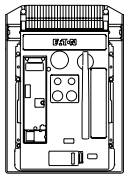
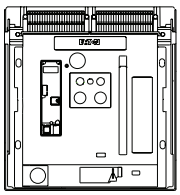
Instruction Leaflet **IL01301051E** effective September 2013 Series NRX

Operating Manual for Series NRX Trip Units - Digitrip™ 520/520M

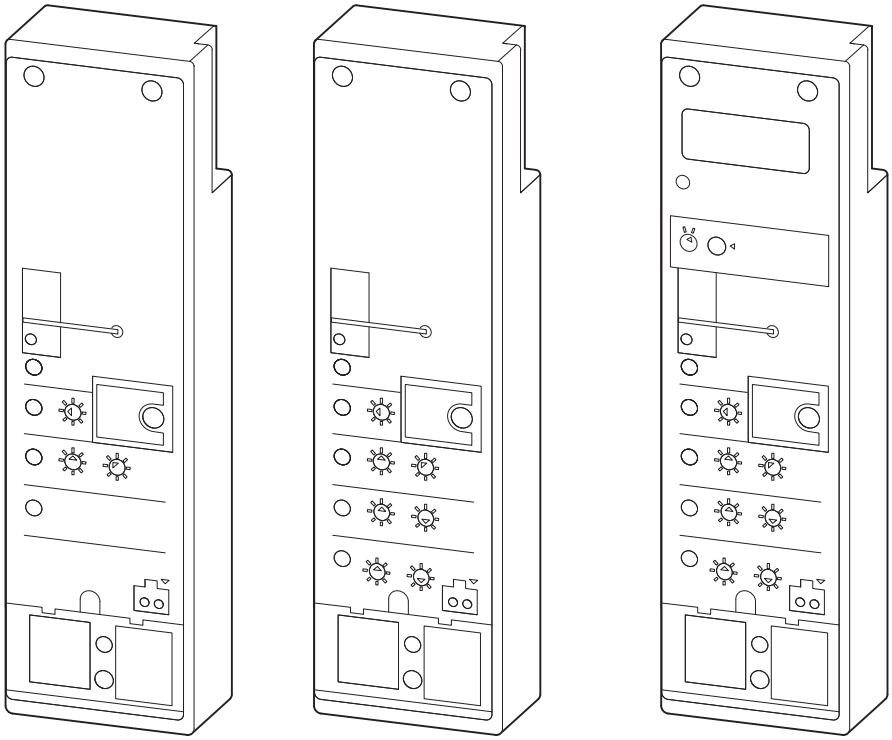
Instructions apply to:



Series NRX, Type NF Frame
ANSI, UL1066, UL489 / IEC, IZMX16, IZM91



Series NRX, Type RF Frame
IEC, IZMX40



Powering Business Worldwide

⚠ WARNING! DANGEROUS ELECTRICAL VOLTAGE!

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

Before commencing the installation

- Disconnect the power supply of the device
- Ensure that devices cannot be accidentally restarted
- Verify isolation from the supply. Earth and short circuit
- Cover or enclose neighboring units that are live
- Danger if breaker mechanism spring is charged! Discharge spring
- Follow the engineering instructions of the device concerned
- Only suitably qualified personnel in accordance with applicable national work safety regulations may work on this device/system
- Before installation and before touching the device ensure that you are free of electrostatic charge
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices

⚠ WARNING

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

- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation
- Emergency stop devices complying with IEC 60204-1, EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE)
- All work relating to transport, installation, commissioning and maintenance must only be carried out by qualified personnel in accordance with applicable national work safety regulations

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

If you have any questions or need further information or instructions, please contact your local Eaton representative or visit www.eaton.com.

Contents

List of Figures

List of Tables

Section 1: General description of Digitrip trip units in Eaton Series NRX circuit breakers

Note: The range of Eaton circuit breakers described in this document is known as Series NRX. In some markets this range may also be referred to as IZMX circuit breakers and/or IZM91/95 circuit breakers**.**

General

Eaton circuit breakers are tripped automatically on overload fault current conditions by the combined action of three components:

1. The sensors, which provide lower-level current signals to the Digitrip unit.
2. The Digitrip trip unit, which measures the current from the sensors, will provide a tripping signal to the trip actuator when the levels and time delay settings are exceeded.
3. The low-energy trip actuator, which converts electrical energy to mechanical energy to trip the circuit breaker.

Sensors

The current sensors consist of two coils: one coil on an iron core and one air core (Rogowski) coil (**Figure 18**). As current begins to flow through the circuit breaker, the iron core coil generates a secondary current which powers the trip unit. At the same time, the air core coil provides signal values which are processed by the electronic circuitry.

Digitrip Trip Unit

This instruction book specifically covers the application of Digitrip 520/520M units installed in Series NRX circuit breakers.

The Digitrip trip units are circuit breaker subsystems that provide the protective functions of a circuit breaker. The primary function of the trip unit is circuit protection but some models offer additional features such as Metering and Maintenance Mode protection. The trip units are enclosed in removable housings, installed in the breaker, and can be replaced or upgraded in the field by the customer.

The line of trip units consists of the Digitrip 520 and 520M for UL/ANSI and IEC standards. The Digitrip 520 and 520M trip units may be applied on both 50 and 60 Hz systems. Refer to **Figure 1** to become familiar with the trip unit general layout.

All trip unit models are microprocessor-based AC protection devices that provide true rms current sensing for the proper coordination with the thermal characteristics of conductors and equipment. The Digitrip unit analyzes the secondary current signals from the circuit breaker current sensors and, when preset current levels and time delay settings are exceeded, will send an initiating trip signal to the trip actuator of the circuit breaker. As a result, all tripping operations initiated by the protection functions are performed by its internal circuitry. There is no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the circuit breaker and external control voltage is not required for basic protection functionality.

The automatic overload and short circuit tripping characteristics for a specific circuit breaker are determined by the rating plug and the selected functional protection settings. Specific setting instructions are provided in **Section 3**: **Protection Settings**.

There are five phase and two ground (time-current) curve shaping adjustments. To satisfy the protection needs of any specific installation, the exact selection of the available protection function adjustments is set by the user. The short delay and ground fault pickup adjustments can be set for either FLAT or I^2t response.

Low-energy trip actuator

The mechanical force required to initiate the tripping action of the circuit breaker is provided by a special low-energy trip actuator. The circuit breaker mechanism assembly contains a mechanism-actuated reset lever and a trip lever to actuate the tripping action of the circuit breaker.

⚠ WARNING

IMPROPER POLARITY CONNECTIONS ON THE TRIP ACTUATOR COIL TO THE DIGITRIP TRIP UNIT WILL DEFEAT THE OVERLOAD AND SHORT CIRCUIT PROTECTION, WHICH COULD RESULT IN PERSONAL INJURY. OBSERVE POLARITY MARKINGS ON THE TRIP ACTUATOR LEADS IF LEADS OR CONTACTS ARE EVER REMOVED.

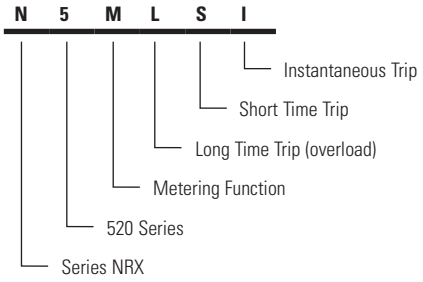
Catalog Number Referencing

Table 1 below offers a quick reference to the basic function and protection features as designated by the trip unit catalog number

Table 1. Catalog Number References

Symbol	Function/Protection
M	Metering function
R	ARMS Maintenance Mode function
L	Long time trip (overload)
S	Short time trip
I	Instantaneous trip
G	Ground (Earth) fault trip
A	Ground (Earth) Alarm only

Example of CAT number



Protection

Each trip unit is completely self-contained and requires no external control power to operate its protection systems. It operates from power and current signal levels derived through current sensors mounted in the circuit breaker. The types of protection available for each model are shown in **Table 3**.

Note: All models (LI, LSI, LSIG, and LSIA) will provide neutral protection.

Mode of trip and status information

On all models there are tri-colored light-emitting diodes (LED), that could be lit green, red, or orange. The status LED will blink green approximately once each second to indicate that the trip unit is operating normally. This Status LED will blink at a faster rate if the Digitrip is in a pick-up or overload condition.

The Digitrip has the ability to detect a problem with nonvolatile memory or if the trip actuator coil is open circuit, or if there is a circuit breaker mechanism problem. Depending upon the state and the status of power to the trip unit when a problem is detected the Status LED will light red or flash red or orange.

LEDs on the face of the trip units (for INST, LONG, SHORT, and GROUND) flash red to indicate the cause or trip mode for an automatic trip operation (for example, ground fault, overload, or short circuit trip). A battery located in the frame module maintains the trip indication until the Reset/Battery Test button is pushed. The battery is good if its LED lights green when the Battery Check button is pushed (see Section 8).

Note: The trip unit provides all protection functions regardless of the status of the battery. The battery is only needed to maintain the cause of trip indication.

Table 2. Legend for Figure 1

Number	Item
1	Four-Character LCD Display
2	Test Port
3	Status LED
4	Rating Plug
5	Cause of Trip LED
6	Pickup Settings
7	Time Delay Settings
8	Auxiliary Power Input
9	Maintenance Mode Setting
10	Maintenance Mode LED
11	Battery
12	Battery Check LED
13	Reset/Battery Test

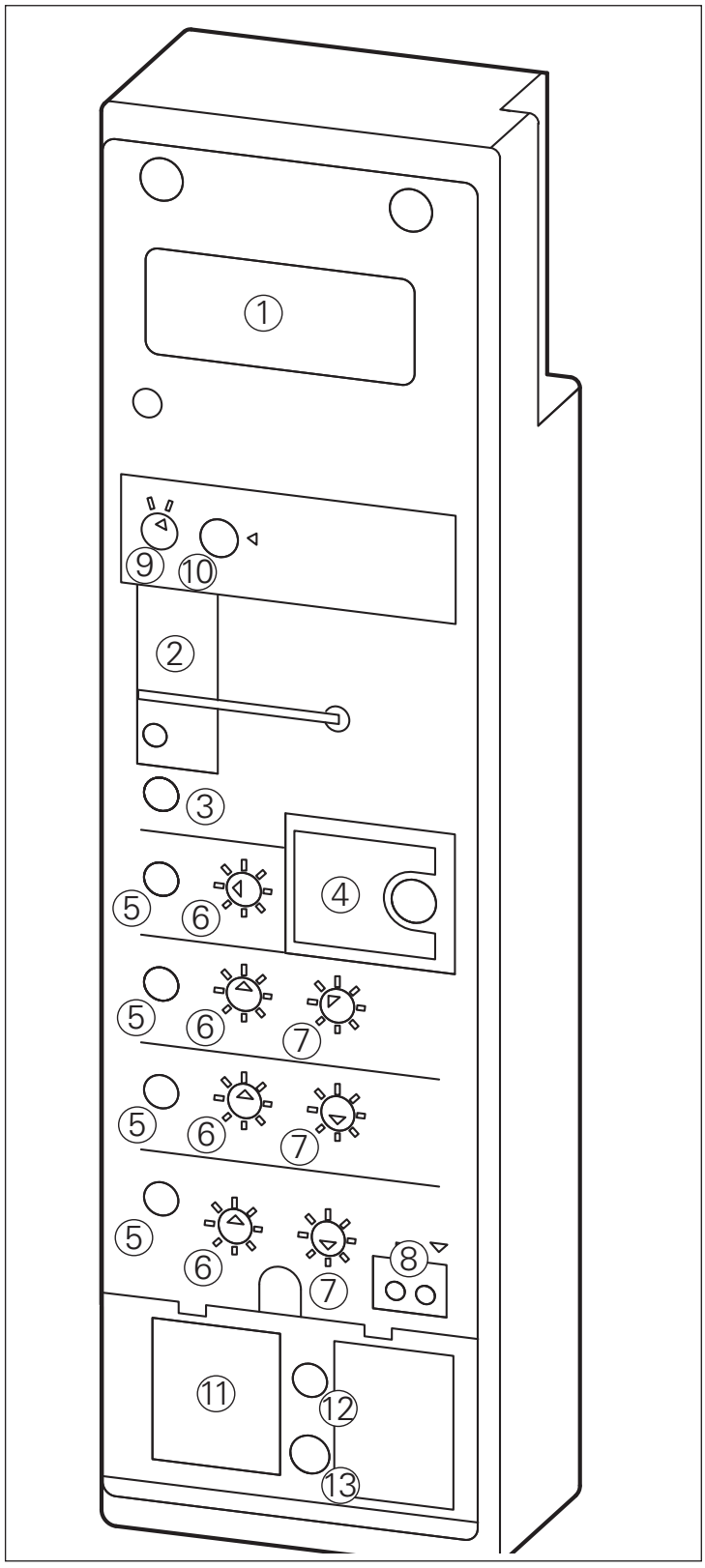
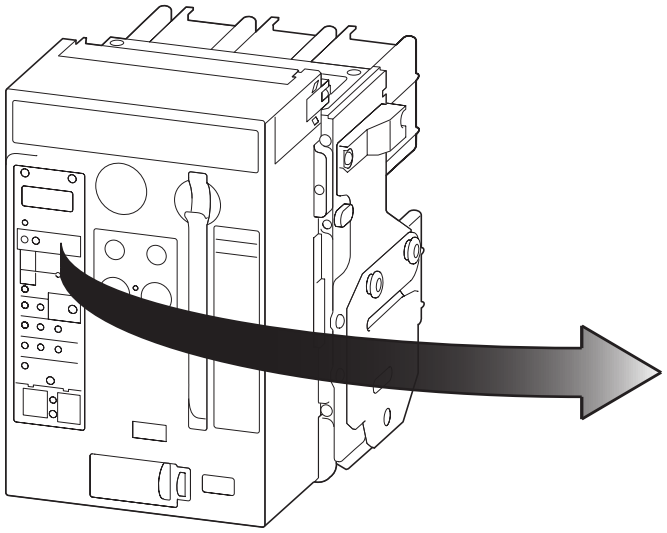


Figure 1. Example Digitrip 520M LSIG with legend



List of Digitrip 520/M trip units with type codings and catalogue numbers

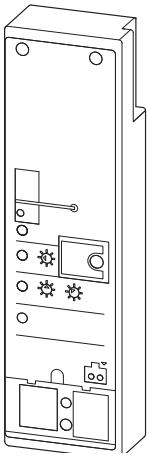
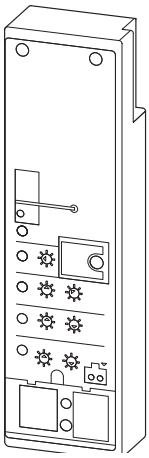
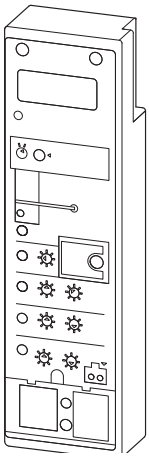
	**Digitrip 520 LI** System Protection IZMX and IZM91/95 frame: **IZMX16/40...A...** **IZM91/95...A...**	**Catalogue Number:** N5LI **Protection Features:** Long delay protection (L) Instantaneous protection (I)
	**Digitrip 520 LSI(G)** Selective Protection IZMX and IZM91/95 frame: **IZMX16/40...V...** **IZM91/95...V...**	**Catalogue Number:** N5LSI **Protection Features:** Long delay protection (L) Short delay protection (S) Instantaneous protection (I) **Catalogue Number:** N5LSIG **Protection Features:** Long delay protection (L) Short delay protection (S) Instantaneous protection (I) Earth fault protection (G)
	**Digitrip 520M LSI/LSIG/LSIA** *with or without Maintenance Mode* Universal Protection IZMX and IZM91/95 frame: **IZMX16/40...U...** **IZM91/95...U...**	**Catalogue Number:** N5M(R)LSI **Protection Features:** Maintenance Mode (R) *optional* Long delay protection (L) Short delay protection (S) Instantaneous protection (I) **Catalogue Number:** N5M(R)LSIG **Protection Features:** Maintenance Mode (R) *optional* Long delay protection (L) Short delay protection (S) Instantaneous protection (I) Earth fault protection (G) **Catalogue Number:** N5M(R)LSIA **Protection Features:** Maintenance Mode (R) *optional* Long delay protection (L) Short delay protection (S) Instantaneous protection (I) Earth fault alarm (A)

Table 3. Available Digitrip 520 and 520M Trip Units

Table 4. Technical Data

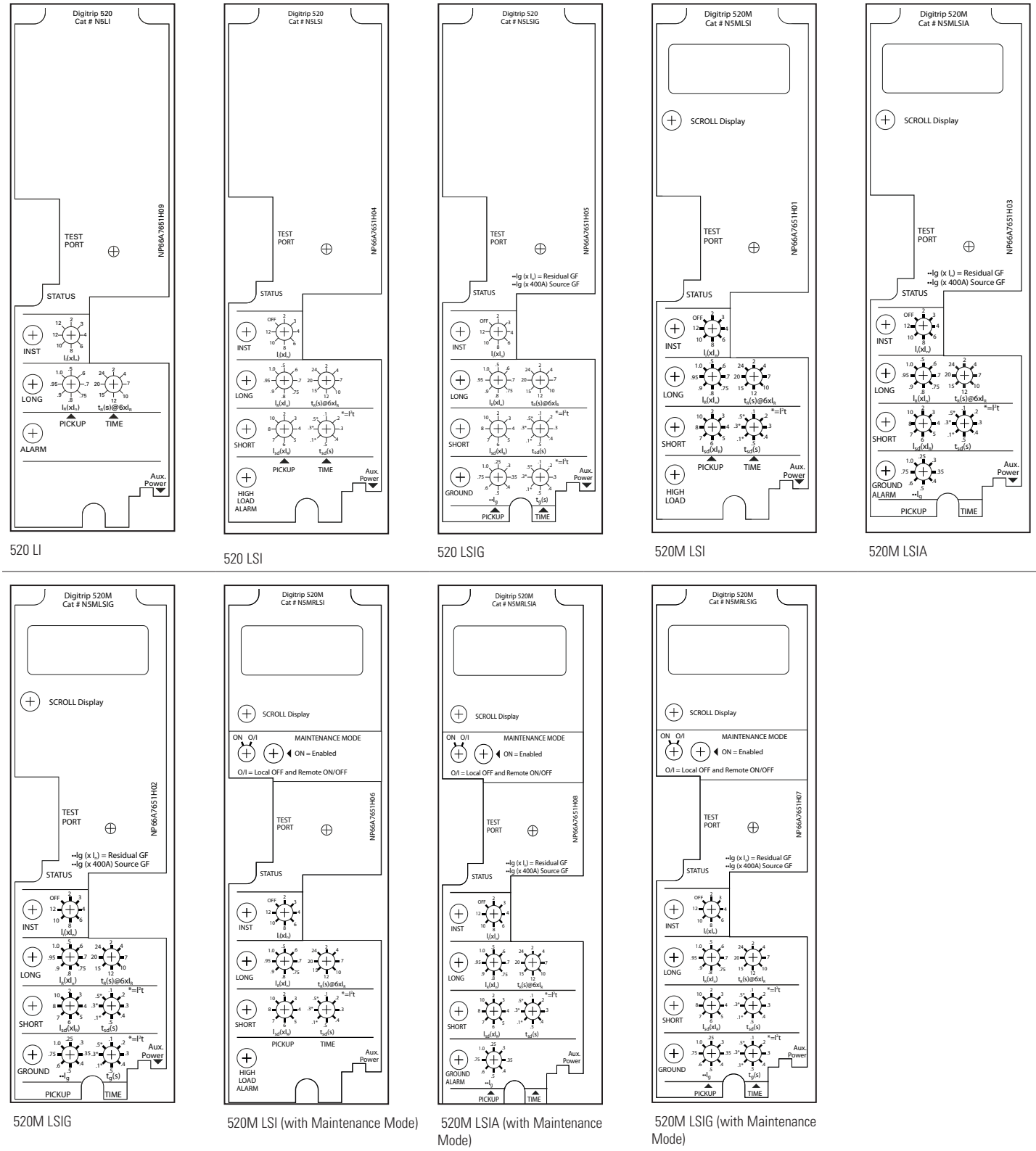
		Digitrip 520 LI System Protection	**Digitrip 520 LSI(G)** Selective Protection	**Digitrip 520M** Universal Protection
Ampere range		NF frame 200-1600A RF frame 800- 4000A	NF frame 200-1600A RF frame 800- 4000A	NF frame 200-1600A RF frame 800- 4000A
RMS sensing		●	●	●
Protection and coordination				
General	Ordering style options	LI	LSI, LSIG	MLSI, MLSIG, MLSIA, MRLSI, MRLSIG, MRLSIA
	Rating plug (I_n)	●	●	●
	Overtemperature trip	●	●	●
Long delay protection (L)	Long delay pickup	(0.5 – 1.0) x I_n	(0.5 – 1.0) x I_n	(0.5 – 1.0) x I_n
	Long delay time t_r at 6 x I_r	2 – 24 s	2 – 24 s	2 – 24 s
	Long delay thermal memory	●	●	●
Short delay protection (S)	Short delay pickup	-	(2 - 10) x I_r	(2 - 10) x I_r
	Short delay time t_{sd}	-	100 – 500 ms	100 – 500 ms
	Zone Selective Interlocking ZSI	-	optional	optional
Instantaneous protection (I)	Instantaneous pickup	(2 - 12) x I_n	(2 - 12) x I_n	(2 - 12) x I_n
	Off position	-	●	●
	Making current release	●	●	●
Option earth fault protection (G)	Earth fault option	-	●	●
	Earth fault alarm	-	-	●①
	Earth fault pickup	-	(0.25 - 1.0) x I_n②	(0.25 - 1.0) x I_n②
	Earth fault delay t_g, I^2t @ 0.625 x (I_n)	-	100 – 500 ms	100 – 500 ms
	Ground (earth) fault delay t_g, flat characteristic curve	-	100 – 500 ms	100 – 500 ms
	Zone Selective Interlocking ZSI	-	optional	optional
	Ground fault memory	-	●	●
Neutral protection		●	●	●
System diagnostics				
Status/long pickup LED		●	●	●
High load alarm/alarm contacts		-	-	●④
Cause of trip LEDs		●③	●③	●③
Magnitude of trip information		-	-	●①
Remote ground trip/alarm contacts		-	-	●①
System metering				
Digital display		-	-	4 character LCD
Maintenance Mode (ARMS)		-	-	optional

I_n = rating plug = rating of current sensors
I_r = Long delay pickup setting

① Requires 24 Vdc auxiliary voltage input (LSIG-ground trip alarm, LSIA ground alarm only).
② Limited to1200 A for UL® rating
③ Four Cause of Trip LEDs: L, S, I, G. Current Release trip is indicated by the red instantaneous LED:
- Orange Instantaneous LED indicates rating plug trip
- Orange Long Delay LED indicates temperature trip
- Red or orange LED status indicates internal trip unit or circuit breaker diagnostic problem detected.

④ Requires 24 Vdc auxiliary voltage input and LSI style.

Digitrip identified by catalogue numbers and nameplates



520 LI

520 LSI

520 LSIG

520M LSI

520M LSIA

520M LSIG

520M LSI (with Maintenance Mode)

520M LSIA (with Maintenance Mode)

520M LSIG (with Maintenance Mode)

Figure 2. Digitrip Nameplates

Installation and removal

Installation of the trip unit

Align the Digitrip trip unit with the two guide grooves of the Series NRX circuit breaker. Keep it parallel with the receiving, molded deck plate. Press the unit into the circuit breaker until the trip unit seats firmly into the receiving housing and the two latching tabs click into place.

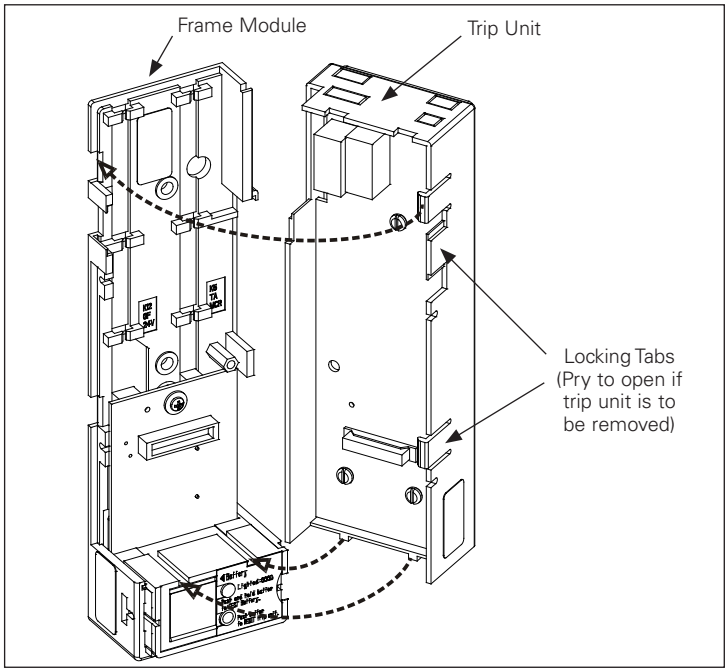


Figure 3. Installation of the Trip Unit into Frame Module of a Series NRX Circuit Breaker

Rating plug installation

⚠ CAUTION

IF A RATING PLUG IS NOT INSTALLED IN THE TRIP UNIT, THE UNIT WILL INITIATE A TRIP WHEN IT IS ENERGIZED. AN ORANGE LED LIGHT WILL LIGHT ABOVE THE INST TEXT

Insert the rating plug into the cavity on the right side of the trip unit. Wiggle the plug slightly to help align the pins on the plug with the sockets in the cavity. The plug should engage with a slight insertion force. At this point, it will be roughly 3/16" above the Digitrip and it will take four turns to tighten it to its stop postion.

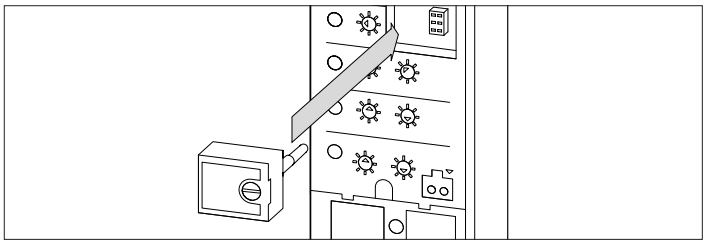


Figure 4. Installation of the Rating Plug into the Trip Unit

Note: The wrong rating plug group for a particular circuit breaker frame will not engage to the circuit breaker frame properly to tighten down (**Section 6**).

⚠ CAUTION

DO NOT FORCE THE RATING PLUG INTO THE CAVITY.

Use a 1/8-inch / 3 mm wide screwdriver to tighten the mounting screw and secure the plug and the trip unit to the circuit breaker.

⚠ CAUTION

THE RATING PLUG SCREW SHOULD BE TIGHTENED ONLY UNTIL IT STOPS. DO NOT USE A LARGE SCREWDRIVER. A 1/8-INCH (3 MM) WIDE SCREWDRIVER BLADE IS ADEQUATE.

Trip unit/rating plug removal

To remove the rating plug from the trip unit, use a 1/8-inch / 3 mm wide screwdriver to loosen the screw. It will take about four turns to release it.

To remove the trip unit from the circuit breaker's Frame Rating Module, break the factory seal, deflect the two locking tabs, and pull to release the unit from the mounting plate. Pull the unit to disengage the molded, 24-pin connector from the circuit breaker. (**Figure 3**)

Wiring

The internal components of the circuit breaker and how they are wired internally and externally to the circuit breaker secondary contacts are shown in the breaker master connection diagrams provided as **Appendix E and F.**

Plexiglass cover

A clear, tamper-proof, plexiglass cover fits on the Digitrip. This cover allows the settings to be viewed but not changed, except by authorized personnel. The plexiglass cover meets applicable tamper-proof requirements. Security is ensured by the insertion of a standard meter seal through the thumb screw holes. The plexiglass cover has access holes for the Scroll pushbutton and Maintenance Mode setting (if applicable).

Voltage supply input/alarms

Auxiliary voltage requirements

When the circuit breaker is wired for external 24 Vdc input, it will provide an auxiliary voltage supply so that the Digitrip 520M liquid crystal display (LCD) will be functional even when the circuit breaker has no load. The burden of the Digitrip is 6 VA. A Digitrip 520M trip unit without auxiliary voltage will not display data until load current reaches approximately 100A (single-phase) or 35A (three-phase) on the Series NRX circuit breaker.

Ground alarm

Auxiliary voltage of 24 Vdc is required to provide either a ground trip or ground alarm only output contact via the relay supplied for the Digitrip 520M trip unit.

Ground fault trip

The 520M (metering) styles will provide ground fault trip contacts when the circuit breaker trips on a ground fault. You must then push the Reset button in order to reset the internal contacts.

Ground fault alarm

A ground fault alarm alerts a user to a ground fault condition without tripping the circuit breaker. A red ground alarm LED on the front of the trip unit will indicate the presence of a ground fault condition that exceeds the programmed setting.

The ground fault alarm relay is energized when the ground current continuously exceeds the ground fault pickup setting for a time in excess of a 0.1-second delay. The alarm relay will reset automatically if the ground current is less than the ground fault pickup.

High load alarm (Digitrip 520M model only)

The Digitrip 520M model of the LSI style only will provide a high load alarm contact instead of the ground alarm function when wired to the circuit breaker secondary contacts 11 and 13. The function activates after a 1-second time delay when any phase current exceeds 85 percent of the I_R setting.

Display feature (Digitrip 520M only)

The Digitrip 520M models have a user interface in addition to the green and red/orange LED trip indicators. This seven-element display performs a metering function and can be used to monitor load currents.

When the Scroll button on the face of the trip unit is pressed and released, the display will show PH 1 for Phase 1 or A, and then the current value. If the Scroll button is not pressed again, the display will continue to show the current value for Phase 1. Each time the Scroll button is pressed the next monitored function will be displayed. The other real-time readings can be displayed in the sequence below:

PH 2	Phase 2 (B)
PH 3	Phase 3 (C)
PH 4	Neutral
PH 5	Ground (if Ground function is supplied)
HI	Highest phase current will be displayed
OL	Overload (Digitrip in overload mode)
	Pushing the Scroll button while the unit is in the OL mode will have the unit again display the overload current value.
HL	High load alarm
HELP	This message indicates that the trip unit is out of calibration or programmed incorrectly and should be replaced at the earliest opportunity.

In addition, the Digitrip 520M will display and freeze the magnitude of the trip value after a trip event if auxiliary voltage is available. Use the Step pushbutton to view each phase value. The highest value that can be locally presented is 9999. Any fault currents greater than this value will be shown as "HI." Pushing the Reset pushbutton will clear this data.

Also related to the phase value after a trip event are four dashes "- - - -". This message means that the microprocessor could not complete its writing of the trip event's magnitude into its nonvolatile memory. A possible cause of this would be the lack or loss of auxiliary voltage during or after the trip event.

Another reason can be a tripping event during Maintanance Mode.

Standards

The Digitrip 520/520M trip units are listed by Underwriters Laboratories™ under UL File E7819 and UL File E52096 for use in Series NRX-NF circuit breakers. These same units are also listed by the Canadian Standards Association (CSA®) under File LR 43556.

All Digitrip units have also passed the IEC 60947-2 test program that includes EMC testing according to Appendix F. As a result, all units meet the low voltage and EMC directives and carry the CE mark.

Section 2: Principles of operation

General

All models of trip units are designed for industrial circuit breaker environments where the ambient temperatures can range from –20°C to +85°C but rarely exceed 70°C to 75°C. If, however, temperatures near the trip unit exceed this range, the trip unit performance may be degraded. In order to ensure that the tripping function is not compromised due to an over-temperature condition, the microcomputer chip has a built-in over-temperature protection feature, factory set to trip the circuit breaker if the chip temperature is excessive. If over-temperature is the reason for the trip, the orange LONG LED will flash.

The Digitrip uses the Eaton custom-designed ASIC (Application Specific Integrated Processor) chip, an integrated circuit that includes a microcomputer to perform its numeric and logic functions. The principles of operation of the trip unit are shown in **Figure 5**.

All sensing and tripping power required to operate the protection function is derived from the current sensors in the circuit breaker. The signals from these sensors provide the correct input information for the protection functions, as well as tripping power, whenever the circuit breaker is carrying current. These signals are digitized by the circuitry.

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

Trip and operation indicators

The LEDs on the face of the trip unit flash red or orange to indicate the reason for any automatic trip operation. Following an automatic trip operation, the backup battery continues to supply power to the LEDs. The LED pulse circuit is provided to reduce battery burden and will supply a quick flash of the trip LED approximately every four seconds. It is therefore important to view the unit for at least five seconds to detect a flashing cause of trip indicator.

Following a trip operation, push the Reset/Battery Test button to turn off the LEDs.

A green Status LED indicates the operational status of the trip unit. Once the load current through the circuit breaker exceeds approximately 35A (three-phase power), the green LED will flash on and off once each second to indicate that the trip unit is energized and operating properly.

Making current release (MCR)

All models of trip units have a making current release function. This safety feature prevents the circuit breaker from being closed and latched-in on a faulted circuit. The NRX NF Frame is equipped with a nonadjustable release that is preset to pick up at a peak current of 45,000A. The release level of the RF Frame is preset to 36,000 A for 1600A frame ratings, 56,000A for 2000A and 2500A frame ratings, and 90,000A for 4000A frame ratings.

The MCR is enabled only for the first two cycles following an initial circuit breaker closing operation. The MCR will trip the circuit breaker instantaneously and flash the instantaneous (INST) red LED.

High instantaneous

For Series NRX NF-Frames, all models of the trip unit have a high instantaneous trip feature. This element is always active even when the customer instantaneous adjustment is set to the OFF position. The high instantaneous is a separate analog peak detecting circuit that is set in the frame rating module of the circuit breaker. It will initiate a trip at a high current peak value which depends on the circuit breaker types and ratings. It will indicate by flashing the red instantaneous (INST) LED.

For the Series NRX RF-Frame, some models of the trip unit have a high instantaneous trip feature. For specifics on instantaneous trip, please reference RF-Frame time current curves, AD01301004E.

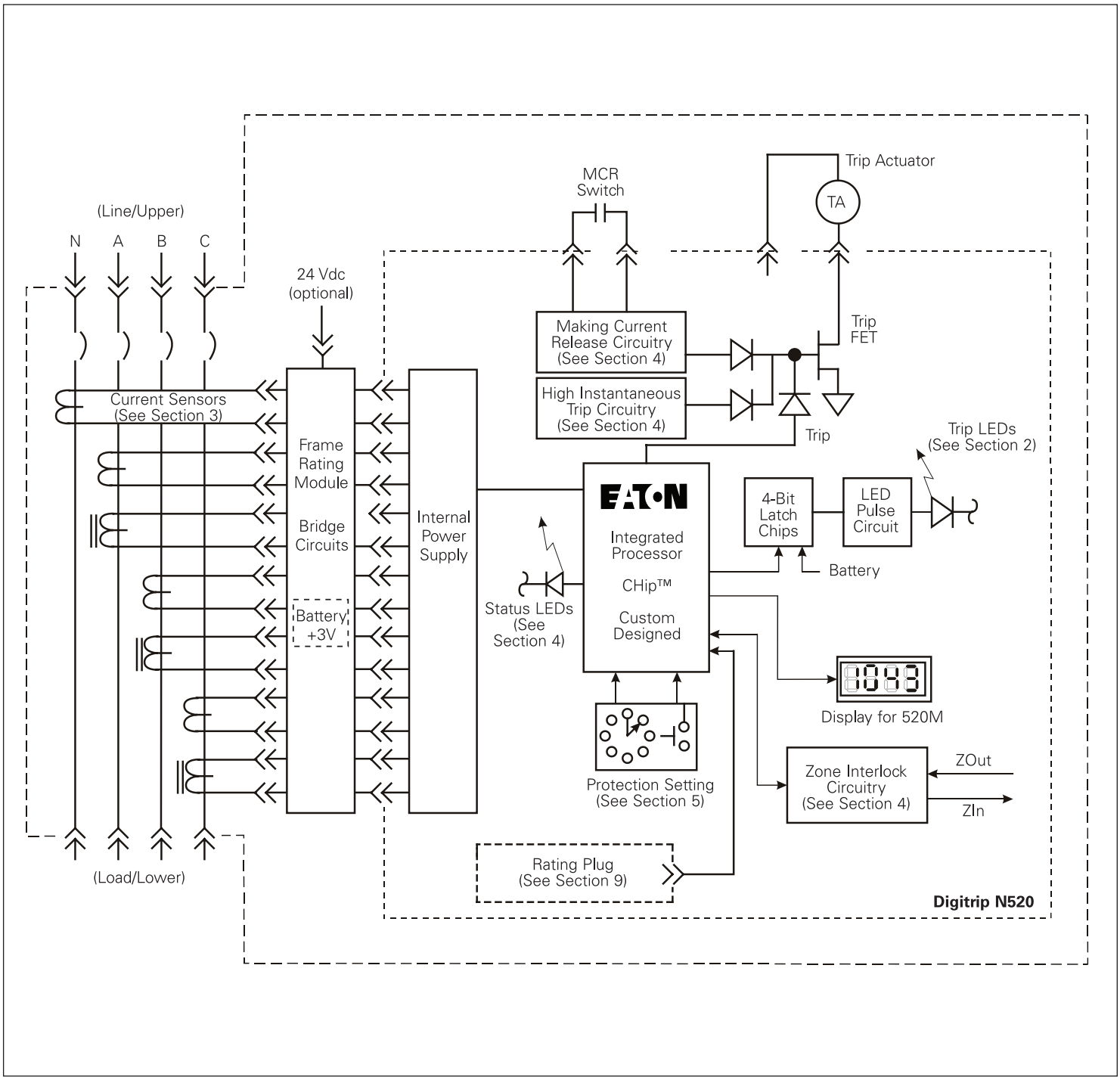


Figure 5. Block Diagram with Breaker Interface

Zone selective interlocking (optional)

Note: The zone selective interlocking function is a circuit breaker option when ordering the Series NRX. Circuit breakers from the factory that are ordered with the zone interlocking function included will have three wires (Zout, Zcom, Zin) connected to secondary contacts (27, 28, 29). These contacts can then be wired for zone interlock to other circuit breakers in the various zones. Zone selective interlocking requires no additional modules or auxiliary power supplies to function.

Zone selective interlocking is available on the SHORT delay and GROUND fault protection functions. The zone interlocking, if supplied, is wired via a single set of three wires labeled Zone In (Zin) and Zone Out (Zout) along with a zone common wire. The zone selective interlocking function has combined the logic interlocking of SHORT delay and GROUND fault. A zone out signal is sent whenever the ground fault pickup is exceeded or when the short delay value of 2 x (I_R)is exceeded. Zone selective interlocking provides the fastest possible tripping for faults within the zone of protection by coordinating among all applicable circuit breakers in the system (mains, ties, feeders, and downstream circuit breakers) to limit a power outage to only the affected parts of the system. When zone interlocking is employed, a fault within the zone of protection of the breaker will:

- Trip the affected circuit breaker immediately, and at the same time
- Send a signal to upstream Digitrip units to restrain from tripping immediately. The restraining signal causes the upstream circuit breakers to follow their set coordination times, so that the service is only minimally disrupted while the fault is cleared in the shortest time possible

For an example of how zone selective interlocking may be used, see **Appendix A** of this instructional leaflet.

Diagnostics indicator—circuit breaker/trip unit

The Digitrip unit has LEDs for diagnostic reasons. The Status LED is bicolor. A normal powered unit will flash the green status at a 1-second repetition rate.

If a problem is encountered in any of the following scenarios:

- NVRAM memory problem
- MCR auxiliary switch or circuit breaker mechanism is in an improper state
- Trip actuator (TA) coil circuit is open

The Status LED will light or flash red. This is an indication to troubleshoot the trip actuator, circuit breaker mechanism/MCR switch or trip unit's NVRAM memory as soon as possible (see Troubleshooting Guide).

In addition, the Digitrip 520M style units (not Maintenance Mode style), provide a relay contact alarm (12 to 11) and can provide these alarm diagnostics externally.

Ground Fault Protection

General

When the Digitrip includes ground fault protection features, the distribution system characteristics (such as system grounding, number of sources, and number and location of ground points) must be considered along with the manner and location in which the circuit breaker is applied to the system.

The Digitrip 520 uses three modes of sensing to detect ground fault currents: residual, source ground, and zero sequence (**Table 5**). Series NRX circuit breakers can accommodate all three types, including four-pole circuit breakers. The circuit breaker secondary contact inputs are used to configure the three schemes. No jumper from 19 to 20 programs the unit for a residual ground fault scheme, while a jumper from 19 to 20 programs the trip unit for either a source ground or zero sequence configuration. If present, this jumper resides on the stationary side of the switchgear assembly for drawout circuit breakers. In all three schemes, the proper current sensor is required per **Table 5**.

Residual sensing

Residual sensing is the standard mode of ground fault sensing in Series NRX circuit breakers. This mode uses one current sensor on each phase conductor (**Figure 18**) and one on the neutral for a four-wire system (**Figure 18**). If the system neutral is grounded, but no phase to neutral loads are used, the Digitrip 520 includes all of the components necessary for ground fault protection. This mode of sensing vectorially sums the outputs of the three or four individual current sensors. For separately mounted neutrals, as long as the vectorial sum is zero, then no ground fault exists. Residual ground fault sensing features are adaptable to main and feeder circuit breaker applications. Available ground fault pickup settings employing residual sensing are given in **Tables 7 and 8**.

⚠ CAUTION

ALWAYS OBSERVE THE POLARITY MARKINGS ON THE INSTALLATION DRAWINGS. IF THE NEUTRAL SENSOR CONNECTIONS ARE INCORRECT, A NUISANCE TRIP MAY OCCUR.

To ensure correct gound fault equipment performance, conduct field tests to comply with requirements (North America: NEC Article 230-95 C).

Source ground sensing

Depending upon the installation requirements, alternate ground fault sensing schemes may be dictated. The ground return method is usually applied when ground fault protection is desired only on the main circuit breaker in a simple radial system. This method is also applicable to double-ended systems where a mid-point grounding electrode is employed. For this mode of sensing, a single current sensor mounted on the equipment-bonding jumper directly measures the total ground current flowing in the grounding electrode conductor. The settings shown in **Table 6** will apply when using the source ground sensor displayed in **Figure 18** and asserting the source ground jumper.

Note: When using a Communication Module (see "Communication Module" section), the enabling of source ground mode is done via the position of the jumper located on this module.

Zero sequence sensing

Zero sequence sensing, also referred to as vectorial summation, is applicable to mains, feeders, and special schemes involving zone protection. The maximum outside diameter is 8.20 in (208,3 mm). The inside minimum diameter is 5.80 in (147,3 mm). The maximum thickness is 1.70 in (43,2 mm). The settings displayed in **Table 5** will apply.

Section 3: Protection settings

General

Before placing any circuit breaker in operation, set each trip unit protection setting to the values specified by the engineer responsible for the installation. The number of settings that must be made is determined by the type of protection supplied by each unit. Each setting is made by turning a rotary switch. The selected setting for each adjustment appears on the trip unit label. The installed rating plug will establish the maximum continuous current rating of the circuit breaker (I_n). Instantaneous and ground current settings are defined in multiples of (I_n).

Should an automatic trip occur as a result of the current exceeding the pre-selected value, the labeled LED will flash red.

Note: Use the following to access Time Current Curves. Go to Eaton's Web site: http://www.eaton.com and search "NRX Digitrip 520 Curves".

Long delay settings

The long delay current setting I_r determines the maximum continous current the circuit breaker can carry without tripping. Each setting is expressed as a multiple of the maximum rated current I_n set by the rating plug. The nominal current pickup value is 110% of the setting. The available current settings for the long time pickup I_r are:

I_r = (0.5/0.6/0.7/7.5/0.8/0.9/0.95/1.0) x I_n

Note: I_r is also the basis for the short delay current setting.

The long time delay t_r determines the duration of an overload without tripping. The available settings for the long time delay t_r are:

t_r = 2/4/7/10/12/15/20/24 s (at 6 x I_r)

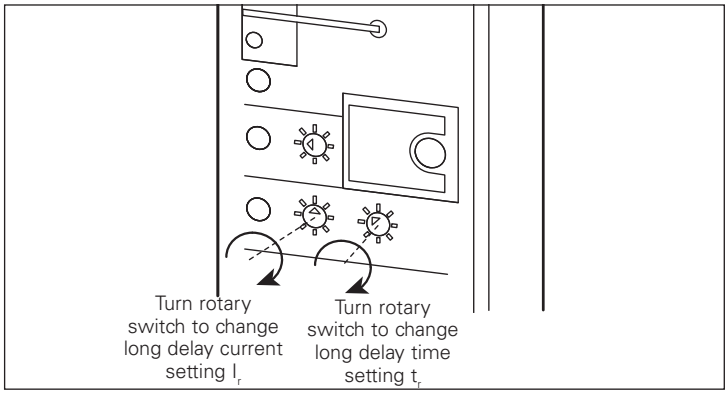


Figure 6. Applying Long Delay Settings

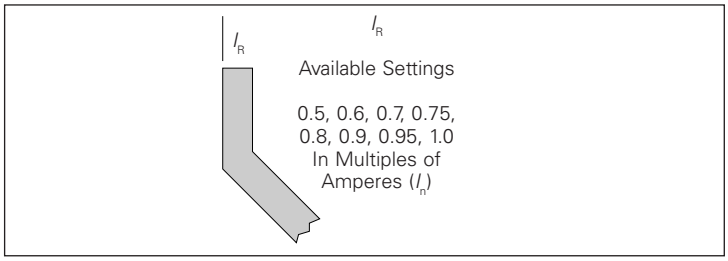


Figure 7. Long Delay Current Settings

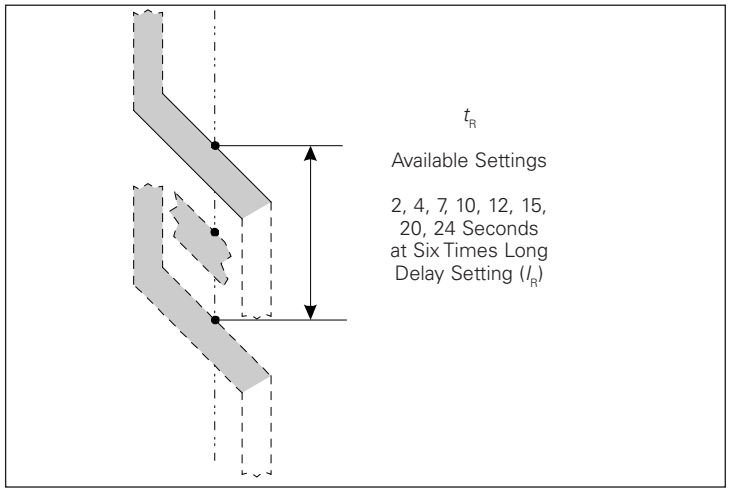


Figure 8. Long Delay Time Settings

Note: In addition to the standard long delay protection element, trip units also have a long time memory (LTM) function, which protects load circuits from the effects of repeated overload conditions. If a circuit breaker is reclosed soon after a long delay trip, and the current again exceeds the long delay setting, (I_R), the LTM automatically reduces the time to trip to allow for the fact that the load circuit temperature is already higher than normal because of the prior overload condition. Each time the overload condition is repeated, the LTM causes the circuit breaker to trip in a progressively shorter time. When the load current returns to normal, the LTM begins to reset; after about 5 minutes it will have reset fully, so the next long delay trip time will again correspond to the Setting value.

Note: In certain applications, it may be desirable to disable the LTM function. Open the test port cover with a small screwdriver blade by prying up the edge near the test port marking. Use small, long-nose pliers to move the LTM jumper inside the test port (see Figure 9) to its (pin bridging) inactive position. (The LTM function can be enabled again at any time by moving the LTM jumper back to its original Active position.)

The action of the LTM must be considered when performing multiple long delay time tests (see **Section 4**).

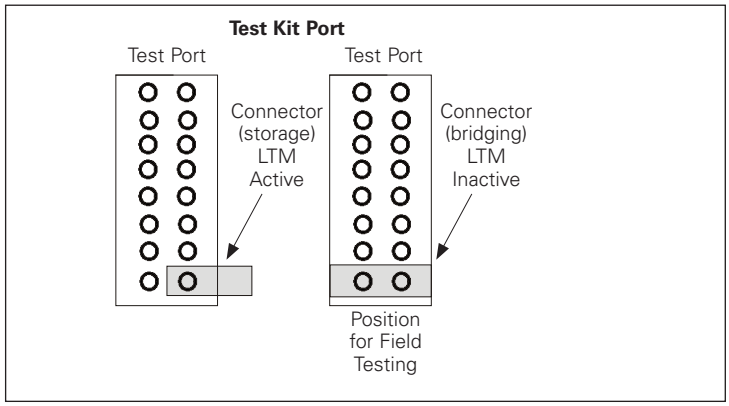


Figure 9. Long Time Memory (LTM) Jumper

Short delay settings

On Digitrip 520 LSI and 520M (R)LSI(G/A) trip units (IZMX...V and ...U) tripping due to the short-circuit current I_{sd} can be delayed by the time t_{sd}. This provides selectivity for the short-circuit protection in switchgear with several grading levels. Available setting values for the short delay pickup I_{sd} are:

I_{sd} = (2/3/4/5/6/7/8/10) x I_r

Important: The short delay setting I_{sd} is based on the long delay I_r

There are two different short delay response curve shapes: fixed time (FLAT) and I^2t. The shape selected depends on the type of selective coordination chosen. The I^2t response curve will provide a longer time delay for current below 8 x I_R than will the FLAT response curve.

Flat response: t_{sd} = 0.1/0.2/0.3/0.4/0.5 s

I^2T = 0.1/0.3/0.5

The I^2t response is applicable to currents less than eight times the ampere rating of the continuous current rating (I_R). For currents greater than 8 x (I_R) the I^2t response reverts to the FLAT response.

Note: See section 2, zone interlocking.

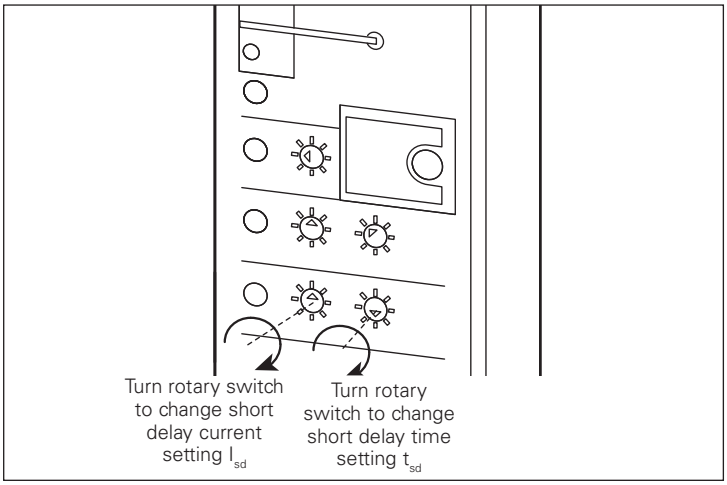


Figure 10. Applying Short Delay Settings

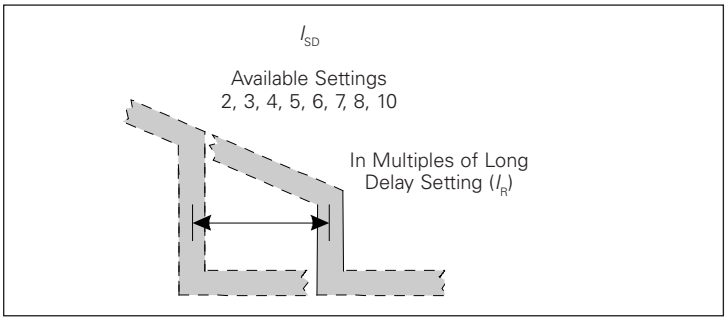


Figure 11. Short Delay Current Settings

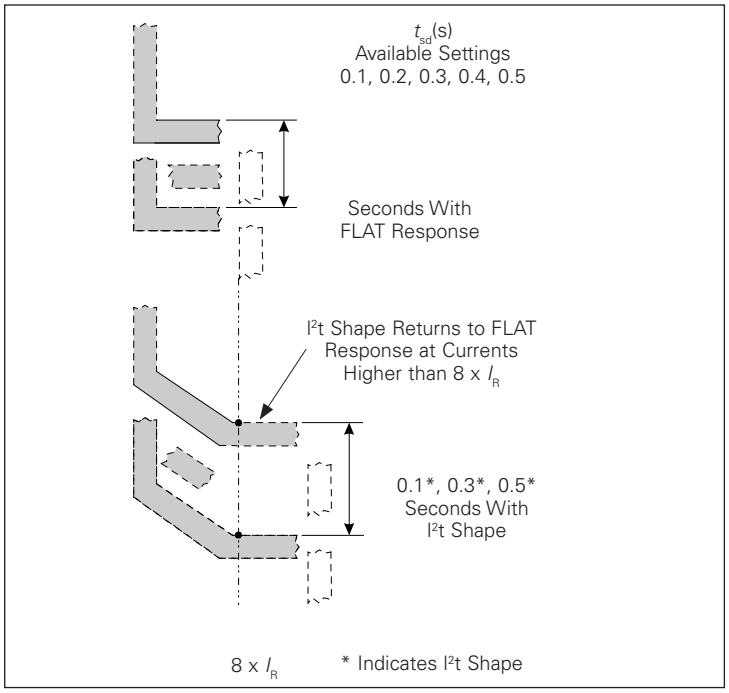


Figure 12. Short Delay Time Settings

Instantaneous settings

If the current setting I_i is exceeded, the circuit breaker is tripped instantaneously.

Available settings values for I_i are:

I_i = (2/3/4/5/6/8/10) x I_n; OFF

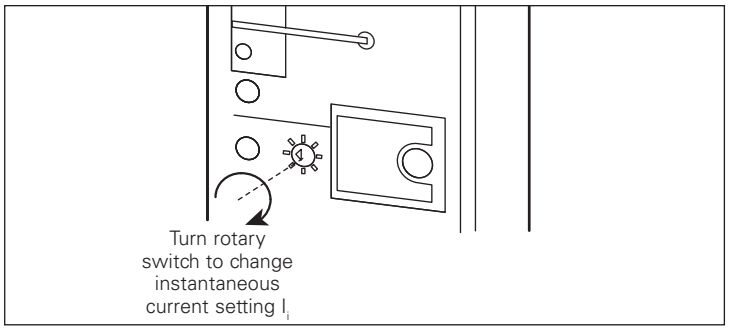


Figure 13. Applying Instantaneous Settings

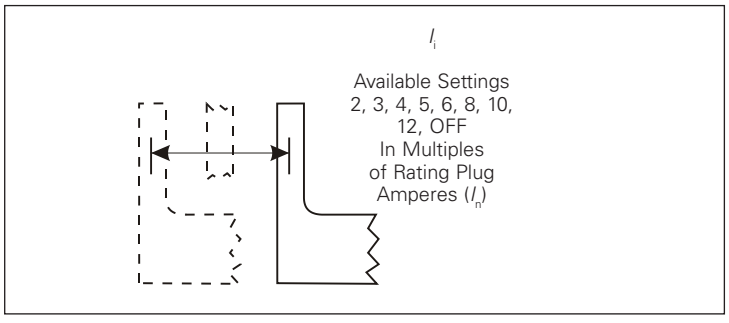


Figure 14. Instantaneous Settings

Ground fault settings

If the trip unit is equipped with earth fault protection, loads can be protected against impermissibly high ground-fault currents. There is a maximum of 1200A for UL type trip units (**Table 7**). The specific ground current settings for each model are listed in **Table 6, Table 7** and **Table 8** and on the applicable time-current curve for the circuit breaker.

The response value I_g together with the setting for the time delay t_g determines the shut off of the ground fault. Available settings for the ground fault pickup I_g are:

I_g = (0.25/0.3/0.35/0.4/0.5/0.6/0.75/1.0) x I_n

There are two different ground fault curve shapes: fixed time (FLAT) or I^2t response. The shape selected depends on the type of selective coordination chosen. The I^2t response will provide a longer time delay for current below 0.625 x I_n than will the FLAT response.

Available settings for the earth fault delay t_g are:

FLAT response: t_g = 0.1/ 0.2/ 0.3/ 0.4/ 0.5 s

I^2t = 0.1/0.3/0.5

The I^2t response is applicable to currents less than 0.625 times the ampere rating of the installed rating plug I_n. For currents greater than 0.625 x I_n the I^2t response reverts to the FLAT response.

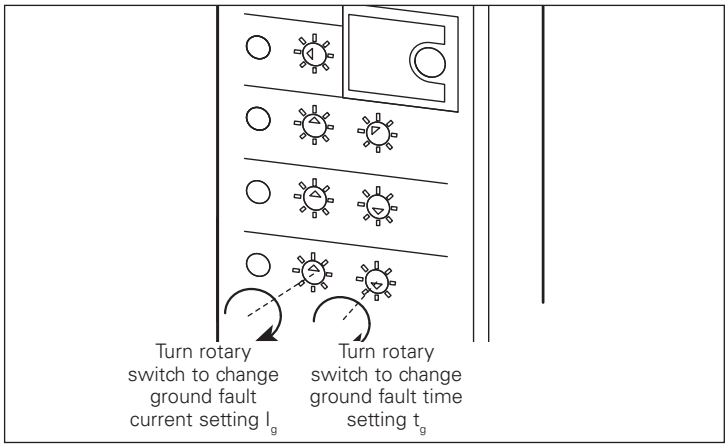


Figure 15. Applying Ground Fault Settings

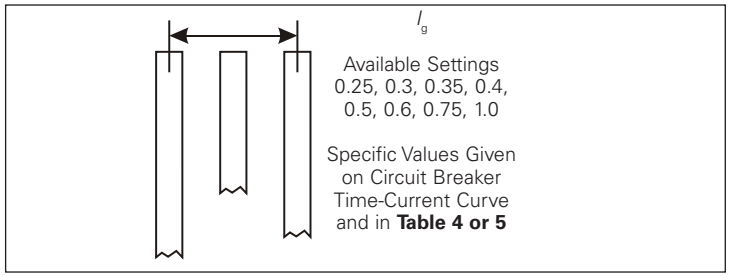


Figure 16. Ground Fault Current Settings

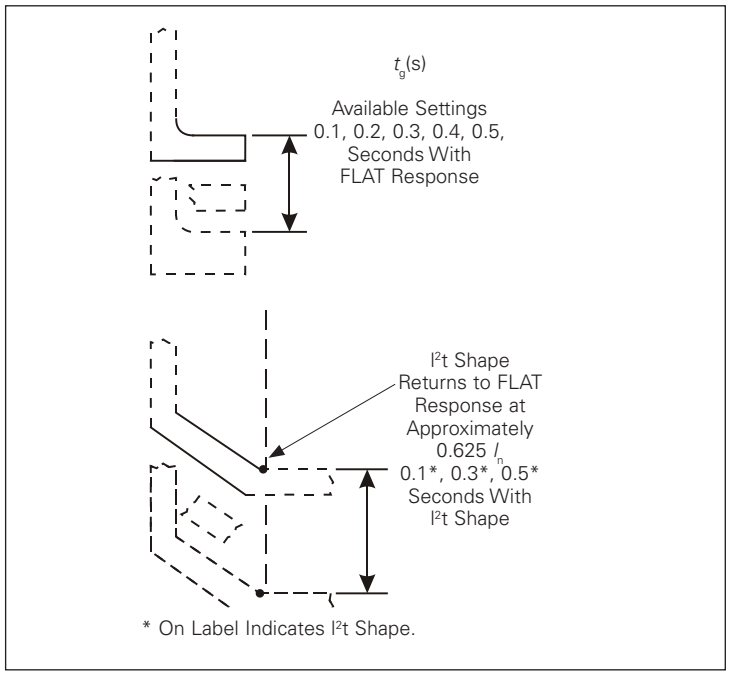


Figure 17. Ground Fault Time Settings

Table 5. Series NRX/Digitrip Ground Fault Sensing Modes

Series NRX Frame	Ground (Earth) Sensing Method	Sensor Style	IZMX Type Coding	Breaker Secondary Contacts Required	Neutral Input Contacts	Ground Sensor Input Contacts
NF RF	Residual	5721B76G12 70C1718G11	IZMX-CT16-N IZMX-CT40-N	No jumper No jumper	15 ,16 15 ,16	
NF, RF	Source ground	70C1527G14	IZMX-CT-NGS	Jumper 19 to 20		17 ,18
NF	Zero sequence	70C1527G14	IZMX-CT-NGS	Jumper 19 to 20		17 ,18

Note: This information applies to trip units with Ground protection.

Table 6. Ground (Earth) Fault Current Settings—Source Ground/Zero Ground Fault Settings

Ground Fault Current Settings (Amperes)								
Available ground fault setting I_n	0.25	0.30	0.35	0.40	0.50	0.60	0.75	1.00
Any rating plug	100A	120A	140A	160A	200A	240A	300A	400A

Table 7. Ground (Earth) Fault Current Setting - Residual - ANSI Ratings

Ground Fault Current Settings (Ampere)s ①②									
	Available Rating Plug Amperes (I_n)	0.25	0.30	0.35	0.40	0.50	0.60	0.75	1.00
Available for NF Frame Only IZMX16/IZM91	**200**	50	60	70	80	100	120	150	200
	250	63	75	88	100	125	150	188	250
	300	75	90	105	120	150	180	225	300
	400	100	120	140	160	200	240	300	400
	500	125	150	175	200	250	300	375	500
	600	150	180	210	240	300	360	450	600
	630	158	189	221	252	315	378	473	630
Available for NF or RF Frames	**800**	200	240	280	320	400	480	600	800
	1000	250	300	350	400	500	600	750	1000
	1200	300	360	420	480	600	720	900	1200
	1250	313	375	438	500	625	750	938	1200
	1600	400	480	560	640	800	960	1200	1200
Available for RF Frame Only IZMX40/IZM95	**2000**	500	600	700	800	1000	1200	1200	1200
	2500	625	750	875	1000	1200	1200	1200	1200
	3000	750	900	1050	1200	1200	1200	1200	1200
	3200	800	960	1120	1200	1200	1200	1200	1200
	4000	1000	1200	1200	1200	1200	1200	1200	1200

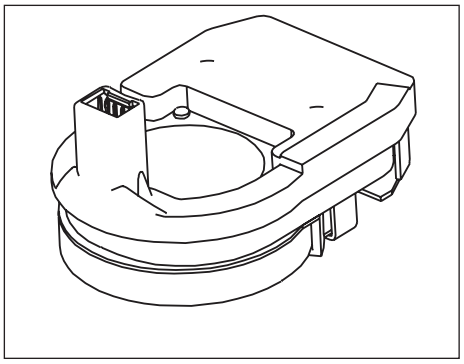
① Tolerance on settings are ±10% of values shown.
② ANSI rating units provide a hard limit of 1200A ground fault current regardless of setting.

Table 8. Ground (Earth) Fault Current Setting - Residual - IEC Ratings

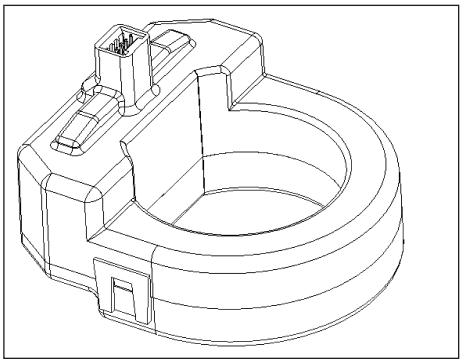
	Ground Fault Current Settings (Amperes) ①								
	Available Rating Plug (Amperes) I_n	**0.25**	**0.30**	**0.35**	**0.40**	**0.50**	**0.60**	**0.75**	**1.00**
Available for NF Frame Only IZMX16/IZM91	**200**	50	60	70	80	100	120	150	200
	250	63	75	88	100	125	150	188	250
	300	75	90	105	120	150	180	225	300
	400	100	120	140	160	200	240	300	400
	500	125	150	175	200	250	300	375	500
	600	150	180	210	240	300	360	450	600
	630	158	189	221	252	315	378	473	630
Available for NF or RF Frames	**800**	200	240	280	320	400	480	600	800
	1000	250	300	350	400	500	600	750	1000
	1200	300	360	420	480	600	720	900	1200
	1250	313	375	438	500	625	750	938	1250
	1600	400	480	560	640	800	960	1200	1600
Available for RF Frame Only IZMX40/IZM95	**2000**	500	600	700	800	1000	1200	1500	2000
	2500	625	750	875	1000	1250	1500	1875	2500
	3000	750	900	1050	1200	1500	1800	2250	3000
	3200	800	960	1120	1280	1600	1920	2400	3200
	4000	1000	1200	1400	1600	2000	2400	3000	4000

① Tolerance on settings are ±10% of values shown.

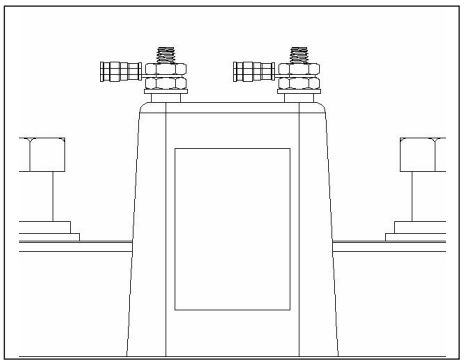
Sensor Types with graphics



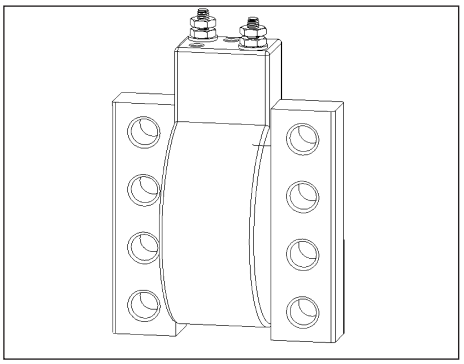
Phase Sensor Type - NF frame (IZMX16/IZM91)



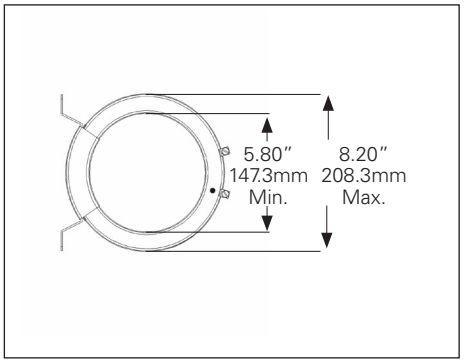
Phase Sensor Type - RF frame (IZMX40/IZM95)



Neutral Sensor Type - NF frame (IZMX16/IZM91)



Neutral Sensor Type - RF frame (IZMX40/IZM91)



Source Ground/Zero Sequence Sensor - NF frame (IZMX16/IZM91) Source Ground
RF frame (IZMX40/IZM95) only

Figure 18. Sensor Types

Section 4: Test procedures

General

⚠ WARNING

DO NOT ATTEMPT TO INSTALL, TEST, OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT.
DE-ENERGIZE THE CIRCUIT AND DISCONNECT THE CIRCUIT BREAKER BEFORE PERFORMING MAINTENANCE OR TESTS.
ANY TRIPPING OPERATION WILL CAUSE DISRUPTION OF SERVICE AND POSSIBLE PERSONAL INJURY, RESULTING IN THE UNNECESSARY SWITCHING OF CONNECTED EQUIPMENT.
TESTING A CIRCUIT BREAKER WHILE IT IS IN-SERVICE AND CARRYING LOAD CURRENT IS NOT RECOMMENDED.
TESTING OF A CIRCUIT BREAKER THAT RESULTS IN THE TRIPPING OF THE CIRCUIT BREAKER SHOULD BE DONE ONLY WITH THE CIRCUIT BREAKER IN THE TEST OR DISCONNECTED CELL POSITIONS OR WHILE THE CIRCUIT BREAKER IS ON A TEST BENCH.

When to test

Testing prior to startup can best be accomplished with the circuit breaker out of its cell or in the TEST, DISCONNECTED, or WITHDRAWN (or removed) cell positions.

Note: Since time-current settings are based on desired system coordination and protection schemes, the protection settings selected and preset in accordance with Section 3 should be reset to their as-found conditions if altered during any routine test sequence.

Functional field testing

⚠ CAUTION

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

Functional test kit (handheld)

Description of handheld test kit

A battery-powered test kit is available and capable of testing the functional trip elements for trip units 520/520M and for Series NRX circuit breakers, including power up, instantaneous trip, short delay trip, and ground (earth) fault trip. These test selections are chosen with the switch labeled "Select Test" located in the upper right-hand corner of the test kit. The test currents are not adjustable for this test kit.

The catalog number for this functional test kit is MTST230V or IZMX-TEST.

Figure 19. Functional Test Kit

Test procedure

⚠ CAUTION

BEFORE PLUGGING A TEST KIT INTO THE TEST PORT, PLACE THE LTM JUMPER IN THE INACTIVE POSITION (SEE FIGURE 16). AFTER TESTING, RETURN THE LTM JUMPER TO ITS ORIGINAL POSITION.

Complete procedural instructions for Eaton's functional test kit can be found in IL01301067E, which is packaged with each test kit.

Note: You can access the test kit I.L. by going to Eaton's Website: http://www.eaton.com and search "IL01301067".

Once the testing procedure is completed, disconnect the test cable from the test kit to prevent accidental operation and battery drainage. Reset the trip unit settings to its original condition. Reposition the LTM jumper to the as-found condition. Install the small cover on the Digitrip and reposition the plexiglass cover.

Currents

Each test selected by the Select Test switch on the test kit supplies a fixed milliampere/millivolt value. The rating plug, such as the long delay setting, will affect the per unit (I_R) current value and the response of the Digitrip unit.

Batteries

The functional test kit contains a total of seven 9V batteries. A lithium ion cell is the preferred battery type for BAT A and is attached to the main pc board of the test kit. If either LED does not light or lights only dimly, replace the appropriate battery or batteries.

Note: The functional test kit also includes a 120/230 Vac auxiliary power cord that plugs into the trip unit. This can be used to conserve test kit battery life.

Ground (Earth) Fault Performance Testing

For additional information and record keeping on performance testing for ground fault trip units see Appendix D.

Section 5: Trip unit battery

General

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

The battery is provided to maintain the LED indication of the cause of trip. A Battery Check pushbutton and a green Battery Check LED is also provided. On the initial installation of the circuit breaker, pull to remove battery and then discard the insulating tab and then replace battery (see **Figure 20**). This will activate the battery. Check the battery status by depressing the Battery Test pushbutton.

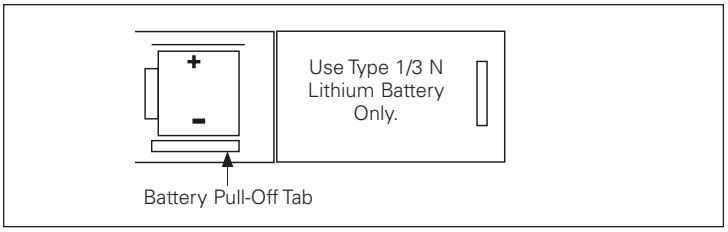
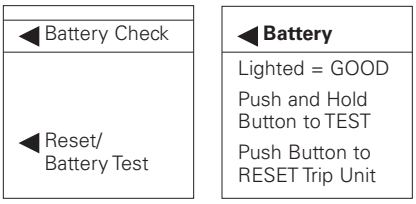


Figure 20. Digitrip Battery Installation

Battery check

The battery is a long-life, lithium, camera-type unit. Check the status of the battery at any time by pressing the Battery Check pushbutton and observing the green LED.



If the Battery Check LED does not light green, replace the battery. The condition of the battery has no effect on the protection function of the trip unit. Even with the battery removed, the unit will still trip the circuit breaker in accordance with its settings. However, without the battery, the cause of trip LED will not light. If the battery is replaced, one or more of the cause of trip LEDs may be illuminated. Push the Reset/Battery test button to turn off the indicators. The trip unit will be ready to indicate the next cause of trip.

Note: A healthy battery is required to fully reset the four-bit latch chips and associated cause of trip LEDs.

Battery installation and removal

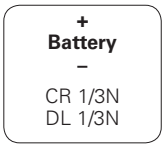
The 3V lithium cell battery (**Figure 20**) is easily removed and replaced. The battery is located in the frame module below the Digitrip trip unit. Insert a small screwdriver at the bottom side to open the access door. Remove the old battery by pulling up on the removal tab that wraps under the battery cell. When inserting the new cell, pay special attention to ensure that the proper polarity is observed. The main body of the battery is the positive (+) side.

Note: While in service, the battery can be replaced without affecting the operation of the circuit breaker or its protective functions. However, it is recommended that the circuit breaker be opened and removed from service.

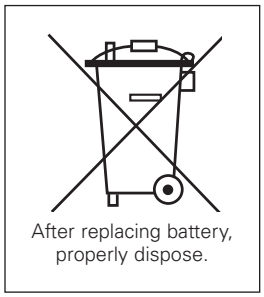
⚠ CAUTION

EXERCISE CARE WHEN REPLACING THE BATTERY TO ENSURE THAT THE CORRECT POLARITY IS OBSERVED. POLARITY MARKINGS ARE SHOWN WHEN THE HINGED COVER IS OPEN. ACCIDENTALLY INSTALLING THE BATTERY IN THE REVERSE DIRECTION WILL NOT HARM THE TRIP UNIT OR THE BATTERY, BUT WILL DEFEAT THE FUNCTION OF THE BATTERY.

The replacement battery should be the same type as what is already in the trip unit or an equivalent.



Acceptable 3V lithium batteries of (type CR 1/3N or DL 1/3N) may be used.



Section 6: Rating plugs

The rating plug defines the rated current (In) for the trip unit and is the basis for the trip unit current settings:

1. The instantaneous and ground current setting (if provided) are multiples of (I_n)
2. The long delay current setting, (I_r), is a fractional multiple of (I_n):
   Long **D**elay current setting = (I_r) = LD x (I_n)
3. The short delay current setting is a multiple of (Ir):
   Short **D**elay current setting = SD x (I_r) = SD x [LD x (I_n)]

A rating plug value, (I_n), that is less than the breakers maximum continuous current rating (as listed on the nameplate of the breaker I_u) may be chosen to be the basis for the coordination of the protection function of the circuit breaker without affecting its short-circuit current capability.

Generally, ratings plugs are defined per customer breaker selection upon ordering and are installed in the factory. Field-installable kits are also available as defined in **Tables 9** and **10**.

⚠ WARNING

THE RATED CURRENT VALUE OF A RATING PLUG MUST NOT EXCEED THE MAXIMUM CURRENT FRAME RATING AS LISTED ON THE BREAKER NAMEPLATE.

For the Series NRX-NF frame, there are three groupings of rating plugs available: Group A, Group B, Group C (**Table 9**). It is important to select the proper group when choosing another replacement rating plug for a particular circuit breaker application. The identification label on the cover of the circuit breaker will identify the proper group rating plug required.

For the Series NRX-RF frame, there are four groupings of rating plugs available: Group D, Group E, Group F and Group G (**Table 10**). The identification label on the cover of the circuit breaker will identify the proper group rating plug required if a replacement rating plug is desired.

Table 9. Series NRX NF Frame Rating Plugs

	Group A			Group B				Group C	
Frame Size	**630A**①	**800A**		**1000A**①	**1200A**	**1250A**①		**1600A**	
RP I_n			**Catalog Number**				**Catalog Number**		**Catalog Number**
400	x	x	NA400T IZMX_RP40A-400	x	x	x	NB400T IZMX_RP40B-400	-	-
500	x	x	NA500T IZMX_RP40A-500	x	x	x	NB500T IZMX_RP40B-500	-	-
600	x	x	NA600T IZMX_RP40A-600	x	x	x	NB600T IZMX_RP40B-600	-	-
630	x①	x①	NA630T IZMX_RP40A-630	x①	x①	x①	NB630T IZMX_RP40B-630	-	-
800	-	x	NA800T IZMX_RP40A-800	x	x	x	NB800T IZMX_RP40B-800	x	NC800T IZMX_RP40C-800
1000	-	-	-	x	x	x	NB1000T IZMX_RP40B-1000	x	NC1000T IZMX_RP40C-1000
1200	-	-	-	-	x	x	NB1200T IZMX_RP40B-1200	x	NC1200T IZMX_RP40C-1200
1250	-	-	-	-	-	x①	NB1250T IZMX_RP40B-1250	x①	NC1250T IZMX_RP40C-1250
1600	-	-	-	-	-	-	-	x①	NC1600T IZMX_RP40C-1600

① IEC Only - (not UL Listed)

Table 10. NRX Type RF Frame Rating Plugs

	Group D		Group E		Group F		Group G	
Frame Size	**1600**		**2000**		**2500**		**4000**	
RP I_n		**Catalog Number**		**Catalog Number**		**Catalog Number**		**Catalog Number**
800	x	RD800T IZMX-RP40D-800	x	RE800T IZMX-RP40E-800	-	-	-	-
1000	x	RD1000T IZMX-RP40D-1000	x	RE1000T IZMX-RP40E-1000	-	-	-	-
1200	x	RD1200T IZMX-RP40D-1200	x	RE1200T IZMX-RP40E-1200	x	RF1200T IZMX-RP40F-1200	x	RG1200T IZMX-RP40G-1200
1250	x	RD1250T IZMX-RP40D-1250	x	RE1250T IZMX-RP40E-1250	x	RF1250T IZMX-RP40F-1250	x	RG1250T IZMX-RP40G-1250
1600	x	RD1600T IZMX-RP40D-1600	x	RE1600T IZMX-RP40E-1600	x	RF1600T IZMX-RP40F-1600	x	RG1600T IZMX-RP40G-1600
2000	-	-	x	RE2000T IZMX-RP40E-2000	x	RF2000T IZMX-RP40F-2000	x	RG2000T IZMX-RP40G-2000
2500	-	-	-	-	x	RF2500T IZMX-RP40F-2500	x	RG2500T IZMX-RP40G-2500
3000	-	-	-	-	-	-	x	RG3000T IZMX-RP40G-3000
3200	-	-	-	-	-	-	x	RG3200T IZMX-RP40G-3200
4000	-	-	-	-	-	-	x	RG4000T IZMX-RP40G-4000

All Frames are IEC Only

Section 7: Maintenance Mode feature

Arcflash Reduction Maintenance System™ mode (ARMS)

⚠ WARNING

ONLY CERTIFIED AND COMPETENT PERSONNEL SHOULD ATTEMPT TO INSTALL OR MAINTAIN POTENTIALLY HAZARDOUS EQUIPMENT. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING. ALWAYS FOLLOW SAFETY PROCEDURES. EATON IS NOT LIABLE FOR MISAPPLICATION OR IMPROPER INSTALLATION OF ITS PRODUCTS.

⚠ CAUTION

OBSERVE ALL RECOMMENDATIONS, NOTES, CAUTIONS, AND WARNINGS RELATING TO THE SAFETY OF PERSONNEL AND EQUIPMENT. OBSERVE AND COMPLY WITH ALL GENERAL AND LOCAL HEALTH AND SAFETY LAWS, CODES, AND PROCEDURES. CONDUCT A FLASH HAZARD ANALYSIS TO DETERMINE PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS.

Maintenance Mode

Per the above WARNING, it is highly recommended that maintenance be conducted on the electrical equipment, including circuit breakers with the system de-energized.

For situations that arise when it is not possible, the Maintenance Mode function of the Digitrip 520M family (catalog numbers N5MRLSI, N5MRLSIG, N5MRLSIA) can reduce arc flash incident energy that is generated on a fault condition. This is accomplished by an analog trip circuit that, when armed, provides a fast-acting response to the fault. The reduced arc condition will occur only in devices downstream of the trip unit in Maintenance Mode. This function is separate from the normal system protection setting of instantaneous. The Maintenance Mode section is located in the upper, white portion of the unit.

Maintenance Mode current setting

The Maintenance Mode setting, when armed, uses a fixed pick up current value for tripping the breaker depending on the frame type. For the NF Frame this value is 2000A, for the RF Frame this value is 8000A. For additional information on clearing times please reference the Maintenance Mode Trip Curve found in the Application Data document, AD01301004E.

Actuating Maintenance Mode

There are three ways to actuate the Maintenance Mode setting. One method is locally via the selector switch in the Maintenance Mode section of the trip unit. Turning the switch to the ON position will arm the setting selected. A blue LED confirms that the function is on.

For the second method of actuating the Maintenance Mode function, this switch must be in the position labeled 0/1. With this setting, a remote switch wired through the circuit breaker secondary contacts 33 and 34 can remotely arm the Maintenance Mode setting. A high quality gold plated or palladium contact is required in this application. The blue LED will verify that the function is armed.

A third method to arm the Maintenance Mode is via a communication device. When Maintenance Mode is enabled via device communications, this setting must be disabled by a communications device.

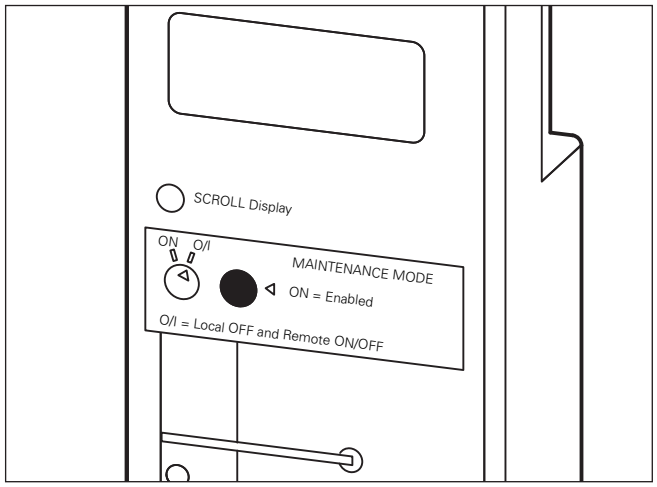


Figure 21. Digitrip 520M in Maintenance Mode

Remote indication of Maintenance Mode

A contact is available for customer use to indicate remotely that the Maintenance Mode setting is actuated. This normally open contact is available on secondary contacts 11 and 12 to light a remote blue indicating light. This contact will not operate if status LED is red indicating the unit has detected a problem with the Trip Actuator coil.

Tripping and testing

The Maintenance Mode function will provide fast tripping even when the regular instantaneous is set to OFF. The instantaneous LED position is also used to indicate a trip initiated by the Maintenance Mode setting. The LCD display, if powered, will indicate this with four dashes. The Maintenance Mode setting, external wiring (if any), and tripping functionality should be periodically verified by primary injection current testing.

Section 8: Communication Adapter Modules (CAM)

This module provides communication from the Digitrip 520M to a field bus network (**Figure 22**). Various networks are supported and available:

- ICAM—INCOM™
- MCAM—Modbus®RTU
- ECAM—ETHERNET
- PCAM—PROFIBUS DP

Power requirements: 6 watts at 24 Vdc (INCOM and Modbus).

These modules, for the drawout type circuit breaker, will snap onto the DIN rail of the cassette. They are designed to install or replace the four contact blocks (eight contacts in total) at secondary contacts 19 through 26. (See **Appendix E and F** for circuit breaker master connection diagrams.)

When the module is installed and powered with 24 Vdc, the Digitrip 520M will be able to communicate with this module via contacts CMM1, CMM2, CMM3, and CMM4. For communication to the Modbus or INCOM network, a plug-in connector on the top of this module provides the required network connections. For additional information on each of the communication modules please reference the following instruction leaflets:

IL01301033E (ICAM)

IL01301034E (MCAM)

IL01301035E (PCAM)

IL01301052E (ECAM)

Note: When using a Communication Module, the enabling of source ground mode is done via the position of the jumper located on this module.

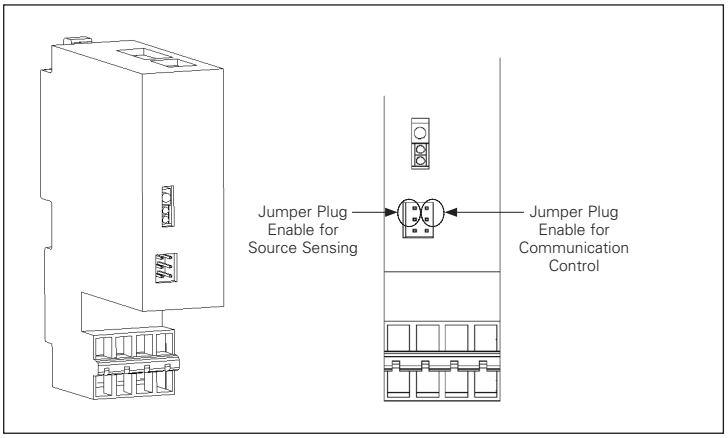


Figure 22. Communication Module

Section 9: References

Series NRX circuit breakers

MN01301001E	NRX Circuit Breaker Manual - NF
MN01301003E	NRX Circuit Breaker Manual - RF
IL70C1592	Rating Plug
IL01301031E	Source Ground/ Zero Sequence Sensor
IL01301032E	Neutral Current Sensor - NF
IL01301046E	Neutral Current Sensor - RF
IL01301067E	Functional Test Kit
TD01301014E	Series NRX Circuit Breaker Wiring Diagrams

Time-current curves

The time-current curves are listed below for particular frame models. All protection function time-current settings should be made by following the recommendations of the specifying engineer in charge of the installation.

Type NF Frame (IZMX16/IZM91)

AD01301004E Application Data

- Long Delay
- Long Delay and Short Delay
- Instantaneous
- Ground Fault
- Maintenance Mode

Type RF Frame (IZMX40/IZM95)

AD01301004E Application Data

- Long Delay
- Long Delay and Short Delay
- Instantaneous
- Ground Fault
- Maintenance Mode

Use the following to access Time Current Curves. Go to Eaton's Web site: http://www.eaton.com and search "NRX Digitrip 520 Curves".

All Series NRX publications can be found on-line at http://www.eaton.com by searching for the respective publication number.

Curve Select

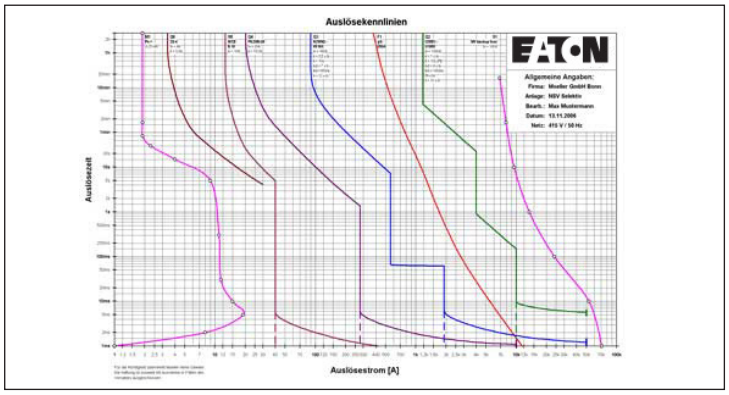


Figure 23. Curve Select

The "CurveSelect" software tool enables the representation of tripping characteristics which correspond to the individual switch and relay settings using Microsoft Excel®. In many electrical power networks the protective devices are connected in series. The program makes it possible to represent and evaluate all curves at the same time with a minimum of effort.

You can download the tool for free at www.eaton.com.

Appendix A: Zone interlocking examples

Case 1: There is no zone selective interlocking. (Standard time delay coordination is used.)

Assume that a ground fault of 2000A occurs and refer to **Figure 24**.

Fault at location 3

The branch circuit breaker will trip, clearing the fault in 0.1 seconds.

Fault at location 2

The feeder circuit breaker will trip, clearing the fault in 0.3 seconds.

Fault at location 1

The main circuit breaker will trip, clearing the fault in 0.5 seconds.

Case 2: There is zone selective interlocking.

Assume a ground fault of 2000A occurs and refer to **Figure 24**.

Fault at location 3

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

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

Fault at location 2

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

Fault at location 1

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

Figure 25 presents a zone selective interlocking connection diagram for a system with two main circuit breakers from incoming sources and a bus tie circuit breaker.

Note: The blocking diode D1 is needed so that the feeder breakers can send interlocking signals to both the main and the tie breakers and prevent the tie breaker from sending an interlocking signal to itself.

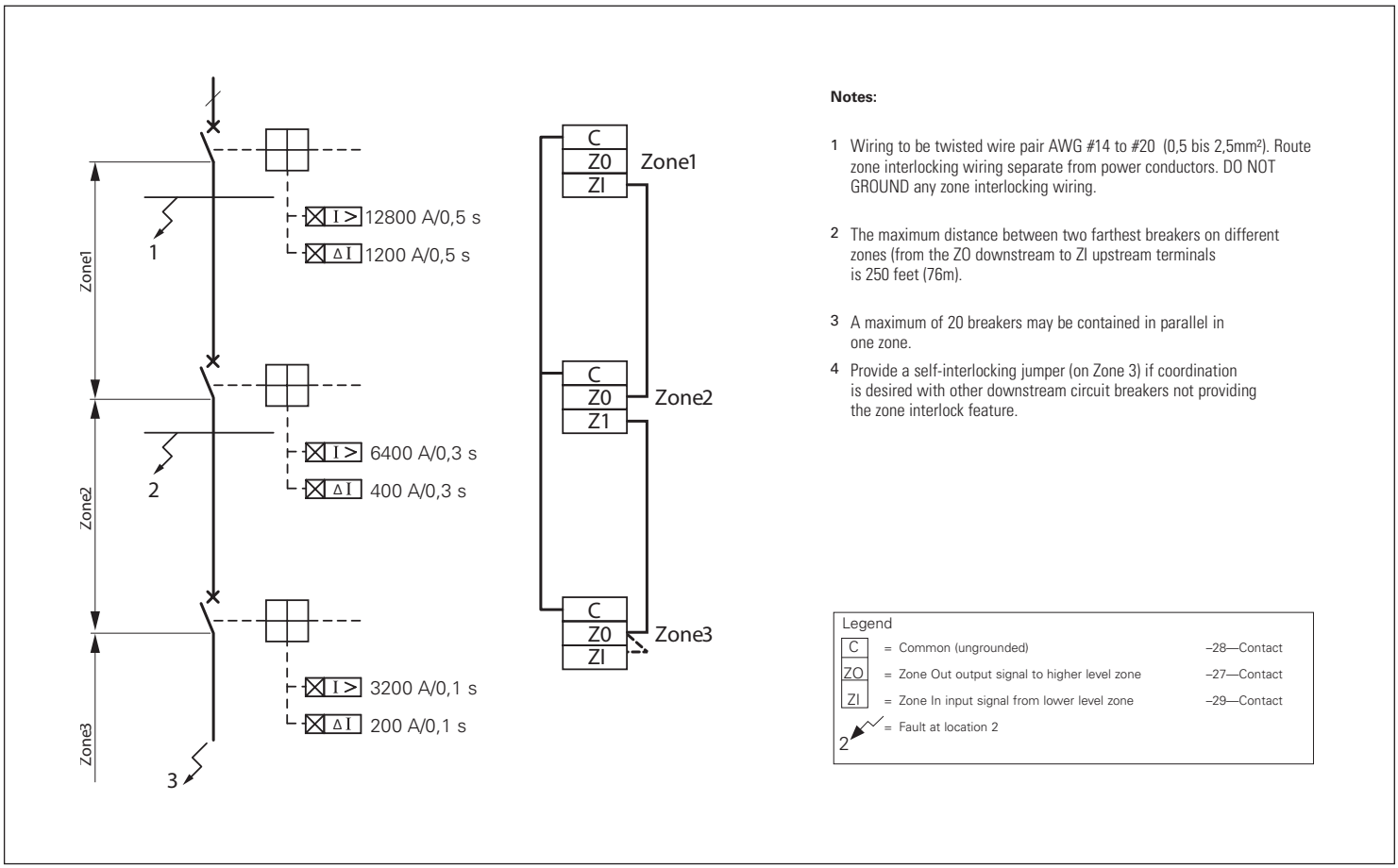


Figure 24. Typical Zone Interlocking

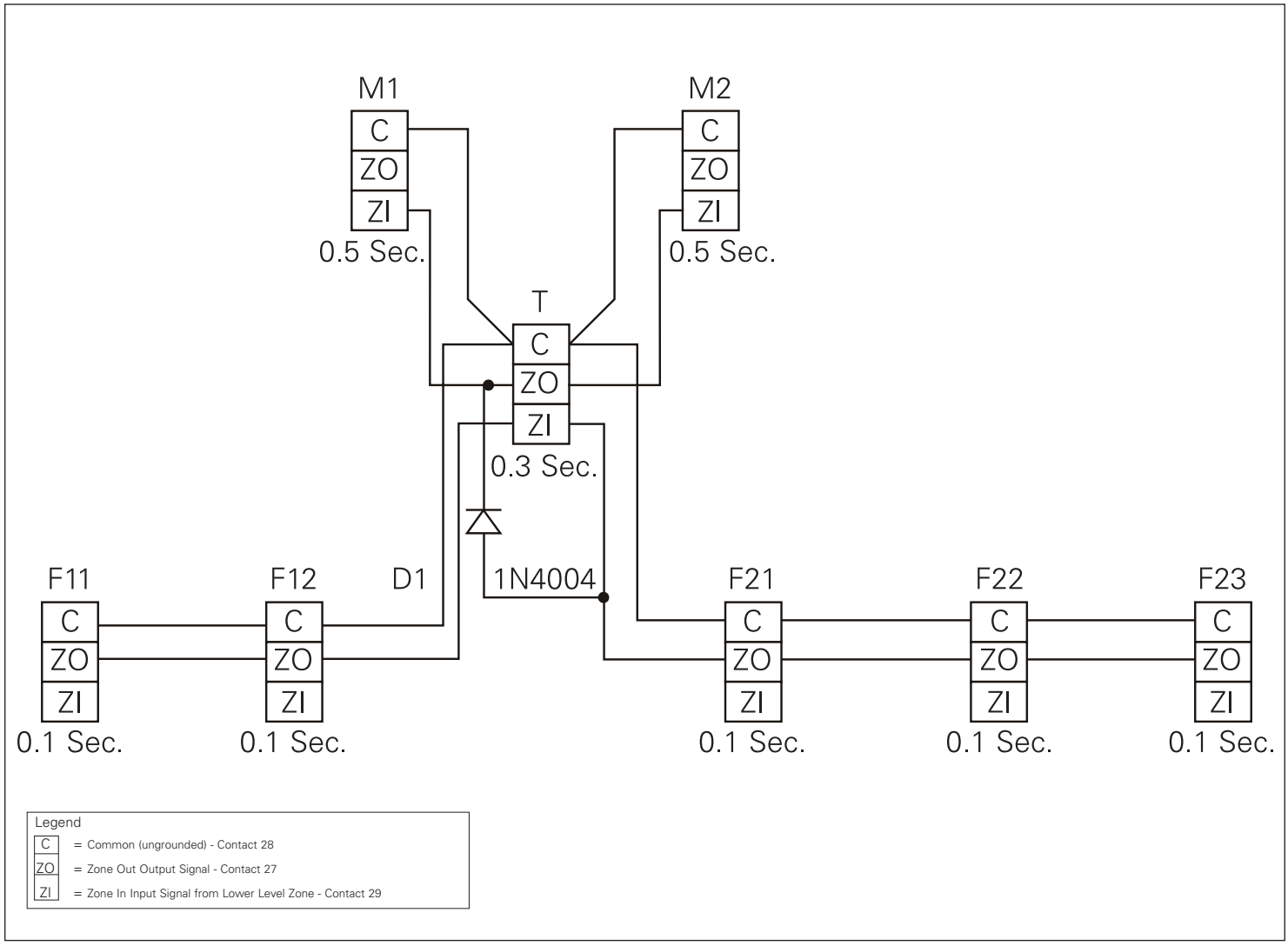


Figure 25. Typical Zone Interlocking Connections with two Main Circuit Breakers (M1, M2) and a Tie Circuit Breaker (T)

Appendix B: Troubleshooting

Symptom	Probable Cause	Possible Solution(s)	References
Unit Status LED is not blinking	Current through breaker is <100A (single-phase) or 35A (three-phase)	No problem. Status LED will not operate with breaker currents <<100A (single-phase) or 35A (three-phase)	
	Trip unit is malfunctioning	Replace trip unit	
Unit Status LED is steadily on	Light loading	No problem. Status LED will not flash until above 35A	See Section 2 note for trip and operational indicators
	Trip unit is malfunctioning	Replace trip unit	
When current starts flowing through the breaker, it trips. The orange (not red) instantaneous trip LED lights	Rating plug is not installed or is loose	Install rating plug and/or check for loose connections	
	Rating plug is open internally	Replace rating plug	
LED does not light when Battery Check button is pressed	Battery installed backwards	Install correctly	See Section 5
	Dead battery	Replace battery	
	Fram module is malfunctioning	Contact Eaton	
Breaker trips on ground fault	There actually is a ground fault	Find location of the fault	
	On three-pole, four-wire residual systems, the neutral current sensor may not have the correct ratio or be properly connected	Check connections at terminals 15 and 16. Check that the connections from the neutral current sensor to the breaker are not reversed. Check terminal 19 and 20 for correct programming of jumper	See Section 2 notes for ground fault protection See Table 5-8
	High inrush phase currents may cause fictitious ground pickup momentarily	If zone interlocking function is employed, connect Zout to Zin jumper to provide some time delay	Refer to Appendix A for zone selective interlocking
	Trip unit is malfunctioning	Replace trip unit	
Breaker trips too rapidly on ground fault or short delay	Zone interlock signal is not present	Check wiring connections	Refer to Appendix A and Section 2 zone selective interlocking
	Trip unit settings are not correct	Change settings	
	Trip unit is malfunctioning	Replace trip unit	
Breaker trips too rapidly on long delay	Long Time Memory selected	Turn off Long Time Memory	Refer to Section 3 for Long Delay Time setting
	Trip unit settings are not correct	Change settings. Long Time Delay setting is based on $6 \times I_R$	
Breaker trips with orange (not red) LED above long verbiage	High temperature Trip encountered	Check application connections, venting, etc.	
Cause of Trip LEDs flashing and breaker is closed	Trip unit was not reset from previous event or test	Depress Reset pushbutton to clear LED flashing	See below
	Battery voltage too low to reset latch chip and LEDs	Replace battery	See Section 5 for battery check
A Cause of Trip LED keeps retriggering in the application	Digitrip memory buffer not completely reset	Need to reset Digitrip unit when Status LED is operational. Possibly do this by temporarily (or permanently) adding auxiliary power and then depress Reset pushbutton to fully clear trip buffer	See Section 2 mode of trip and status information
Status LED is red continuously or flashing red	Circuit breaker MCR (b) auxiliary switch not indicating proper state	Check auxiliary switch for continuity	Refer to Appendix E or F master connection diagram
	Circuit breaker mechanism not properly closing	Check with factory	
	Trip actuator coil not connected (coil supervisor alarm)	Check coil connector R5 and check coil resistance	
	Internal memory problem	Replace Digitrip unit	

Symptom	Probable Cause	Possible Solution(s)	References
Circuit breaker tripping and orange LED (not red) illuminated above SHORT text or above alarm text (LI style)	Circuit breaker MCR (b) auxiliary switch not indicating proper state	Check MCR (b) switch	Refer to Appendix E or F master connection diagram
	Circuit breaker mechanism not closing properly	Check with factory	Refer to Section 2 for diagnostics
Maintenance Mode will not shut off	Verify remote switch or local switch is not on		
	Maintenance mode was initially enabled by communication and is not available	Restore communication link if possible and check for possible wiring errors.	

Appendix C: Specifications

Protection	Trip Pickup	Trip Time	Trip Pickup Tolerance	Trip Time Tolerance
LONG I^2t	I_R = 0.5, 0.6, 0.7, 0.75, 0.8, 0.9, 0.95, 1.0 x I_n	2, 4 ,7, 10, 12, 15, 20, 24 at 6 x I_R	110% ±10% x I_R	+ 0, –30%
SHORT FLAT	2, 3, 4, 5, 6, 7, 8, 10 x I_R	0.1, 0.2, 0.3, 0.4, 0.5	±10%	Per curve
SHORT I^2t	2, 3, 4, 5, 6, 7, 8, 10 x I_R	0.1*, 0.3*,0.5* at 8 x I_R	±10%	Per curve
INST	2, 3, 4, 6, 8, 10, 12, OFF x I_n OFF N/A on LI style	≤ 50 ms	±10%	Per curve
GROUND FLAT	0.25, 0.3, 0.35, 0.4, .05, 0.6, 0.75, 1 x I_n	0.1, 0.2, 0.3, 0.4, 0.5	±10%	Per curve
GROUND I^2t	0.25, 0.3, 0.35, 0.4, .05, 0.6, 0.75, 1 x I_n	0.1*, 0.3*, 0.5* at 0.625 x I_n	±10%	Per curve
MCR	Automatically defined by the breaker type	≤ 30 ms		
HIGH INST	Automatically defined by breaker type	≤ 30 ms		
Frequency		50, 60 Hz		
Temperature range of circuit breaker		-20°C to 55°C		
Temperature trip of PC board		85°C		
Relative humidity (noncondensing)		0 to 85%		
Metering accuracy		+- 3% x NF Max Frame Rating (1600A), +-4% RF Max Frame Rating (4000A)		
Control voltage consumption		6 watts		
Control voltage (if desired for Digitrip 520M alarm relays)		24 Vdc ±10%		

Alarm Relays (Resistive Load)		
AC	0.5A	@ 230 Vac
AC	1A	@ 120 Vac
DC	1A	@ 48 Vdc
DC	0.35A	@ 125 Vdc

Appendix D: Performance testing for ground fault trip units—primary injection

North American Testing Requirements

In North America and certain other countries it is required that any ground fault protection system be performance tested when first installed. Conduct tests in accordance with the approved instructions provided with the equipment. Make a written record of this test and make the results available to the authority having inspection jurisdiction.

Standards requirements

As a follow-up to the basic performance requirements stipulated by the NEC, UL Standard No. 1053 requires that certain minimum instructions must accompany each ground fault protection system. These statements (in General Test Instructions), plus a copy of the record forms (**Figure 28, Figure 29, and Figure 30**), are included as part of this instructional leaflet.

General test instructions

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

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

⚠ WARNING

ELECTRICAL SHOCK OR BURN INJURY CAN OCCUR WHEN WORKING ON POWER SYSTEMS. ALWAYS TURN OFF POWER SUPPLYING CIRCUIT BREAKER BEFORE CONDUCTING TESTS. TEST OUT OF THE CELL, IF POSSIBLE.

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

Use a low voltage (0- to 24-volt), high-current, AC source to apply a test current of 125 percent of the ground pickup setting through one phase of the circuit breaker. This should cause the circuit breaker to trip in less than 1 second and operate the alarm indicator, if one is supplied. Reset the circuit breaker and the alarm indicator. Repeat the test on the other two phases (**Figure 26**).

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

Apply the same current as described above through any two phases of the circuit breaker. The breaker should not trip, and the alarm indicator, if one is supplied, should not operate. Repeat the test using the other two combinations of circuit breaker phases (**Figure 27**) or through a breaker pole and the neutral that employs a neutral sensor. Record the test results on the test form provided with the equipment (**Figure 30**).

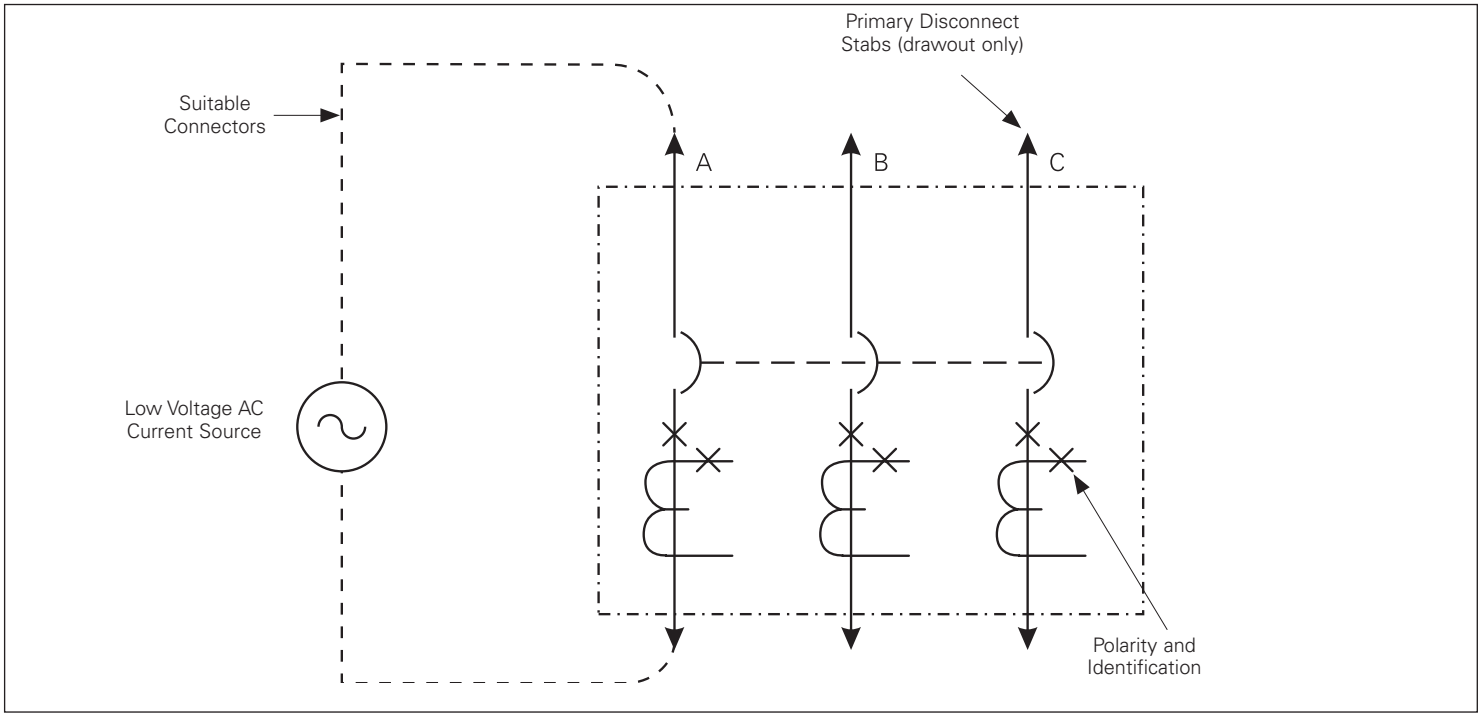


Figure 26. Connection Details for Conducting Single-Pole, Single-Phase Current Tests With the Circuit Breaker Removed From the Cell

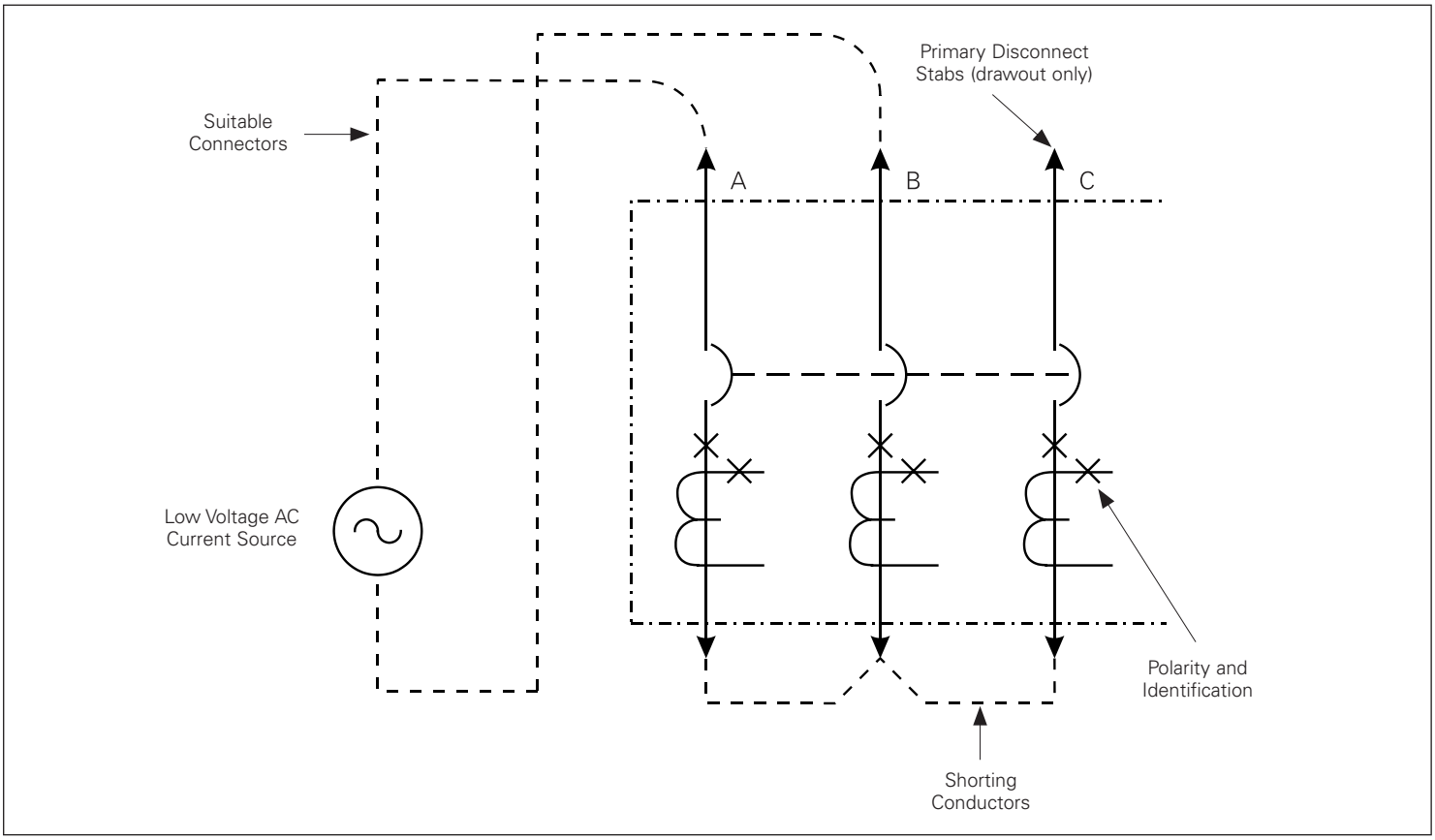


Figure 27. Connection Details for Conducting Single-Phase Current Tests With the Circuit Breaker Removed From the Cell

⚠ CAUTION

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

Record keeping

Use the forms in this section for record keeping. Record the indicated reference information and initial time-current trip function settings. If desired, make a copy of the form and attach it to the interior of the circuit breaker cell door or another visible location. **Figure 29** provides a place for recording test data and actual trip values.

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

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

Figure 28. Typical Trip Function Record Nameplate

Series NRX AUTOMATIC TRIP OPERATION RECORD				
Circuit No./Address	**Breaker Shop Order Reference**			
Trip Function	**Settings Reference**			
	Orig. 0	**Rev. 1**	**Rev. 2**	**Rev. 3**
Instantaneous				
Long Delay Setting				
Long Delay Time				
Short Setting				
Short Time				
Ground Fault Setting				
Ground Fault Time				
Date of Trip	**Trip Mode Indicator**	**Setting Ref.**	**Setting Change Made**	**Investigated By**

Figure 29. Automatic Trip Operation Record

GROUND FAULT TEST RECORD FORM Ground Fault Test Record should be retained by those in charge of the building's electrical installation in order to be available to the authority having jurisdiction.			
Test Date	**Circuit Breaker Number**	**Results**	**Tested By**

Figure 31. Typical Performance Test Record Form

Appendix E: Typical breaker master connection diagram - NF

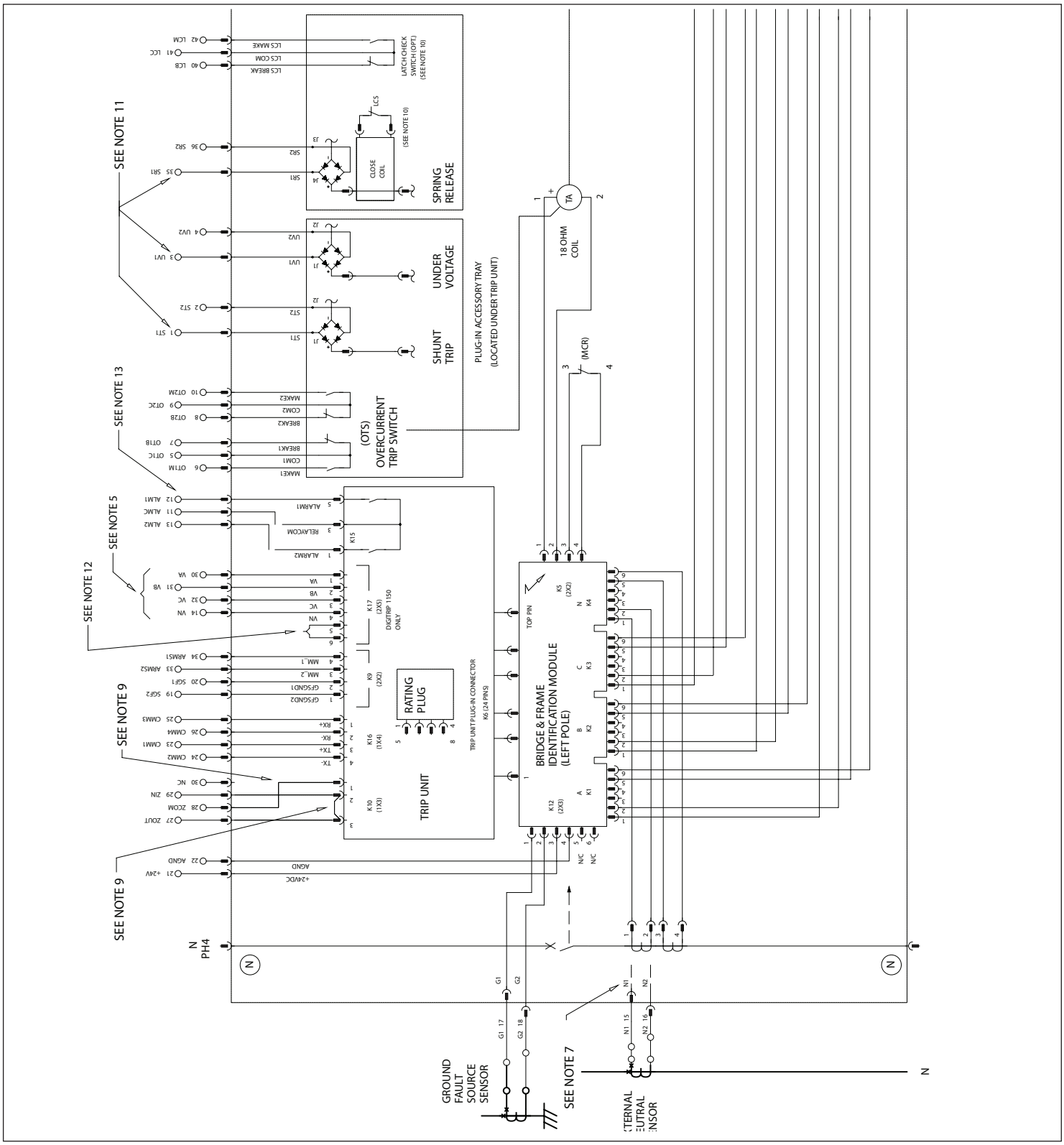


Figure 32. Series NRX-NF frame (IZMX16/IZM91) breaker master connection diagram drawing number 6D32389 (continued next page)

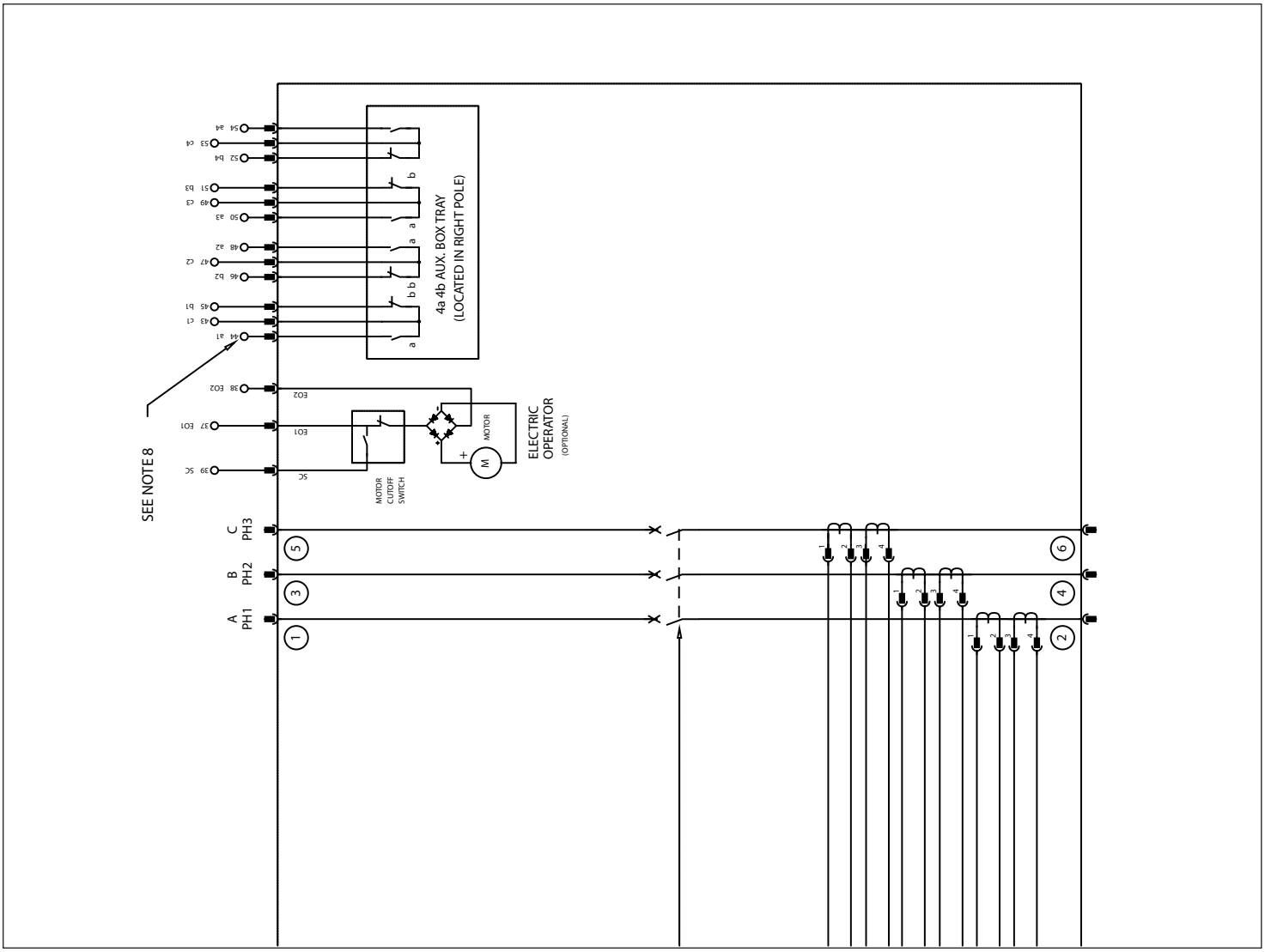


Figure 33. Series NRX-NF frame (IZMX16/IZM91) breaker master connection diagram drawing number 6D32389 (continued from previous page)

Notes for Figures 31 and 32 (Diagram drawing number 6D32389 - NF Frame)

1. All contacts shown with circuit breaker open and discharged and control power de-energized. The OTS are shown in reset position.
2. All trip unit wires are #22 AWG—0.34 mm^2—300V.
3. All accessory wires are #18 AWG—0.82 mm^2—600V.
4. 54 contacts maximum.
5. PT module inputs for Digitrip 1150 only.
6. Connectors K15 and K16 are not always present.
7. On three-pole circuit breakers only, connector K4—1.2 wires only are wired out to secondary contacts.
8. Odd number contacts have guide rib on black housing.
9. Zone interlock wiring shown dotted—optional jumper is standard.
10. Latch check switch can be wired either externally (option) or internally (option) to a spring release accessory. Wiring LCS internally ensures the one-shot pulse provided by the SR circuitry is made active only after the mechanism spring is charged and the latch is in its proper state.
11. For accessories having a DC rating, the odd numbers will be treated as positive voltage.
12. Reserved for spring charge SC input contact.
13. For Digitrip 520M ALM2 is an alarm used for GF (Ground fault style trip unit). ALM1 is used for diagnostic alarm or maintenance mode active. For Digitrip 1150, these contracts can be programmed as desired.

Appendix F: Typical breaker master connection diagram - RF

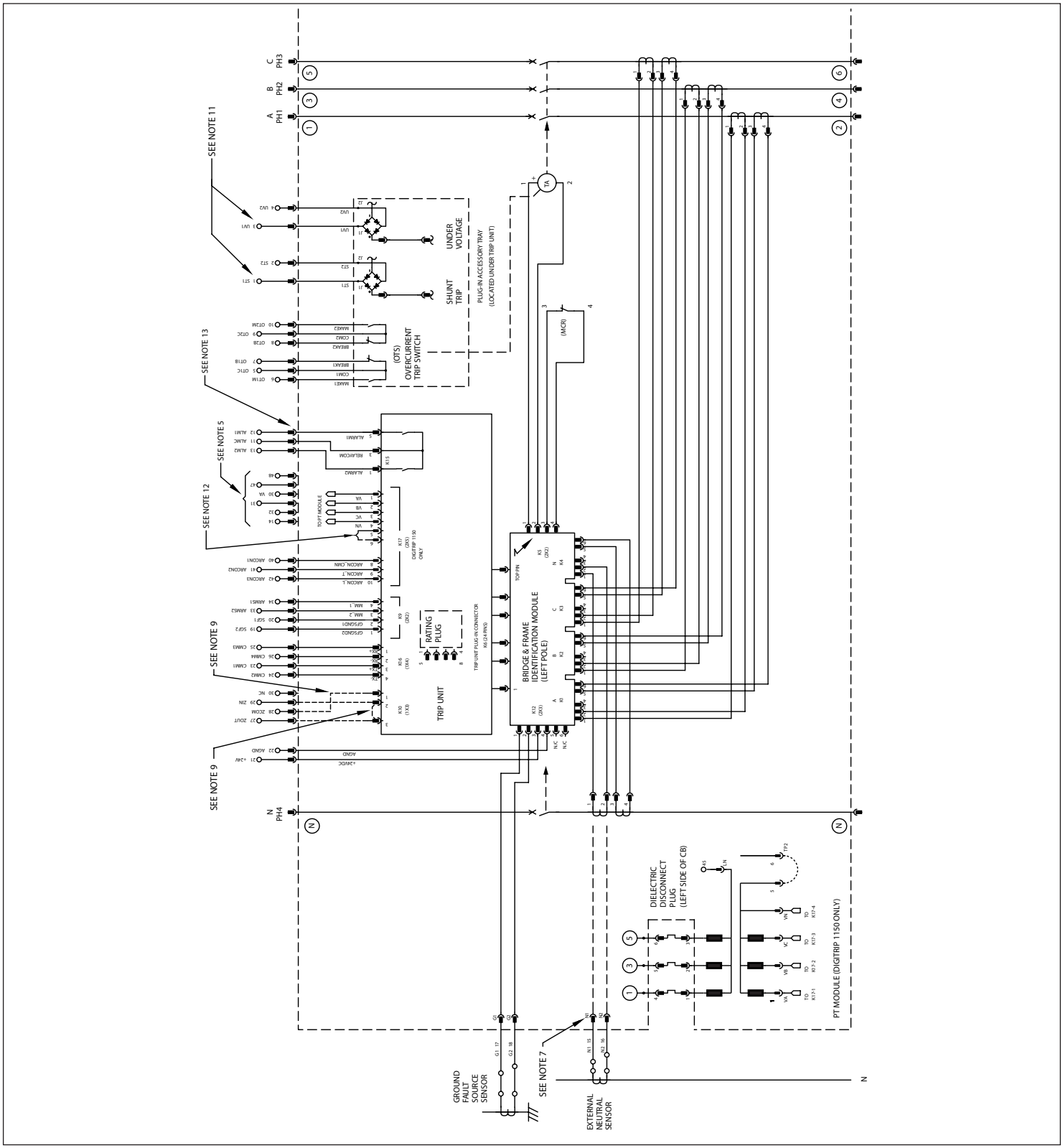


Figure 34. Series NRX-RF frame (IZMX40/IZM95) breaker master connection diagram drawing number 6D32424 (continued on next page)

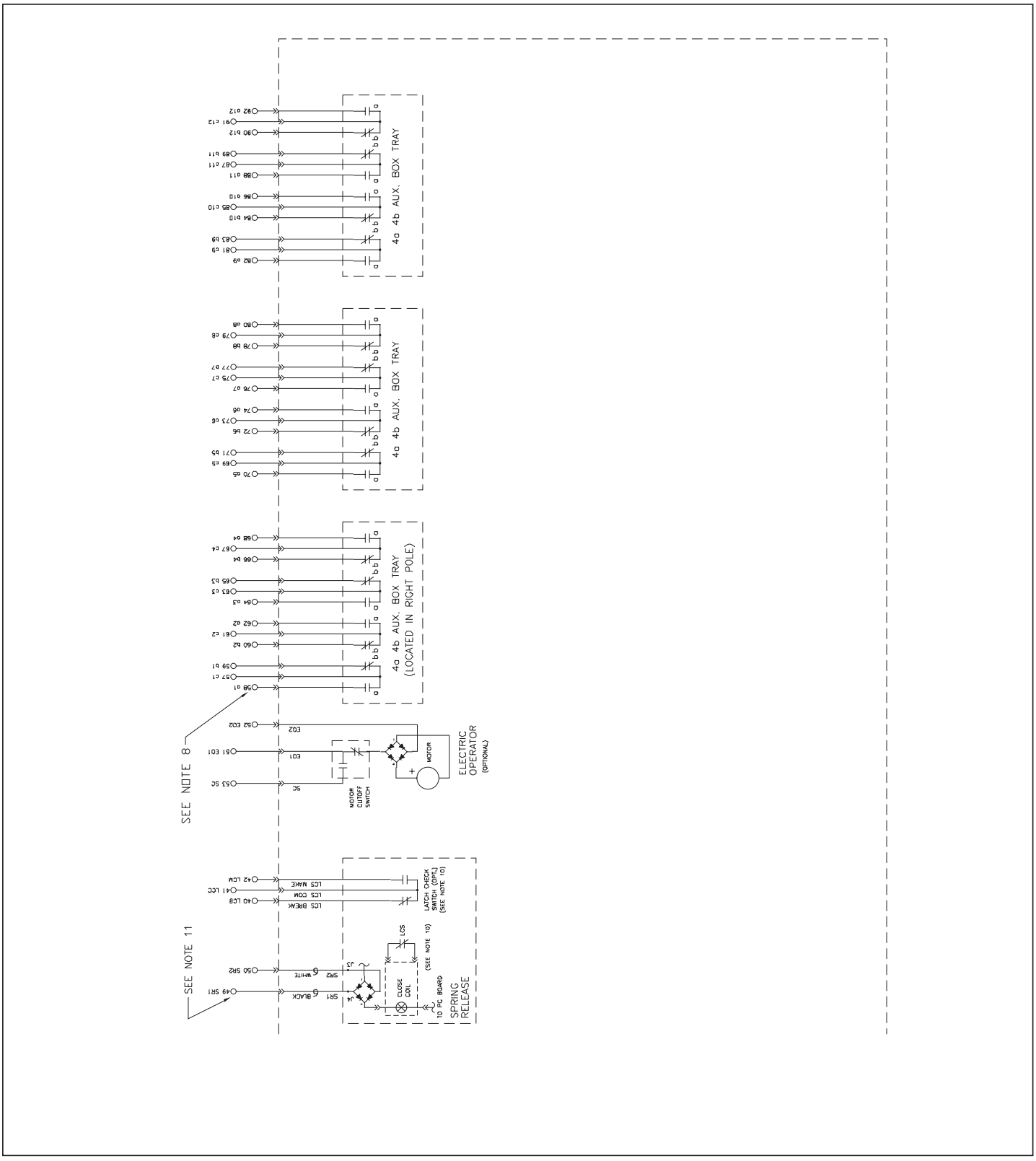


Figure 35. Series NRX-RF frame (IZMX40/IZM95) master connection diagram drawing number 6D32424 (continued from previous page and notes on next page)

Notes for pages 36 and 37 (Diagram drawing number 6D32424 - RF Frame)

1. All contacts shown with circuit breaker open and discharged and control power de-energized. The OTS are shown in reset position.
2. All trip unit wires are #22 AWG—0.34 mm^2—300V.
3. All accessory wires are #18 AWG—0.82 mm^2—600V.
4. 92 contacts maximum.
5. Contacts 14, 30, 31 and 32, 47, 48 not used.
6. Connectors K15 and K16 are not always present.
7. On three-pole circuit breakers only, connector K4—1.2 wires only are wired out to secondary contacts.
8. Odd number contacts have guide rib on black housing.
9. Zone interlock wiring shown dotted—optional jumper is standard.
10. Latch check switch can be wired either externally (option) or internally (option) to a spring release accessory. Wiring LCS internally ensures the one-shot pulse provided by the SR circuitry is made active only after the mechanism spring is charged and the latch is in its proper state.
11. For accessories having a DC rating, the odd numbers will be treated as positive voltage.
12. Reserved for spring charge SC input contact.
13. For Digitrip 520M ALM2 is used for GF (ground fault style trip unit) or high load alarm (non-ground fault style trip unit). ALM1 is used for diagnostic alarm or maintenance mode active. For Digitrip 1150, these contacts can be programed as desired.

Disclaimer of warranties and limitation of liability

The information, recommendations, descriptions, and safety notations in this document are based on Eaton Corporation's ("Eaton") experience and judgment, and may not cover all contingencies. If further information is required, an Eaton sales office should be consulted.

Sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between Eaton and the purchaser.

THERE ARE NO UNDERSTANDINGS, AGREEMENTS, WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OTHER THAN THOSE SPECIFICALLY SET OUT IN ANY EXISTING CONTRACT BETWEEN THE PARTIES. ANY SUCH CONTRACT STATES THE ENTIRE OBLIGATION OF EATON. THE CONTENTS OF THIS DOCUMENT SHALL NOT BECOME PART OF OR MODIFY ANY CONTRACT BETWEEN THE PARTIES.

In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability, or otherwise for any special, indirect, incidental, or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations, and descriptions contained herein.

The information contained in this manual is subject to change without notice.

Eaton
Electrical Sector
1000 Eaton Boulevard
Cleveland OH 44122
United States
877-ETN-CARE (877-386-2273)
Eaton.com

Printed in USA
Publication No. IL01301051EH03
September 2013

Powering Business Worldwide