
LSIG ① ②	Yes	Yes
LSIA (Remote over IMPACC only)	Yes	Yes
PROTECTION AND COORDINATION		
Interchangeable Rating Plug (I_n)	70-1200A	800-2500A
Over-Temperature Trip	Yes	Yes
LONG DELAY PROTECTION		
Long Delay Setting (I_r) ③	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)
Long Delay Pickup	116% of I_r	116% of I_r
Long Delay Time I^2t @ 6 x I_r ④	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)
Long Delay Time I^4t @ 6 x I_r (SDT Slope Flat only) ⑤	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)
Long Delay Thermal Memory (Powered or Unpowered)	Yes (programmable)	Yes (programmable)
High Load Alarm	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r
SHORT DELAY PROTECTION		
Short Delay Pickup ③	1.5 - 8.0 x I_r (0.1 steps)	1.5 - 8.0 x I_r (0.1 steps)
Short Delay Time I^2t @ 8 x I_r ⑥	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Short Delay Time Flat ⑥	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Zone Selective Interlocking	No	No
INSTANTANEOUS PROTECTION		
Instantaneous Pickup ⑦	2.0 - 8.0 x I_n (0.1 steps)	2.0 - 10.0 x I_n (0.1 steps) (1600 & 2000A) 2.0 - 6.0 x I_n (0.1 steps) (2500A)
Discriminator	Yes	Yes
Override (Fixed Instantaneous) ⑧	Yes	Yes
GROUND FAULT PROTECTION		
Ground Fault Alarm (not to exceed 1200A) ⑨	0.2 - 1.0 x I_s (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)
Ground Fault Pickup (not to exceed 1200A) ⑦	0.2 - 1.0 x I_s (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)
Ground Fault Delay I^2t @ 0.62 x I_n/I_s ⑩	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Ground Fault Delay Flat	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Zone Selective Interlocking	No	No
Ground Fault Memory	Yes	Yes
SYSTEM MONITORING		
Digital Display	Yes (Using OPT)	Yes (Using OPT)
Current	Yes	Yes
Cause of Trip LEDs	Yes	Yes
Magnitude of Trip Information	Yes	Yes
Remote Signal Contacts	No	No
Power and Energy	No	No
Power Quality - Harmonics	No	No
Power Factor	No	No
COMMUNICATIONS		
IMPACC	Field Upgradeable	Field Upgradeable
TESTING		
Testing Method	OPT, BIM, IMPACC	OPT, BIM, IMPACC

Notes:

I_n = Rating Plug
I_r = Long Delay Setting
I_s = Sensor Rating
OPT = Hand Held Programmer (OPTIMizer)
BIM = Breaker Interface Module

① No ground fault alarm (A) provided
② Refer to para. 3-2.3 and Figure 3-4 for details
③ Setting Tolerance ±5%
④ Setting Tolerance +0-30%
⑤ Setting Tolerance +10-40%
⑥ Setting Tolerance (See time-current curves)
⑦ Setting Tolerance ±10%
⑧ Setting Tolerance ±20%
⑨ Only available with LSIA
⑩ I_s (K, L & N-Frame), I_n (R-Frame, SPB)
⑪ Contact factory or Vista for K-Frame availability

Table 3.3 Digitrip OPTIM 750 Trip Unit System Capabilities Overview

TRIP UNIT TYPE	DIGITRIP OPTIM 750			
RMS Sensing	Yes			
Programmable	Yes			
CIRCUIT BREAKERS				
Types	Series C̄ K, L and N-Frames ⑪	Series C̄ R-Frames	SPB Pow-R	DSII/DSLII Power
Ampere Range	70 - 1200A	800 - 2500A	200 - 5000A	100 - 5000A
Interrupting Rating @ 480V	30 thru 100KA	65 thru 100KA	50 thru 150KA	30 thru 200KA
TRIP UNIT ORDERING OPTIONS				
LSI ① ②	No	Yes	Yes	Yes
LSIG ① ②	Yes	Yes	Yes	Yes
LSIA ②	Yes	Yes	Yes	Yes
PROTECTION AND COORDINATION				
Interchangeable Rating Plug (I_n)	70-1200A	800-2500A	200-5000A	100-5000A
Over-Temperature Trip	Yes	Yes	Yes	Yes
LONG DELAY PROTECTION				
Long Delay Setting (I_r) ③	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)
Long Delay Pickup	116% of I_r	116% of I_r	116% of I_r	105% or I_r
Long Delay Time I^2t @ 6 x I_r ④	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)
Long Delay Time I^4t @ 6 x I_r (SDT Slope Flat only) ⑤	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)
Long Delay Thermal Memory (Powered or Unpowered)	Yes (programmable)	Yes (programmable)	Yes (programmable)	Yes (programmable)
High Load Alarm	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r
SHORT DELAY PROTECTION				
Short Delay Pickup ③	1.5 - 8.0 x I_r (0.1 steps)	1.5 - 8.0 x I_r (0.1 steps)	1.5 - 8.0 x I_r (0.1 steps) (400 - 3000A) 1.5 - 6.0 x I_r (0.1 steps) (4000 - 5000A)	1.5 - 10.0 x I_r (0.1 steps)
Short Delay Time I^2t @ 8 x I_r ⑥	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Short Delay Time Flat ⑥	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Zone Selective Interlocking	Yes	Yes	Yes	Yes
INSTANTANEOUS PROTECTION				
Instantaneous Pickup ⑦	2.0 - 8.0 x I_n (0.1 steps)	2.0 - 10.0 x I_n (0.1 steps) (1600 & 2000A) 2.0 - 6.0 x I_n (0.1 steps) (2500A)	2.0 - 10.0 x I_n (0.1 steps) (400 - 3000A) 2.0 - 6.0 x I_n (0.1 steps) (4000 & 5000A)	2.0 - 10.0 x I_n (0.1 steps)
Discriminator	Yes	Yes	Yes	Yes
Override (Fixed Instantaneous) ⑧	Yes	Yes	Yes	Yes
GROUND FAULT PROTECTION				
Ground Fault Alarm (not to exceed 1200A) ⑨	0.2 - 1.0 x I_s (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)
Ground Fault Pickup (not to exceed 1200A) ⑦	0.2 - 1.0 x I_s (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)
Ground Fault Delay I^2t @ 0.62 x I_n/I_s ⑩	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Ground Fault Delay Flat	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Zone Selective Interlocking	Yes	Yes	Yes	Yes
Ground Fault Memory	Yes	Yes	Yes	Yes
SYSTEM MONITORING				
Digital Display	Yes (Using OPT or BIM)	Yes (Using OPT or BIM)	Yes (Using OPT or BIM)	Yes (Using OPT or BIM)
Current	Yes	Yes	Yes	Yes
Cause of Trip LEDs	Yes	Yes	Yes	Yes
Magnitude of Trip Information	Yes	Yes	Yes	Yes
Remote Signal Contacts	Yes	Yes	Yes	Yes
Power and Energy	No	No	No	No
Power Quality - Harmonics	No	No	No	No
Power Factor	No	No	No	No
COMMUNICATIONS				
IMPACC	Yes	Yes	Yes	Yes
TESTING				
Testing Method	OPT, BIM, IMPACC	OPT, BIM, IMPACC	OPT, BIM, IMPACC	OPT, BIM, IMPACC + Secondary Injection

Notes:
I_n = Rating Plug
I_r = Long Delay Setting
I_s = Sensor Rating
OPT = Hand Held Programmer (OPTIMizer)
BIM = Breaker Interface Module

① No ground fault alarm (A) provided
② Refer to para. 3-2.3 and Figure 3-4 for details
③ Setting Tolerance ±5%
④ Setting Tolerance +0-30%
⑤ Setting Tolerance +10-40%
⑥ Setting Tolerance (See time-current curves)
⑦ Setting Tolerance ±10%
⑧ Setting Tolerance ±20%
⑨ Only available with LSIA
⑩ I_s (L & N-Frame), I_n (R-Frame, SPB, DSII/DSLII)
⑪ Contact factory or Vista for K-Frame availability

Table 3.4 Digitrip OPTIM 1050 Trip Unit System Capabilities Overview

TRIP UNIT TYPE	**DIGITRIP OPTIM 1050**			
RMS Sensing	Yes			
Programmable	Yes			
CIRCUIT BREAKERS				
Types	Series C̄ K, L and N-Frames ⑪	Series C̄ R-Frames	SPB Pow-R	DSII/DSLII Power
Ampere Range	70 - 1200A	800 - 2500A	200 - 5000A	100 - 5000A
Interrupting Rating @ 480V	30 thru 100KA	65 thru 100KA	50 thru 150KA	30 thru 200KA
TRIP UNIT ORDERING OPTIONS				
LSI ① ②	No	Yes	Yes	Yes
LSIG ① ②	Yes	Yes	Yes	Yes
LSIA ②	Yes	Yes	Yes	Yes
PROTECTION AND COORDINATION				
Interchangeable Rating Plug (I_n)	70-1200A	800-2500A	200-5000A	100-5000A
Over-Temperature Trip	Yes	Yes	Yes	Yes
LONG DELAY PROTECTION				
Long Delay Setting (I_r) ③	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)	0.4 - 1.0 x I_n (0.01 steps)
Long Delay Pickup	116% of I_r	116% of I_r	116% of I_r	105% or I_r
Long Delay Time I^2t @ 6 x I_r ④	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)	2-24 secs (0.10 steps)
Long Delay Time I^4t @ 6 x I_r (SDT Slope Flat only) ⑤	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)	1-5 secs (0.10 steps)
Long Delay Thermal Memory (Powered or Unpowered)	Yes (programmable)	Yes (programmable)	Yes (programmable)	Yes (programmable)
High Load Alarm	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r	0.5 - 1.0 x I_r
SHORT DELAY PROTECTION				
Short Delay Pickup ③	1.5 - 8.0 x I_r (0.1 steps)	1.5 - 8.0 x I_r (0.1 steps)	1.5 - 8.0 x I_r (0.1 steps) (400 - 3000A) 1.5 - 6.0 x I_r (0.1 steps) (4000 - 5000A)	1.5 - 10.0 x I_r (0.1 steps)
Short Delay Time I^2t @ 8 x I_r ⑥	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Short Delay Time Flat ⑥	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Zone Selective Interlocking	Yes	Yes	Yes	Yes
INSTANTANEOUS PROTECTION				
Instantaneous Pickup ⑦	2.0 - 8.0 x I_n (0.1 steps)	2.0 - 10.0 x I_n (0.1 steps) (1600 & 2000A) 2.0 - 6.0 x I_n (0.1 steps) (2500A)	2.0 - 10.0 x I_n (0.1 steps) (400 - 3000A) 2.0 - 6.0 x I_n (0.1 steps) (4000 & 5000A)	2.0 - 10.0 x I_n (0.1 steps)
Discriminator	Yes	Yes	Yes	Yes
Override (Fixed Instantaneous) ⑧	Yes	Yes	Yes	Yes
GROUND FAULT PROTECTION				
Ground Fault Alarm (not to exceed 1200A) ⑨	0.2 - 1.0 x I_s (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)
Ground Fault Pickup (not to exceed 1200A) ⑦	0.2 - 1.0 x I_s (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)	0.24 - 1.0 x I_n (0.01 steps)
Ground Fault Delay I^2t @ 0.62 x I_n/I_s ⑩	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Ground Fault Delay Flat	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)	0.1 - 0.5 secs (0.01 steps)
Zone Selective Interlocking	Yes	Yes	Yes	Yes
Ground Fault Memory	Yes	Yes	Yes	Yes
SYSTEM MONITORING				
Digital Display	Yes (Using OPT or BIM)	Yes (Using OPT or BIM)	Yes (Using OPT or BIM)	Yes (Using OPT or BIM)
Current	Yes	Yes	Yes	Yes
Cause of Trip LEDs	Yes	Yes	Yes	Yes
Magnitude of Trip Information	Yes	Yes	Yes	Yes
Remote Signal Contacts	Yes	Yes	Yes	Yes
Power and Energy	Yes	Yes	Yes	Yes
Power Quality - Harmonics	Yes	Yes	Yes	Yes
Power Factor	Yes	Yes	Yes	Yes
COMMUNICATIONS				
IMPACC	Yes	Yes	Yes	Yes
TESTING				
Testing Method	OPT, BIM, IMPACC	OPT, BIM, IMPACC	OPT, BIM, IMPACC	OPT, BIM, IMPACC + Secondary Injection

Notes:

I_n = Rating Plug
I_r = Long Delay Setting
I_s = Sensor Rating
OPT = Hand Held Programmer (OPTIMizer)
BIM = Breaker Interface Module

① No ground fault alarm (A) provided
② Refer to para. 3-2.3 and Figure 3-4 for details
③ Setting Tolerance ±5%
④ Setting Tolerance +0-30%
⑤ Setting Tolerance +10-40%
⑥ Setting Tolerance (See time-current curves)
⑦ Setting Tolerance ±10%
⑧ Setting Tolerance ±20%
⑨ Only available with LSIA
⑩ I_s (L & N-Frame), I_n (R-Frame, SPB, DSII/DSLII)
⑪ Contact factory or Vista for K-Frame availability

- If it is later determined that the Long Delay Setting (I_r) is to be 140 amperes in lieu of the original 100 amperes. The Long Delay Setting (I_r) can be re-programmed to 0.7 (I_n) = 0.7 (200) = 140 amperes, the new required Long Delay Setting (I_r).

- The re-programming change to the Long Delay Setting (I_r) alters the Short Delay Pickup originally programmed, since the Short Delay Pickup is a function of the Long Delay Setting (I_r). The new Short Delay Pickup = 2.0 (I_r) = 2.0 (140) = 280 amperes. This new Short Delay Pickup may or may not be acceptable. If it isn't, it will also have to be re-programmed.

3-2.3 PROTECTION AND CURVE SHAPING FEATURES

There are three different OPTIM Trip Unit configurations:

- LSI (Except on Model 750 and 1050 K, L and N-Frame breakers)
- LSIA
- LSIG

LSI Configuration

The LSI configuration provides a required long delay protection and a user selectable short delay protection and/or instantaneous protection. Modals 750 and 1050 achieve LSI by turning off the "A" feature on the LSIA unit.

LSIA Configuration

The LSIA configuration provides the same protective functions described for the LSI configuration plus it senses ground fault conditions and provides for a local or remote alarm of the condition. It does not trip the circuit breaker due to a ground fault condition. The alarm feature can be turned OFF if desired.

LSIG Configuration

The LSIG configuration provides the same protective functions described for the LSI configuration plus ground fault protection. It senses ground fault conditions and trips the circuit breaker. If a local ground alarm contact is present, it actuates also.

For any of the three configurations described, the short circuit functions (short delay and instantaneous) are user selectable using the OPTIMizer, Breaker Interface Module or Series III Software as follows:

- Both short delay and instantaneous enabled
- Only short delay enabled
- Only instantaneous enabled

Notice: *Short delay and instantaneous cannot be disabled at the same time.*

The three trip unit configurations are available by circuit breaker type as follows (Tables **3.2** and **3.3**):

- Series $\overline{C}$ L and N-Frame (LSIA and LSIG)
- Series $\overline{C}$ K-Frame, R-Frame, SPB Pow-R and DSII/DSLII (LSI, LSIA and LSIG)

All Digitrip OPTIM Trip Units are available in six overcurrent protective function combinations of long, short, instantaneous and ground (Figure **3-4**). When the protection functions are combined with slope adjustments I^4t, I^2t or Flat, the Digitrip OPTIM Trip Unit provides the following ten programmable curve shaping possibilities:

- Overload
  - Long Delay Setting
  - Long Delay Time, I^2t Response
  - Long Delay Time, I^4t Response

- Short Circuit
  - Short Delay Pickup
  - Short Delay Time, Flat Response
  - Short Delay Time, I^2t Response
  - Instantaneous

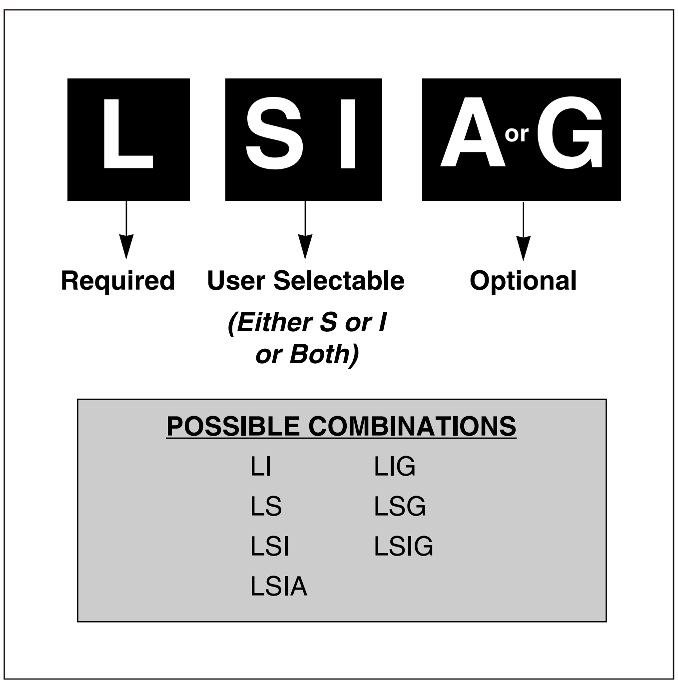
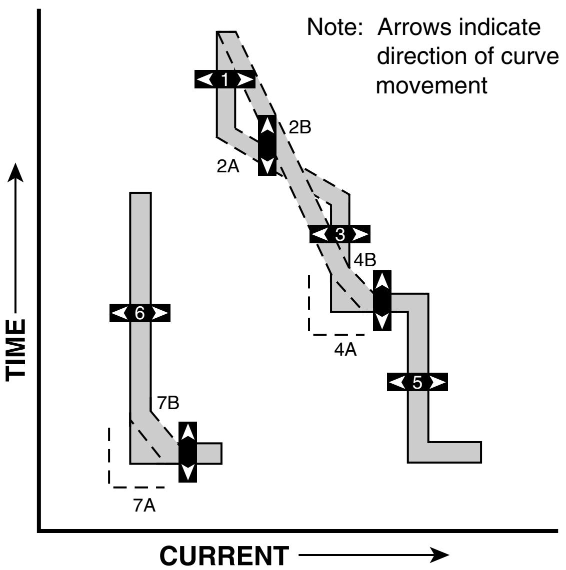


Figure 3-4 Overcurrent Protective Function Combinations



OVERLOAD AND SHORT CIRCUIT
1. Long Delay Setting
2A. Long Delay Time I^2t
2B. Long Delay Time I^4t
SHORT CIRCUIT
3. Short Delay Pickup
4A. Short Delay Time Flat Response
4B. Short Delay Time I^2t Response
5. Instantaneous
GROUND FAULT
6. Ground Fault Pickup
7A. Ground Fault Delay Flat Response
7B. Ground Fault Delay I^2t Response

Figure 3-5 Typical OPTIM Trip Unit Time-Current Curve (10 Curve Shaping Adjustments)

- Ground Fault
  - Ground Fault Pickup
  - Ground Fault Delay, Flat Response
  - Ground Fault Delay, I^2t Response

The ten curve shaping possibilities are illustrated in Figure **3-5**. Each portion of the curve is discussed and illustrated individually in the following paragraphs (3-2.4, 3-2.5, 3-2.6 and 3-2.7).

Notice: *For the sake of simplification, many curve illustrations in this section will be represented as single line curves. Keep in mind, however, that a time-current curve in reality is represented by a band of minimum and maximum values, not a single line (Figures **3-1** and **3-5**).*

3-2.4 LONG DELAY PROTECTION

All Digitrip OPTIM Trip Units provide programmable long delay protection consisting of (Tables **3.2** and **3.3** and Figure **3-4**):

- Long delay current setting
- Long delay time setting
- Long delay thermal memory
- High load alarm (in software with IMPACC, and discreet contact on R, SPB and DSII breakers)

Long Delay Current Setting (I_r)

The long delay current setting (I_r) is established as a multiple of the rating plug value (I_n). The programmable range is as follows:

- **0.4 to 1.0 times (I_n) in 0.01 increments**

Example: A 600 ampere Series C̄ L-Frame circuit breaker with a 400 ampere rating plug installed and the long delay current setting programmed to 160 amperes results in a 40% setting.

The long delay current setting (I_r) for OPTIM Trip Units is the nominal continuous current rating of the breaker. The breaker will carry this maximum amount of current (I_r) continuously without tripping. **It is not the actual long delay pickup point.** The breaker will pickup and ultimately trip at a current level that is nominally higher than the Long Delay Current Setting (I_r):

- For DSII/DSLII, Long Delay Pickup is calibrated for nominally **105% (Ir)**
- For K, L, N and R-Frames and SPB, the calibration is for nominally **116% (I_r)**

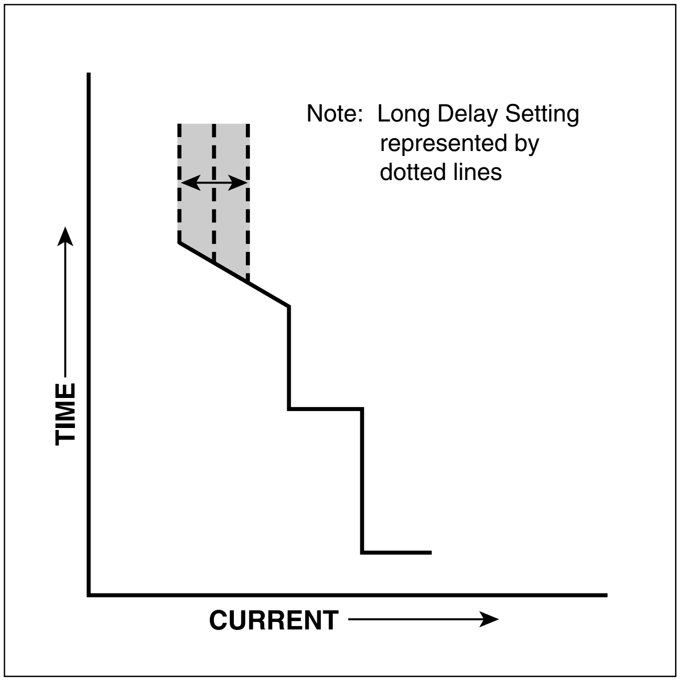


Figure 3-6 Typical Long Delay Setting Adjustment

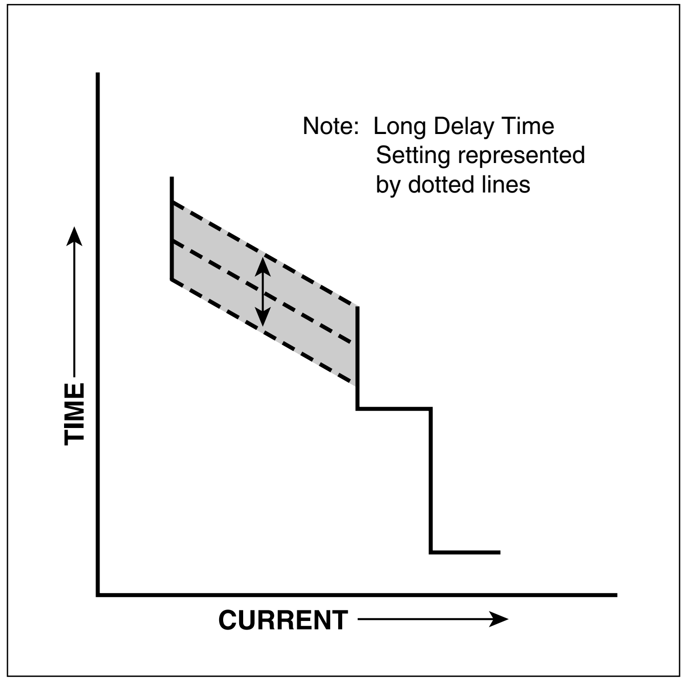


Figure 3-7 Typical Long Delay Time Adjustment (I^2t) Response

Long delay pickup, which is determined from the time-current curves, establishes the current level at which the trip unit's long time tripping function begins timing. If after a programmed amount of time the current condition still exists, the trip unit's tripping system is enabled.

Alarm indicators are provided as follows:

- K, L and N-Frame Breakers
  - BIM Contacts
  - LED (Long Delay Pickup) flashes on breaker trip unit
  - Ground Alarm Contact (optional accessory for 750 and 1050 units)
- R-Frame, SPB and DSII/DSLII Breakers
  - BIM Contacts
  - LED (Long Delay Pickup) flashes on breaker trip unit
  - Discrete Contacts

Figure **3-6** graphically illustrates how the long delay setting portion of the overall curve can be moved horizontally and independently by means of the programmable settings.

Long Delay Time Setting (I^2t or I^4t Slopes)

The long delay time setting is established at **6** times the long delay current setting **(6 x I_r)**. This is the reference point where the programmed long delay time setting is fixed on the time-current curve.

The long delay time setting is programmable to an I^2t or an I^4t slope over a wide range of times for all OPTIM Trip Units as follows:

- **I^2t Slope - 2 to 24 seconds in increments of 0.10 secs.**
- **I^4t Slope - 1 to 5 seconds in increments of 0.10 secs.**

Notice: *(1) When an I^4t slope is programmed for the long delay time setting, the short delay time setting must be set to a FLAT slope.*

(2) When an I^2t slope is programmed for the long delay time setting, the short delay time setting may be set to FLAT or I^2t.

The long delay time setting is used to establish the amount of time a sustained overload condition will be carried before the circuit breaker trips. Figures **3-7** and **3-8** graphically illustrate how the long delay time portion of the overall curve can be moved vertically and independently by means of the programmable settings.

Long Delay Thermal Memory

All Digitrip OPTIM Trip Units are provided with a selectable (powered or unpowered) thermal memory to protect against cumulative overheating should a number of overload conditions occur in quick succession.

Notice: *Keep in mind during testing that a faster trip time may be observed due to the cumulative Thermal Memory Effect (powered or unpowered).*

Both the powered and unpowered Thermal Memory may be enabled or disabled via the OPTIMizer, BIM or IMPACC computer.

High Load Alarm

A high load phase and neutral alarm is provided on all OPTIM Trip Units to signal a high load condition. The programmable range is as follows:

- **0.5 to 1.0 times (I_r)**

High Load Alarm indicators are provided as follows:

- IMPACC on all OPTIM units with communications
- L and N-Frame Breakers
  - BIM Contacts
- R-Frame, SPB and DSII/DSLII Breakers
  - BIM Contacts
  - Automatic Trip Relay Contact

3-2.5 SHORT DELAY PROTECTION

Short delay protection is selectable with all Digitrip OPTIM Trip Units. It can be selected in combination with instantaneous protection or without instantaneous protection. Either both, one or the other (short or instantaneous) must always be provided (Tables **3.2** and **3.3** and Figure **3-4**). Short delay protection can consist of the following:

- Short delay pickup setting
- Short delay time setting (I^2t Slope)
- Short delay time setting (Flat Slope)
- Zone Selective Interlocking (Model 750 and 1050 only)

Short Delay Pickup Setting

The short delay pickup setting establishes the current level at which the trip unit's short time tripping function begins timing. It is programmable as a multiple of the long delay current setting (I_r). The programmable range depends on the circuit breaker type as follows:

- Series $\overline{C}$ K, L, N and R-Frames
  - **1.5 to 8.0 times (I_r) in 0.1 increments**
- SPB Systems Pow-R
  - **1.5 to 8.0 times (I_r) in 0.1 increments** (400-3000 ampere frames)
  - **1.5 to 6.0 times (I_r) in 0.1 increments** (4000/5000 ampere frames)

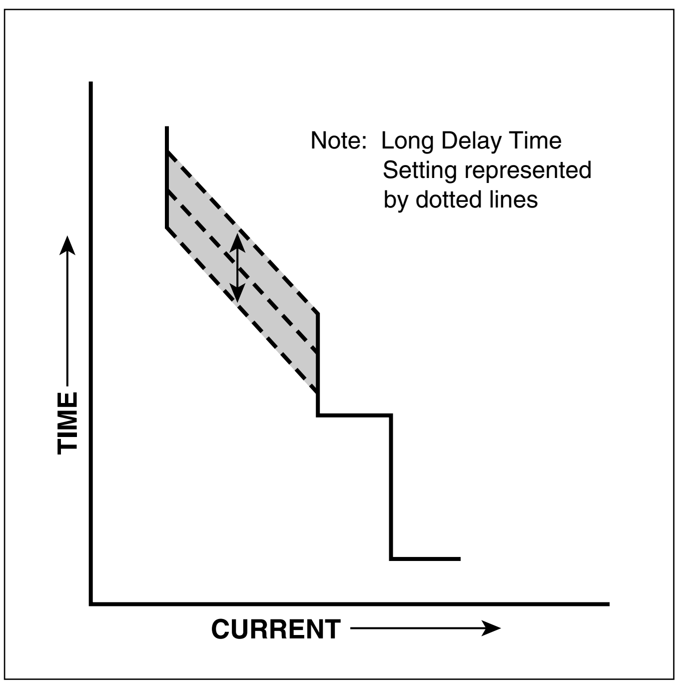


Figure 3-8 Typical Long Delay Time Adjustment (I^4t) Response

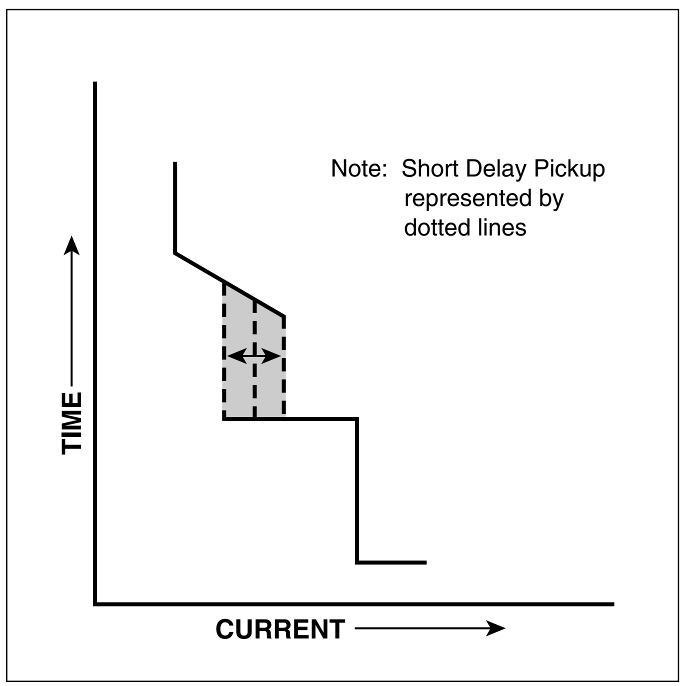


Figure 3-9 Typical Short Delay Pickup Adjustment

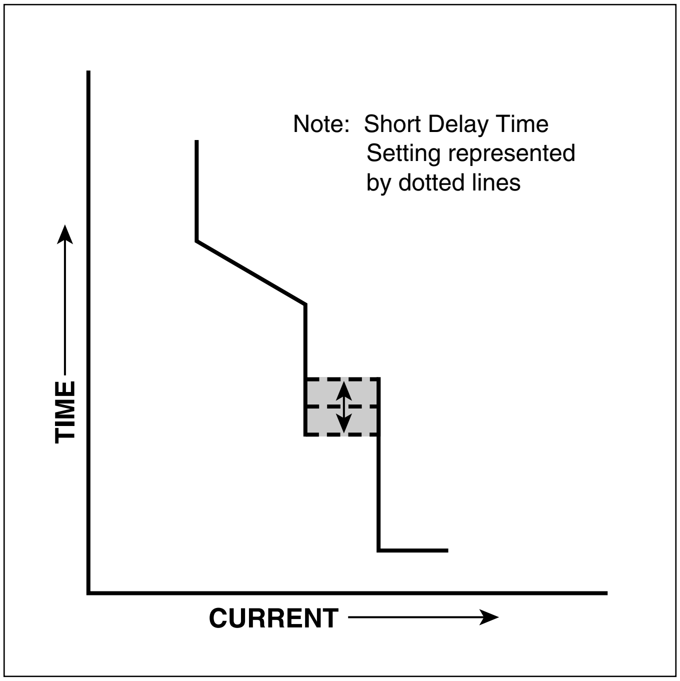


Figure 3-10 Typical Short Delay Time Adjustment, Flat Response

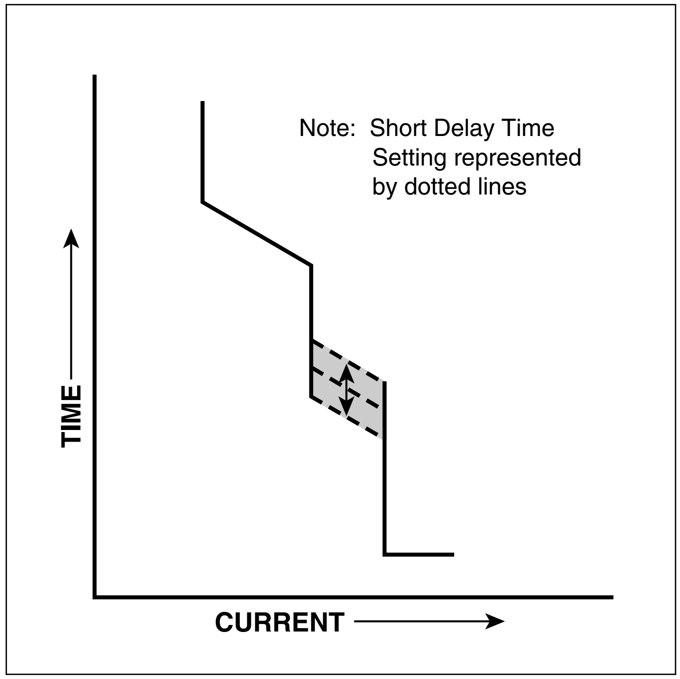


Figure 3-11 Typical Short Delay Time Adjustment, (I^2t) Response

- DSII/DSLII
  - **1.5 to 10.0 times (I_r) in 0.1 increments**

Figure **3-9** graphically illustrates how the short delay pickup portion of the overall curve can be moved horizontally and independently by means of the programmable settings.

Short Delay Time Setting (I^2t or Flat Slopes)

The short delay time setting is programmable from **0.1 to 0.5 seconds in 0.01 increments** for all OPTIM Trip Units. The short delay time setting is programmable to an **I^2t** or a **Flat slope**. The 0.1 to 0.5 second setting is the nominal trip time at **8.0 times I_r** for I^2t slope.

Notice: *(1) When an I^4t slope is programmed for the long delay time setting, the short delay time setting must be set to a FLAT slope.*

(2) When an I^2t slope is programmed for the long delay time setting, the short delay time setting may be set to FLAT or I^2t.

The short delay time setting establishes the amount of time a short-circuit will be carried before the circuit breaker trips. Figures **3-10** and **3-11** graphically illustrate how the short delay time portion of the overall curve can be moved vertically and independently by means of programmable settings.

Zone Selective Interlocking (OPTIM Models 750 and 1050)

Zone selective interlocking is provided for the short delay and the ground fault delay tripping functions for improved system protection. The Digitrip OPTIM Trip Unit zone selective interlocking feature is compatible with Digitrip Trip Units, Model 510 and higher.

The zone selective interlocking feature is a means of communications over a pair of wires between two or more compatible trip units. Zone selective interlocking makes it possible for programmed trip unit settings to be altered automatically to respond to different fault conditions and locations, thereby localizing the effects of an interruption and providing positive coordination between circuit breakers.

Figure **3-12** illustrates a typical ground fault protection scheme using zone selective interlocking. For faults outside the zone of protection, the trip unit on the circuit breaker nearest the fault sends an interlocking signal to the trip unit of the up-stream circuit breakers. This interlocking signal restrains immediate tripping of the upstream circuit breakers until their programmed coordi-

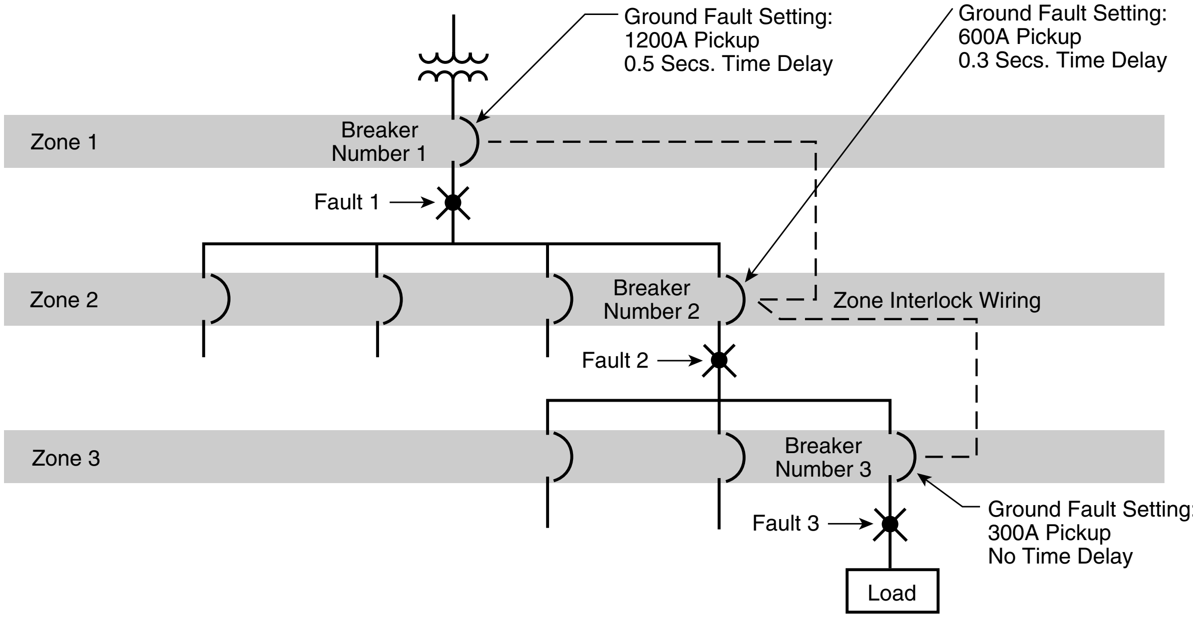


Figure 3-12 Multi-layer Ground Fault Protection Scheme Using Zone Selective Interlocking

nation times are reached. Thus zone selective interlocking applied correctly can reduce damage due to short circuit or ground fault conditions.

Refer to the wiring diagrams presented in Table **A.1** of Appendix A for specific connection schemes. For more detailed application information, contact Cutler-Hammer.

3-2.6 INSTANTANEOUS PROTECTION

Instantaneous protection is selectable with all Digitrip OPTIM Trip Units. It can be selected in combination with short delay protection or without short delay protection. One or the other (instantaneous or short) must always be selected (Tables **3.2** and **3.3** and Figure **3-4**). Instantaneous protection is provided via:

- Instantaneous Pickup

Two additional functions are available to trip the circuit breaker with no intentional delay under high short circuit conditions:

- Discriminator
- Instantaneous Override

Instantaneous Pickup

The instantaneous pickup setting establishes the current level at which the trip unit's instantaneous tripping function will trip the circuit breaker with no intentional time delay. It is programmable as a multiple of the plug rating value (I_n). The programmable range depends on the circuit breaker type as follows:

- Series $\bar{C}$ K, L and N-Frames
  - **2.0 to 8.0 times (I_n) in 0.1 increments**
- Series $\bar{C}$ R-Frame
  - **2.0 to 10.0 times (I_n) in 0.1 increments** (1600/2000 ampere frames)
  - **2.0 to 6.0 times (I_n) in 0.1 increments** (2500 ampere frame)
- SPB Systems Pow-R
  - **2.0 to 10.0 times (I_n) in 0.1 increments** (400-3000 ampere frames)
  - **2.0 to 6.0 times (I_n) in 0.1 increments** (4000/5000 ampere frames)
- DSII/DSLII
  - **2.0 to 12.0 times (I_n) in 0.1 increments**

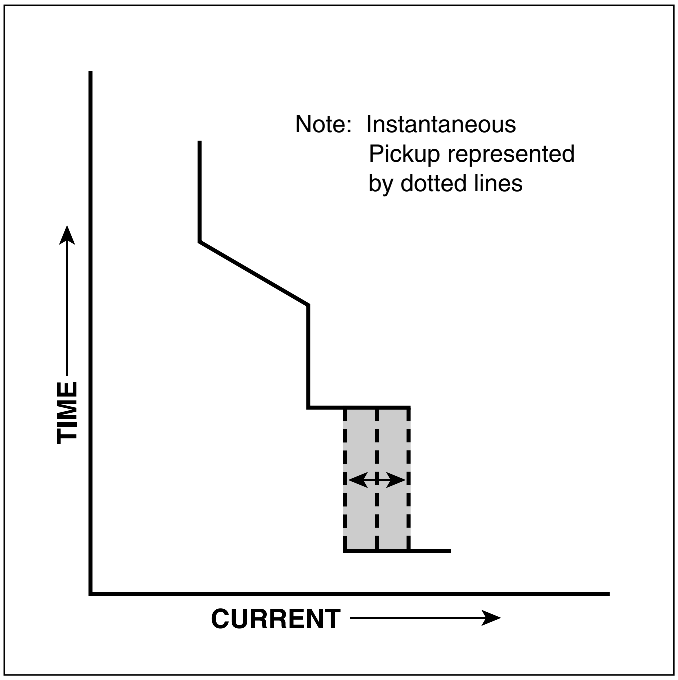


Figure 3-13 Typical Instantaneous Pickup Adjustment

Figure **3-13** graphically illustrates how the instantaneous pickup portion of the overall curve can be moved horizontally and independently by means of the programmable settings.

Discriminator

A selectable discriminator circuit is provided on all OPTIM Trip Units. This prevents the circuit breaker from remaining closed for the entire duration of the programmed short delay time, if the breaker is closed on a high short circuit fault with the instantaneous protective function disabled.

The discriminator circuit (high initial current release) is preset at **11** times the rating plug value **(11 x I_n)**. It is active for approximately ten cycles following the initial current flow through the circuit breaker, and is reset whenever the load current falls below 10% of the circuit breaker frame or current sensor rating.

In the event the circuit breaker is not intended to trip out on a circuit whose current could initially be higher than 11 x I_n, it is possible to make the discriminator inactive. If a circuit breaker would close onto a high short-circuit current in this situation, type LS or LSG trip units would rely on the short delay protection function. If the fault current exceeds the short-time withstand current capability of the circuit breaker, override protection circuitry would trip the circuit breaker without delay.

Override (Fixed Instantaneous)

An override (fixed instantaneous) circuit is included in all circuit breakers except DSII and DSLII circuit breakers. It protects against a short-circuit current that exceeds the short-time withstand current capability of the circuit breaker. The override circuit is set to a value no greater than the short time withstand current rating of the circuit breaker in which the override circuitry is installed. Since the specific values vary by circuit breaker type and rating, refer to the applicable time-current curves for the value associated with a particular circuit breaker.

3-2.7 GROUND FAULT PROTECTION

Ground fault protection is optional with all OPTIM Trip Units. It can be provided in a number of combinations with long, short and instantaneous. When ground fault trip protection is not provided, a ground fault alarm may be specified, (Tables **3.2** and **3.3** and Figure **3-4**). The available trip unit options by circuit breaker type are as follows:

- Series $\overline{C}$ K, L and N-Frame and SPB and DSII Circuit Breakers
  - **LSIG** (with ground fault trip)
  - **LSIA** (with ground fault alarm where "A" may be disabled)
- Model 550 Series $\overline{C}$ K, L, and N-Frame or all SPB and DSII Circuit Breakers
  - **LSI** (without ground fault trip or alarm)

Ground fault protection and other related features are as follows:

- Ground fault alarm
- Ground fault pickup
- Ground fault delay (I^2t Slope)
- Ground fault delay (Flat Slope)
- Zone selective interlocking (Models 750 and 1050 only)
- Ground fault memory

When an OPTIM trip assembly includes ground fault protection, the distribution system characteristics, such as system grounding, number of sources, number and location of ground points, must be considered. The manner and location in which the circuit breaker is connected to the system should also be considered.

OPTIM units with ground fault protection already have all the necessary equipment for a 3-phase 3-wire grounded system. This basic mode for 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, no ground fault exists.

If the system is 4-wire and a neutral conductor exists, it is necessary to use an additional sensor for the purpose of properly accounting for this neutral current in the ground fault scheme. This sensor is mounted separately on the neutral conductor at the point where the neutral conductor connects to the neutral bus. This sensor is usually the same as the phase sensors internal to the circuit breaker. The sensor does not have to be ordered separately since it is included when an LSIA or LSIG version is ordered.

On R-Frame, SPB and DSII circuit breakers, zero sequence ground current measurement is alternatively available.

Ground Fault Alarm

A programmable ground fault alarm alerts a user of a ground fault condition without tripping the circuit breaker. In addition to being programmable, the ground fault alarm can be enabled or disabled. A red Ground Fault Alarm LED on the front of the trip unit will indicate the presence of a ground fault condition that exceeds the programmed setting (Figure **3-14**).

Figure 3-14 Ground Fault Alarm LED

The ground fault alarm contact is energized when the ground current exceeds the ground fault pickup setting continuously for a time in excess of the ground fault delay setting. Refer to Tables **3.2** and **3.3** for programmable values.

Ground Fault Pickup

The ground fault pickup establishes the current level at which the trip unit's ground fault function begins timing. The pickup settings are the same for both ground fault trip (LSIG) units and ground fault alarm (LSIA) units. These settings are programmable over a range of factors by circuit breaker type as follows:

- Series $\overline{C}$ K, L and N-Frame Circuit Breakers
  - **0.2 to 1.0 times sensor rating (I_s) in 0.01 increments** (not to exceed 1200A)
- Series $\overline{C}$ R-Frame Circuit Breakers
  - **0.24 to 1.0 times rating plug (I_n) in 0.01 increments** (not to exceed 1200A)
- SPB Pow-R and DSII/DSLII Circuit Breakers
  - **0.24 to 1.0 times rating plug (I_n) in 0.01 increments** (not to exceed 1200A)

Figure **3-15** graphically illustrates how the ground fault pickup portion of the overall curve can be moved horizontally by means of the programmed settings.

Ground Fault Time Delay (I^2t or Flat Slopes)

The ground fault time delay setting is programmable with an I^2t or a Flat slope for all ground fault type OPTIM Trip Units as follows:

- **0.1 to 0.5 seconds in 0.01 increments at 0.62 times rating plug (I_n)**
  (for I^2t slope)
- **0.1 to 0.5 seconds in 0.01 increments**
  (for Flat slope)

Figures **3-16** and **3-17** graphically illustrate how the ground fault delay portion of the overall curve can be moved vertically by means of the programmed settings.

Zone Selective Interlocking (Models 750 and 1050)

Zone selective interlocking is provided for the short delay time and the ground fault delay tripping functions for improved system coordination. Refer to paragraph 3-2.5 under "Zone Selective Interlocking" and Figure **3-12** for additional details.

Ground Fault Memory

Ground faults may be sporadic in nature. As such, damaging ground faults can occur and then subside in less time than the programmed time for tripping the circuit breaker. Should this type of cyclical ground fault condition persist, the cumulative effect could result in equipment damage.

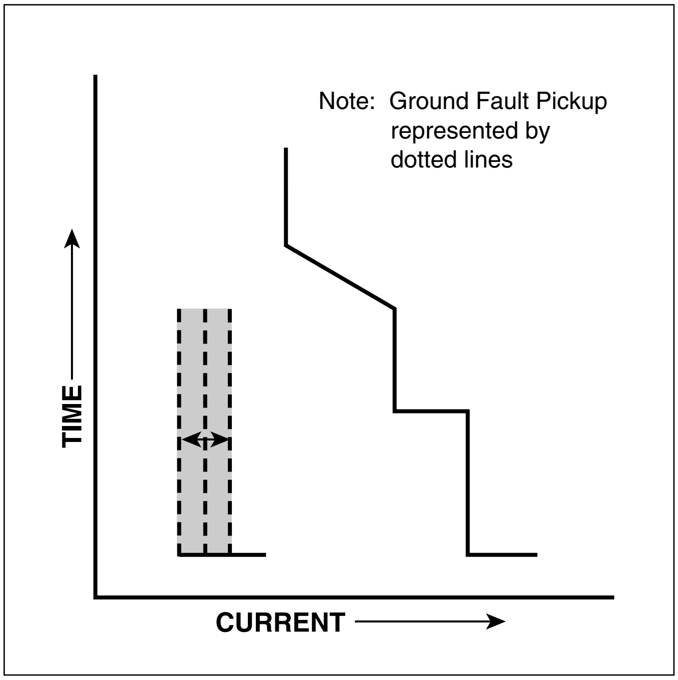


Figure 3-15 Typical Ground Fault Pickup Adjustment

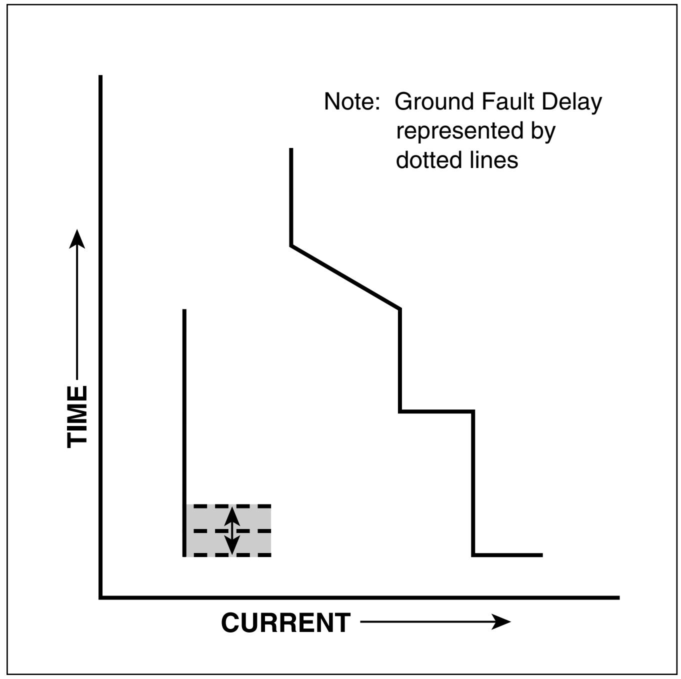


Figure 3-16 Typical Ground Fault Time Delay Adjustment, Flat Response

To protect against the the cyclical ground fault condition just described, all OPTIM Trip Units with ground fault protection are provided with a ground fault memory function. The time above pickup is retained in memory and decays slowly. If another ground fault, high enough to cause pickup, occurs before the time in memory totally decays, the new time adds to the memorized time. It is this cumulative time that determines whether the circuit breaker will or will not trip on these types of cyclical ground fault conditions.

3-2.8 TIME-CURRENT CURVES

The specific time-current curves applicable to all Digitrip OPTIM Trip Units are identified in Appendix A, Table **A.1**. Contact Cutler-Hammer for a specific curve.

3-3 SYSTEM MONITORING

Digitrip OPTIM Trip Units provide an electrical distribution system with superior programmable protection and coordination along with advanced warning capabilities, system diagnostics, monitoring and communications. A significant part of Digitrip OPTIM's effectiveness is a result of its system monitoring capabilities. A comprehensive list of

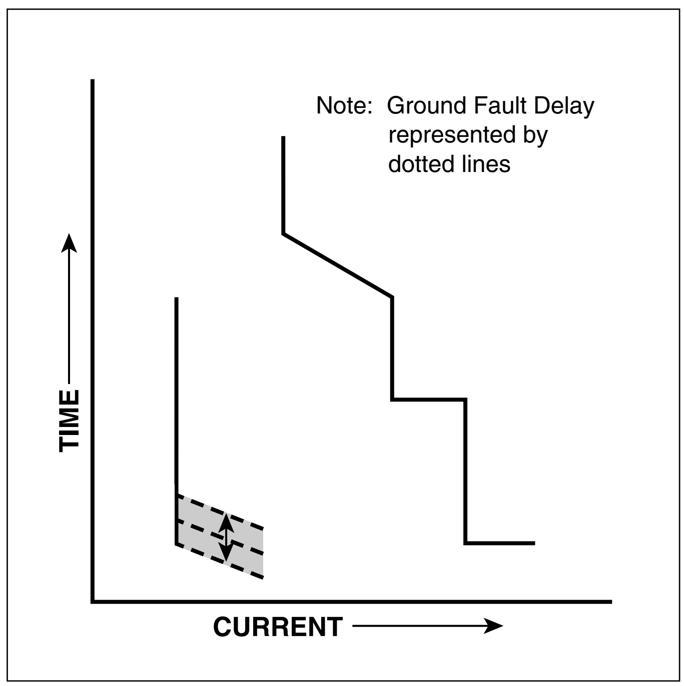


Figure 3-17 Typical Ground Fault Time Delay Adjustment, (I^2t) Response

metered parameters are monitored and then displayed over the OPTIM information system. Local LEDs are used to indicate a number of conditions and/or operations. The LEDs are complemented by **trip event information stored in non-volatile memory.** Information can be accessed via the OPTIMizer Hand Held Programmer, Breaker Interface Module, or over the IMPACC System.

System monitoring encompasses the following three broad categories:

- Load Current Monitoring
- Power and Energy Monitoring
- Power Quality Monitoring

Refer to Tables **3.2** and **3.3** for a general overview of the features included in system monitoring. The expected accuracies associated with displayed parameters are also summarized in Tables **3.2** and **3.3**.

3-3.1 DISPLAYS AND LED INDICATORS

All information in the trip unit may be accessed by using one or more of the following devices:

- OPTIMizer Hand Held Programmer (I.B. 29C892)
- Breaker Interface Module (I.B. 29C893)
- Remote Computer via IMPACC (I.B. 29C890)

For detailed information on the use of a specific device, refer to the instruction book (IB) reference indicated next to the particular display device.

The trip unit's information system utilizes front mounted LEDs to indicate a number of trip unit functions, such as mode of trip. Refer to paragraphs 2-4.1 (K, L and N-Frame type trip units) and 2-5.1 (R-Frame, SPB and DSII/DSLII type trip units) for detailed information on the LEDs provided.

3-3.2 NORMAL SERVICE/AUTOMATIC TRIP CURRENT MONITORING

Digitrip OPTIM Trip Units monitor a variety of currents for both normal service and automatic trip conditions. The value of currents are displayed in amperes by one of the devices outlined in paragraph 3-3.1.

Normal Service Condition

During normal service conditions with the circuit breaker closed, the OPTIM Trip Unit monitors all of the following:

- Present magnitude phase A, B and C currents
- Present magnitude ground current or present magnitude neutral current
- Minimum/Maximum magnitudes all monitored currents

Automatic Trip Condition

When a system condition results in an automatic trip, the OPTIM Trip Unit monitors and stores in non-volatile memory the reason for the trip and all of the following:

- Magnitude phase A, B and C trip currents
- Magnitude ground trip current
- Magnitude neutral trip current

3-3.3 REMOTE SIGNAL CONTACTS

Series $\bar{C}$ R-Frame, SPB Pow-R and DSII/DSLII Contacts (Models 750 and 1050)

A power relay module, described in paragraph 2-7.2, is mounted internally to Series C R-Frame, SPB Pow-R and DSII/DSLII circuit breakers to provide control power and relay contacts for remote signaling.

Series $\bar{C}$ K, L and N-Frame Contacts

The Series $\bar{C}$ L and N-Frame breakers provide alarm contacts by either of two options:

- A remotely mounted ground fault indicator module may be hard wired directly to the breaker with Models 750 and 1050. This ground fault indicator module provides dedicated alarming contacts for ground fault conditions only. Refer to Table **2.2** for contact ratings and Table **A.1** of Appendix A for the appropriate wiring diagrams.

- The remotely mounted Breaker Interface Module (BIM) has contacts that can be configured to operate under specific conditions. The signaling of the appropriate contact operation is done via an IMPACC communications link between the breaker and the Breaker Interface Module. Refer to the Breaker Interface Module instruction book (I.B. 29C893) for specifics on the programming and ratings of these contacts.

WARNING

UNEXPECTED SIGNALS TO CLOSE OR TRIP A CIRCUIT BREAKER FROM A REMOTE LOCATION VIA THE COMMUNICATIONS NETWORK CAN CAUSE PERSONAL INJURY TO PERSONNEL WORKING IN THE IMMEDIATE VICINITY OF THE CIRCUIT BREAKER. PERMISSIVE CONTROL SWITCHES OR OTHER MEANS SHOULD BE PROVIDED LOCALLY AT THE

CIRCUIT BREAKER FOR MAINTENANCE PERSONNEL TO USE IN CONTROLLING REMOTE CLOSE OR TRIP SIGNALS.

The OPTIM Trip Unit can respond to commands from a remote master computer to trip the circuit breaker remotely. In addition, the trip unit can respond to a close command from a remote master computer. Upon receipt of a command to close the circuit breaker, the reclose relay is energized for 2 seconds. This contact closure results in the circuit breaker closing, if the circuit breaker is equipped with the applicable optional electrical operator or spring release feature.

3-3.4 POWER AND ENERGY MONITORING

Only Digitrip OPTIM 1050 Trip Units can monitor and then display power and energy values via the OPTIMizer Hand Held Programmer, Breaker Interface Module or a remote computer. The displayed information is as follows:

- Power (Present Demand) in kilowatts (kW)
- Peak Demand in kilowatts (kW)
- Total Energy in kilowatthours (kWh)
- Forward Energy in kilowatthours (kWh)
- Reverse Energy in kilowatthours (kWh)

An OPTIM 1050 Trip Unit installed in a Series C̄ K, L or N-Frame Circuit Breaker uses the breaker's current sensors and an externally mounted potential transformer module to compute power and energy values (Figure **2-14** and paragraph 2-7.1). The values are not non-volatile in memory.

An OPTIM 1050 Trip Unit installed in a Series C R-Frame, SPB Pow-R or DSII/DSLII Circuit Breaker uses the breaker's current sensors and a potential transformer module mounted internally to the circuit breaker to compute power and energy values (Figure **2-14** and paragraph 2-7.2). The values are not non-volatile in memory.

Power (Present Demand)

The power value, also referred to as present demand, is displayed in kilowatts (kW). It is a power value averaged over approximately one second.

Peak Demand

The peak demand, displayed in kilowatts (kW), is based on a sampling window of fifteen (15) minutes. Power is repeatedly averaged over this interval and the maximum 15 minute average is displayed as peak demand. When the trip unit is first energized, there is a delay of 15 minutes before the first non-zero value is displayed. The peak demand value displayed remains and is not changed until a higher peak demand is calculated in a subsequent 15 minute window.

Energy

Energy values are displayed in kilowatthours (kWh), and are a summation of the average power over time. Energy values are updated approximately once a second.

- Forward energy is based on load current flow from the "Line" side to the "Load" side of the breaker.
- Reverse energy is based on load current flow from the "Load" side to the "Line" side of the breaker.

3-3.5 POWER QUALITY (HARMONICS) MONITORING

Only Digitrip OPTIM 1050 Trip Units can calculate and display via the OPTIMizer Hand Held Programmer, Breaker Interface Module or a remote computer power quality information. The displayed information is as follows:

- THD magnitude of phase A, B and C currents
- THD magnitude of ground or neutral currents
- % harmonic content phase A, B and C currents (to 27th harmonic)
- % harmonic content ground or neutral currents (to 27th harmonic)

THD (Total Harmonic Distortion) indicates the amount of harmonic current present as a percentage of the RMS value of the 60 Hz component of the line current. This measure of distortion can be useful in a troubleshooting mode to detect individual circuit breaker load currents that could lead to system overheating problems and subsequent early equipment failure.

3-3.6 POWER FACTOR

Digitrip OPTIM 1050 Trip Units calculate the system power factor, which is a unit-less ratio of real power (kW) to apparent power (kVA). The power factor is displayed by the OPTIMizer Hand Held Programmer, Breaker Interface Module or a remote computer. A positive number indicates a lagging current.

3-4 COMMUNICATIONS

Model 750 and 1050 units and Model 550 with field upgrade to IMPACC have the ability to communicate both information and control signals via the INCOM Communications Network. INCOM interconnects microprocessor based electrical distribution and control products with remote personal computers into a comprehensive information and control communications network. The integral communications capability of OPTIM Trip Units permits the receiving device to be the following:

- Breaker Interface Module only
- Remote Master Computer only
- Remote Master Computer with a Breaker Interface Module

Refer to paragraph 1-3 and Figure **1-9** for additional information on sub-network and network communications. In addition, Section 3 of Instruction Book 29C890 (Overview of Digitrip OPTIM Trip Unit System) presents more information on communications with a remote master computer. Refer to paragraph 4-6 of Instruction Book 29C893 (Breaker Interface Module) for additional information concerning communications with the Breaker Interface Module.

3-4.1 IMPACC

All OPTIM Trip Unit programming, configuration, advance warning, diagnostic, monitoring, and control capabilities can be accessed from a remote master computer using IMPACC Series III software. Other software packages are also available.

Custom Billing Software, a stand alone application specific software package, provides the capabilities to determine energy usage data by individually monitored departments in a facility. It can then create a bill based on this data.

Waveform and harmonic display software is capable of performing a waveform capture of phase currents as well as ground or neutral (Figure **3-18**). In addition, total harmonic distortion (THD) and individual harmonic contents can be displayed.

Refer to Section 3 of Instruction Book 29C890 (Overview of Digitrip OPTIM Trip Unit System) for more detailed information on communications with IMPACC.

3-5 TESTING

WARNING

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

DE-ENERGIZE THE CIRCUIT, "REMOVE", "DISCONNECT" OR MOVE THE CIRCUIT BREAKER TO AN APPROPRIATE "TEST" POSITION BEFORE PERFORMING MAINTENANCE OR TESTS.

DO NOT ATTEMPT TO PERFORM DIELECTRIC (OR HIGH POT OR HIGH VOLTAGE) WITHSTAND TESTS ON THE CIRCUIT BREAKER WHILE THE VOLTAGE DISCONNECT PLUG TO THE POTENTIAL TRANSFORMER MODULE IS INSTALLED FOR R-FRAME, SPB AND DSII/DSLII BREAKERS. FOR L AND N-FRAME BREAKERS, REMOVE THE FUSES FROM THE PTM BEFORE HIPOT TESTING (FIGURE 2-14). POTENTIAL TRANSFORMER MODULE AND/OR TRIP UNIT DAMAGE OR FAILURE CAN RESULT FROM ENERGIZING THE POTENTIAL TRANSFORMER MODULE AT MORE THAN 600 VOLTS.

VERIFY THAT NO VOLTAGE IS PRESENT ON THE CIRCUIT BREAKER BEFORE REMOVING THE VOLTAGE DISCONNECT PLUG OR FUSES. REMOVE THE VOLTAGE DISCONNECT PLUG OR FUSES TO ISOLATE THE POTENTIAL TRANSFORMER MODULE BEFORE PERFORMING ANY VOLTAGE TESTS ON THE CIRCUIT BREAKER. REINSTALL THE PLUG OR FUSES ONLY AFTER ALL VOLTAGE TESTS HAVE BEEN COMPLETED AND CONFIRM THAT NO VOLTAGE IS PRESENT ON THE CIRCUIT BREAKER.

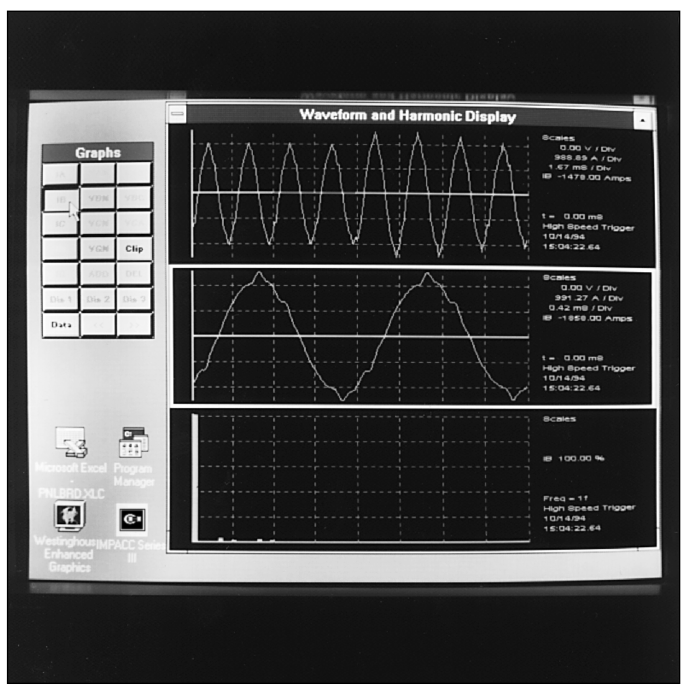


Figure 3-18 Typical Waveform and Harmonic Display

CAUTION

TESTING A CIRCUIT BREAKER UNDER TRIP CONDITIONS WHILE IN SERVICE AND CARRYING LOAD CURRENT, WHETHER DONE BY LOCAL OR REMOTE MEANS, IS NOT RECOMMENDED.

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

TESTING OF A CIRCUIT BREAKER THAT RESULTS IN TRIPPING OF THE CIRCUIT BREAKER SHOULD BE DONE ONLY WITH THE CIRCUIT BREAKER IN A "TEST" OR "DISCONNECTED" CELL POSITION, OR WHILE REMOVED TO A TEST BENCH.

Digitrip OPTIM 550, 750 and 1050 Trip Units have a test capability. "No-Trip" and "Trip" tests can be performed using any of the following:

- OPTIMizer Hand Held Programmer (Figure **1-6** and I.B. 29C892))
- Breaker Interface Module (Model 550 with IMPACC kit) (Figure **1-7** and I.B. 29C893)
- Remote computer/IMPACC software (Figure **1-8** and I.B. 29C890)

Refer to the applicable instruction book for information on performing tests using one of the outlined methods.

3-5.1 SECONDARY INJECTION TESTING

A test current may be injected into the secondary transformer terminals (5A level) for DSII/DSLII circuit breakers only. For K, L, N and R-Frame and SPB Pow-R circuit breakers, these terminals are either not present or not accessible.

DSII and DSLII Type Power Circuit Breakers have a field test kit receptacle that can be used for secondary injection testing to test OPTIM Trip Units. With the Auxiliary Power Module installed, the circuit breaker can be tested using secondary currents provided by an Amptector Trip Unit Test Kit. Refer to supplemental DSII/DSLII Circuit Breaker information in Table **A.1** of Appendix A for secondary injection testing details.

3-5.2 WHEN TO TEST

Tests can be performed with the circuit breaker in the "Connected" position while carrying load current. However, as stated in the CAUTION at the beginning of this section, good practice will limit circuit breaker in-service "Trip" tests to maintenance periods during times of minimum load conditions. Testing is recommended with the circuit breaker out of its cell or in an appropriate "Test," "Disconnected" or "Removed" cell positions.

Notice: *Since time-current settings are based on desired system coordination and protection schemes, the protection settings selected and programmed should not be altered during or as a part of any routine test sequence.*

3-5.3 CONDUCTING TESTS

WARNING

CIRCUIT BREAKER OPERATING MECHANISMS OPEN AND CLOSE THE MOVING PARTS QUICKLY AND WITH VERY HIGH ENERGY. TOUCHING THE MOVING PARTS DURING OPERATION COULD RESULT IN SERIOUS BODILY INJURY. KEEP CLOTHING AND ALL PARTS OF THE BODY WELL AWAY FROM ALL MOVING PARTS. IN ADDITION, FOLLOW ALL INSTRUCTIONS GIVEN FOR TESTING A SPECIFIC TYPE CIRCUIT BREAKER IN THE APPROPRIATE INSTRUCTIONAL MATERIAL FOR THAT CIRCUIT BREAKER.

Notice: *Testing will not be permitted to proceed if there is greater than the following per unit of current flowing on a phase or ground circuit:*

- *No-Trip Test*
  - *>1.0 phase or 0.2 ground*
- *Trip Test*
  - *>0.5 phase or 0.2 ground*

The maximum permitted current value can be determined by multiplying the appropriate per unit value times the ampere rating of the installed rating plug.

The Digitrip OPTIM test capability can be used to perform No-Trip and Trip tests. All testing requires control power, except for No-Trip testing with the OPTIMizer Hand Held Programmer. This testing can be accomplished using the internal battery power of the OPTIMizer. Control power, depending on the testing method, can be supplied by an Auxiliary Power Module or by auxiliary power supplied to the circuit breaker (Figure **3-19** and paragraph 2-7). The auxiliary power is required to activate the breaker's flux transfer shunt trip.

Figure 3-19 Auxiliary Power Module

Notice: *Basic protection functions are not affected during the performance of testing procedures.*

Before starting a test sequence, check to be sure that the ***Operational Status*** LED on the face of the OPTIM Trip Unit is blinking at approximately a 1 second on-off duty cycle, indicating power is being applied to the trip unit and it is functioning normally (Figures **2-4** and **2-10**). In the event that the LED is not blinking at this rate, check to be sure that control power is available or the battery in the OPTIMizer Hand Held Programmer is good.

When performing tests, keep in mind that different combinations of protection features can contribute to the results of the testing, and be the cause of unexpected tripping actions. **Long delay thermal memory or ground fault memory, for example, could result in an unexpected tripping action.** Paragraphs 3-2.4 and 3-2.7 should be reviewed if there are any questions.

Keep in mind that the ***Trip Reset*** pushbutton located on the front of the trip unit will have to be pushed to reset trip unit conditions after a test is completed that causes the circuit breaker to trip and LED indicators to be lit (Figures **2-4** and **2-10**).

3-5.4 PERFORMANCE TESTING FOR GROUND FAULT TRIP UNITS

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 available to the authority having inspection jurisdiction.

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 **3-21** are intended to satisfy this requirement.

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 point 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.

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 3-21 Typical Performance Test Record Form

SECTION 4: STARTUP AND TESTING

4-1 INTRODUCTION

This section addresses those procedures associated with the startup and testing of installed Digitrip OPTIM Trip Units. As a minimum, the OPTIMizer Hand Held Programmer Instruction Book 29C892 along with this instruction book will be required to complete the system setup, program the trip unit, and functionally test the trip unit and circuit breaker.

4-2 WIRING

This section references wiring diagrams that are associated with specific circuit breakers and their installed Digitrip OPTIM Trip Units. All wiring must conform to applicable federal, state and local codes.

4-2.1 WIRING DIAGRAMS

Specific wiring diagrams (connection diagrams) present all the required direct connections associated with a particular circuit breaker type with an installed Digitrip OPTIM Trip Unit. Wiring diagrams are identified by circuit breaker type in Appendix A. These wiring diagrams are required to create an accurate wiring plan drawing.

4-2.2 WIRING PLAN DRAWING

External wiring associated with a circuit breaker and its installed Digitrip OPTIM Trip Unit must follow a suitable wiring plan drawing. The phrase "wiring plan drawing" refers to the drawing or drawings made for a specific application. All electrical connections between the circuit breaker and external equipment are described. This drawing is the responsibility of the OEM or user.

4-2.3 NETWORK WIRING DIAGRAM

A network wiring diagram would also be helpful for sub-network and network systems. This diagram is the responsibility of the OEM or user. Refer to Figure **4-1** to review a typical network wiring diagram.

4-3 INITIAL STARTUP

This information is intended to be used when applying control power to a system, including the trip units. It is especially important during the first power application.

4-3.1 BEFORE POWER APPLICATION

WARNING

STARTUP PROCEDURES MUST BE PERFORMED BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH DIGITRIP OPTIM TRIP UNITS, THE LOW VOLTAGE CIRCUIT BREAKERS IN WHICH THEY ARE APPLIED, AND ALL OTHER ASSOCIATED ELECTRICAL AND/OR MECHANICAL EQUIPMENT. FAILURE TO OBSERVE THIS WARNING COULD RESULT IN PERSONAL INJURY, DEATH AND/OR EQUIPMENT DAMAGE.

After all installation wiring is complete and before power is applied to any equipment, perform the following steps:

Step 1: Verify that all wiring is correct as shown on the applicable wiring diagrams and/or wiring plan drawings.

Step 2: Remove and discard the factory default settings label covering the programming port on each trip unit.

Step 3: Verify that a correct rating plug is securely installed in each trip unit.

Notice: *Mechanical rejection means will prevent the installation of a rating plug in a trip unit for which it was not intended.*

Step 4: Press the battery test/check pushbutton. The associated green LED should light. Refer to paragraph 5-4.1 for specific assistance.

Step 5: Use the OPTIMizer Hand Held Programmer to assign unique device addresses and select baud rates. Refer to the OPTIMizer Hand Held Programmer Instruction Book 29C892 for specific assistance.

Notice:
- *For applications with Breaker Interface Modules*
  - *the acceptable address ranges for trip units are 1-32 (HEXADECIMAL).*
- *For applications with a remote PC and no Breaker Interface Modules present*
  - *the acceptable address ranges for trip units are 1-FFE (HEXADECIMAL).*

Step 6: Use the OPTIMizer Hand Held Programmer to check and adjust, if necessary, trip unit pickup and time settings in keeping with system coordination requirements.

Step 7: If the system is utilizing one or more Breaker Interface Modules or is network connected through IMPACC, verification of circuit breaker addresses and protective/ monitoring criteria can be accomplished using a Breaker Interface Module or remote computer. As required, refer to Instruction Book 29C893 to review the use of the Breaker Interface Module or Instruction Book 29C890 for an overview of the complete Digitrip OPTIM Trip Unit System, including IMPACC communications.

4-3.2 INITIAL POWER APPLICATION

a. Apply system power and observe individual trip units and/or other system monitoring devices, such as the Breaker Interface Module or remote computer.

b. The green ***Unit Status*** LED should blink if either (Figures **2-4** and **2-10**):

   1. The circuit breaker current in at least one phase exceeds 20% of the installed rating plug value

   (or)

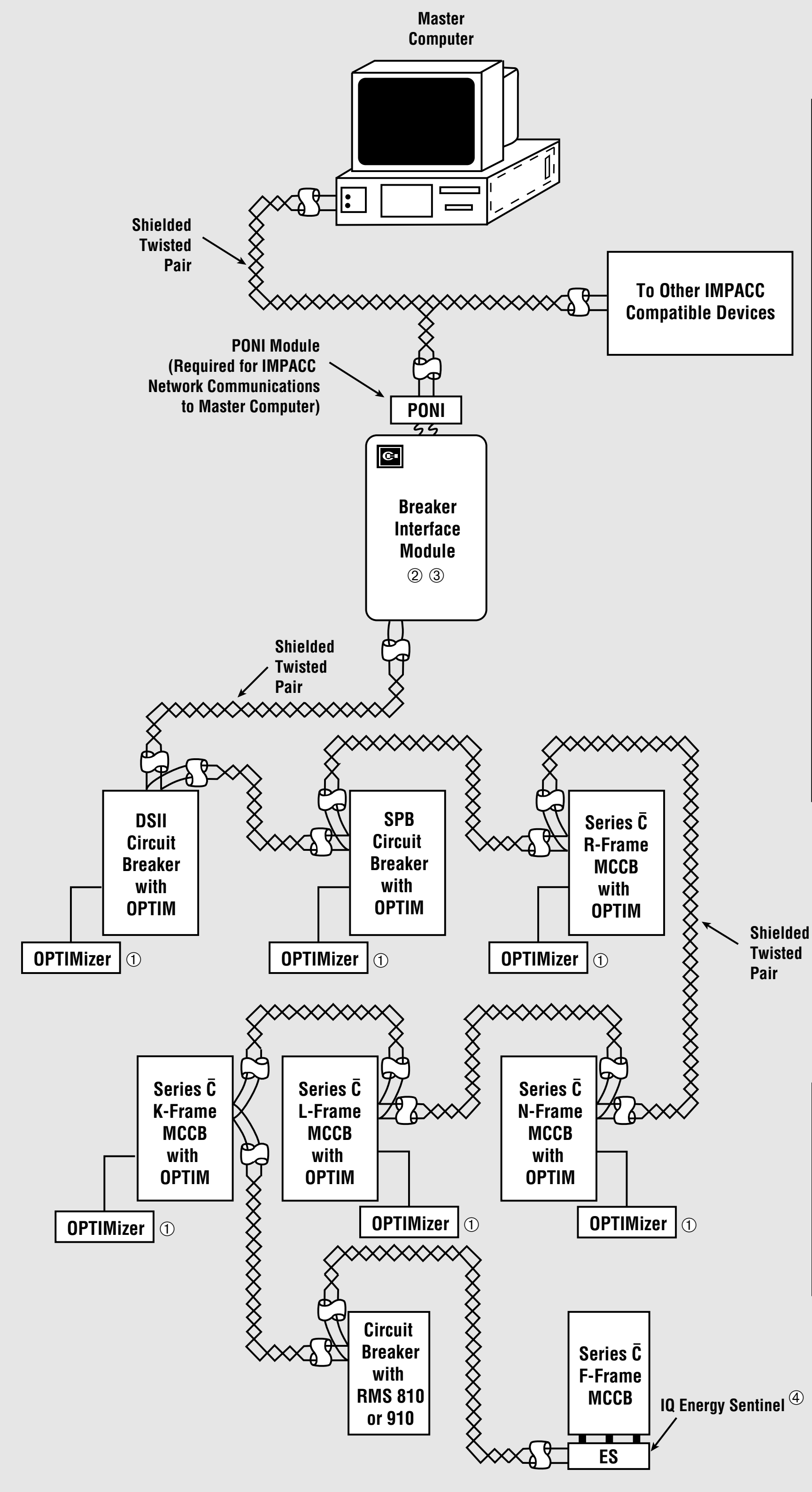
   2. Auxiliary power is supplied to the circuit breaker.

   The red transmit LED will blink whenever the trip unit is communicating on the IMPACC Network.

c. Should what appears to be a problem occur, refer to the Troubleshooting Guide (Table **5.1**) of this manual. For additional troubleshooting assistance, refer to the Troubleshooting Guides in the OPTIMizer Hand Held Programmer and/or the Breaker Interface Module instruction books (I.B. 29C892 and I.B. 29C893 respectively). For further assistance, consult Cutler-Hammer.

4-4 TESTING

Section 3-5 provides details associated with testing OPTIM Trip Units and circuit breakers equipped with OPTIM Trip Units. It is recommended that Section 3-5 be read first. In addition, follow the testing instructions presented in the OPTIMizer Hand Held Programmer instruction book (I.B. 29C892) or the Breaker Interface Module instruction book (I.B. 29C893). Testing can also be performed using a remote computer over the IMPACC system.



① For network interconnection cable, use Belden 9463 or Cutler-Hammer IMPCABLE.

② When interconnecting devices, tie shield drain wires together for shield path continuity.

③ Connect the shield path to a solid earth ground at one point only.

④ On last device in network, tape shield drain wire back upon cable.

⑤ Use a 1/2 watt carbon or metal film resistor at each end of the network as an end of line termination resistor (EOLTR). EOLTR should be 100 ohms for 9600 baud communication rate networks or 150 ohms for 1200 baud communication rate networks.

⑥ Network interconnection to computer requires use of an IMPACC master (CONI or MINT).

⑦ Devices without built-in communications require network interface module (PONI).

For detailed network wiring specifications, call the automatic fax retrieval system (FRED) at 412/494-3745 and request document 17513 or contact the Advanced Products Support Center. Refer to the paragraph entitled “Technical Assistance” in this document.

Figure 4-1 Typical Network Wiring Diagram

SECTION 5: TROUBLESHOOTING AND MAINTENANCE

5-1 LEVEL OF REPAIR

This manual is written based on the assumption that only unit-level troubleshooting will be performed. If the cause of a malfunction is traced to a Digitrip OPTIM Trip Unit, the device should be replaced. The malfunctioning device may be returned to Cutler-Hammer for further evaluation.

5-2 TROUBLESHOOTING

OPTIM Trip Units can be used with or without auxiliary power. In addition, guidelines can vary to some degree by circuit breaker type. To make the guidelines of Table **5.1** as user friendly as possible, the troubleshooting table is divided by circuit breaker type, with and without auxiliary power.

5-3 TRIP UNIT REPLACEMENT

If a trip unit or a circuit breaker must be replaced, consult Cutler-Hammer for specific replacement instructions.

5-4 MAINTENANCE AND CARE

Except for the rating plug and the battery for the local indicator, the Digitrip OPTIM Trip Unit is designed to be a self contained and maintenance free device.

The Digitrip OPTIM Trip Unit should be stored in an environment that does not exceed the temperature range of -30° to +85°C. The environment should also be free of excess humidity. Store the device in its original packing material.

Table 5.1 Troubleshooting Guide *(continued on next page)*

Symptom	Probable Cause	Possible Solution(s)	References
K, L and N-Frame Circuit Breakers with Auxiliary Power			
Unit Status LED is not blinking at approximately a one second on-off duty cycle.	Auxiliary power is not present or is reversed.	Measure voltage at +30VDC and NEG on side terminal block to be 30 ± 3 volts. Check polarity.	Table A.1 Wiring Diagrams
	Open connection on breaker internal wiring.	Check orange and black wires on the side terminal block.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3
As soon as auxiliary power is applied, instantaneous trip LED comes on and breaker trips if initially closed.	Rating plug is not installed or pins are not making good connection.	Install rating plug and/or check connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Replace rating plug	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3
LED does not come on when battery check button is pressed.	Battery installed backwards	Install correctly	Para. 5-4.1
	Dead battery	Replace battery	Para. 5-4.1, Table 2.2
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
Power values are grossly in error (1050 Trip Units only).	Connections from PT Module to breaker not made or are incorrect.	Check connections	Table A.1 Wiring Diagrams
	Line frequency incorrect	Verify operating frequency with OPTIMizer.	I.B. 29C892, Para. 3-6
	Trip unit may be the problem	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3
"Connection Failure" displayed when OPTIMizer is plugged in.	**FIRST DISCONNECT AUXILIARY POWER TEMPORARILY, THEN CHECK THE FOLLOWING:**		
	OPTIMizer not working or cord not properly plugged into OPTIMizer.	Verify OPTIMizer operation on another breaker.	I.B. 29C892 Para. 2-2.2 & 3-2
	Cord not properly plugged into breaker.	Check connection. If unit status LED is blinking, connection is OK.	Para. 2-4.1
	Rating plug is not installed or is loose.	Instantaneous LED will be on. Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Instantaneous LED will be on. Replace rating plug.	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3
	RECONNECT AUXILIARY POWER		
BIM will not communicate with trip unit.	Breaker address is > 32 (HEX)	Check address with OPTIMizer and change as required.	I.B. 29C892 Para. 3-5.1
	No auxiliary power	If possible, open breaker or reduce breaker current to <20% of frame rating. Then, check that unit status LED is blinking. If not, see first symptom in this table.	Symptom: "Unit Status LED is not blinking."
	Rating plug is not installed or is loose.	Instantaneous LED will be on. Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Instantaneous LED will be on. Replace rating plug.	Para. 5-4.2, Table 2.1
	Open INCOM connection	Check INCOM connections on side terminal block. The transmit LED should flash when there is communication. With INCOM connector unplugged, the resistance "looking into" the INCOM terminals should be approximately 2.5 ohms.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
Ground fault alarm unit does not operate on a ground fault.	Connections to ground fault alarm unit are incorrect.	Check connections	Table A.1 Wiring Diagrams
	Ground fault alarm is not operating	Press test button on ground fault alarm unit. Button should illuminate. If it does not, check that 120V is being supplied to unit. If it is, replace the ground fault alarm unit.	Table A.1 Instructions for ground fault alarm
	Breaker is not providing an alarm signal.	Temporarily disconnect the wires to L1 and L2 on the ground fault alarm unit. With these connections open, approximately 5 volts should appear between GF, AL and COM when the ground fault current exceeds pickup. On ground fault alarm breakers, this voltage will be present as long as pickup is exceeded. On ground fault trip breakers, this voltage appears only transiently after a trip and must be observed with an oscilloscope. If the voltage is not present, the problem may be in the breaker. Refer to Note 1 at the end of Table 5.1.	Table A.1 Intstructions for ground fault alarm
Breaker trips on ground fault.	There actually is a ground fault	Find the location of the fault and remove it.	N.A.
	On four wire systems the neutral current sensor may not have the correct ratio or be properly connected.	(1) Check that the neutral sensor and neutral sensor connections on side terminal block are good. (2) Check that the neutral current sensor ratio matches the breaker. (3) Check that connections from the neutral current sensor to the breaker are not reversed polarity.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3
Breaker trips too rapidly on ground fault or short delay (zone selective interlocking not used).	GOUT to GIN and/or SOUT to SIN are not connected.	Add connections	Table A.1 Wiring Diagrams
	Trip unit settings are not correct	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1	Para. 5-3
Breaker trips too rapidly on long delay.	Powered thermal memory may cause breaker to trip too soon.	If powered thermal memory is not required, turn it off using OPTIMizer.	I.B. 29C892, Para 3-6
	Trip unit settings are not correct	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
Zone selective interlocking on ground fault and/or short delay does not work.	*See directions for checking zone selective interlocking*		Appendix B
Communication over IMPACC is not working. (Direct with BIM not involved)	No auxiliary power	Check that the Unit Status LED is blinking. If not, see first symptom in this table.	Symptom: "Unit Status LED is not blinking."
	Open INCOM connection	Check INCOM connections on side terminal block. The transmit LED should flash when there is communication. With INCOM connector unplugged, the resistance "looking into" the INCOM terminals should be approximately 2.5 ohms.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
K, L and N-Frame Circuit Breakers without Auxiliary Power			
Unit Status LED is not blinking at approximately a one second on-off duty cycle	Current thru breaker is < 20% of frame rating.	No problem. Status LED will not operate with breaker currents < 20% of frame rating.	N.A.
	Trip unit may be the problem	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
As soon as current starts to flow thru the 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.	Para 2-6 & 5-4.2
	Rating plug is open internally	Replace rating plug	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
LED does not come on when battery check button is pressed.	Battery installed backwards	Install correctly	Para. 5-4.1
	Dead battery	Replace battery	Para. 5-4.1, Table 2.2
	Trip unit may be the problem	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
Power values are grossly in error (1050 trip units only).	Connections from PT Module to breaker not made or are incorrect.	Check connections	Table A.1 Wiring Diagrams
	Frequency incorrect	Verify operating frequency with OPTIMizer	I.B. 29C892, Para 3-6
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
"Connection Failure" when OPTIMizer is plugged in.	OPTIMizer not working or cord not properly plugged into OPTIMizer.	Verify OPTIMizer operation on another breaker.	I.B. 29C892 Para. 2-2.2 & 3-2
	Cord not properly plugged into breaker.	Check connection. If unit status LED is blinking, connection is OK.	Para. 2-4.1
	Rating plug is not installed or is loose.	Instantaneous LED will be on. Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Replace rating plug	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
Ground fault alarm unit does not operate on a ground fault.	Connections to ground fault alarm unit are incorrect.	Check connections	Table A.1 Wiring Diagrams
	Ground fault alarm is not operating	Press test button on ground fault alarm unit. Button should illuminate. If it does not, check that 120V is being supplied to unit. If it is, replace the ground fault alarm unit.	Table A.1 Instructions for ground fault alarm
	Breaker is not providing an alarm	Temporarily disconnect the wires to L1 and L2 on the ground fault alarm unit. With these connections open, approximately 5 volts should appear between GF, AL and COM when the ground fault current exceeds pickup. On ground fault alarm breakers, this voltage will be present as long as pickup is exceeded. On ground fault trip breakers, this voltage appears only transiently after a trip and must be observed with an oscilloscope. If the voltage is not present, the problem may be in the breaker. Refer to Note 1 at the end of Table 5.1.	Table A.1 Instructions for ground fault alarm and wiring diagrams
Breaker trips on ground fault.	There actually is a ground fault	Check circuit to find the location of the fault.	N.A.
	On four wire systems the neutral current sensor may not have the correct ratio or be properly connected.	(1) Check neutral sensor and neutral sensor connections on side terminal block are good. (2) Check that the neutral current sensor ratio matches the breaker. (3) Check that connections from the neutral current sensor to the breaker are not reversed.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
Breaker trips too rapidly on ground fault or short delay (zone selective interlocking not used).	GOUT to GIN and/or SOUT to SIN are not shorted.	Add connections	Table A.1 Wiring Diagrams
	Trip unit settings are not correct.	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
Breaker trips too rapidly on long delay.	Unpowered thermal memory may cause breaker to trip too soon.	If unpowered thermal is not required, turn it off using OPTIMizer.	I.B. 29C892, Para. 3-6
	Trip unit settings are not correct.	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace breaker. Refer to Note 1 at end of Table 5.1.	Para. 5-3
Zone selective interlocking on ground fault and/or short delay does not work.	*See directions for checking zone selective interlocking*		Appendix B
R-Frame, SPB Pow-R and DSII/DSLII Circuit Breakers with Auxiliary Power			
Unit status LED is not blinking.	No voltage or incorrect voltage input.	Measure voltage at terminals C9 - C10 on RD and SPB breakers or 5 - 6 on DSII breakers, should be 115V 60Hz or 230V 50Hz per breaker label.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
As soon as auxiliary power is applied, instantaneous trip LED comes on.	Rating plug not installed or pins not making good connection. Note: Breaker cannot be closed if rating plug is not installed.	Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Replace rating plug	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
LED does not come on when battery check button inside rating plug is pressed.	Battery installed backwards	Install correctly	Para. 5-4.1
	Dead battery	Replace battery	Para. 5-4.1, Table 2.2
	Bad rating plug	Replace rating plug	Para. 5-4.2, Table 2.1

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
Power values are grossly in error. (1050 Trip Units only)	No voltage input to trip unit.	Check PT disconnect plug is installed.	
	Frequency incorrect	Verify operating frequency with OPTIMizer.	I.B. 29C892, Para. 3-6
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
"Connection Failure" when OPTIMizer is plugged in.	**FIRST DISCONNECT VOLTAGE SUPPLY TO TERMINALS C9 AND C10 ON RD AND SPB BREAKERS OR 5 AND 6 ON DSII BREAKERS TEMPORARILY.** ***(Place drawout breakers in disconnect position which will remove voltage supply)***		
	OPTIMizer not working or cord not properly plugged into OPTIMizer.	Verify OPTIMizer operation on another breaker.	I.B. 29C892 Para. 2-2.2 & 3-2
	Cord not properly plugged into breaker.	Check connection. If unit status LED is blinking, connection is OK.	Para. 2-5.1
	Rating plug is not installed or is loose.	Instantaneous LED will be on. Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Instantaneous LED will be on. Replace rating plug.	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
	RECONNECT VOLTAGE SUPPLY		
BIM will not communicate with trip unit.	Breaker address is > 32 (HEX)	Check address with OPTIMizer and change as required.	I.B. 29C892 Para. 3-5.1
	No auxiliary power	If possible, open breaker or reduce breaker current <20% of frame rating. Then check that unit status LED is blinking. If not, see first symptom in this portion of the table.	Symptom: "Unit Status LED is not blinking."
	Rating plug is not installed	Instantaneous LED will be on. Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Instantaneous LED will be on. Replace rating plug.	Para. 5-4.2, Table 2.1
	Open INCOM connection	Check connections at terminals C11 and C12 on RD and SPB breakers or C6 and C7 on DSII breakers. The transmit LED should flash when there is communication. With the external connections to C11 and C12 or C6 and C7 opened temporarily, the resistance across C11 and C12 or C6 and C7 should be approximately 2.5 ohms.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace trip unit	Para. 5-3

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
Breaker trips on ground fault.	There actually is a ground fault	Find the location of the fault and remove it.	N.A.
	On four wire systems the neutral current sensor may not have the correct ratio or be properly connected.	Check the connections at terminals at D6 and D7 on RD and SPB breakers or 19 and 20 on DSII breakers. Check that the neutral current sensor ratio matches the breaker. Check that connections from the neutral current sensor to the breaker are not reversed. Check that the shorting straps on the four point ground fault terminal block on RD and SPB breakers are connected D5 - D6 and D7 - D8.	Table A.1 Wiring Diagrams
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Breaker trips too rapidly on ground fault or short delay (zone selective interlocking not used).	Connections from C4 to C5 and/or D9 to D10 missing on RD or SPB breakers.	Add connections	Table A.1 Wiring Diagrams
	Connections from Z2 to Z3 and/or Z4 to Z5 missing on DSII breakers.	Add connections	Table A.1 Wiring Diagrams
	Trip unit settings are not correct	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Breaker trips too rapidly on long delay.	Powered thermal memory can cause breaker to trip too soon. Trip unit settings are not correct	If powered thermal memory is not required, turn it off with the OPTIMizer. Change settings	I.B. 29C892, Para. 3-6 I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Zone selective interlocking on ground fault and/or short delay does not work.	*See directions for checking zone selective interlocking*		Appendix B
Communication over IMPACC is not working. (Direct with BIM not involved)	Address incorrect	Verify both the IMPACC address and trip unit address are properly setup.	Review Section 3 of IB 29C890
	No auxiliary power	If possible, open breaker or reduce breaker current to <20% of frame rating. Then check that unit status LED is blinking. If not, see first symptom in this portion of the table.	Symptom: "Unit Status LED is not blinking."
(Continues on next page)	Open INCOM connection	Check connections at terminals C11 and C12 on RD and SPB breakers or C6 and C7 on DSII	Table A.1 Wiring Diagrams

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
		breakers. The transmit LED should flash when there is communication. With the external connections to C11 and C12 or C6 and C7 opened temporarily, the resistance “looking into” C11 and C12 or C6 and C7 should be approximately 2.5 ohms.	
R-Frame, SPB Pow-R and DSII/DSLII Circuit Breakers without Auxiliary Power			
Unit Status LED is not blinking.	Current thru breaker is < 20% of frame rating.	No problem. Status LED will not operate with breaker currents < 20% of frame rating.	N.A.
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
As soon as current starts to flow thru the breaker, it trips and the instantaneous trip LED comes on.	Rating plug is not installed or is loose. Breaker cannot be closed without rating plug installed.	Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally	Replace rating plug	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
LED does not come on when battery check button is pressed.	Battery installed backwards	Install correctly	Para. 5-4.1
	Dead battery	Replace battery	Para. 5-4.1, Table 2.2
	Bad rating plug	Replace rating plug	Para. 5-4.2, Table 2.1
“Connection Failure” when OPTIMizer is plugged in.	OPTIMizer not working or cord not properly plugged into OPTIMizer.	Verify OPTIMIzer operation on another breaker.	I.B. 29C892 Para. 2-2.2 & 3-2
	Cord not properly plugged into breaker.	Check connection. If unit status LED is blinking, connection is OK.	Para. 2-5.1
	Rating plug is not installed or is loose.	Instantaneous LED will be on. Install rating plug and/or check for loose connections.	Para. 2-6 & 5-4.2
	Rating plug is open internally.	Replace rating plug	Para. 5-4.2, Table 2.1
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Breaker trips on ground fault.	There actually is a ground fault.	Find location of the fault	N.A.
(Continues on next page)	On four wire systems the neutral current sensor may not have the correct ratio or be properly connected.	Check connections at terminals D6 and D7 on RD and SPB breakers or 19 and 20 on DSII breakers. Check that the neutral current sensor ratio matches the breaker. Check that the connections from the neutral current sensor to the breaker are not reversed. Check that the shorting	Table A.1 Wiring Diagrams

Table 5.1 Troubleshooting Guide (continued from previous page)

Symptom	Probable Cause	Possible Solution(s)	References
		straps on the four point ground fault terminal block on the RD and SPB breakers are connected D5 - D6 and D7 - D8.	
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Breaker trips too rapidly on ground fault or short delay (zone selective interlocking not used).	Connection from C4 to C5 and/or from D9 to D10 is missing on RD or SPB breakers.	Replace connections	Table A.1 Wiring Diagrams
	Connection from Z2 to Z3 and/or Z4 to Z5 missing on DSII breakers.	Replace connections	Table A.1 Wiring Diagrams
	Trip unit settings are not correct.	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Breaker trips too rapidly on long delay.	Unpowered thermal memory can cause breaker to trip too soon.	If unpowered thermal memory is not required, turn it off with the OPTIMizer.	I.B. 29C892, Para. 3-6
	Trip unit settings are not correct	Change settings	I.B. 29C892, Section 3 or I.B. 29C893, Section 4
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Power values are grossly in error. (1050 Trip Units only)	No voltage input to trip unit.	Check PT disconnect plug is installed.	Table A.1 Wiring Diagrams
	Frequency incorrect	Verify operating frequency with OPTIMizer	I.B. 29C892, Para. 3-6
	Trip unit may be the problem.	Replace trip unit	Para. 5-3
Zone selective interlocking on ground fault and/or short delay does not work.	*See directions for checking zone selective interlocking*		Appendix B

Notes:

(1) OPTIM Trip Units are not replaceable on Series C̄ LD and ND circuit breakers. Because replacing the complete circuit breaker is difficult, consult the factory before attempting replacement.

Figure 5-1 Battery Test Pushbutton and LED Shown on Face of OPTIM Trip Unit

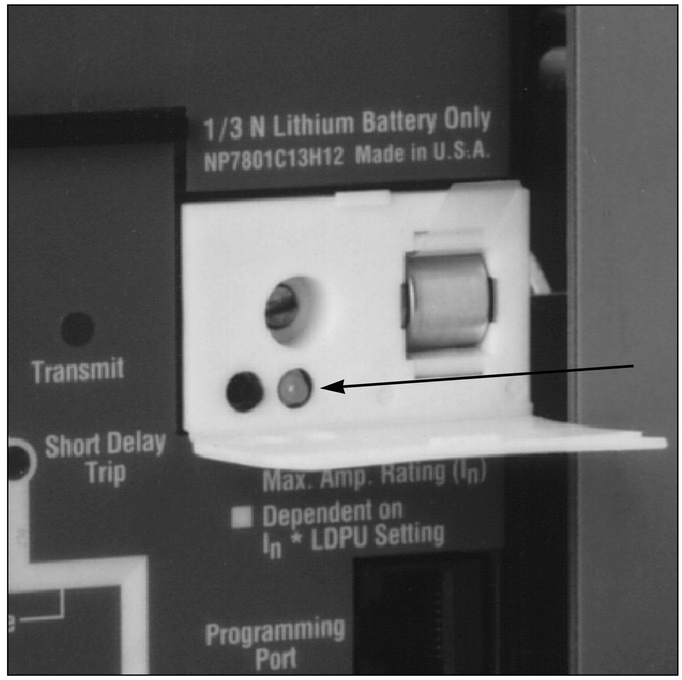


Figure 5-2 Battery Test Pushbutton and LED Shown on OPTIM Rating Plug

5-4.1 LOCAL INDICATOR BATTERY CHECK AND REPLACEMENT

The battery is a 3 volt lithium battery. Following a trip operation and with no supplementary control power available, the battery should maintain the mode of trip LED for approximately 60 hours continuously. The ready status of the battery can be checked at any time by depressing the battery check/test pushbutton and observing the battery test LED. If the LED does not light with the pushbutton depressed, the battery should be replaced. The correct polarity should, however, first be checked (Figure **5-1** and **5-2**). The battery test pushbutton and LED are located on the face of OPTIM Trip Units used with Series $\overline{C}$ K, L and N-Frame circuit breakers, and in the rating plug of OPTIM Trip Units used with Series $\overline{C}$ R-Frame, SPB Systems Pow-R, and DSII/DSLII circuit breakers.

Notice: *The battery can be replaced at any time with the circuit breaker in service without affecting the operation of the circuit breaker and its protection function.*

The battery can easily be replaced from the front of the trip unit. The replacement battery should be the same type or equivalent 3 volt lithium battery. Refer to Table **2.2** for acceptable battery replacements.

Notice: *Care should be exercised when replacing the battery to insure that the correct polarities are observed.*

Series $\overline{C}$ K, L and N-Frame Replacement - The battery is located behind the access cover for the battery and programming port compartment of OPTIM Trip Units used with Series $\overline{C}$ K, L and N-Frame circuit breakers (Figure **5-3**). To remove the access cover, pull down on the release tab located in the center of the cover while pulling out on the cover. Pull out on the battery tab to remove the battery. When replacing the battery, be certain that the negative side is pointing to the left when facing the front of the trip unit. Replace the access cover.

Series $\overline{C}$ R-Frame, SPB and DSII/DSLII Replacement - The battery is located behind the hinged cover of the rating plug (Figure **5-4**). Lower the cover and remove the battery by pulling out on the battery tab. When replacing the battery, be certain that the negative side is pointing left when facing the front of the trip unit. Polarity markings are also shown on the inside of the hinged cover. Close the rating plug's hinged cover.

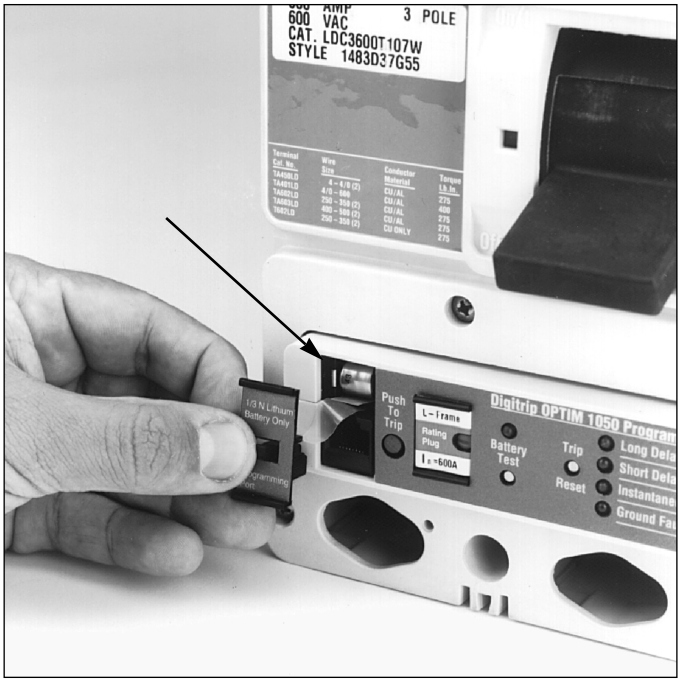


Figure 5-3 Battery Shown Installed in Battery/Programming Port Compartment

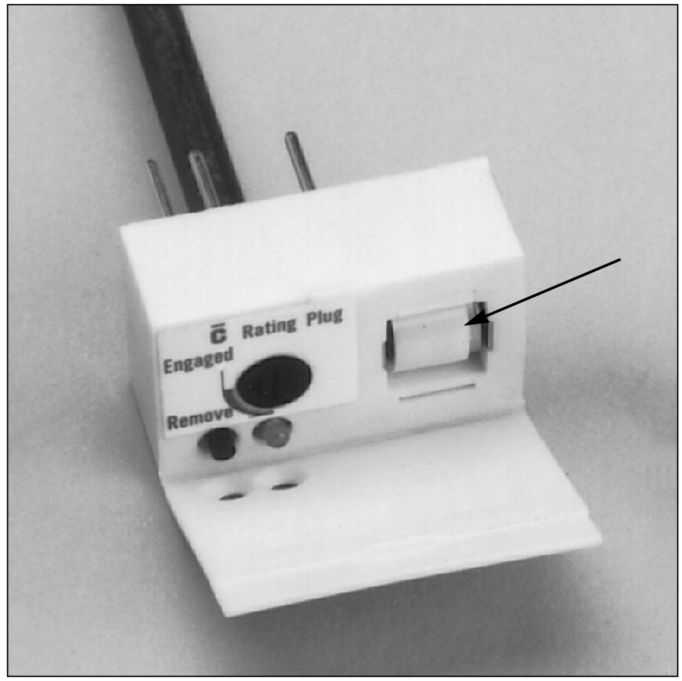


Figure 5-4 Battery Shown Installed Behind Rating Plug Hinged Cover

5-4.2 RATING PLUG REPLACEMENT

Notice: *Mechanical rejection means will prevent the installation of a rating plug in a trip unit for which it was not intended.*

The fixed type interchangeable rating plugs used in OPTIM Trip Units can be simply removed and replaced using a small common flathead screwdriver. Refer to Figures **5-5** and **5-6** and proceed with the following steps:

Step 1: Make sure that the circuit breaker in which the trip unit is installed is open.

Step 2: Figure **5-5** shows the rating plug location in OPTIM Trip Units used with Series $\overline{C}$ L and N-Frame circuit breakers. If Figure **5-5** is applicable, proceed with Step 3. If not, proceed to Step 5.

Step 3: Remove the rating plug by turning the small positioning screw in a counterclockwise direction until it is loose. Use two fingers to remove the rating plug by pulling out on the small molded top and bottom lips.

Step 4: Install a new rating plug by pushing it gently into the rating plug cavity until it is seated. Secure the rating plug in position by turning the positioning screw in the clockwise direction until it is snug. Do not over tighten the screw.

Step 5: Figure **5-6** shows the rating plug location in OPTIM Trip Units used with Series $\overline{C}$ R-Frame, SPB Pow-R and all DSII/DSLII circuit breakers. If Figure **5-6** is applicable, proceed with Step 6.

Step 6: Lower the rating plug's hinged cover to access the positioning screw. Remove the rating plug by turning the screw in a counterclockwise direction until it is loose. Use two fingers to remove the rating plug by pulling out on the plug.

Step 7: Install a new rating plug by pushing it gently into the rating plug cavity until it is seated. Secure the rating plug in position by turning the positioning screw in the clockwise direction until snug. Do not over tighten the screw. Close the hinged cover.

Notice:
- *For the Series $\overline{C}$ R-Frame trip unit, the rating plug screw is engaged/disengaged with only a 1/4 turn.*
- *For the SPB and DSII/DSLII trip unit, the rating plug screw is engaged/disengaged with several turns.*

Figure 5-5 Rating Plug Shown Removed (L and N-Frame Type OPTIM Trip Units)

Figure 5-6 Rating Plug Shown Being Removed (R-Frame, SPB and DSII/DSLII Type OPTIM Trip Units)

5-5 RETURN PROCEDURE

The Troubleshooting Guide (Table **5.1**) is intended for service personnel to identify whether a problem being observed is external or internal to the device. If a problem is determined to be internal, the device should be returned to the factory for replacement. To have a Digitrip OPTIM Trip Unit returned, contact your local Cutler-Hammer authorized distributor.

5-6 TECHNICAL ASSISTANCE

For information, technical assistance or referral to a local authorized distributor, contact the Customer Support Center at 1-800-356-1243.

APPENDIX A - INSTRUCTIONAL REFERENCES

A list of instructional references is provided in Table **A.1** to identify instructional documents that could be of assistance.

Table A.1 Instructional References (continued on next page)

DOCUMENT DESCRIPTION	DOCUMENT NUMBER
Circuit Breakers	
Series $\overline{C}$ K-Frame Frame Book	IL 29-120K
Series $\overline{C}$ L-Frame Frame Book	IL 29-120L
Series $\overline{C}$ N-Frame Frame Book	IL 29-120N
Series $\overline{C}$ R-Frame Frame Book Series $\overline{C}$ R-Frame Supplement	IL 29-120R IL 29C713
SPB Systems Pow-R Breaker Supplement	IL 29849
DSII/DSLII Breaker Supplement	IL 8700C39
Digitrip OPTIM Trip Unit System	
OPTIM Trip Unit System Overview	IB 29C890
OPTIM Trip Units	IB 29C891
OPTIMizer Hand Held Programmer	IB 29C892
Breaker Interface Module	IB 29C893
Digitrip RMS Trip Units	
Digitrip RMS 810	IL 29-888
Digitrip RMS 910	IL 29-889
Digitrip OPTIM Wiring Diagrams	
Series $\overline{C}$ K, L and N-Frame Wiring	IL 29C894
Series $\overline{C}$ R-Frame Wiring	IL 29C714
SPB Systems Pow-R Wiring	IL 15545
DSII/DSLII Wiring	IL 1A33600
Energy Monitoring Devices	
IQ Energy Sentinel Series $\overline{C}$ F-Frame Series $\overline{C}$ J-Frame Series $\overline{C}$ K-Frame	 IL 17537 IL 17538 IL 17539
Universal IQ Energy Sentinel Internal External	 IL 17540 IL 17541
Communication Devices	
Communications Module (PONI) INCOM PONI RS-232 PONI Modem PONI Buffered PONI CONI IMPACC Wiring Spec.	 IL 17547 IL 17202 IL 17203 IL 17361 IL 17436 IL 17513

Table A.1 Instructional References (continued from previous page)

DOCUMENT DESCRIPTION	DOCUMENT NUMBER
Accessories	
Potential Transformer Module (K, L and N-Frame)	29C126
Ground Fault Indicator	1259C14G01
Digitrip OPTIM Time-Current Curves	
Series $\overline{C}$ K-Frame Curves	
I^2t Long & Short Delay Phase	SC-6924-98
I^2t Long & Flat Short Delay Phase	SC-6925-98
I^4t Long & Flat Short Delay Phase	SC-6926-98
400A Instantaneous & Override Phase	SC-6927-98
250A Instantaneous & Override Phase	SC-6928-98
125A Instantaneous & Override Phase	SC-6929-98
Ground Fault Protection	SC-6930-98
Series $\overline{C}$ L-Frame Curves	
I^2t Long & Short Delay Phase	SC-6323-96
I^2t Long & Flat Short Delay Phase	SC-6324-96
I^4t Long & Flat Short Delay Phase	SC-6325-96
600A Instantaneous & Override Phase	SC-6326-96
400A Instantaneous & Override Phase	SC-6327-96
Ground Fault Protection	SC-6330-96
Series $\overline{C}$ N-Frame Curves	
I^2t Long & Short Delay Phase	SC-6331-96
I^2t Long & Flat Short Delay Phase	SC-6332-96
I^4t Long & Flat Short Delay Phase	SC-6333-96
Instantaneous & Override Phase	SC-6334-96
Ground Fault Protection	SC-6335-96
Series $\overline{C}$ R-Frame Curves	
1600/2000A I^2t Long & Short Delay Phase	SC-6336-96
1600/2000A I^2t Long & Flat Short Delay Phase	SC-6337-96
1600/2000A I^4t Long & Flat Short Delay Phase	SC-6338-96
2500A I^2t Long & Short Delay Phase	SC-6339-96
2500A I^2t Long & Flat Short Delay Phase	SC-6340-96
2500A I^4t Long & Flat Short Delay Phase	SC-6341-96
1600A Instantaneous & Override Phase	SC-6342-96
2000A Instantaneous & Override Phase	SC-6343-96
2500A Instantaneous & Override Phase	SC-6344-96
1600A Ground Fault Protection	SC-6345-96
2000A Ground Fault Protection	SC-6346-96
2500A Ground Fault Protection	SC-6347-96
SPB Systems Pow-R Curves	
400-1200A I^2t Long & Short Delay Phase	SC-6348-96
400-1200A I^2t Long & Flat Short Delay Phase	SC-6349-96
400-1200A I^4t Long & Flat Short Delay Phase	SC-6350-96
1600-3000A I^2t Long & Short Delay Phase	SC-6351-96
1600-3000A I^2t Long & Flat Short Delay Phase	SC-6352-96
1600-3000A I^4t Long & Flat Short Delay Phase	SC-6353-96
4000-5000A I^2t Long & Short Delay Phase	SC-6354-96
4000-5000A I^2t Long & Flat Short Delay Phase	SC-6355-96
4000-5000A I^4t Long & Flat Short Delay Phase	SC-6356-96
400-1200A Instantaneous & Override Phase	SC-6357-96
1600-3000A Instantaneous & Override Phase	SC-6358-96
4000-5000A Instantaneous & Override Phase	SC-6359-96
Ground Fault Protection	SC-6360-96
DSII/DSLII Curves	
400-1200A I^2t Long & Short Delay Phase	SC-6275-95
400-1200A I^2t Long & Flat Short Delay Phase	SC-6276-95
400-1200A I^4t Long & Flat Short Delay Phase	SC-6277-95
1600-5000A I^2t Long & Short Delay Phase	SC-6278-95
1600-5000A I^2t Long & Flat Short Delay Phase	SC-6279-95
1600-5000A I^4t Long & Flat Short Delay Phase	SC-6280-95
400-1200A Instantaneous & Override Phase	SC-6281-96
1600-5000A Instantaneous & Override Phase	SC-6282-96
Ground Fault Protection	SC-6283-96

APPENDIX B - CHECKING ZONE SELECTIVE INTERLOCKING

Notice: *See wiring diagrams for specifications on wire size, number of permissible breakers and other details. See Table* ***A.1*** *for a list of wiring diagrams.*

Step 1: To test the short delay interlocks, follow steps 2 thru 4.

Step 2: With no current flowing in any of the breakers in the system and with no auxiliary power applied, temporarily connect the short delay output to the short delay input on each breaker (both upstream and downstream) in the system one by one. The designations of the breaker terminals which should be connected are:

NEP/LEP Trip Units	REP Trip Units	
SOUT TO SIN	RD and SPB D9 to D10	DSII Z2 to Z3

Temporarily set the short delay time to .2 seconds or greater and a flat response. Set the instantaneous trip to maximum. If the breaker has a Digitrip 750 or 1050 trip unit, an OPTIMizer or BIM must be used to change settings. If the breaker has a Digitrip 510, 610, 810 or 910 trip unit, the settings can be changed by the switches on the trip unit. Then run a short delay test with a simulated current 20% above the short delay pick up. If the breaker has a Digitrip 750 or 1050 trip unit, the test must be run using an OPTIMizer or BIM. The trip time should be a bit less than the short delay time setting. If the time is less than .1 seconds, there is a problem with the breaker. After the test on each breaker is complete, return all connections and settings to their original condition.

Step 3: Next, and still with no current flowing in any of the breakers in the system and with no auxiliary power applied, temporarily connect 5 to 6 volts dc from a battery or other convenient source in parallel with the short delay interlock output on one downstream breaker. The designations for the breaker terminals to which this voltage is to be applied are:

	NEP/LEP Trip Units	REP Trip Units *(RD and SPB)*	*(DSII)*
+ side of voltage	SOUT	D9	Z2
- side of voltage	COM	C1	Z1

Step 4: Next on the upstream breaker that is fed from this downstream breaker temporarily set the short delay time to .2 seconds or greater and a flat response. Set the instantaneous trip to maximum. If the upstream breaker has a Digitrip 750 or 1050 trip unit, an OPTIMizer or BIM must be used to change settings. If the upstream breaker has a Digitrip 510, 610, 810 or 910 trip unit, the settings can be changed by the switches on the trip unit.

Then run a short delay test on the upstream breaker with a simulated current 20% above the short delay pick up. If the upstream breaker has a Digitrip 750 or 1050 trip unit, the test must be run using an OPTIMizer or BIM. If the zone selective system is working properly, the trip time will be a bit less than the short delay time setting on the upstream breaker. If the time is less than .1 seconds, a wiring error is indicated. Then disconnect the voltage at the downstream breaker and repeat the test on the upstream breaker. Now the trip time should be less than .1 second. Note these tests must be run with the temporary voltage applied at each downstream breaker. Furthermore, if there is more than one upstream breaker fed from downstream breakers, each upstream breaker must be tested with each downstream breaker. After all tests are complete, return all settings to their original condition.

Step 5: To test the ground fault interlocks on breakers with NEP or LEP trip units, repeat steps 2 thru 4 except substitute GOUT for SOUT and GIN for SIN. To test the ground fault interlocks on RD or SPB breakers with REP trip units, repeat steps 2 thru 4 except substitute C4 for D10 and C5 for D9. To test the ground fault interlocks on DSII breakers with REP trip units, repeat steps 2 thru 4 except substitute Z4 for Z2 and Z5 for Z3.

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