Cutler-Hammer

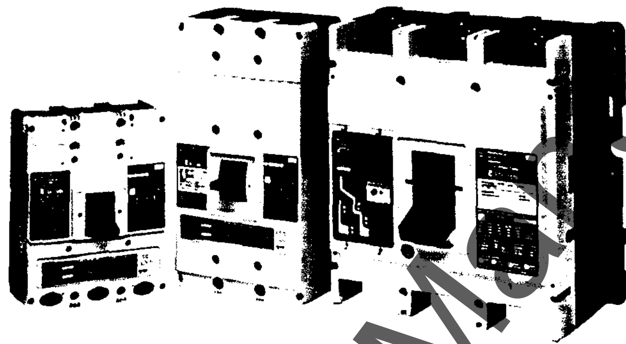
I.B. 29C891

Instructions for Operation and Maintenance of Digitrip OPTIM Trip Units

PROTECTION AND COORDINATION

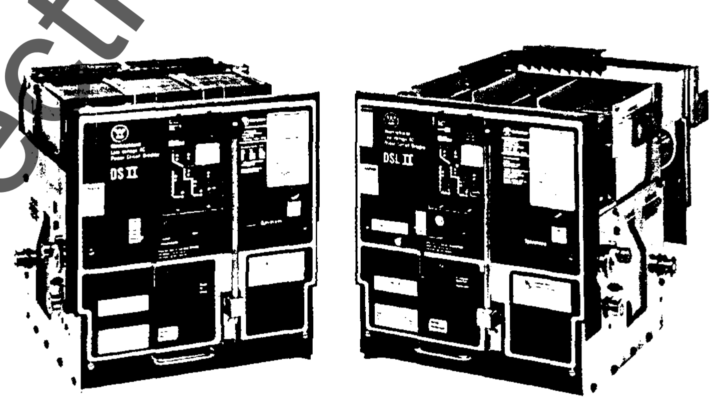
POWER QUALITY

ENERGY MONITORING



Series C̄ L, N and R Molded Case Circuit Breakers

SPB Systems Pow-R Circuit Breakers



DSII/DSLII Power Circuit Breakers

COMMUNICATIONS SYSTEMS

Effective 5/96

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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 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**). Two different models are available, OPTIM 750 and OPTIM 1050. The OPTIM 1050 Trip Unit has all the features of the OPTIM 750 Trip Unit plus several additional. The OPTIM 1050 Trip Unit's additional features are:

- Monitoring power and energy
- Monitoring current harmonics

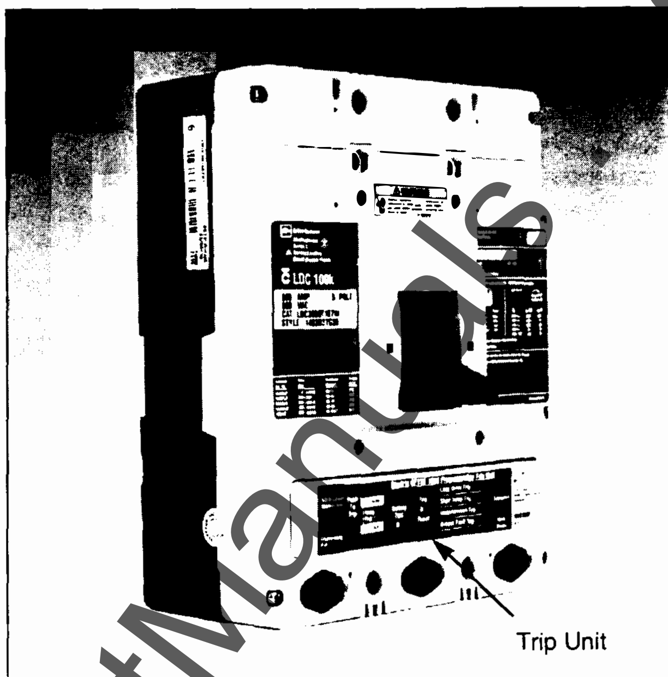


Figure 1-1 Series C̄ L-Frame Molded Case Circuit Breaker with OPTIM Trip Unit

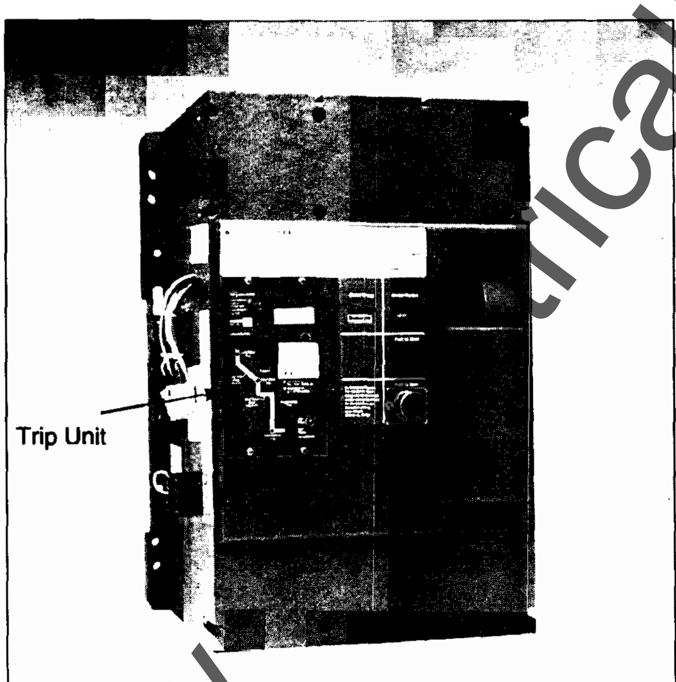


Figure 1-2 SPB Systems Pow-R Circuit Breaker with OPTIM Trip Unit

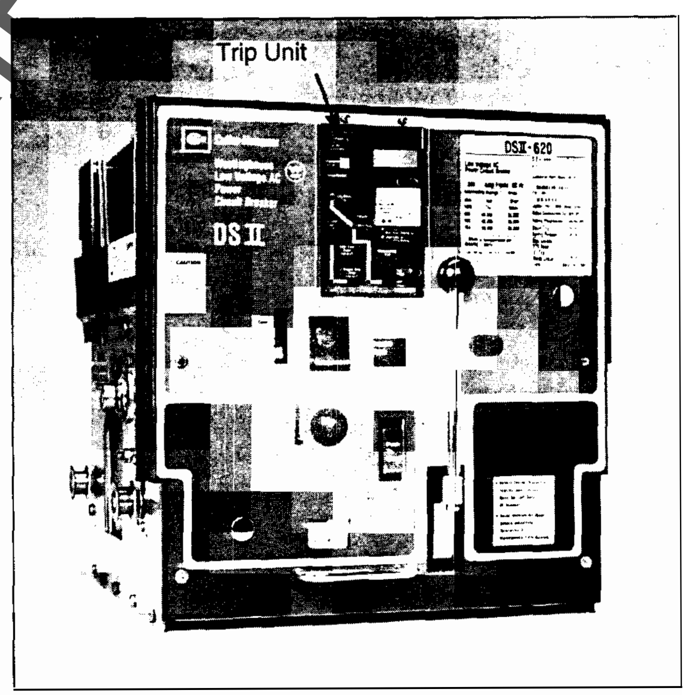


Figure 1-3 DSII Power Circuit Breaker with OPTIM Trip Unit

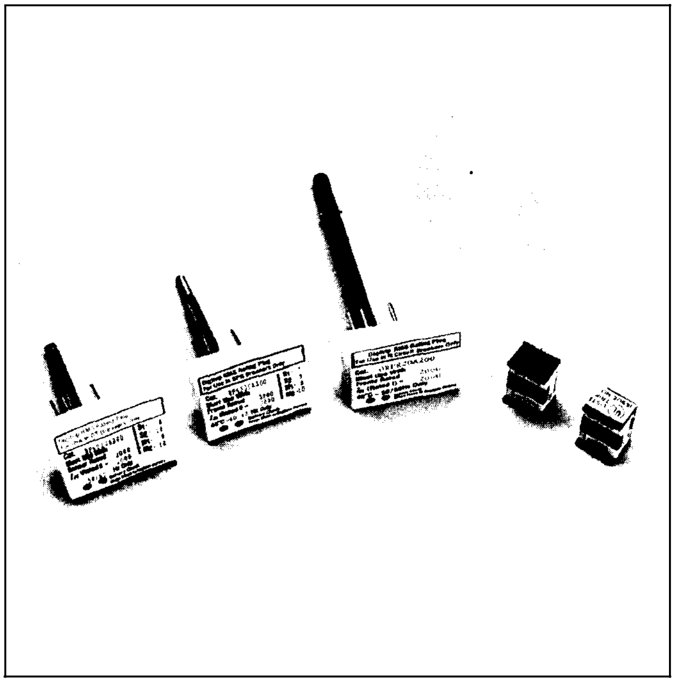


Figure 1-4 Family of Digitrip OPTIM Trip Unit Rating Plugs

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 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 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, required OPTIMizer Hand Held Programmer, the optional Breaker Interface

RMS 310	RMS 510	RMS 610	OPTIM 750	RMS 810	RMS 910	OPTIM 1050
RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing	RMS Sensing
5 Functions	9 Functions	9 Functions	10 Functions	9 Functions	9 Functions	10 Functions
Front Adjustable	Front Adjustable	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
					Harmonics	Harmonics

Figure 1-5 Family of Digitrip Trip Units Comparison

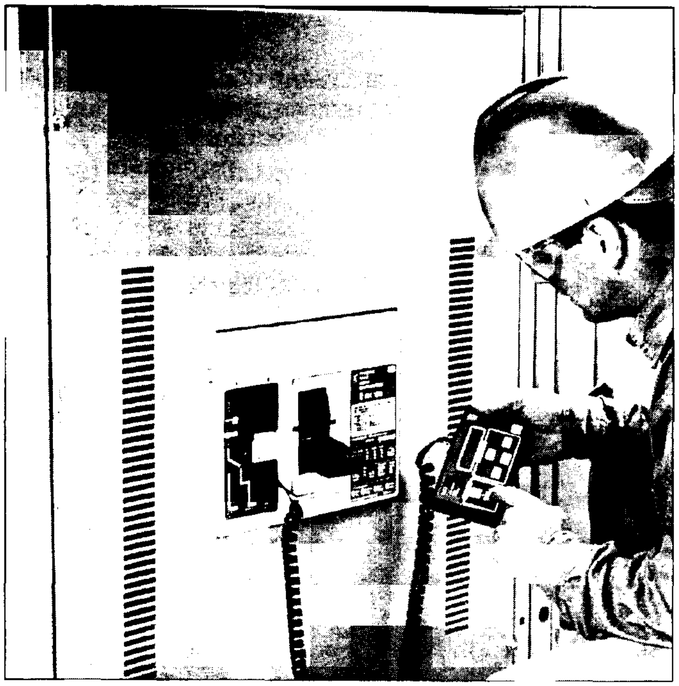


Figure 1-6 Hand Held Programmer in Use

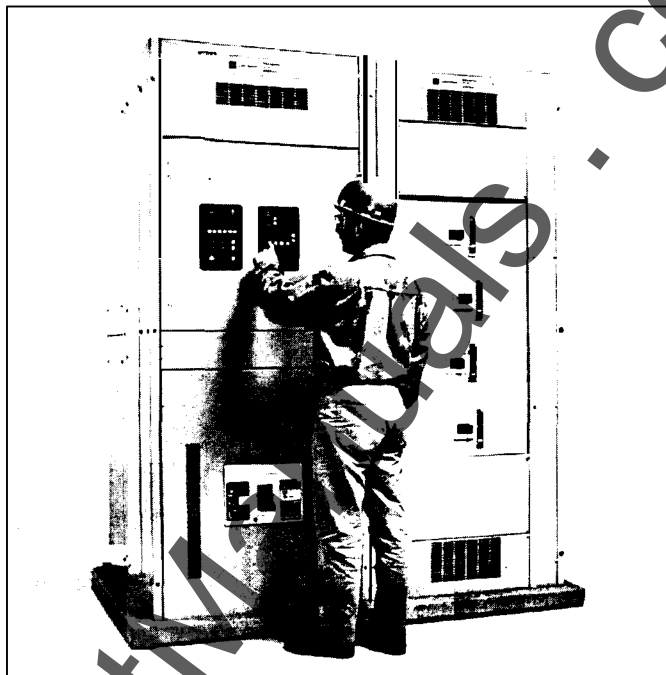


Figure 1-7 Breaker Interface Module in Service

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 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 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 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 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 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, neutral, and ground currents
- Minimum and maximum current values
- Average demand current
- Cause of trip
- Magnitude of fault current responsible for an automatic trip operation

Communications

Trip units are capable of two way communication via a network twisted pair for remote monitoring and control. The circuit breaker, through the trip unit, is able to respond to open and close commands via the communication network. To close the breaker, a motor operator accessory is required. Refer to Table **A.1** in Appendix A for motor operator instructional references.

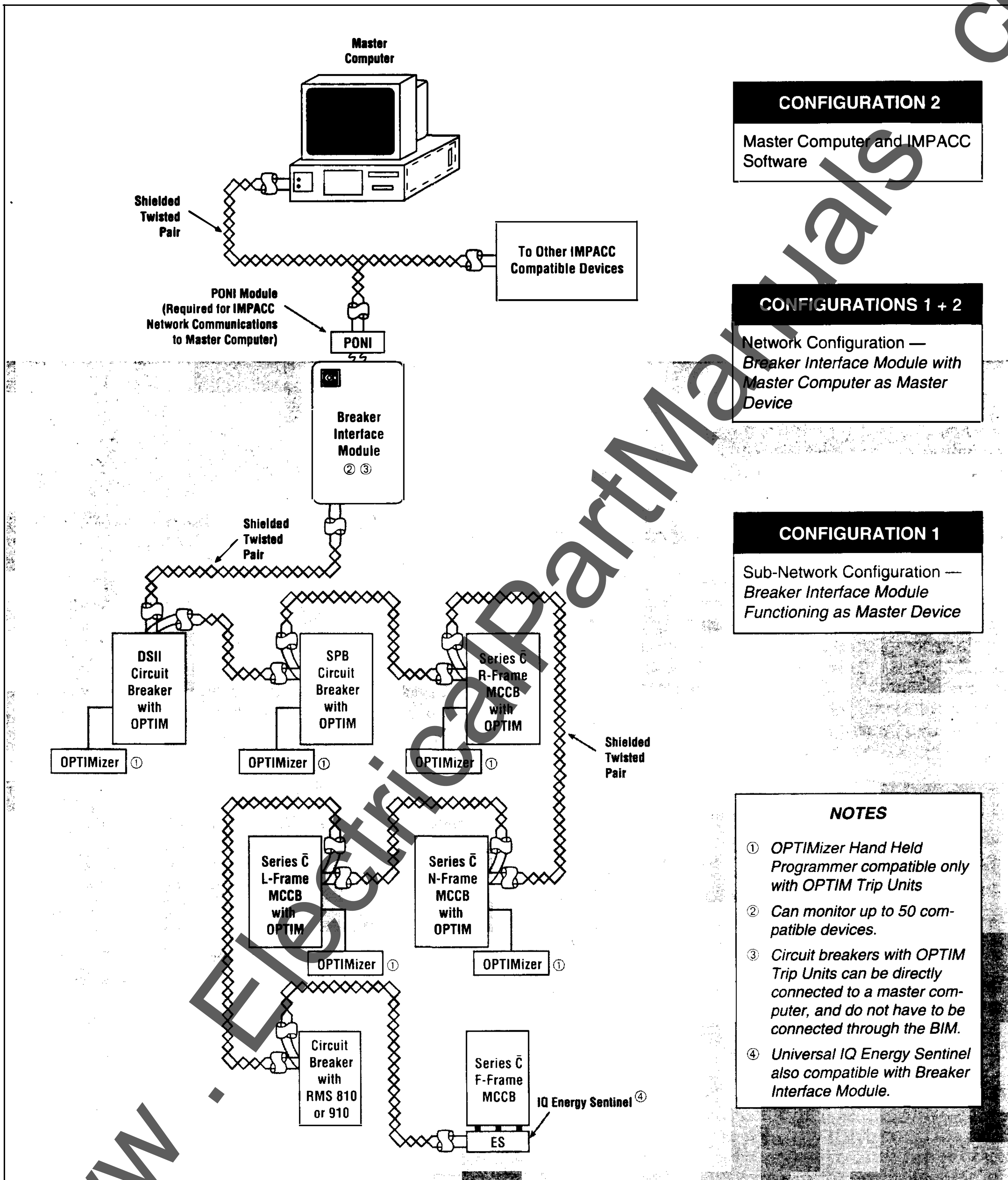


Figure 1-9 Typical System Configurations

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 requires 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
- Remote computer

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)
- Digital Waveforms (Remote computer only)

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

Although there are only two different OPTIM Trip Unit models (750 and 1050) differentiated by the features offered, there are three different non-interchangeable

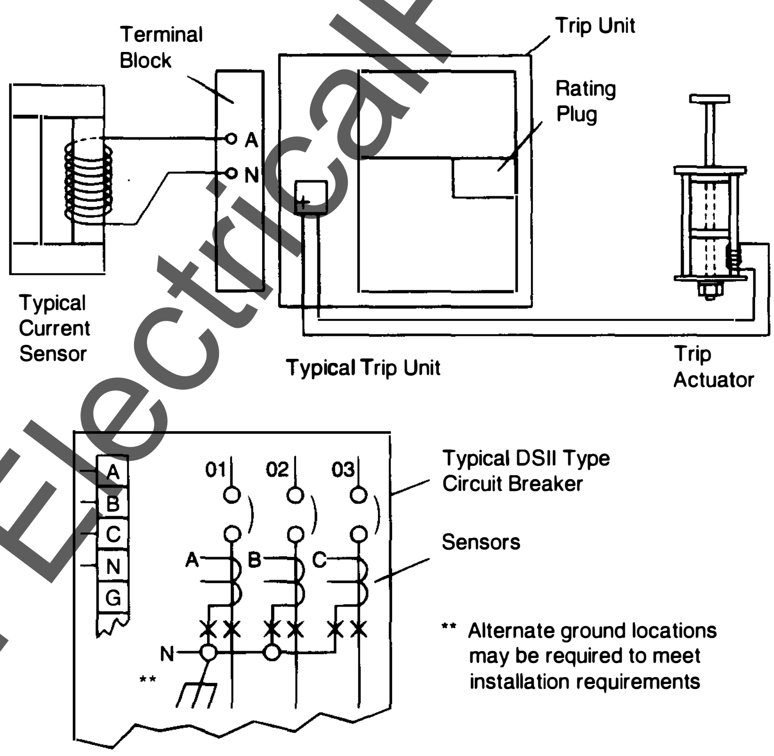


Figure 2-1 *Typical OPTIM Trip Unit Circuitry (DSII Type Circuit Breaker Shown)*

physical packages. Three different physical packages are required to accommodate the wide range of low voltage circuit breakers utilizing the Digitrip OPTIM Tripping System.

2-4 SERIES C̄ L-FRAME AND N-FRAME OPTIM TRIP UNITS

The OPTIM Trip Units used in Series C̄ L and N-Frame Circuit Breakers are permanently assembled at the factory, and are not field replaceable. The continuous ampere rating of each circuit breaker is selectable via rating plugs over the following range:

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

The OPTIM Trip Unit applicable to the Series C̄ L-Frame molded case circuit breaker 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 the Series C̄ 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.

2-4.1 L-FRAME 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

The L-Frame and N-Frame OPTIM Trip Units provide the following features (Figures **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

Notice: *Trip unit indicators can be powered from either a control power source wired externally*

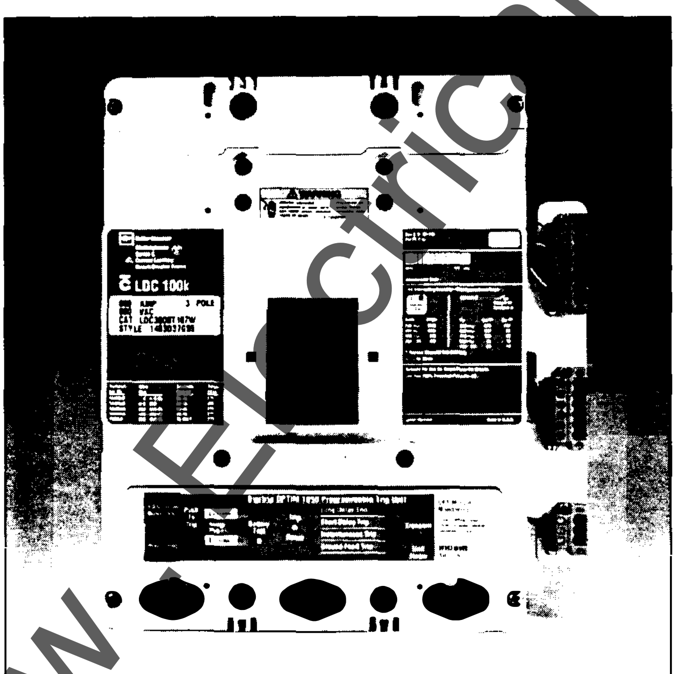


Figure 2-2 OPTIM Trip Unit Mounted in Series C̄ L-Frame Circuit Breaker

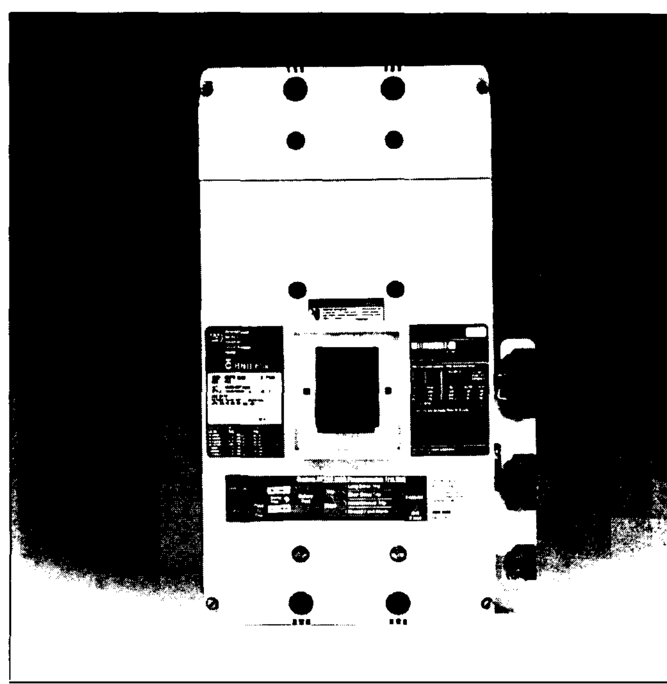
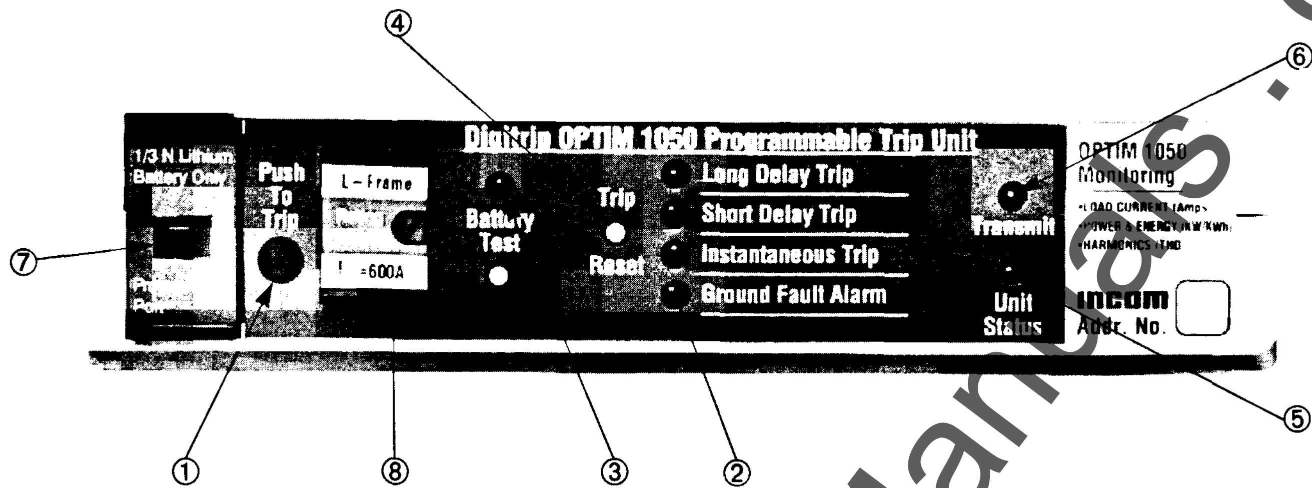


Figure 2-3 OPTIM Trip Unit Mounted in Series C̄ N-Frame Circuit Breaker



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 Status LED
⑦ Battery Compartment/Programming Port Access Cover
⑧ Rating Plug

Figure 2-4 Front View of L-Frame Type OPTIM Trip Unit (N-Frame Design is Similar)

to the circuit breaker or 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 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.

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.

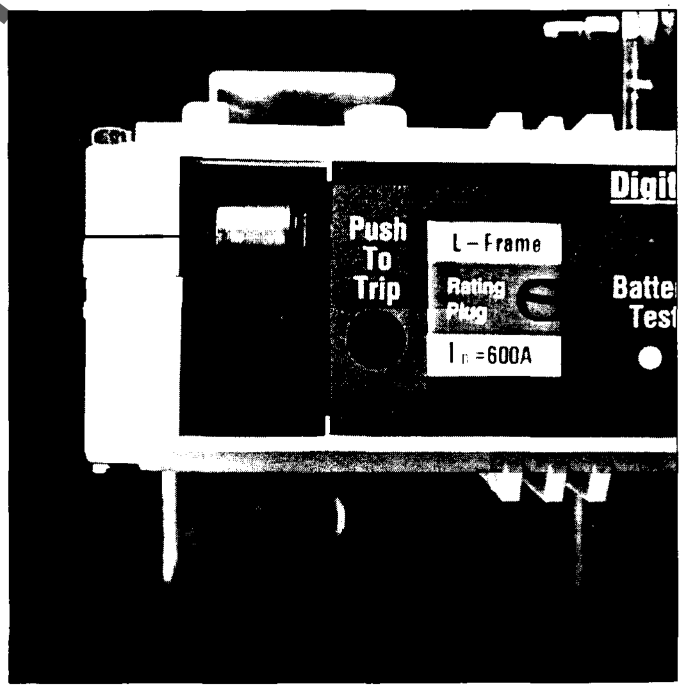


Figure 2-5 L and N-Frame Type OPTIM Trip Unit Battery Compartment

SECTION 2: HARDWARE DESCRIPTION AND EQUIPMENT INTERFACES

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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.

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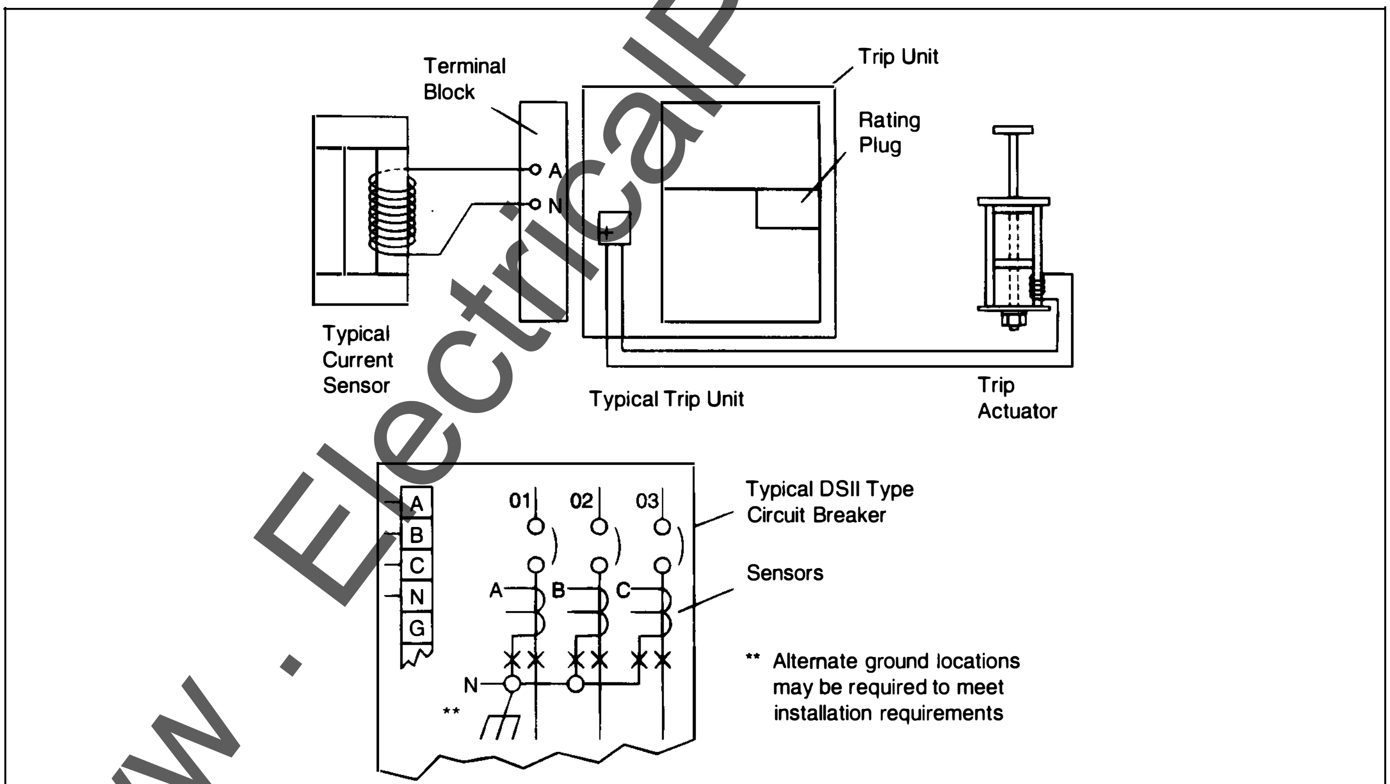

Figure 2-1 *Typical OPTIM Trip Unit Circuitry (DSII Type Circuit Breaker Shown)*

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The OPTIM Trip Unit applicable to the Series C̄ 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.

2-4.1 L-FRAME 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

The L-Frame and N-Frame OPTIM Trip Units provide the following features (Figures **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

Notice: *Trip unit indicators can be powered from either a control power source wired externally*

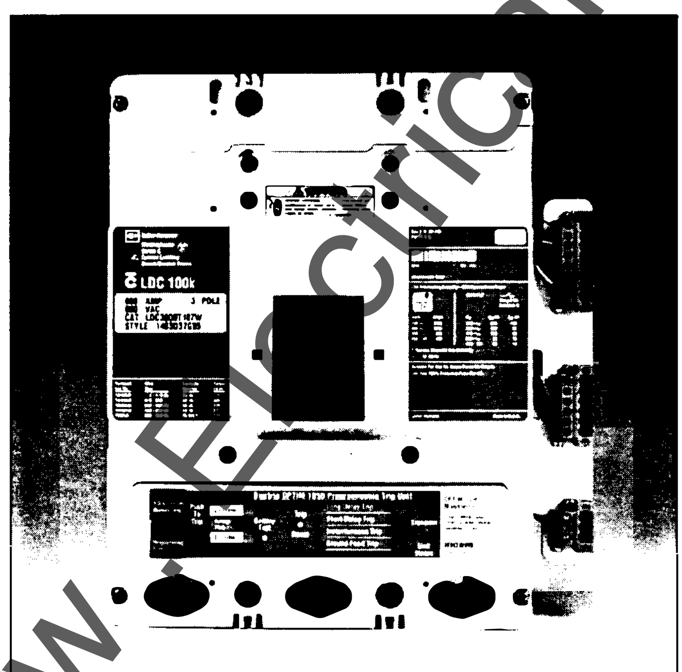


Figure 2-2 OPTIM Trip Unit Mounted in Series C̄ L-Frame Circuit Breaker

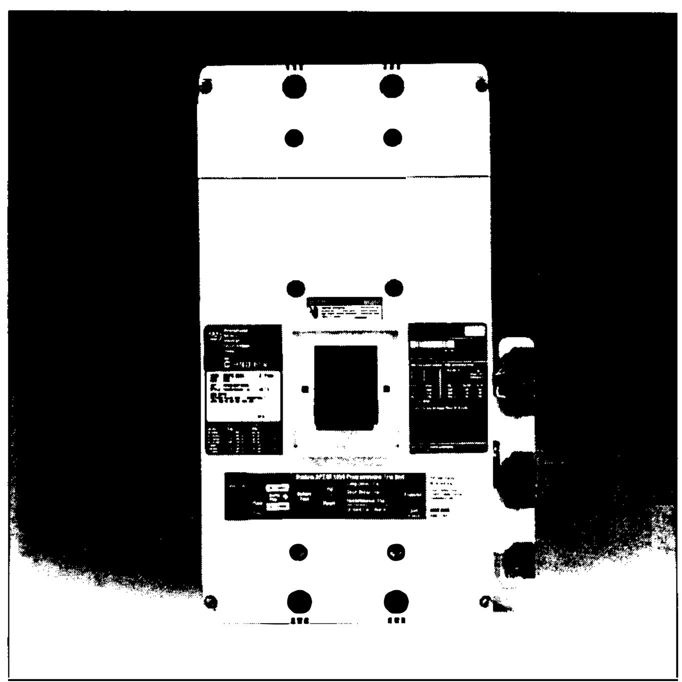
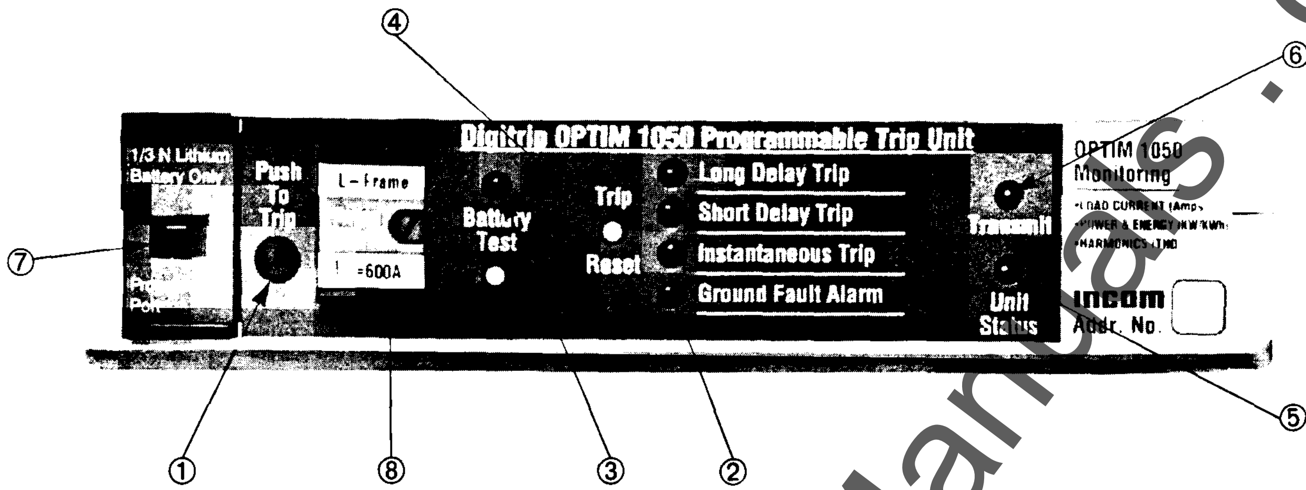


Figure 2-3 OPTIM Trip Unit Mounted in Series C̄ N-Frame Circuit Breaker



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 Status LED
⑦ Battery Compartment/Programming Port Access Cover
⑧ Rating Plug

Figure 2-4 Front View of L-Frame Type OPTIM Trip Unit (N-Frame Design is Similar)

to the circuit breaker or 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 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.

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.

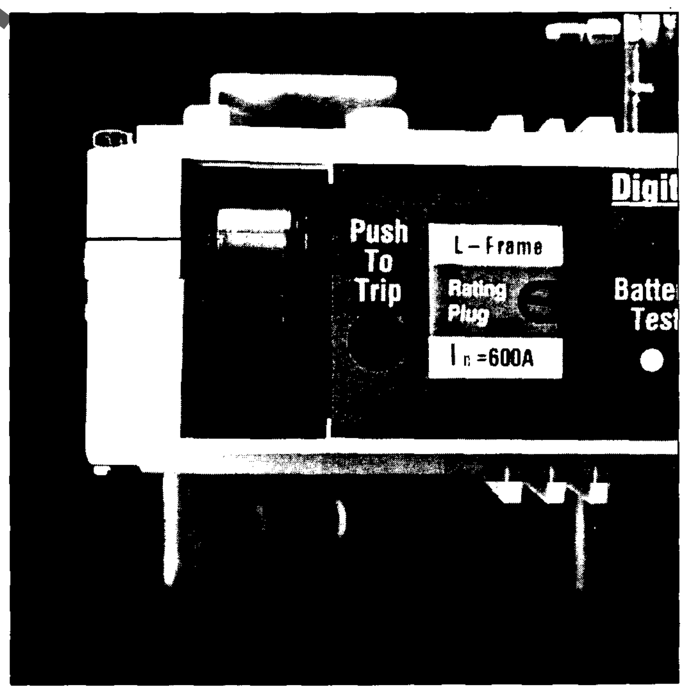


Figure 2-5 L and N-Frame Type OPTIM Trip Unit Battery Compartment

INCOM Status LED

The red transmit LED blinks 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 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 C̄ R-FRAME, SPB AND DSII/DSLII OPTIM TRIP UNITS

The OPTIM Trip Units used in Series C̄ R-Frame, SPB Systems Pow-R and DSII/DSLII circuit breakers are field replaceable. 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 C̄ 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.

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

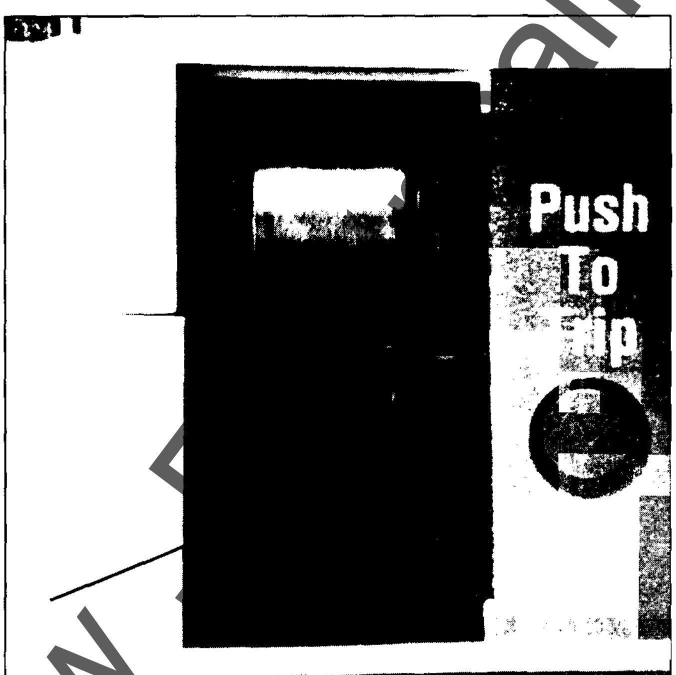
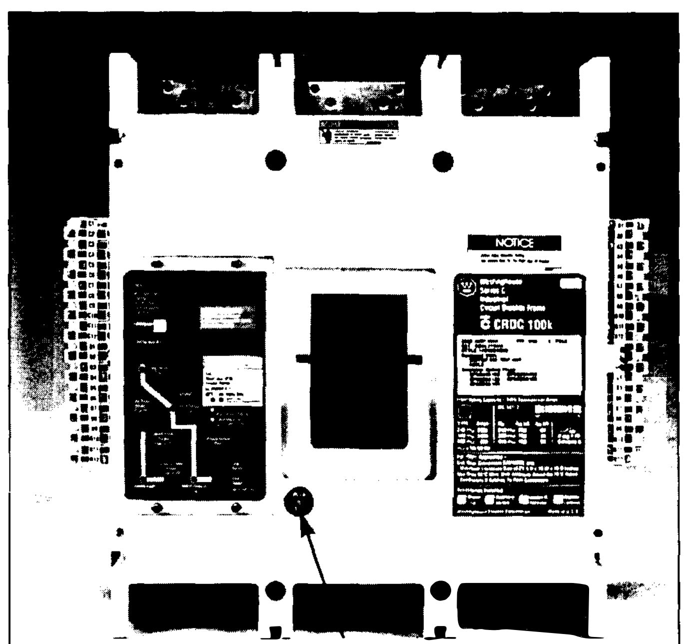


Figure 2-6 L and N-Frame Type OPTIM Trip Unit Programming Port



Push-To-Trip Button

Figure 2-7 OPTIM Trip Unit Mounted in Series C̄ R-Frame Circuit Breaker

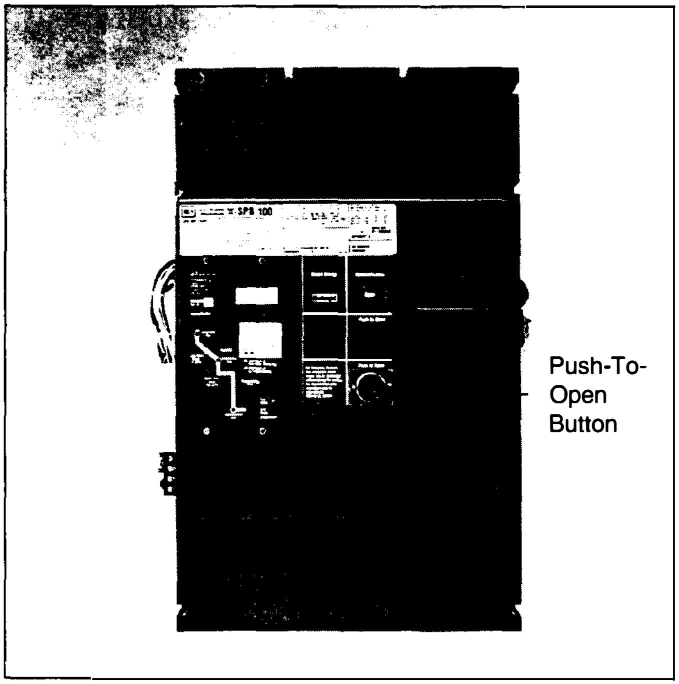


Figure 2-8 OPTIM Trip Unit Mounted in SPB Circuit Breaker

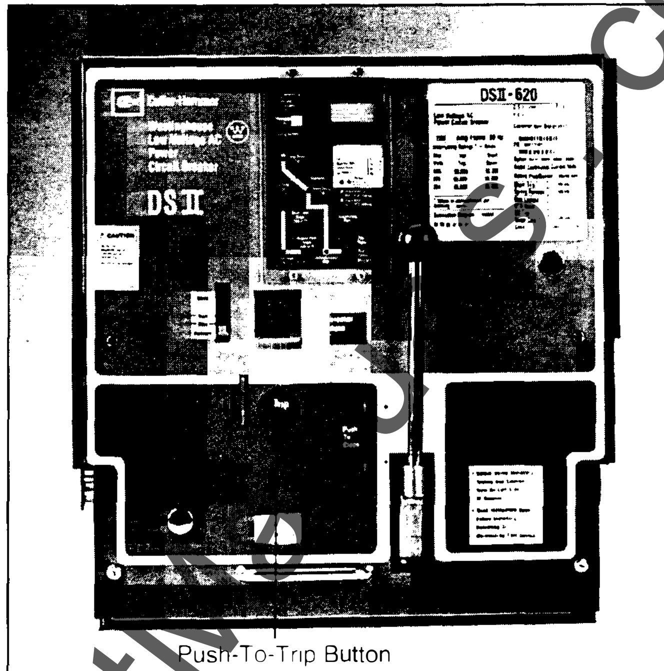


Figure 2-9 OPTIM Trip Unit Mounted in DSII Circuit Breaker

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 OPTIM Trip Unit.

Notice: *Trip unit indicators can be powered from either a control power source wired externally to the circuit breaker or 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.*

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.

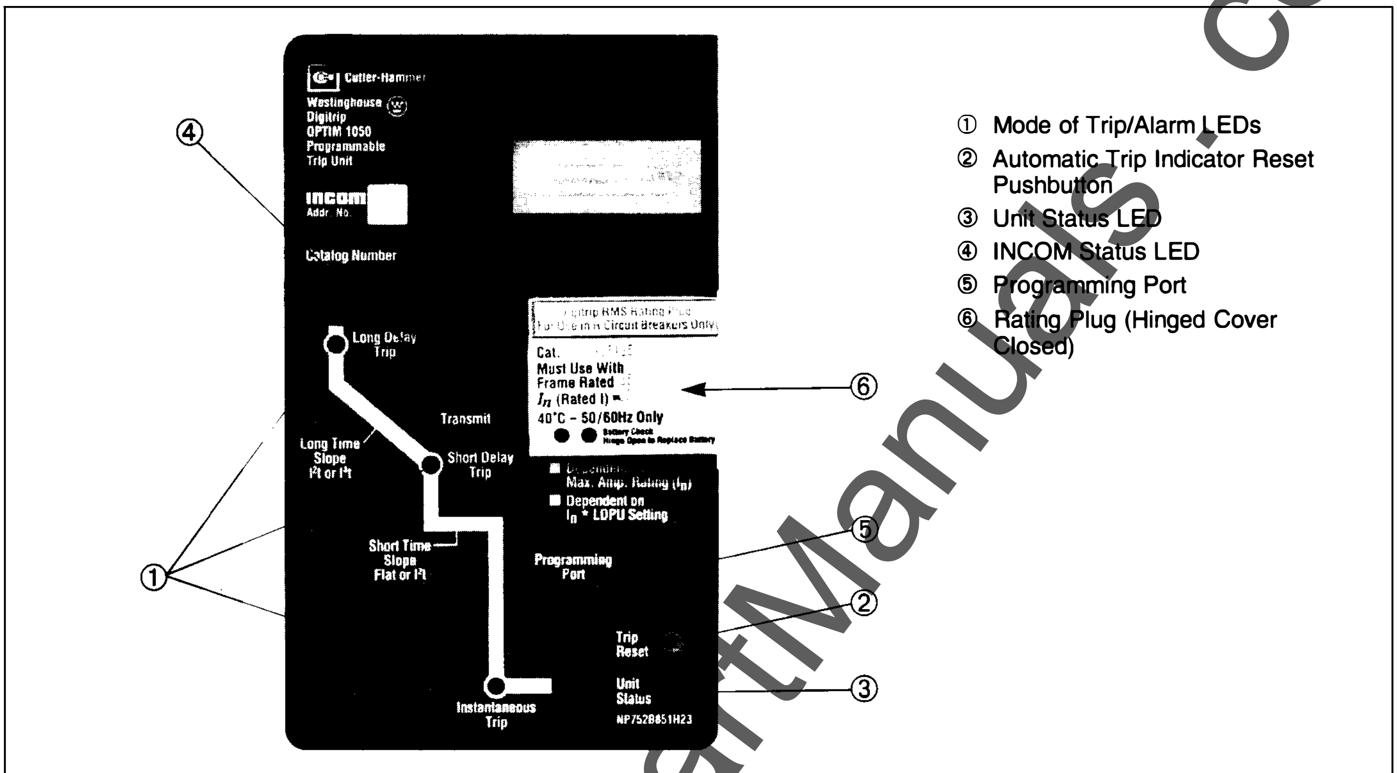


Figure 2-10 Front View of R-Frame, SPB and DSII/DSLII Type OPTIM Trip Unit with R-Frame Rating Plug Installed

INCOM Status LED

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

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

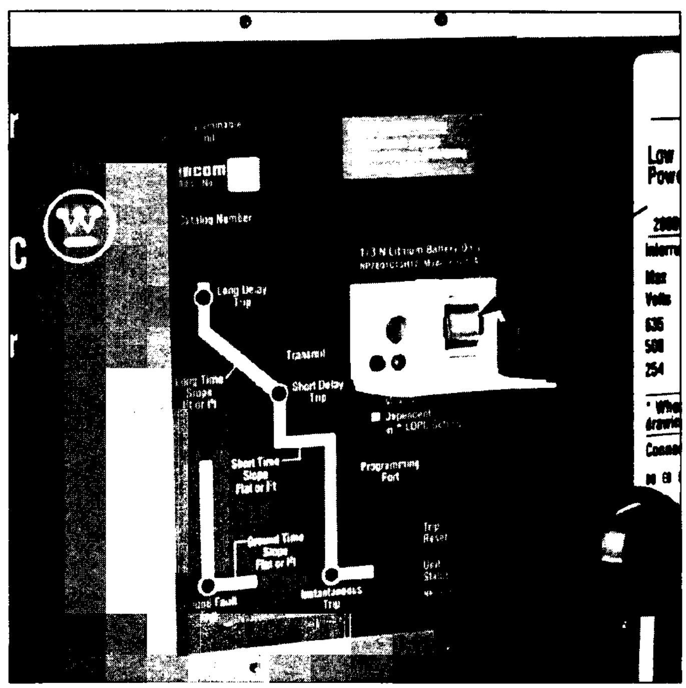


Figure 2-11 R-Frame, SPB and DSII/DSLII Type OPTIM Trip Unit Battery Compartment

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**.

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.

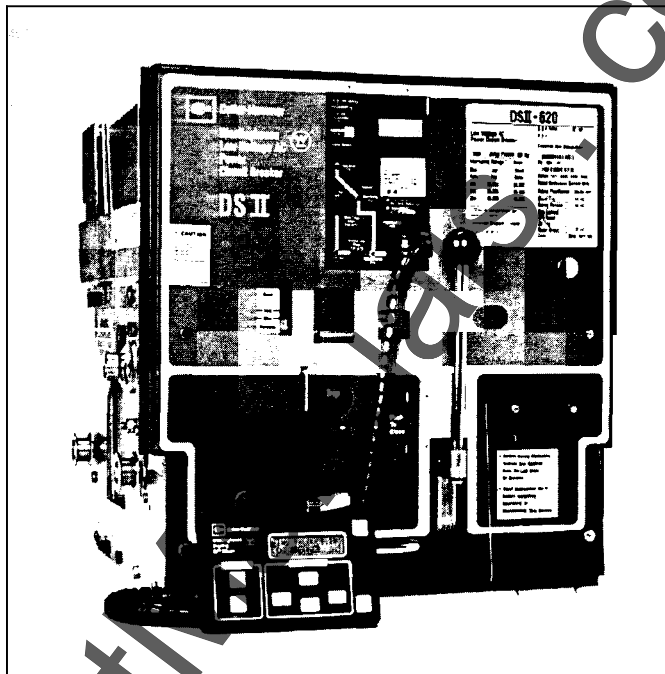


Figure 2-12 OPTIMizer Shown Connected to Programming Port of DSII Type Circuit Breaker

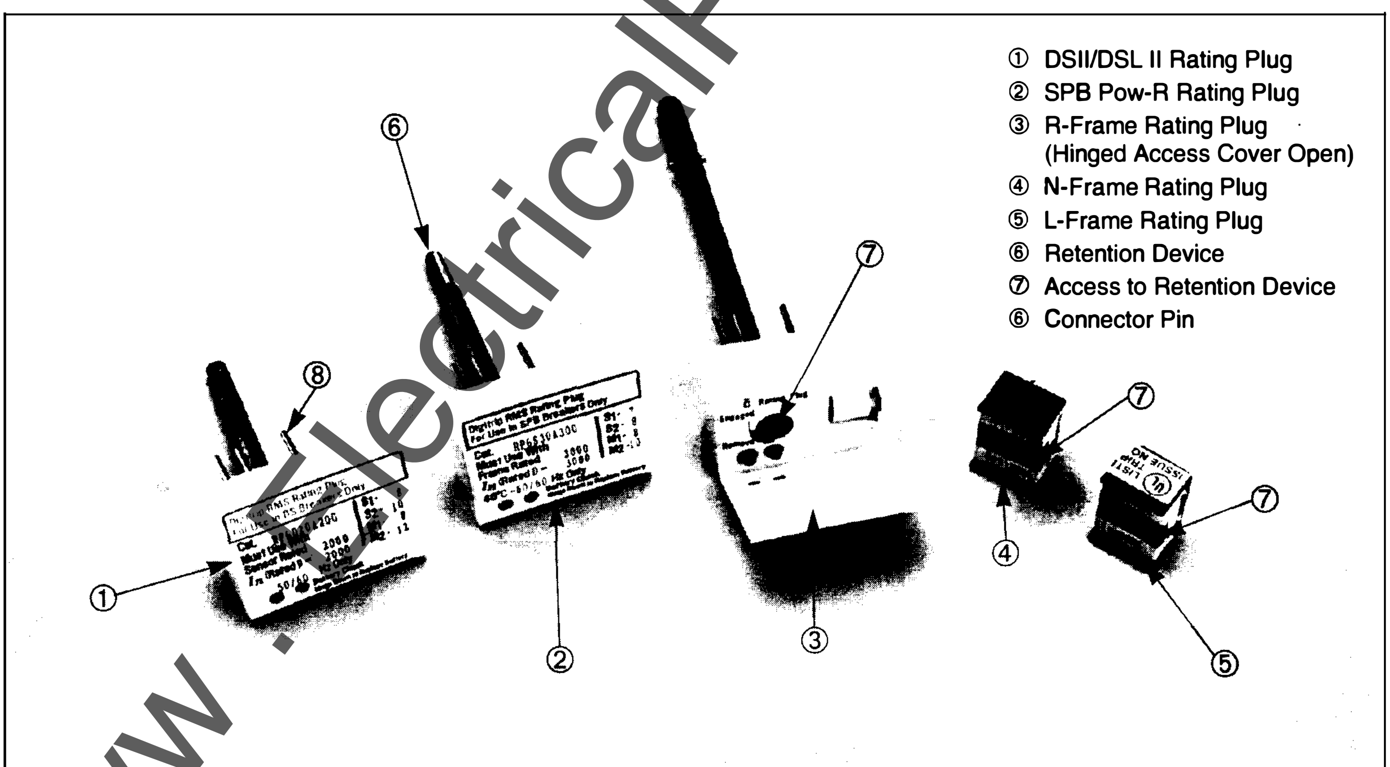


Figure 2-13 *Family of OPTIM Trip Unit Rating Plugs*

CAUTION

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 utilize a number of accessory items mounted either inside the circuit breaker or remotely to the circuit breaker, depending upon the specific circuit breaker type (Figure **2-14**). Refer to Table **2.2** for specific accessory details, catalog numbers and/or approved accessory items.

2-7.1 L-FRAME AND N-FRAME OPTIM TRIP UNIT ACCESSORIES

DC Power Supply

L-Frame and N-Frame circuit breakers with OPTIM 750/1050 Trip Units utilize a 30 Vdc power supply mounted externally to the circuit breakers to meet control power requirements for IMPACC communications. One power supply can feed up to 16 circuit breakers plus a Breaker Interface Module. The power supply must be 30 Vdc, ± 5% and capable of 400mA.

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. L-Frame and N-Frame circuit breakers utilize an externally mounted potential transformer module, which can feed up to 16 circuit breakers (Figure **2-15**).

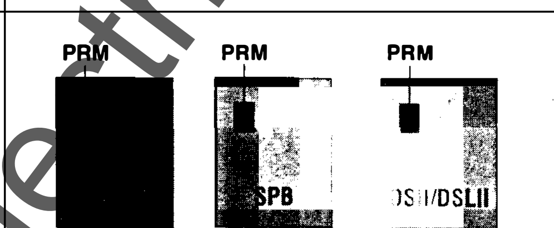
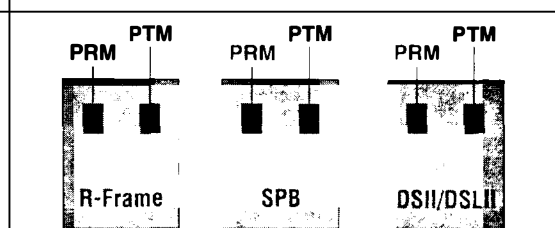
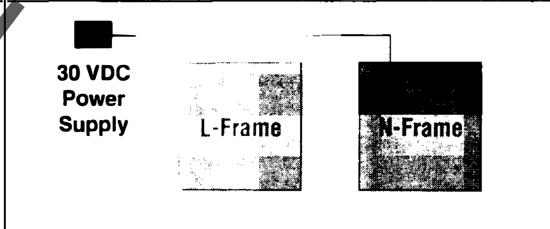
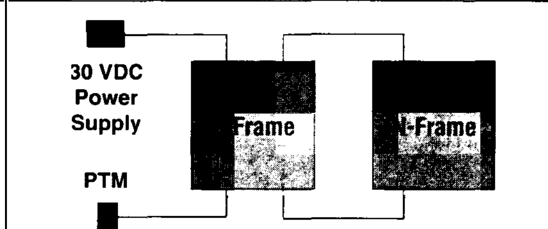
Circuit Breaker Type	**OPTIM 750 Trip Unit** *(Requires)* **POWER/RELAY MODULE (PRM)** *or* **REMOTELY MOUNTED 30 VDC POWER SUPPLY**	**OPTIM 1050 Trip Unit** *(Requires)* **POWER/RELAY MODULE (PRM)** *or* **REMOTELY MOUNTED 30 VDC POWER SUPPLY** *and* **POTENTIAL TRANSFORMER MODULE (PTM)**
Series C̄ R-Frame *and* **SPB Systems Pow-R** *and* **DSII/DSLII**		
Series C̄ L-Frame *and* **Series C̄ N-Frame**		

Figure 2-14 Power Accessory Requirements and Locations

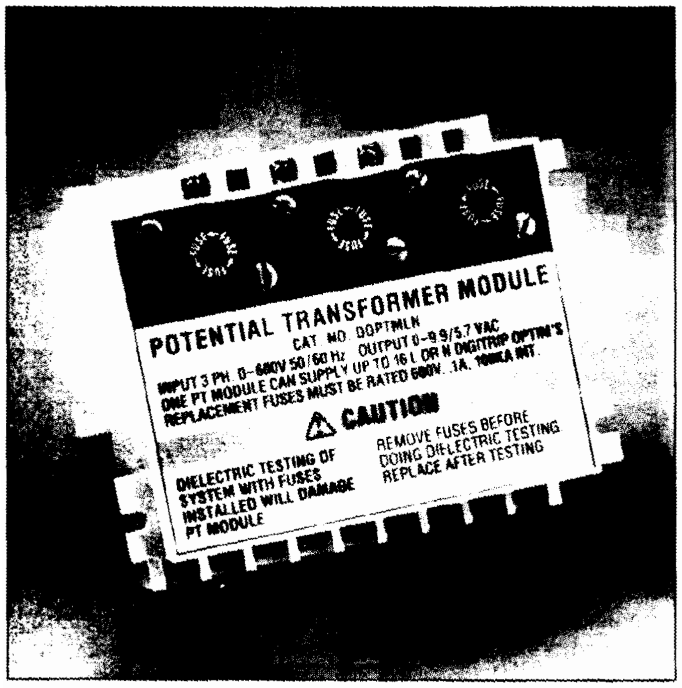


Figure 2-15 Externally Mounted Potential Transformer Module

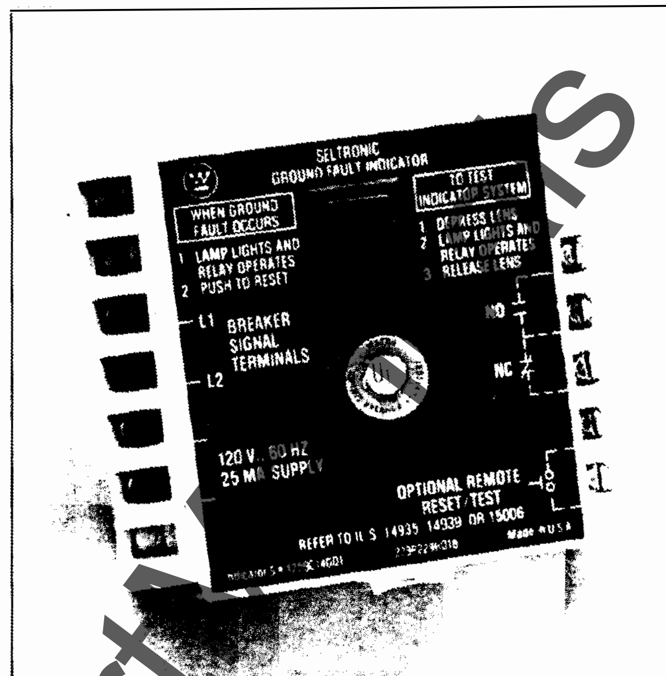


Figure 2-16 Ground Fault Alarm Indicator

Ground Fault Alarm Indicator

L-Frame 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.

2-7.2 R-FRAME, SPB AND DSII/DSLII OPTIM TRIP UNIT ACCESSORIES

Power/Relay Module (PRM)

R-Frame, SPB and DSII/DSLII circuit breakers with OPTIM 750/1050 Trip Units utilize a power/relay module to:

1 meet control power requirements
2. provide for remote alarm relay indication

The power/relay module is not required for the trip unit to provide protective functions. One power/ relay module is required for each circuit breaker, and is mounted internal to the circuit breaker. The power/relay module requires a 120 V, 50/60 Hz, 6 Va control power supply. Refer to paragraph 3-3.3 for the specific conditions under which relays operate.

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. R-Frame, SPB and DSII/DSLII circuit breakers utilize a potential transformer module mounted internal to the circuit breaker. One potential transformer module is required for each circuit breaker.

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.

Table 2.1 Rating Plugs Applicable to All OPTIM Trip Units

Series C̄ L-Frame Breaker	
Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)
70	125
90	
100	
110	
125	
125	250
150	
175	
200	
225	
250	
200	400
225	
250	
300	
350	
400	
300	600
350	
400	
500	
600	

Series C̄ N-Frame Breaker	
Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)
400	800
450	
500	
550	
600	
700	
800	
600	1200
700	
800	
1000	
1200	

Series C̄ R-Frame Breaker	
Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)
800	1600
1000	
1200	
1600	
1000	2000
1200	
1600	
2000	
1600	2500
2000	
2500	

SPB Systems Pow-R Breakers	
Rating Plug (I_n) (Amperes)	Frame Rating (Amperes)
200	400
250	
300	
400	
400	800
600	
800	
600	1200
800	
1000	
1200	
800	1600
1000	
1200	
1600	
1000	2000C
1200	
1600	
2000	
1600	2000
2000	
1600	2500
2000	
2500	
1600	3000
2000	
2500	
3000	
2000	4000
2500	
3000	
3200	
4000	
3000	5000
3200	
4000	
5000	

DSII/DSLII Breakers	
Rating Plug (I_n) (Amperes)	Sensor Rating (Amperes)
100	200
200	
200	300
250	
300	
200	400
250	
300	
400	
300	600
400	
600	
400	800
600	
800	
600	1200
800	
1000	
1200	
800	1600
1000	
1200	
1600	
1000	2000
1200	
1600	
2000	
1600	2400
2000	
2400	
1600	3200
2000	
2400	
3000	
3200	
2000	4000
2400	
3200	
4000	
3200	5000
4000	
5000	

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
Typical Assembly Mounted Power Supply	(1) International Power Sources 200 Butterfield Drive Ashland, MA 01721 (508) 881-7434
• Part No.	PU200-16, 200W, 30 Vdc
• Part No.	PU110-16, 110W, 30 Vdc
	(2) Farnell Advanced Power 32111 Aurora Road Solon, OH 44139 (216) 349-0755
• Part No	NS075030/M 75W, 30 Vdc
• Part No	NS055030/M 55W, 30 Vdc
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	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	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	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	L, N R, SPB DSII, DSLII	±0.02 ±0.02 ±0.02	Balanced three Phase Load per ANSI Std. C12.1-1988
Energy	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

Three 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** and **3.3**.

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 750 and 1050 Trip Unit Capabilities

Capability	OPTIM 750	OPTIM 1050
Protection and Coordination	Yes (10 functions LSIG)	Yes (10 functions LSIG)
Remote Communications	Yes (IMPACC Network)	Yes (IMPACC Network)
Power Quality	No	Yes (Harmonics)
Energy Monitoring	No	Yes (Power and Energy)

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 vary by the actual 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 as a result of slopes, 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 C L-Frame circuit breaker with an installed 200 ampere rating plug value (I_n).
- 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.
- If it is later determined that the Long Delay Setting (I_r) is to be 140 amperes in lieu of the original 100

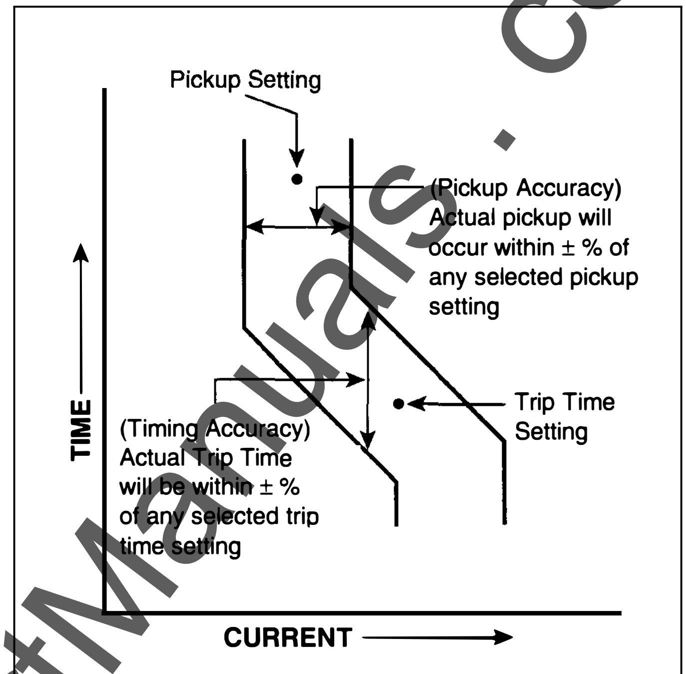


Figure 3-1 Sample of Partial Time-Current Trip Curve

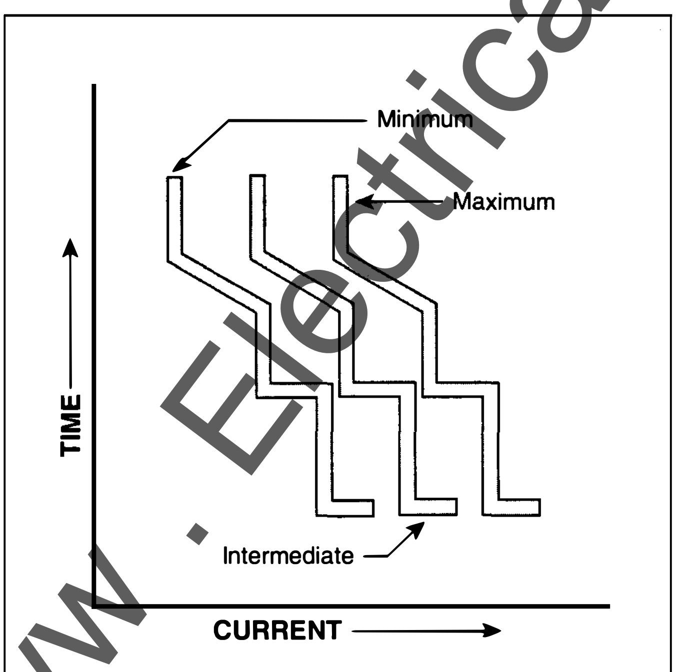


Figure 3-2 Typical Trip Curve Horizontal Movement

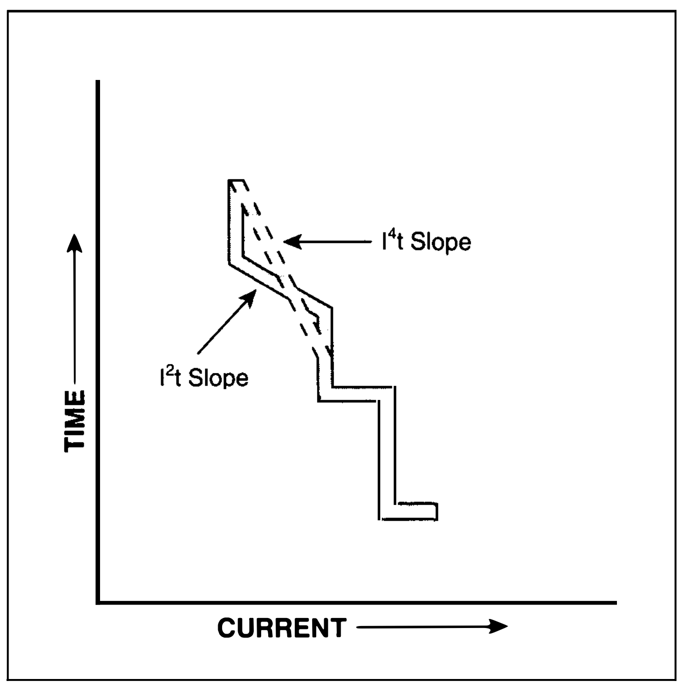


Figure 3-3 Typical Long Delay Time Slope Adjustment

Table 3.2 Digitrip OPTIM 750 Trip Unit System Capabilities Overview

TRIP UNIT TYPE	DIGITRIP OPTIM 750			
RMS Sensing	Yes			
Programmable	Yes			
CIRCUIT BREAKERS				
Types	Series C̄ L and N-Frames	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	0.4 - 1.0 x I_r	0.4 - 1.0 x I_r	0.4 - 1.0 x I_r	0.4 - 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)

Table 3.3 Digitrip OPTIM 1050 Trip Unit System Capabilities Overview

TRIP UNIT TYPE	DIGITRIP OPTIM 1050			
RMS Sensing	Yes			
Programmable	Yes			
CIRCUIT BREAKERS				
Types	Series C̄ L and N-Frames	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	0.4 - 1.0 x I_r	0.4 - 1.0 x I_r	0.4 - 1.0 x I_r	0.4 - 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)

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
- LSIA
- LSIG

LSI Configuration

The LSI configuration provides a required long delay protection and a user selectable short delay protection and/or instantaneous protection.

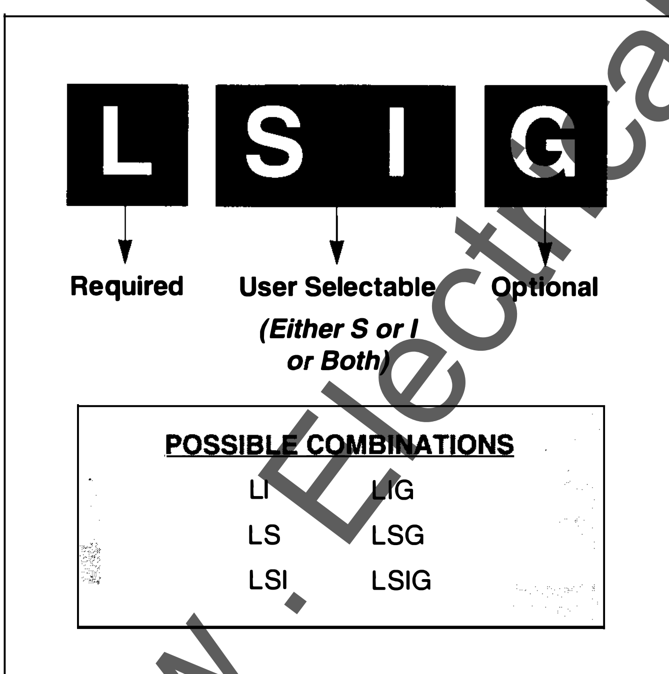


Figure 3-4 Overcurrent Protective Function Combinations

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 remote alarm of the condition. It does not trip the circuit breaker due to a ground fault condition.

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.

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

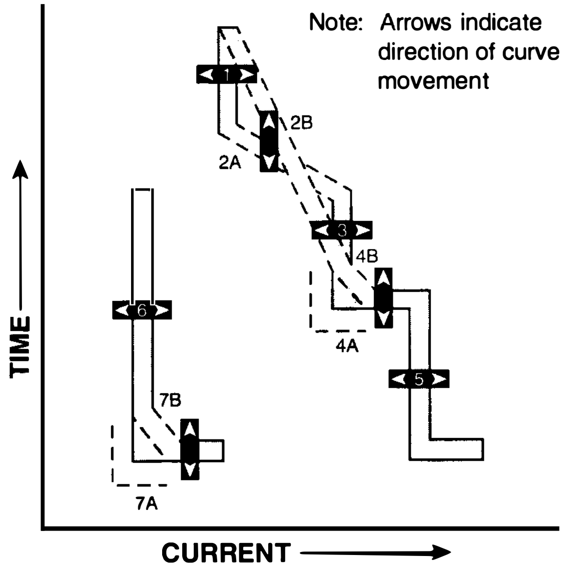
Notice: *Short delay and instantaneous cannot be disabled at the same time.*

The three trip unit configurations are available by circuit breaker type as follows (Tables **3.2** and **3.3**):
- Series $\bar{C}$ L and N-Frame (LSIA and LSIG)
- Series $\bar{C}$ 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
- 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



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)

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

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 0.4 results in a setting of 160 amperes.

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 L, N and R-Frames and SPB, the calibration is for nominally **116% (I_r)**

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.

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.

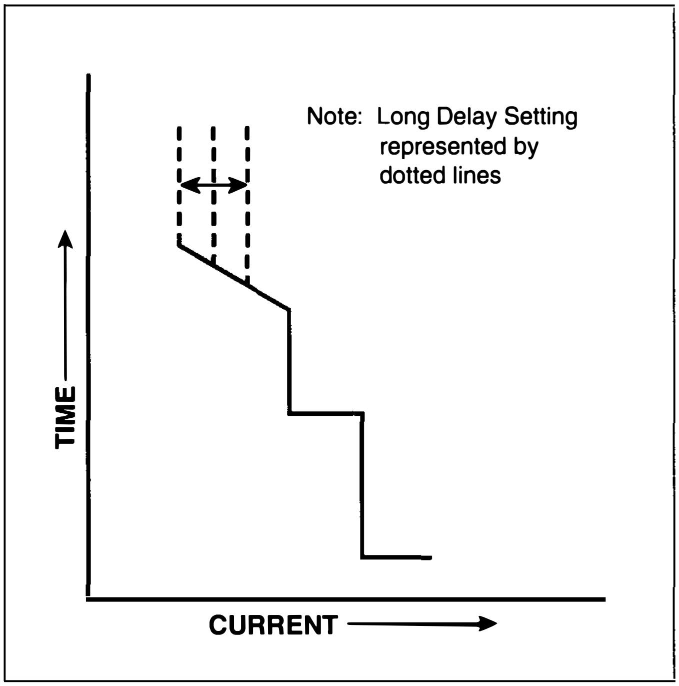


Figure 3-6 Typical Long Delay Setting Adjustment

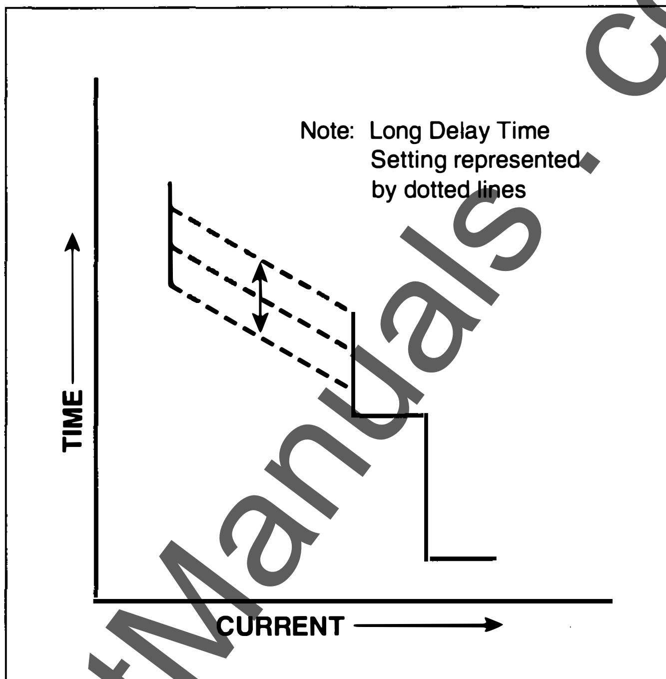


Figure 3-7 Typical Long Delay Time Adjustment (I^2t) Response

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.

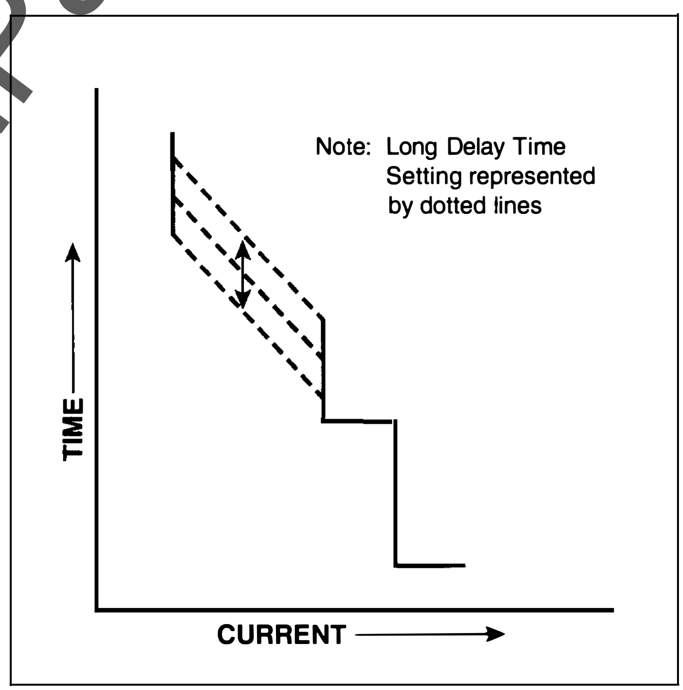


Figure 3-8 Typical Long Delay Time Adjustment (I^4t) Response

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 will 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 an impending trip condition. The programmable range is as follows:

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

Alarm indicators are provided as follows:

- L and N-Frame Breakers
  - BIM Contacts
  - LED (Long Delay Pickup) flashes on breaker trip unit
- R-Frame, SPB and DSII/DSLII Breakers
  - BIM Contacts
  - LED (Long Delay Pickup) flashes on breaker trip unit
  - 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

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 over a range of factors times the long delay current setting (I_r). The programmable range depends on the circuit breaker type as follows:

- Series $\bar{C}$ 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)
- 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 range is established 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.

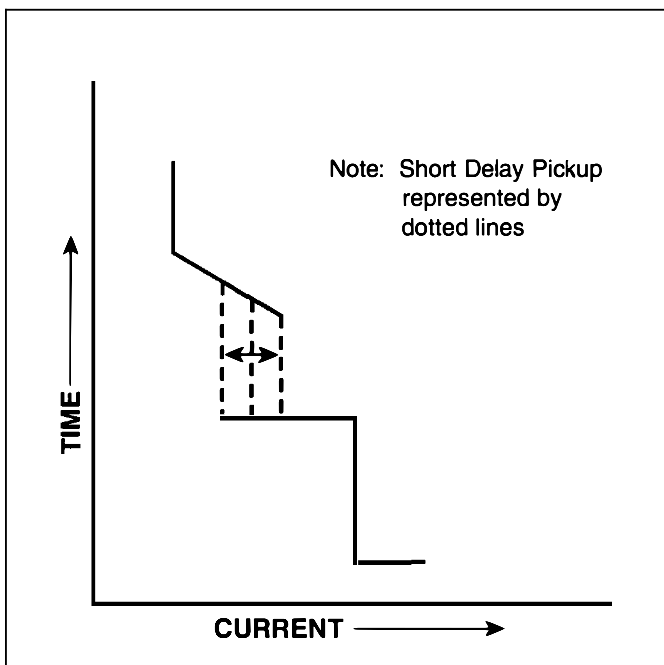


Figure 3-9 Typical Short Delay Pickup Adjustment

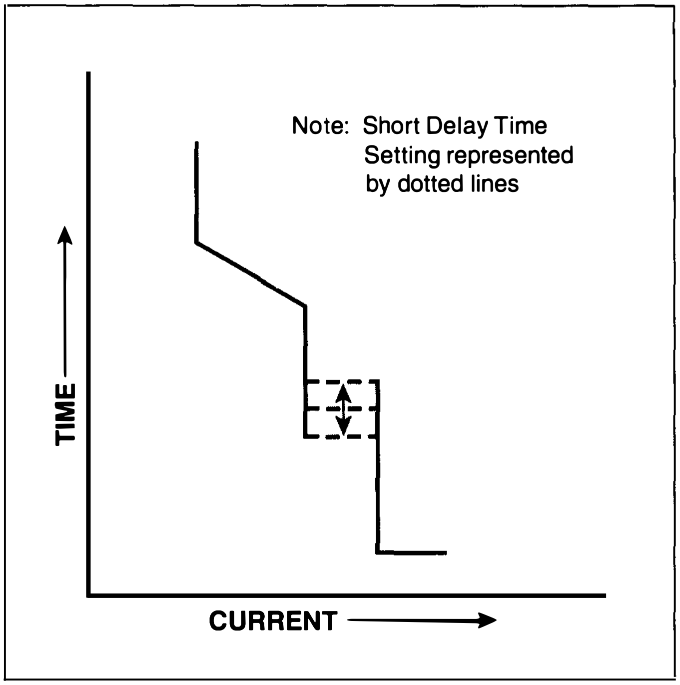


Figure 3-10 Typical Short Delay Time Adjustment, Flat Response

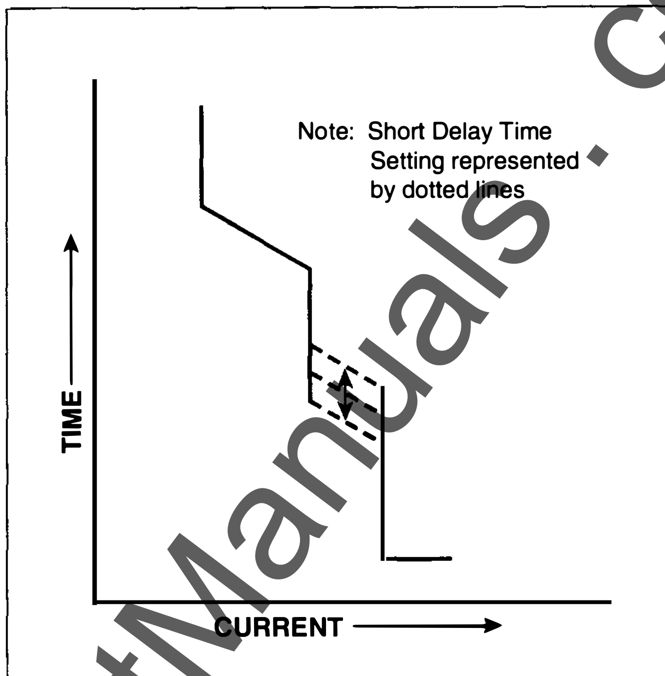


Figure 3-11 Typical Short Delay Time Adjustment, (I^2t) Response

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

Zone selective interlocking is provided for the short delay time and the ground fault delay tripping functions for improved system coordination. Digitrip OPTIM Trip Unit zone selective interlocking is compatible with all other Digitrip Trip Units. Figure **3-12** illustrates a typical ground fault protection scheme using zone selective interlocking.

The zone selective interlocking feature of Digitrip OPTIM Trip Units will initiate a trip immediately when the fault is within the circuit breaker's zone of protection. This interlocking provides fast tripping within the zone of protection, and gives positive coordination between mains, feeders and downstream circuit breakers. The interlocking signal requires only a pair of wires from the downstream circuit breaker to the upstream circuit breaker. Refer to the wiring diagrams presented in Table **A.1** of Appendix A for specific connection schemes.

For faults outside the zone of protection, the OPTIM Trip Unit on the circuit breaker nearest the fault sends an interlocking signal to the OPTIM Trip Units of the upstream circuit breakers. This interlocking signal restrains immediate tripping of the upstream circuit breakers until their programmed coordination times are reached. Thus zone selective interlocking applied correctly can result in minimum service disruption and reduced damage due to short circuit or ground fault conditions.

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

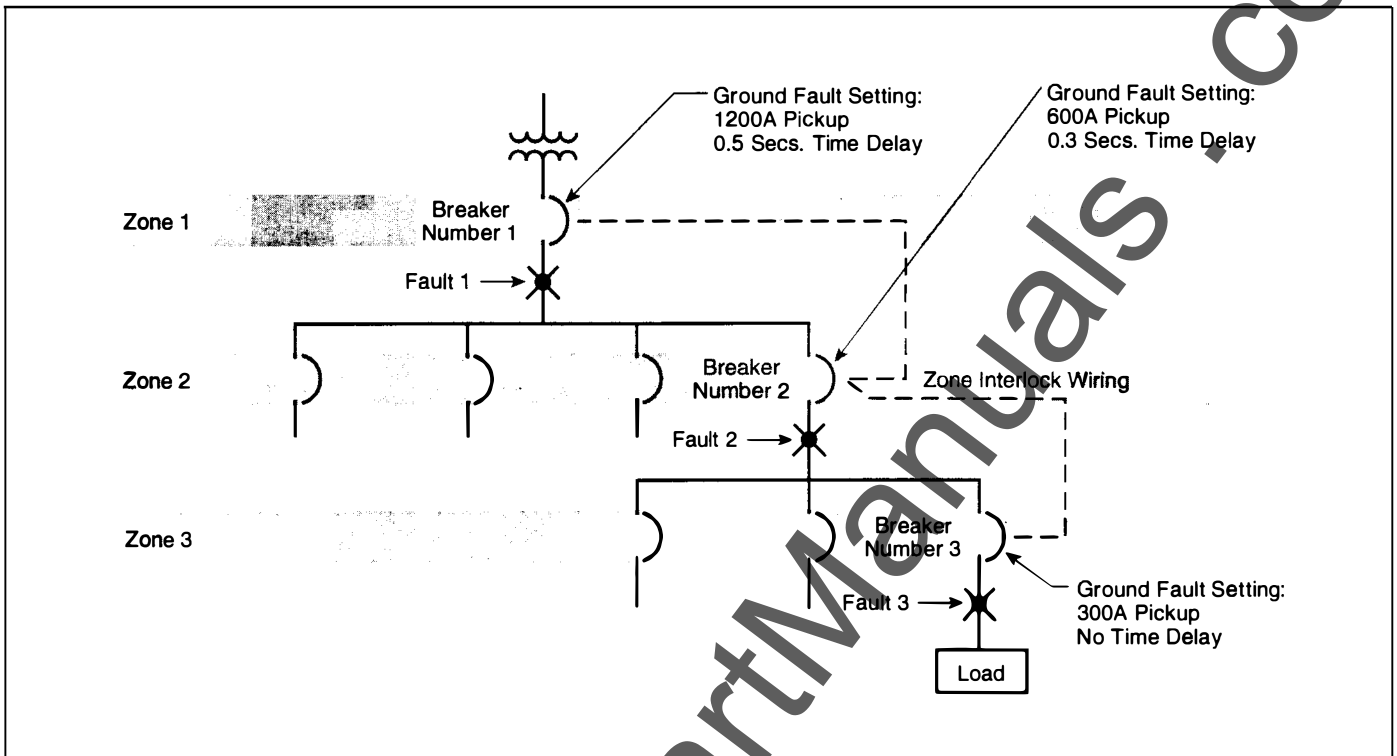


Figure 3-12 Multi-layer Ground Fault Protection Scheme Using Zone Selective Interlocking

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 over a range of factors times the plug rating value (I_n). The programmable range depends on the circuit breaker type as follows:

- Series C̄ L and N-Frames
  - **2.0 to 8.0 times (I_n) in 0.1 increments**
- Series C̄ 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** 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 circuit 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 enabled for approximately ten cycles following the initial current flow through the circuit breaker, provided the load current exceeds approximately 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 time function before tripping. If the fault current exceeds the short-time withstand cur-

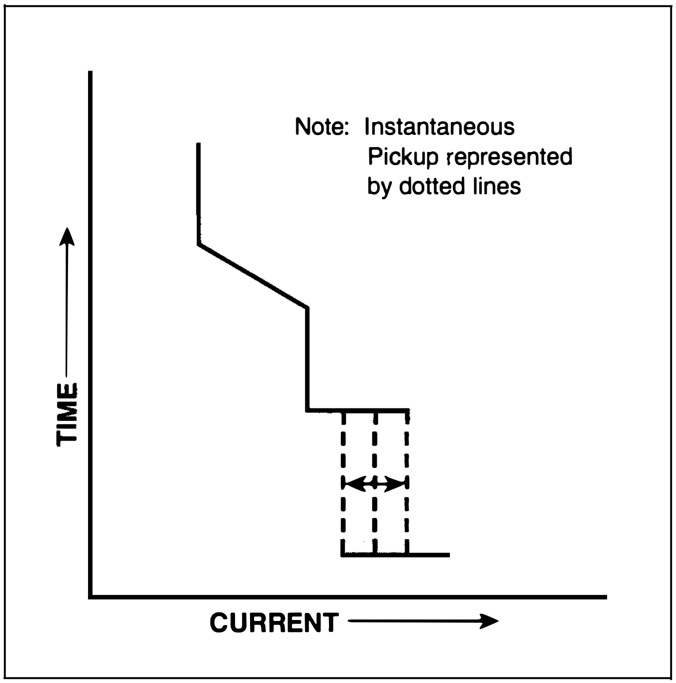


Figure 3-13 Typical Instantaneous Pickup Adjustment

rent capability of the circuit breaker, an 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 type circuit breakers, where the withstand and interrupting capabilities are the same. It protects against a short-circuit current that exceeds the short-time withstand current capability of the circuit breaker, when the discriminator has been made inactive. 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 is available as part of the trip unit (Tables **3.2** and **3.3** and Figure **3-4**). The available trip unit options by circuit breaker type are as follows:

- Series $\bar{C}$ L and N-Frame Circuit Breakers
  - **LSIG** (with ground fault trip)
  - **LSIA** (with ground fault alarm)
- Series $\bar{C}$ R-Frame, SPB Pow-R and DSII/DSLII Circuit Breakers
  - **LSIG** (with ground fault trip)
  - **LSIA** (with ground fault alarm)
  - **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
- 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.

A standard OPTIM trip assembly includes all the necessary equipment for ground fault protection when the system neutral is grounded but the neutral is not carried with the phase conductors. 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 neutral is grounded and a neutral conductor is carried is carried with the phase conductors, it is necessary to use an additional sensor for the purpose of canceling out any residual current in the phase conductors. This sensor is mounted separately on the neutral conductor at the point where the neutral conductor connects to the neutral bus. These sensors are usually duplicates of the phase sensors internal to the circuit breaker.

Depending on the installation requirements, other ground fault sensing schemes can also be employed. Two common methods are: ground return and zero sequence. Either method can be used with the OPTIM Trip Unit. Either application uses a ring type current sensor. For the ground return method, the sensor is arranged to have the system main bonding jumper pass directly through the sensor. The zero sequence method has all phase and neutral conductors pass through the sensor.

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**).

Other compatible Ground Fault Alarm indicators are also available, depending upon the circuit breaker type:

- **Series C̄ L and N-Frame**
  - A relay module, for use with Series C̄ L and N-Frame circuit breakers, may be remotely mounted to provide an indicator light and contacts to operate other devices. Refer to Table **A.1** of Appendix A for specific GFI references.
- **Series C̄ R-Frame, SPB Pow-R and DSII/DSLII**
  - A relay module is mounted internally in Series C̄ R-Frame, SPB Pow-R and DSII/DSLII circuit breakers. The relay contacts operate after the breaker trips due to a ground fault condition.

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 C̄ 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 C̄ 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.

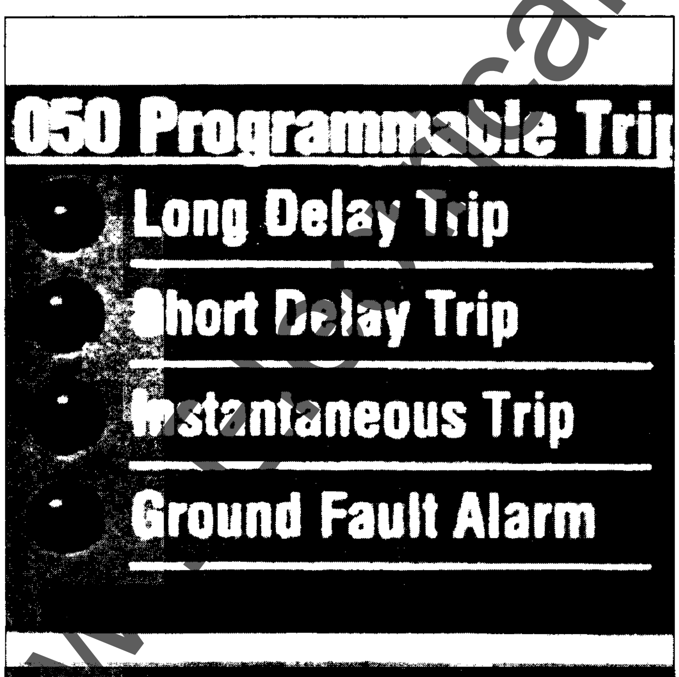


Figure 3-14 Ground Fault Alarm LED

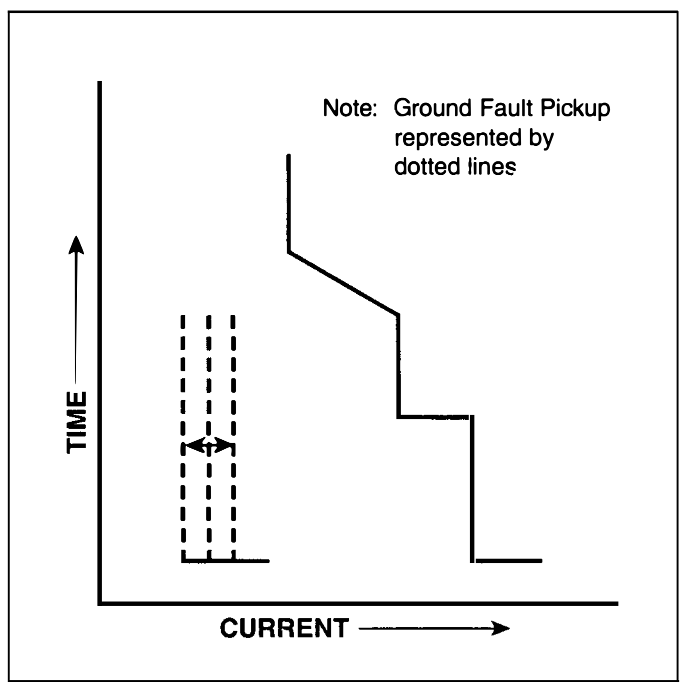


Figure 3-15 Typical Ground Fault Pickup Adjustment

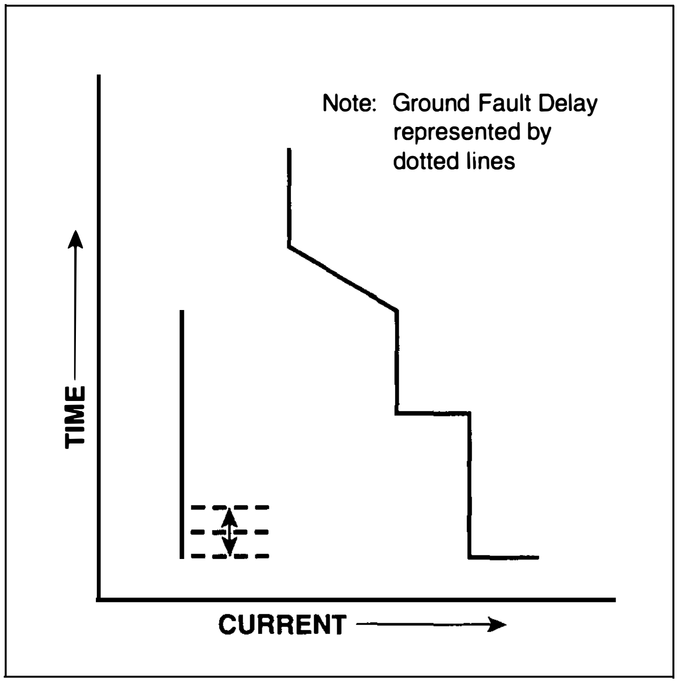


Figure 3-16 Typical Ground Fault Time Delay Adjustment, Flat Response

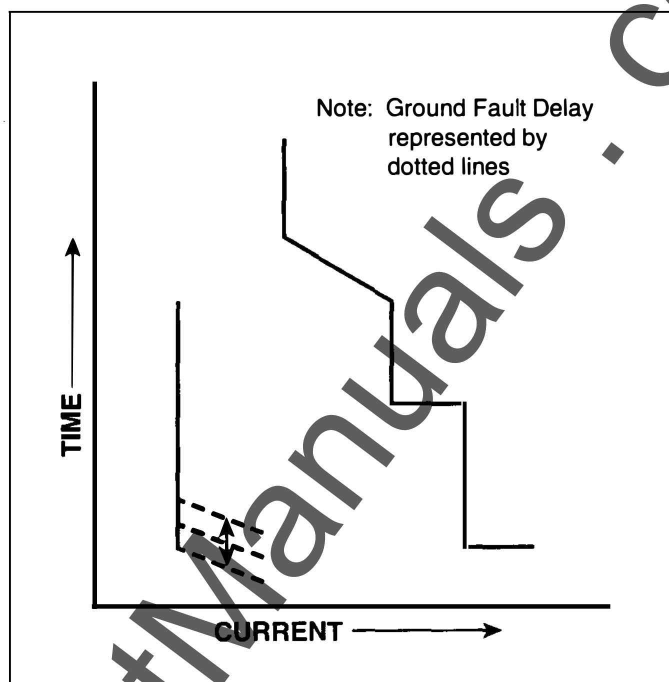


Figure 3-17 Typical Ground Fault Time Delay Adjustment, (I^2t) Response

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

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

Normally, the ground fault pickup, which initiates the timing routine, must be maintained throughout the timing cycle for tripping to occur. If conditions change and the fault current value is not maintained above the pickup level, the tripping system will reset. Ground faults are, however, 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.

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. The memory retains the presence of a ground fault which was significant enough to initiate ground fault pickup but not sustained long enough to trip the circuit breaker. The time retained in memory 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 effect 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 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

System programmed, monitored, calculated, event and help information are 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 (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 any or all of the following:

- Present magnitude phase A, B and C currents
- Present magnitude ground current
- 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 memory the reason for the trip, date/time of trip and any or 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 C̄ R-Frame, SPB Pow-R and DSII/DSLII Contacts

A means is provided with OPTIM Trip Unit equipped R-Frame, SPB and DSII/DSLII circuit breakers for remote signal contacts. A power relay module, described in paragraph 2-7.2, is mounted internally to Series C̄ R-Frame, SPB Pow-R and DSII/DSLII circuit breakers to provide required power and contacts for the remote signals.

Series C̄ L and N-Frame Contacts

The Series C̄ L and N-Frame breakers provide alarm contacts by either of two options:

- A remotely mounted ground fault indicator module may by hard wired directly to the accessory's terminal on the right hand side of the breaker. 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 fault 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.

The contacts operate when the trip unit detects the following conditions:

- High load alarm
- Long delay trip alarm
- Short circuit trip alarm
- Ground fault trip alarm
- Neutral overcurrent alarm
- Communications open/close contact

High Load Alarm

The high load alarm operates when the load current exceeds a selected percentage of the long delay setting (I_r). The high load alarm is programmable from 40 to 100% of the long delay setting **(40-100% x I_r)**. The contact operates after the programmed setting has been reached and maintained for 40 seconds. The 40 second delay allows the system to ride through momentary high load conditions and, therefore, avoids nuisance alarms.

Long Delay Trip Alarm

The long delay trip alarm contact operates after the circuit breaker trips due to overload conditions which exceeded the long delay trip settings.

Short Circuit Trip Alarm

The contact operates after the circuit breaker trips due to one of the following:

- Instantaneous trip
- Short delay trip
- Discriminator trip
- Override trip
- Rating plug removed

Ground Fault Trip Alarm

For OPTIM LSG, LIG and LSIG Trip Units, the ground fault trip alarm contact operates after the circuit breaker trips due to conditions which exceeded the ground fault protection settings.

Neutral Overcurrent Alarm

The neutral overcurrent alarm contact operates when the neutral current exceeds the long delay setting (I_r).

Communication Open/Close Contact

⚠ ◆ 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 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 $\bar{C}$ L or N-Frame Circuit Breaker uses the breaker's current sensors and an externally mounted potential transformer module to compute and display power and energy values (Figure **2-14** and paragraph 2-7.1).

An OPTIM 1050 Trip Unit installed in a Series $\bar{C}$ 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 and display power and energy values (Figure **2-14** and paragraph 2-7.2).

Power (Present Demand)

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

Peak Demand

The peak demand, displayed in kilowatts (kW), parameter is based on a sampling window of fifteen (15) minutes. Power is repeatedly averaged over this interval and the maximum 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 and neutral currents
- % harmonic content phase A, B and C currents (to 27th harmonic)
- % harmonic content ground and neutral currents (to 27th harmonic)

THD (Total Harmonic Distortion) is used to define, as a percentage of the line current, the amount of harmonic current that a circuit is seeing or the system is experiencing. 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 can calculate and display via the OPTIMizer Hand Held Programmer, Breaker Interface Module or a remote computer the system power factor which is a unit-less ratio of useful power (kW) to actual power (kVA).

3-4 COMMUNICATIONS

An important function of all OPTIM Trip Units is their 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. A Trip Curve Package is available that can display, configure, and coordinate time-current curves for OPTIM Trip Units and other devices that can be included on an IMPACC System (Figure **3-18**).

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 and neutral (Figure **3-19**). 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

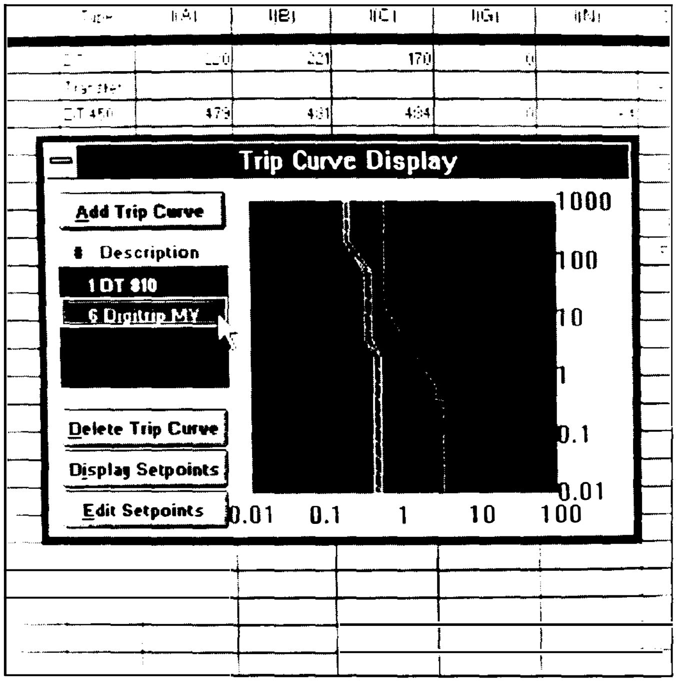


Figure 3-18 Typical Time-Current Curve Display

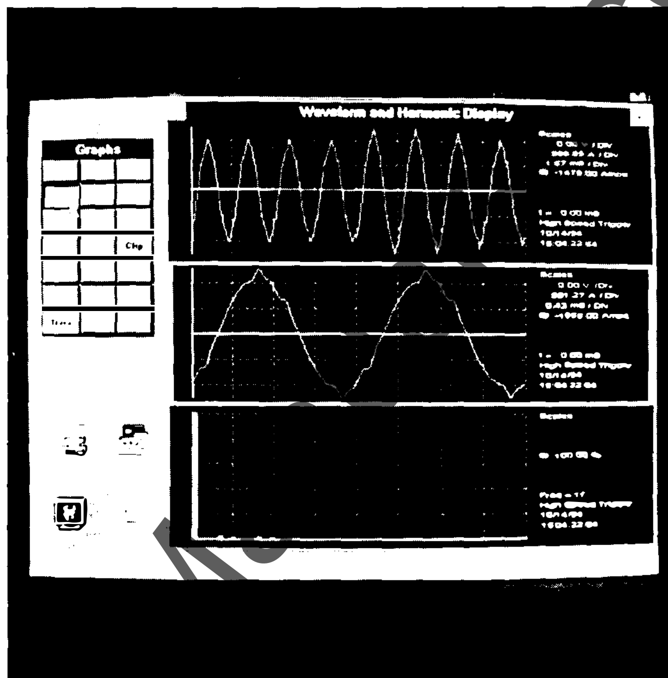


Figure 3-19 Typical Waveform and Harmonic Display

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.

⚠ 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 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 (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 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 **3-20** and paragraph 2-7). The additional power is required to activate the breaker's flux transfer shunt trip.

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

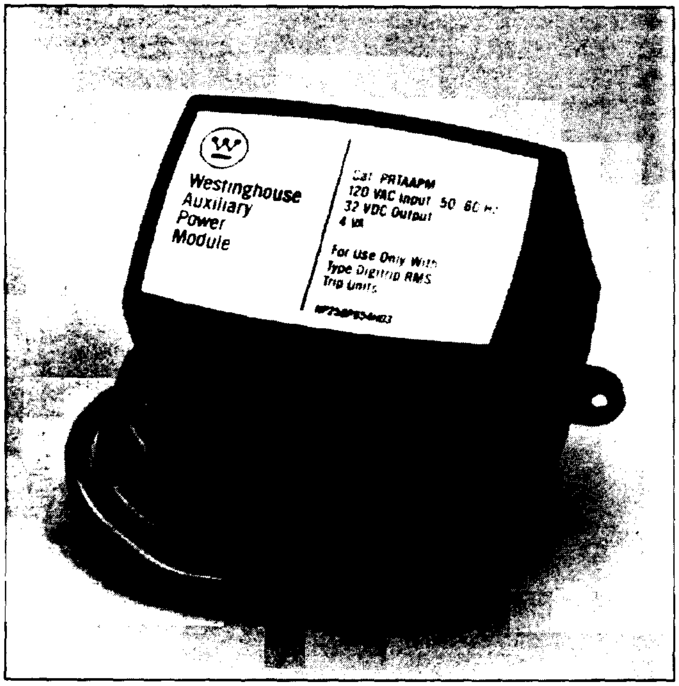


Figure 3-20 Auxiliary Power Module

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 subnetwork 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)

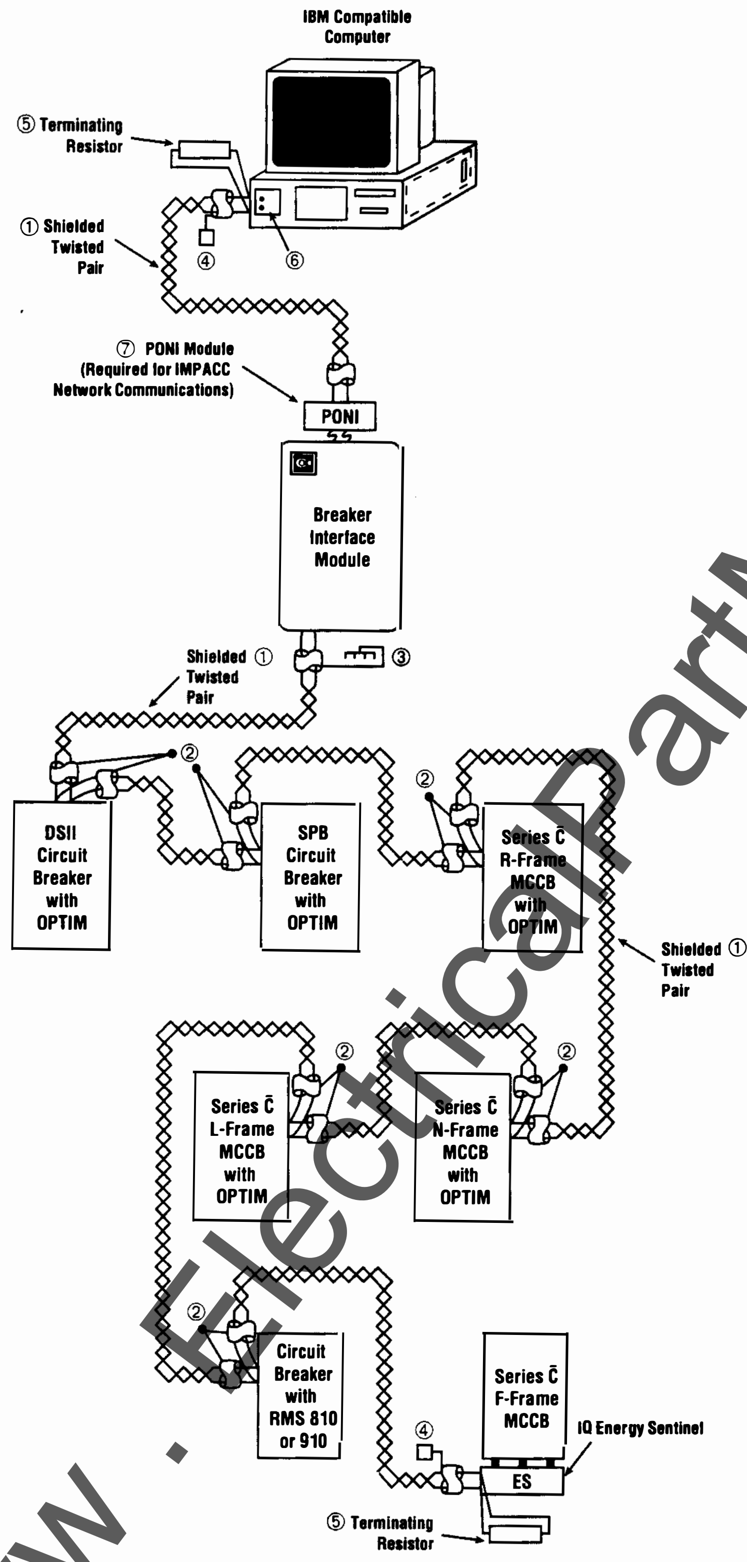
2. Auxiliary power is supplied to the circuit breaker.

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
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
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

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 $\overline{C}$ L-Frame Frame Book	IL 29-120L
Series $\overline{C}$ N-Frame Frame Book	IL 29-120N
Series $\overline{C}$ R-Frame Frame Book	IL 29-120R
Series $\overline{C}$ R-Frame Supplement	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 $\overline{C}$ L-Frame Wiring	IL 29C894
Series $\overline{C}$ 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	IL 17537
Series $\overline{C}$ J-Frame	IL 17538
Series $\overline{C}$ K-Frame	IL 17539
Universal IQ Energy Sentinel	
Internal	IL 17540
External	IL 17541
Communication Devices	
Communications Module (PONI)	
INCOM PONI	IL 17547
RS-232 PONI	IL 17202
Modem PONI	IL 17203
Buffered PONI	IL 17361
CONI	IL 17436
IMPACC Wiring Spec.	IL 17513

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

DOCUMENT DESCRIPTION	DOCUMENT NUMBER
Accessories	
Potential Transformer Module (L and N-Frame)	29C126
Ground Fault Indicator	1259C14G01
Digitrip OPTIM Time-Current Curves	
Series C̄ 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
250A Instantaneous & Override Phase	SC-6328-96
125A Instantaneous & Override Phase	SC-6329-96
Ground Fault Protection	SC-6330-96
Series C̄ 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 C̄ 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

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

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Series $\overline{C}$ N-Frame Frame Book	IL 29-120N
Series $\overline{C}$ R-Frame Frame Book	IL 29-120R
Series $\overline{C}$ R-Frame Supplement	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 $\overline{C}$ L-Frame Wiring	IL 29C894
Series $\overline{C}$ 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	IL 17537
Series $\overline{C}$ J-Frame	IL 17538
Series $\overline{C}$ K-Frame	IL 17539
Universal IQ Energy Sentinel	
Internal	IL 17540
External	IL 17541
Communication Devices	
Communications Module (PONI)	
INCOM PONI	IL 17547
RS-232 PONI	IL 17202
Modem PONI	IL 17203
Buffered PONI	IL 17361
CONI	IL 17436
IMPACC Wiring Spec.	IL 17513

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Series $\bar{C}$ 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
250A Instantaneous & Override Phase	SC-6328-96
125A Instantaneous & Override Phase	SC-6329-96
Ground Fault Protection	SC-6330-96
Series $\bar{C}$ 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 $\bar{C}$ 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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