

# Digitrip models 520, 520*i*; and 520M, 520M*i*, 520MC, 520MC*i* trip units for use only in Magnum and Magnum DS circuit breakers



## ⚠ WARNING

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

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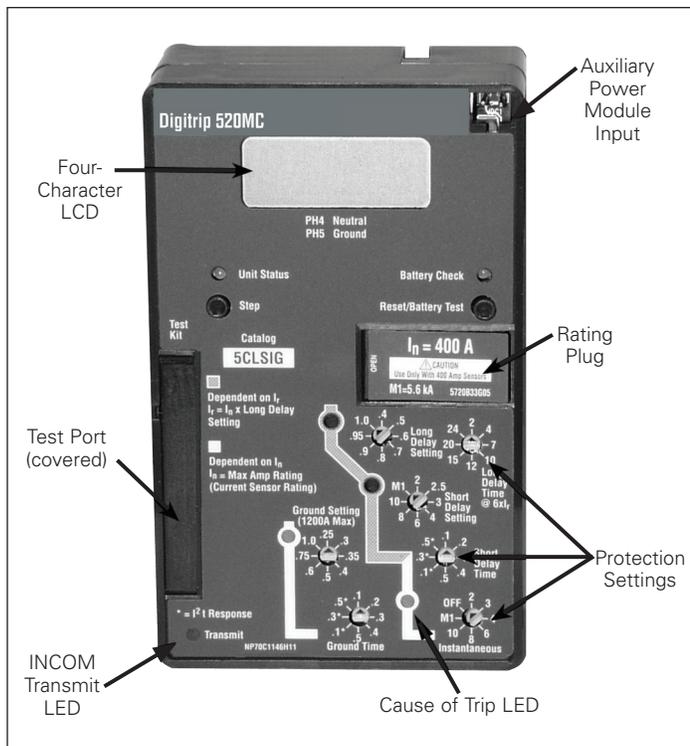
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## Section 1: General description of Digitrip trip units

Digitrip™ trip units are breaker subsystems that provide the protective functions of a circuit breaker. The trip units are in removable housings, installed in the breaker, and can be replaced or upgraded in the field by the customer. This instructional leaflet specifically covers the application of Digitrip trip units (see **Table 1**) installed in Magnum™ and Magnum DS breakers. Throughout this instructional leaflet, the use of the term “Magnum breakers” refers to both the Magnum and Magnum DS low voltage, AC power circuit breakers.

The Magnum Digitrip line of trip units consists of the 520, 520M, and 520MC for UL® standards and models 520i, 520Mi, and 520MCi for IEC standards. (See **Table 1** for available protection types.) Only models 520MC and 520MCi provide communications. (See **Table 2** for data that will be communicated.)

The Digitrip 520, 520M, and 520MC trip units may be applied on both 50 and 60 Hz systems.



**Figure 1. Digitrip 520MC Trip Unit with Rating Plug**

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 primary function of the Digitrip trip unit is circuit protection. The Digitrip 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. In addition to the basic protection function, the Digitrip 520 family of trip units provides mode of trip information such as:

- Long time trip (overload)
- Short time trip
- Instantaneous trip
- Ground (earth) fault trip (if supplied)

The current sensors provide operating power to the trip unit. As current begins to flow through the breaker, the sensors generate a secondary current that powers the trip unit.

The Digitrip 520 family of trip units provides five phase and two ground (time-current) curve shaping adjustments. To satisfy the protection needs of any specific installation, the exact selection of the available protection function adjustments is optional. The short delay and ground fault pickup adjustments can be set for either FLAT or I<sup>2</sup>t response. A pictorial representation of the applicable time-current curves for the selected protection functions is provided, for user reference, on the face of the trip unit as shown in **Figure 1**.

### Protection

Each trip unit is completely self-contained and requires no external control power to operate its protection systems. It operates from current signal levels derived through current sensors mounted in the circuit breaker. The types of protection available for each model are shown in **Table 1** and **Figure 16** through **Figure 27**.

**Note:** The Digitrip 220+ (LI model—**Figure 16**), 520 (LSI model—**Figure 17**), 520M (MLSI model—**Figure 20**) and 520MC (CLSI model—**Figure 24**) can be used on three-pole or four-pole circuit breakers for the protection of the neutral circuit. Only these four models can provide neutral protection, although models MLSIA, MLSIG, MWLSIG, CLSIA, CLSIG, and CWLSIG can provide neutral metering. Refer to the National Electrical Code® (NEC®) for the appropriate application for four-pole breakers.

### Mode of trip and status information

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

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

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

**Table 1. Protection Types Available for Digitrip Trip Units**

Digitrip Trip Unit Type		520/520i	520M/520Mi	520MC/520MCi
Ampere range		200–6300A	200–6300A	200–6300A
rms sensing		Yes	Yes	Yes
Communications		No	No	Yes ③
<b>Protection and coordination</b>				
Figure number reference		16, 17, 18, 19	20, 21, 22, 23	24, 25, 26, 27, 28, 29
Protection	Ordering options	LI, LSI, LSIG, WLSIG	MLSI, MLSIG, MLSIA, MWLSIG	CLSI, CWLSIG, ARMLSI, ARMLSIG, ARMLSIA, ARMWLSIG
	Fixed rating plug ( $I_n$ )	Yes	Yes	Yes
	Overtemperature trip	Yes	Yes	Yes
Long delay protection	Long delay setting	0.4–1.0 x ( $I_n$ )	0.4–1.0 x ( $I_n$ )	0.4–1.0 x ( $I_n$ )
	Long delay time $I^2t$ at 6 x ( $I_n$ )	2–24s	2–24s	2–24s
	Long delay thermal memory	Yes	Yes	Yes
Short delay protection	Short delay pickup ①	200–1000% x ( $I_n$ )	200–1000% x ( $I_n$ )	200–1000% x ( $I_n$ )
	Short delay time $I^2t$ at 8 x ( $I_n$ )	100–500 ms	100–500 ms	100–500 ms
	Short delay time FLAT	100–500 ms	100–500 ms	100–500 ms
	Short delay time ZSI ②	Yes	Yes	Yes
Instantaneous Protection	Instantaneous pickup ①	200–1000% x ( $I_n$ )	200–1000% x ( $I_n$ )	200–1000% x ( $I_n$ )
	OFF position	Yes, except for LI	Yes	Yes
	Making current release	Yes	Yes	Yes
Ground (earth) fault protection	Ground fault option	Yes	Yes	Yes
	Ground fault alarm	No	Yes ④	Yes ④
	Ground fault pickup	25–100% x ( $I_n$ ) ③	25–100% x ( $I_n$ ) ③	25–100% x ( $I_n$ ) ③
	Ground fault delay $I^2t$ at 0.625 x ( $I_n$ )	100–500 ms	100–500 ms	100–500 ms
	Ground fault delay flat	100–500 ms	100–500 ms	100–500 ms
	Ground fault ZSI ②	Yes	Yes	Yes
	Ground fault memory	Yes	Yes	Yes
Neutral protection		Yes, Cat LSI only	Yes, Cat MLSI only	Yes, Cat CLSI only
Maintenance Mode		No	No	Yes ⑦
<b>System diagnostics</b>				
Status/long pickup LED		Yes	Yes	Yes
High load alarm/alarm contacts		No	Yes ④, Cat MLSI only	Yes ④, Cat CLSI only
Cause of Trip LEDs		Yes ⑤	Yes ⑤	Yes ⑤
Magnitude of trip current		No	Yes ④	Yes ④
Remote ground trip/alarm contacts		No	Yes ④	Yes ④
<b>System metering</b>				
Digital display		No	Four-char. LCD	Four-char. LCD

① Additional setting is marked M1 where:

800–3200A Frame: M1 =  $14 \times \frac{1}{n}$  for plug amps 200–1250A  
M1 =  $12 \times \frac{1}{n}$  for plug amps 1600, 2000, 2500A  
M1 =  $10 \times \frac{1}{n}$  for plug amps 3000, 3200A, 4000A (IEC only)  
4000–6300A Frame: M1 =  $14 \times \frac{1}{n}$  for plug amps 2000, 2500A  
M1 =  $12 \times \frac{1}{n}$  for plug amps 3200, 4000, 5000A (see Section 2)  
M1 =  $10 \times \frac{1}{n}$  for plug amps 6000, 6300A

② ZSI = Zone selective interlock (see Section 3).

③ Limited to 1200A; this is only for UL versions, not for IEC models that have “W” in catalog number.

④ Requires Ground Alarm/Power Supply Module (see Section 1).

⑤ Four Cause of Trip LEDs—L, S, I, G. Making current release is indicated by the Instantaneous LED.

⑥ 6300A rating for IEC only.

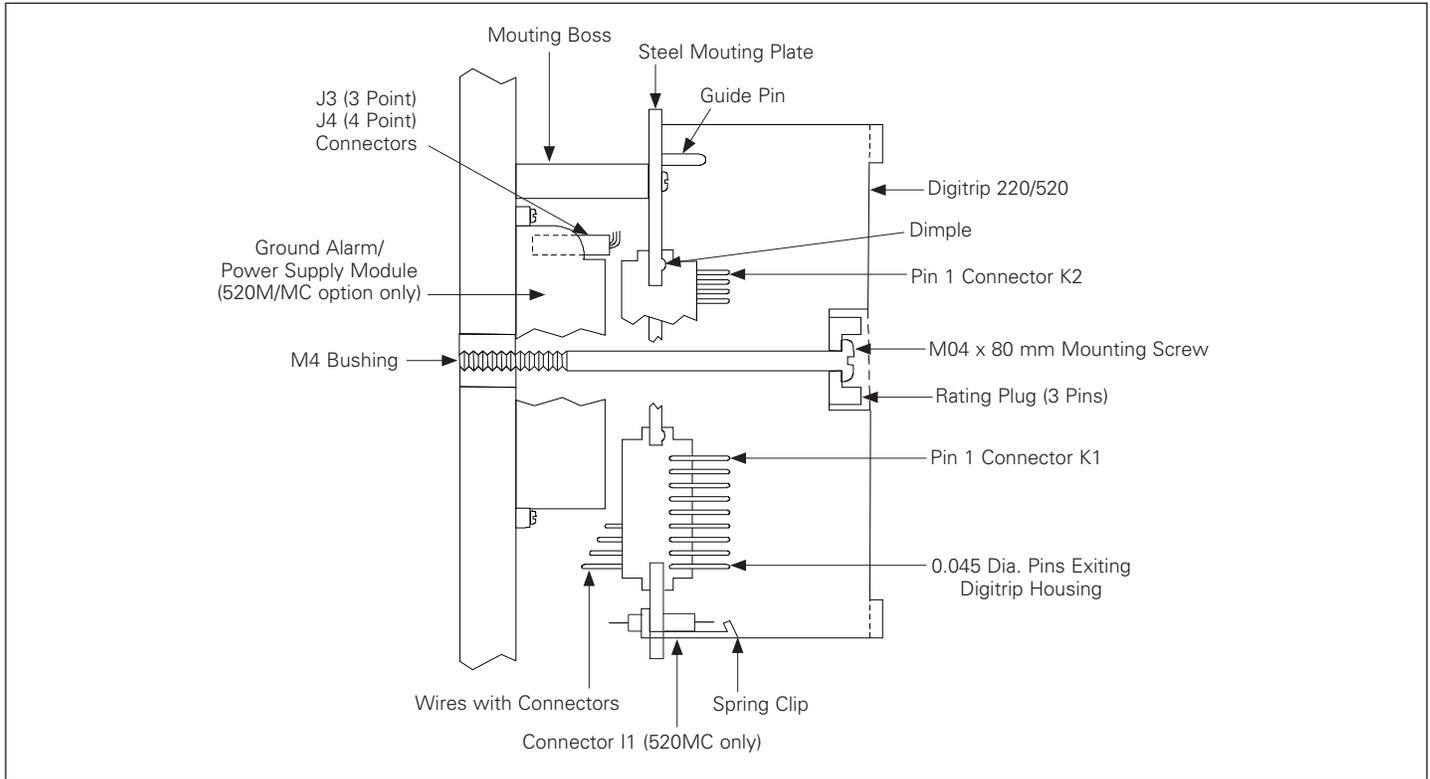
⑦ Units with ARM in catalog number.

**Table 2. Communication Functions Available for Digitrip 520MC Units**

Catalog Number	5CLSI	5CLSIG	5CLSIA	5WLSIG
Remote information via communications	X	X	X	X
<b>Breaker Status</b>				
Open/Closed/Tripped	X	X	X	X
Address register	X	X	X	X
<b>Trip event values</b>				
Protection settings	X	X	X	X
<b>Current values</b>				
Phase A current (amperes)	X	X	X	X
Phase B current (amperes)	X	X	X	X
Phase C current (amperes)	X	X	X	X
Phase N current (amperes) ①	X	X	X	X
Phase G current (amperes)	N/A	X	X	X
<b>Remote messages—alarm</b>				
Overload (long pickup)	X	X	X	X
High load alarm	X	N/A	N/A	N/A
Ground alarm	N/A	X ②	X	X ②
<b>Remote messages—trip</b>				
Long delay trip	X	X	X	X
Short delay trip	X	X	X	X
Instantaneous trip	X	X	X	X
Ground trip	N/A	X	N/A	X
Overtemperature trip ③	X	X	X	X
Plug trip (plug problem) ④	X	X	X	X
MCR trip (making current release trip) ⑤	X	X	X	X
High instantaneous trip ⑥	X	X	X	X
<b>Slave action commands</b>				
Remote reset	X	X	X	X

- ① Breaker must be four-pole or neutral sensor wired.
- ② Breaker will trip and Alarm contact will operate.
- ③ Overtemperature trip indication via communications—Long LED shown on front panel.
- ④ Plug trip cause through communications—INST LED shown on front panel.
- ⑤ MCR trip cause through communications—INST LED shown on front panel.
- ⑥ High instantaneous trip cause through communications—INST LED on front panel.

**Notes:**  
X = Function included  
N/A = Not applicable



**Figure 2. Installation of the Digitrip Unit into a Magnum Breaker (Side View)**

**Installation and removal**

**Installation of the trip unit**

Align the Digitrip unit with the guide pins and spring clip of the Magnum circuit breaker. Press the unit into the breaker until the pins on the trip unit seat firmly into the connector housing and the unit clicks into place (see **Figure 2**).

**Rating plug installation**

**⚠ WARNING**

**DO NOT ENERGIZE THE MAGNUM BREAKER WITH THE DIGITRIP REMOVED OR DISCONNECTED FROM ITS CONNECTOR. DAMAGE TO INTERNAL CURRENT TRANSFORMERS MAY OCCUR DUE TO AN OPEN CIRCUIT CONDITION.**

**⚠ CAUTION**

**IF A RATING PLUG IS NOT INSTALLED IN THE TRIP UNIT, THE UNIT WILL INITIATE A TRIP WHEN IT IS ENERGIZED.**

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

**⚠ CAUTION**

**DO NOT FORCE THE RATING PLUG INTO THE CAVITY.**

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

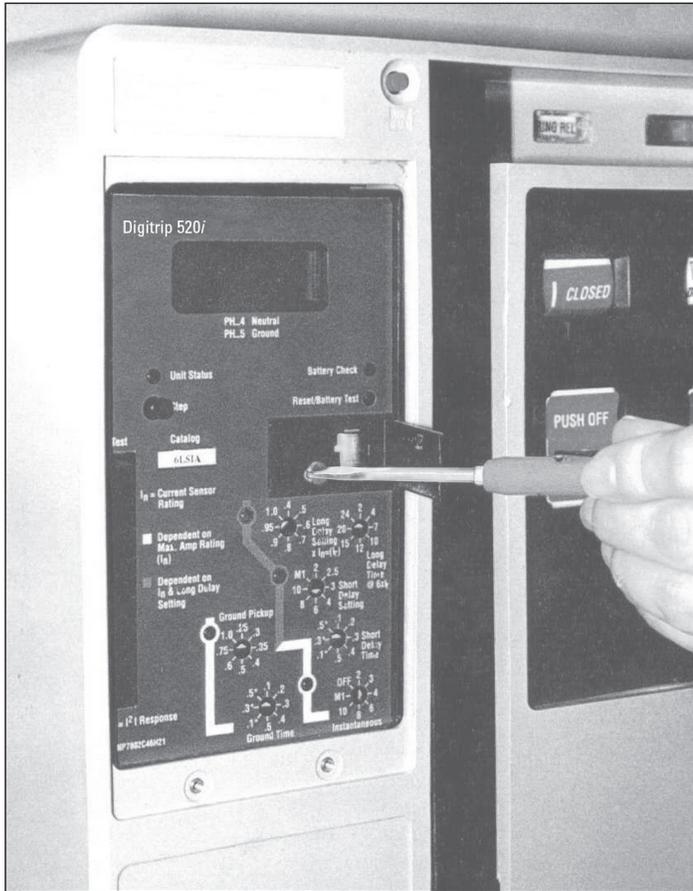
**⚠ CAUTION**

**THE M4 SCREW SHOULD BE TIGHTENED ONLY UNTIL IT IS SNUG BECAUSE THERE IS NO STOP. 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, open the rating plug door. Use a 1/8-inch (3 mm) wide screwdriver to loosen the M4 screw. Pull the door to release the rating plug from the trip unit.

To remove the trip unit from the circuit breaker, deflect the spring clip to release the unit from the steel mounting plate. Pull the unit to disengage the two or three 9-pin connectors from the circuit breaker (see **Figure 2**).



**Figure 3. Installation of the Rating Plug and Mounting Screw**

### Wiring

The internal components of the breaker, and how they are wired out to the breaker secondary contacts, are shown in the breaker master connection diagram provided as Appendix C.

### Plexiglass cover

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

### Ground Alarm/Power Supply Module (520M/MC models only)

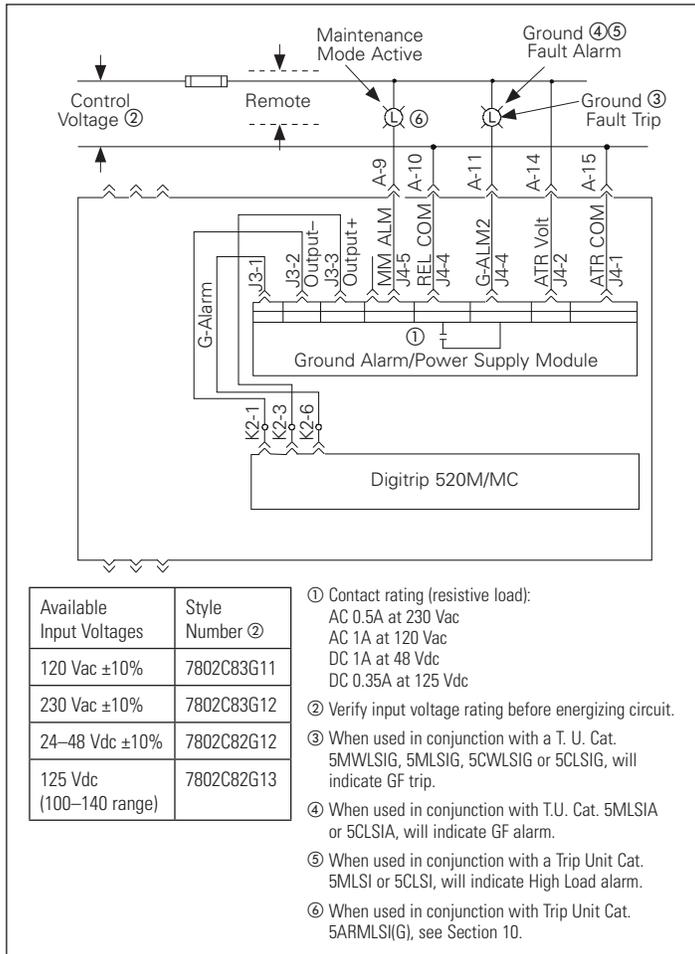
The Ground Alarm/Power Supply Module (see **Figure 4**) is an optional accessory for the Digitrip 520M, 520Mi and is a required accessory to enable communications on the Digitrip 520MC and 520MCi models. The module can be installed beneath the metal mounting plate of the trip unit in the Magnum circuit breaker. The module covers the following input voltage ratings: 120 Vac (7802C83G11), 230 Vac (7802C83G12), 24–48 Vdc (7802C82G12), and 125 Vdc (7802C82G13). The burden of the Power/Relay Module is 10 VA.



**Figure 4. Ground Alarm/Power Supply Module for the 520M or 520MC Trip Units**

**Auxiliary power**

When the module is wired as shown in **Figure 5**, it will provide an auxiliary power supply so that the 520M/520Mi or 520MC/520MCi liquid crystal display (LCD) will be functional even when the circuit breaker has no load. A Digitrip 520M or 520MC trip unit without auxiliary power will not display data until load current reaches approximately 30% single-phase or 10% three-phase of the (I<sub>n</sub>) rating.



**Figure 5. Wiring Diagram for 520M and 520MC Models with Ground Alarm/Power Supply Module**

**Ground alarm**

A second function of the module is to provide either a ground trip or ground alarm only output contact via the relay supplied in the module. On Digitrip 520M/520MC with ground fault protection, an LED on the front of the unit also provides an indication of ground fault trip.

**Ground fault trip**

When the Ground Alarm/Power Supply Module is used with the MLSIG model, this unit will provide ground fault trip contacts when the circuit breaker trips on a ground fault. You must then push the Reset button on the Digitrip in order to reset the contacts (see **Figure 5**, Note 3).

**Ground fault alarm**

A ground fault alarm alerts a user to a ground fault condition without tripping the circuit breaker. A red Alarm Only 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 (see **Figure 5**, Note 4).

**High load alarm (520M/520MC models only)**

The Digitrip 520M and 520MC models of the LSI style only (**Figure 20** and **Figure 24**) and the module shown in **Figure 4** and **Figure 5** will provide a High Load Alarm contact instead of the Ground Alarm function when wired to the breaker secondary contacts A-10 and A-11. The function activates after a 1-second time delay when any phase current exceeds 85% of the I<sub>r</sub> setting.

**Display feature (520M and 520MC only)**

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

When the Step button on the face of the trip unit is pressed and released, the display will show PH 1, for Phase 1 or A, and the current value. If the Step button is not pressed again, the display will continue to show the current value for Phase 1. Each time that the Step 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
- OL Overload (Digitrip in Overload mode)  
Pushing the Step button while the unit is in the OL mode will have the unit again display the overload current value
- HL High Load Alarm (Cat 5MLSII and 5ARMLSII only)
- HELP This message will indicate that the trip unit is out of calibration and should be replaced at the earliest opportunity.

In addition, the Digitrip 520MC and Digitrip 520M (product built with Auxiliary Power Module input pins present, see **Figure 1**) will display and freeze the magnitude of the trip value after a trip event if auxiliary power is available. Use the Step pushbutton to view each phase value. The highest value that can be 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 power during the trip event.

**Standards**

The Digitrip 520, 520M, and 520MC trip units are listed by Underwriters Laboratories®, under UL File E52096, for use in Magnum circuit breakers. These same units are recognized by the Canadian Standards Association® (CSA®).

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

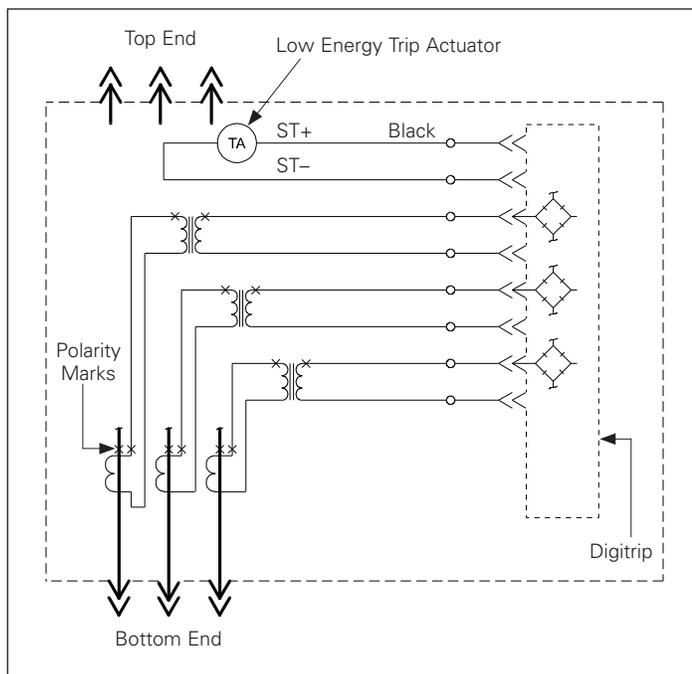
## Section 2: General description of Magnum circuit breakers

### General

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

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

**Figure 6** shows this tripping circuit for a typical Magnum circuit breaker. This arrangement provides a very flexible system, covering a wide range of tripping characteristics described by the time-current curves referenced in Section 9.



**Figure 6. Tripping Circuit for a Typical Magnum Breaker (Partial)**

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

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

### **⚠ WARNING**

**IMPROPER POLARITY CONNECTIONS ON THE TRIP ACTUATOR COIL WILL DEFEAT THE OVERLOAD AND SHORT CIRCUIT PROTECTION, WHICH COULD RESULT IN PERSONAL INJURY. OBSERVE POLARITY MARKINGS ON THE TRIP ACTUATOR LEADS AND CONNECT THEM PROPERLY, USING THE INSTRUCTIONS PROVIDED.**

### Low-energy trip actuator

The mechanical force required to initiate the tripping action of a Magnum circuit breaker is provided by a special low-energy trip actuator. The trip actuator is located under the black molded platform on which the Digitrip unit is supported. The trip actuator contains a permanent magnet assembly, moving and stationary core assemblies, a spring, and a coil. Nominal coil resistance is 22 ohms and the black lead is positive. The circuit breaker mechanism assembly contains a mechanism-actuated reset lever and a trip lever to actuate the tripping action of the circuit breaker.

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

### Ground fault protection

#### General

When the Digitrip 520 family includes ground fault protection features, the distribution system characteristics (for example, system grounding, number of sources, number and location of ground points, and the like) must be considered along with the manner and location in which the circuit breaker is applied to the system. These elements are discussed in this section.

The Digitrip 520 uses three modes of sensing to detect ground fault currents: residual, source ground, and zero sequence (see **Table 3**). Magnum circuit breakers can accommodate all three types, except for four-pole breakers. The breaker secondary contact inputs B-6, B-7 are used to configure the breaker cell positions for the three schemes. No jumper from B-6 to B-7 programs the unit for a residual ground fault scheme, while a jumper from B-6 to B-7 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. In all three schemes, the proper current sensor input is required on the external sensor input terminals B-4, B-5 of the breaker secondary contacts.

**Table 3. Digitrip Sensing Modes**

Ground (Earth) Fault Sensing Method	Breaker Secondary Contacts Req'd.	Applicable Breakers	Figure Reference	Digitrip GF Sensing Element Used
Residual	No jumper	Three- or four-pole	7, 8, 10, 14	Element R <sub>5</sub>
Source ground	Jumper B6 to B7	Three-pole only	12	Element R <sub>4</sub>
Zero sequence	Jumper B6 to B7	Three-pole only	13	Element R <sub>4</sub>

**Note:** This information applies to trip units with ground.

#### Residual sensing

Residual sensing is the standard mode of ground fault sensing in Magnum circuit breakers. This mode uses one current sensor on each phase conductor and one on the neutral for a four-wire system (shown in **Figure 7** and **Figure 8**). If the system neutral is grounded, but no phase to neutral loads are used, the Digitrip 520 family of units 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. The neutral sensor must have characteristics and a ratio that are identical to the three internally mounted phase current sensors. Available types of neutral sensors are shown in **Figure 9**. Residual ground fault sensing features are adaptable to main and feeder breaker applications. Available ground fault pickup settings employing residual sensing are given in **Table 4**. **Figure 10** shows a four-pole breaker with residual ground fault sensing.

**⚠ CAUTION**

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

**Source ground sensing**

Depending upon the installation requirements, alternate ground fault sensing schemes may be dictated (see **Figure 11** and **Figure 12**). The ground return method is usually applied when ground fault protection is desired only on the main circuit breaker in a simple radial system. This method is also applicable to double-ended systems where a midpoint grounding electrode is employed. For this mode of sensing, a single current sensor mounted on the equipment-bonding jumper directly measures the total ground current flowing in the grounding electrode conductor and all other equipment-grounding conductors.

The settings shown in **Table 3** will apply when the neutral sensor is not the same as the frame rating in a ground return sensing scheme.

**Zero sequence sensing**

Zero sequence sensing, also referred to as vectorial summation (see **Figure 13**), is applicable to mains, feeders, and special schemes involving zone protection. Zero sequence current transformers (5.06 x 15.37 in. [128 x 390 mm] rectangular inside dimensions) are available with 100:1 and 1000:1 ratios (styles 9253C07G01, G11).

**Multiple source/multiple ground**

A multiple source/multiple ground scheme is shown in **Figure 14**. In this figure, a ground fault is shown that has two possible return paths, via the neutral, back to its source. The three neutral sensors are interconnected to sense and detect both ground fault and neutral currents.

Contact Eaton for more details on this scheme.

**Ground fault settings**

The adjustment of the ground fault functional settings (FLAT response or I<sup>2</sup>t) is discussed in Section 4. The effect of these settings is illustrated in the ground fault time-current curve referenced in Section 9. Applicable residual ground fault pickup settings and current values are given in **Table 4**, as well as in the ground time-current curve.

**Table 4. Ground (Earth) Fault Current Settings**

**Ground Fault Current Settings (Amperes) ①**

<b>Installed Sensor and Rating Plug (Amperes) I<sub>n</sub></b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.40</b>	<b>0.50</b>	<b>0.60</b>	<b>0.75</b>	<b>1.0</b>
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
630	158	189	221	252	315	378	473	630
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	312	375	438	500	625	750	938	1250
1600	400	480	560	640	800	960	1200	1600 ②
2000	500	600	700	800	1000	1200	1500 ②	2000 ②
2500	625	750	875	1000	1250	1500	1875	2500
3000	750	900	1050	1200	1500 ②	1800 ②	2250 ②	3000 ②
3200	800	960	1120	1200	1600 ②	1920 ②	2400 ②	3200 ②
4000 ③	1000	1200	1400 ②	1600 ②	2000 ②	2400 ②	3000 ②	4000 ②
5000 ③	1250 ②	1500 ②	1750 ②	2000 ②	2500 ②	3000 ②	3750 ②	5000 ②
6000	1500 ②	1800 ②	2100 ②	2400 ②	3000 ②	3600 ②	4500 ②	6000 ②
6300 ③	1575	1890	2205	2520	3150	3780	4725	6300

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

② On models 520 LSIG, 520M, and 520MC LSIG, the shaded values are set to a maximum trip value of 1200A for NEC.

③ See page 17.

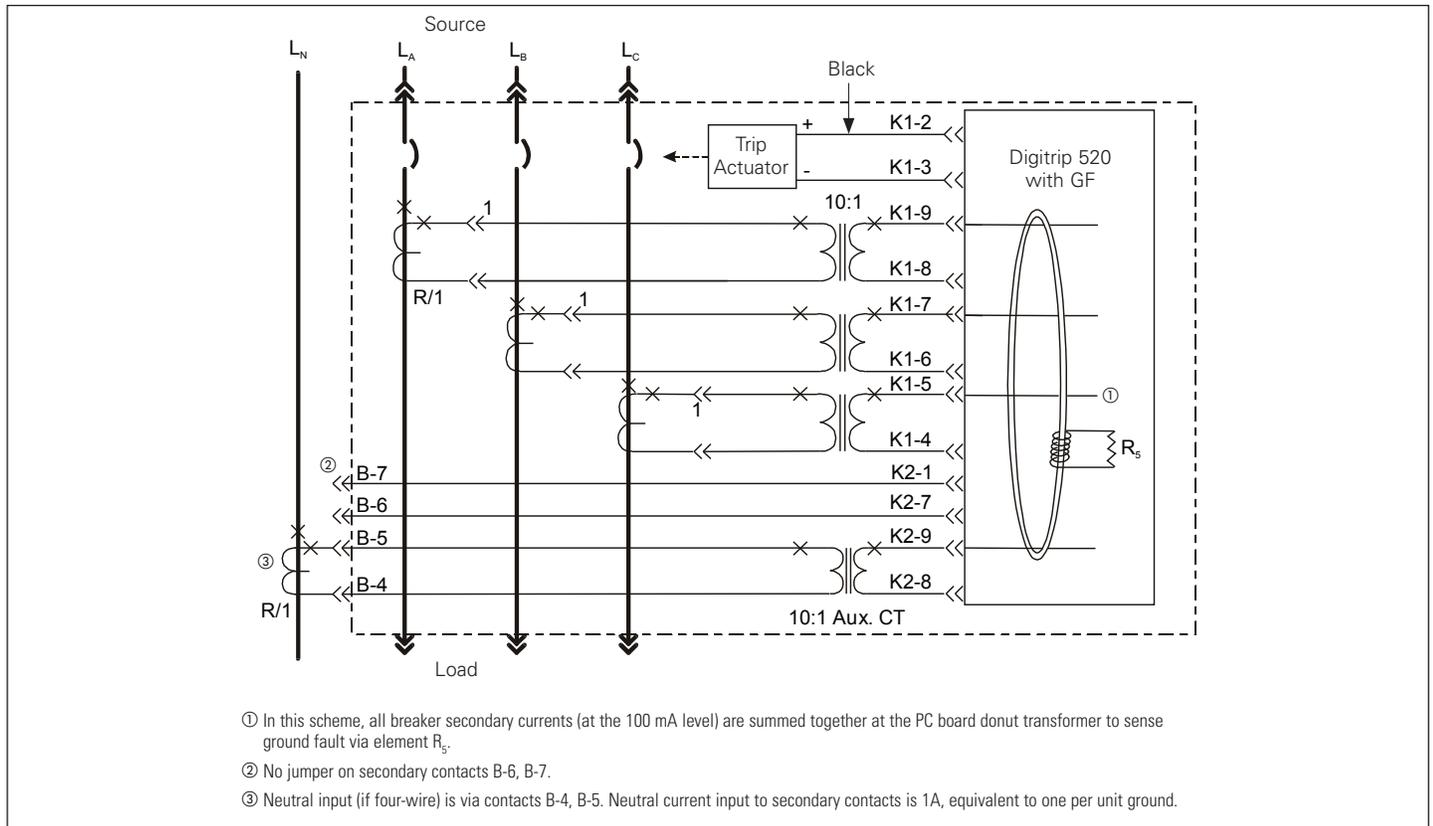


Figure 7. Three-Pole, Four-Wire Breaker with Neutral Sensor Connections for 3200A Frame Using Residual Ground Fault Sensing

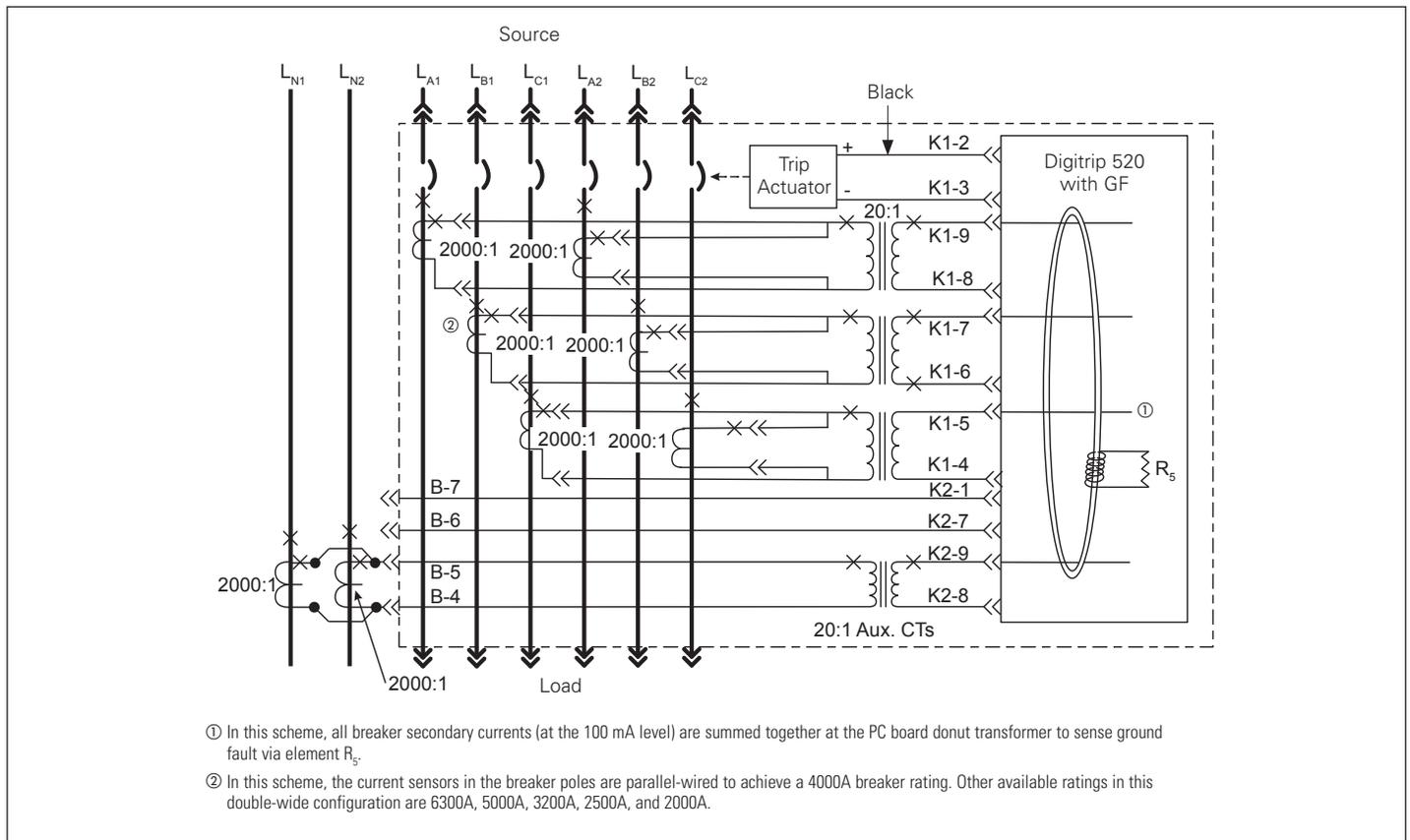


Figure 8. Neutral Sensor Connections for 4000A Frame Using Residual Ground Fault Sensing

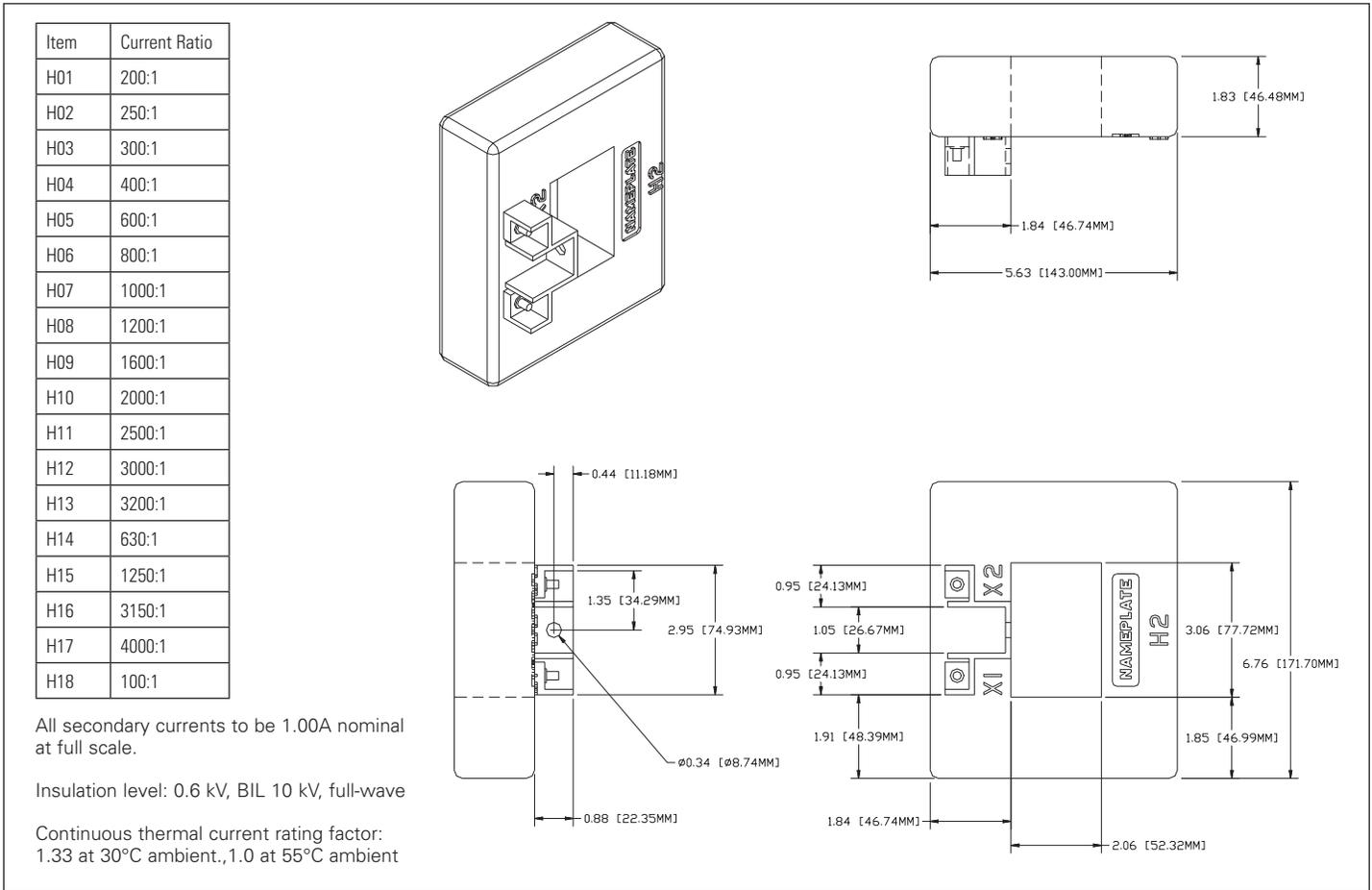


Figure 9. Digitrip Neutral Sensor Types (or Source Ground Sensor)

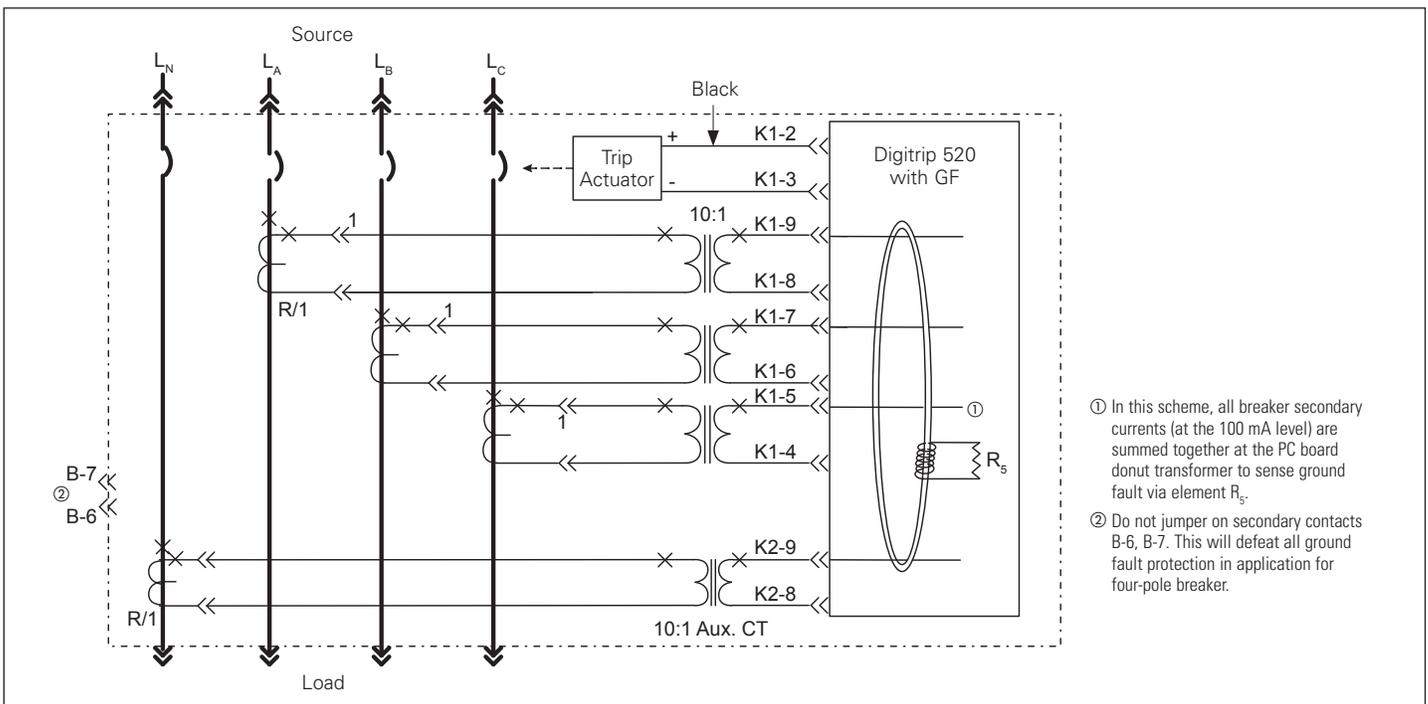


Figure 10. Four-Pole 3200A Frame (4000A IEC) Using Residual Ground Fault (Earth-Fault) Sensing

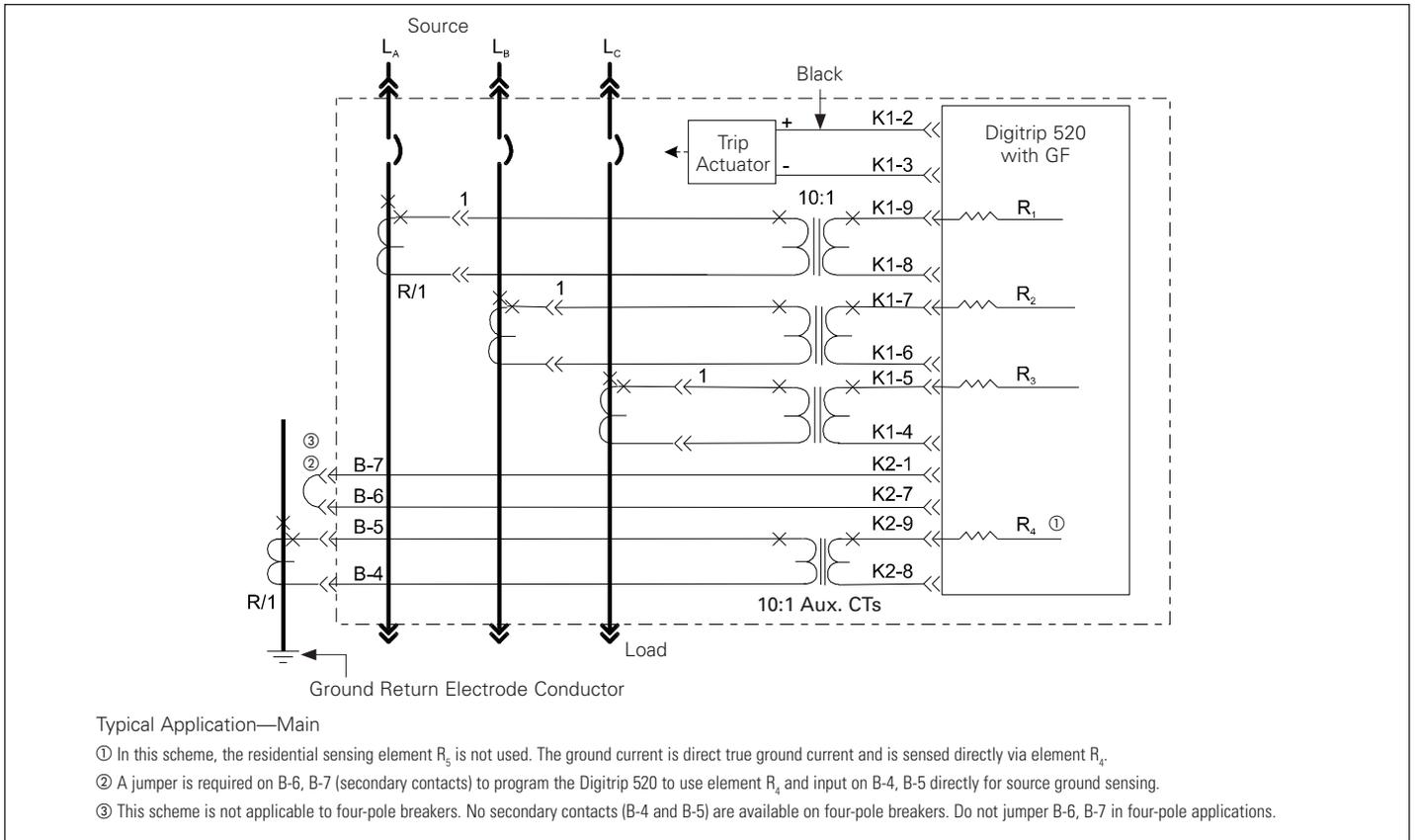


Figure 11. Source Ground Fault Sensing Scheme for 3200A Frame

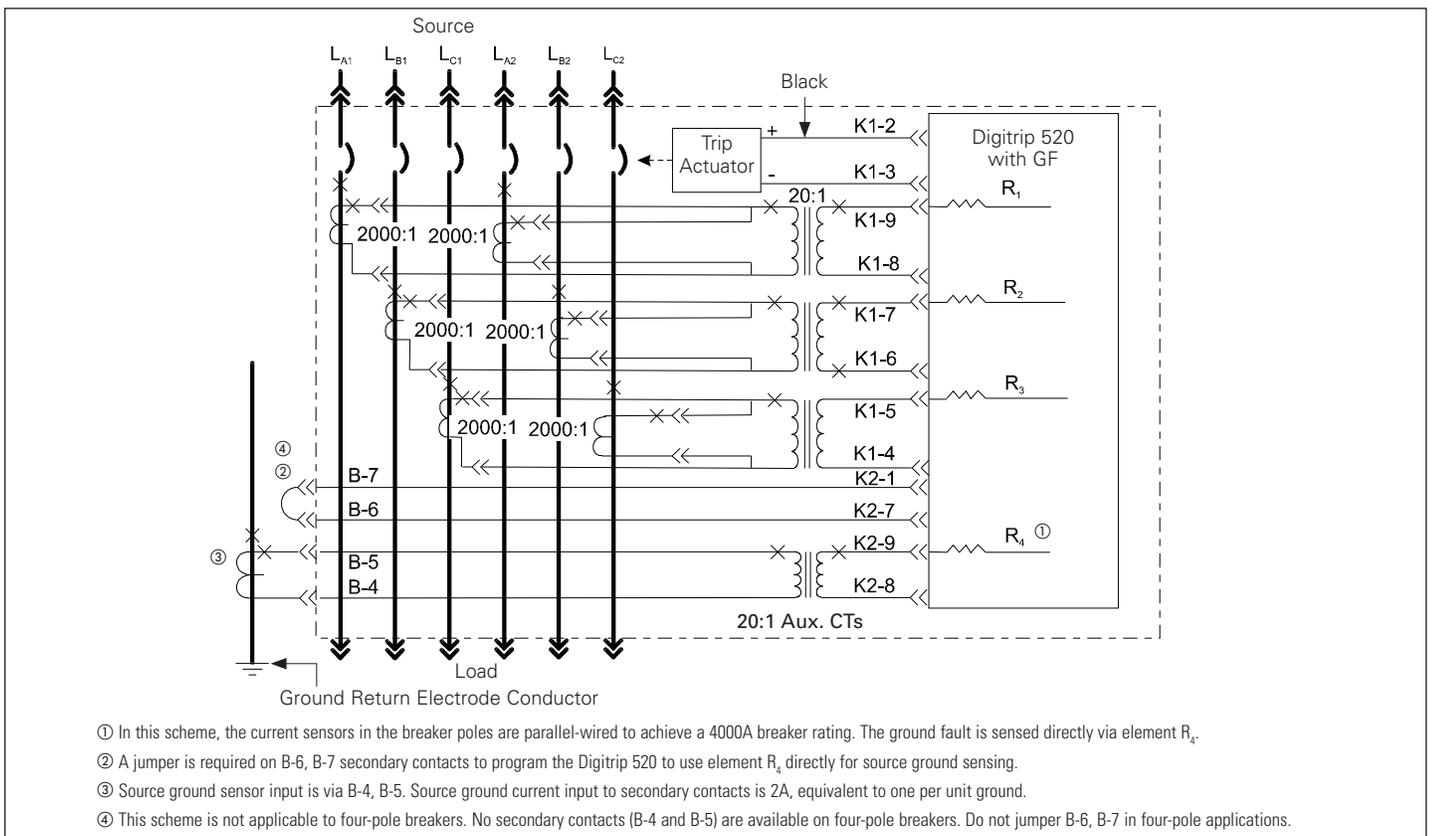


Figure 12. Source Ground Fault Sensing Scheme for 4000A Frame—Double-Wide

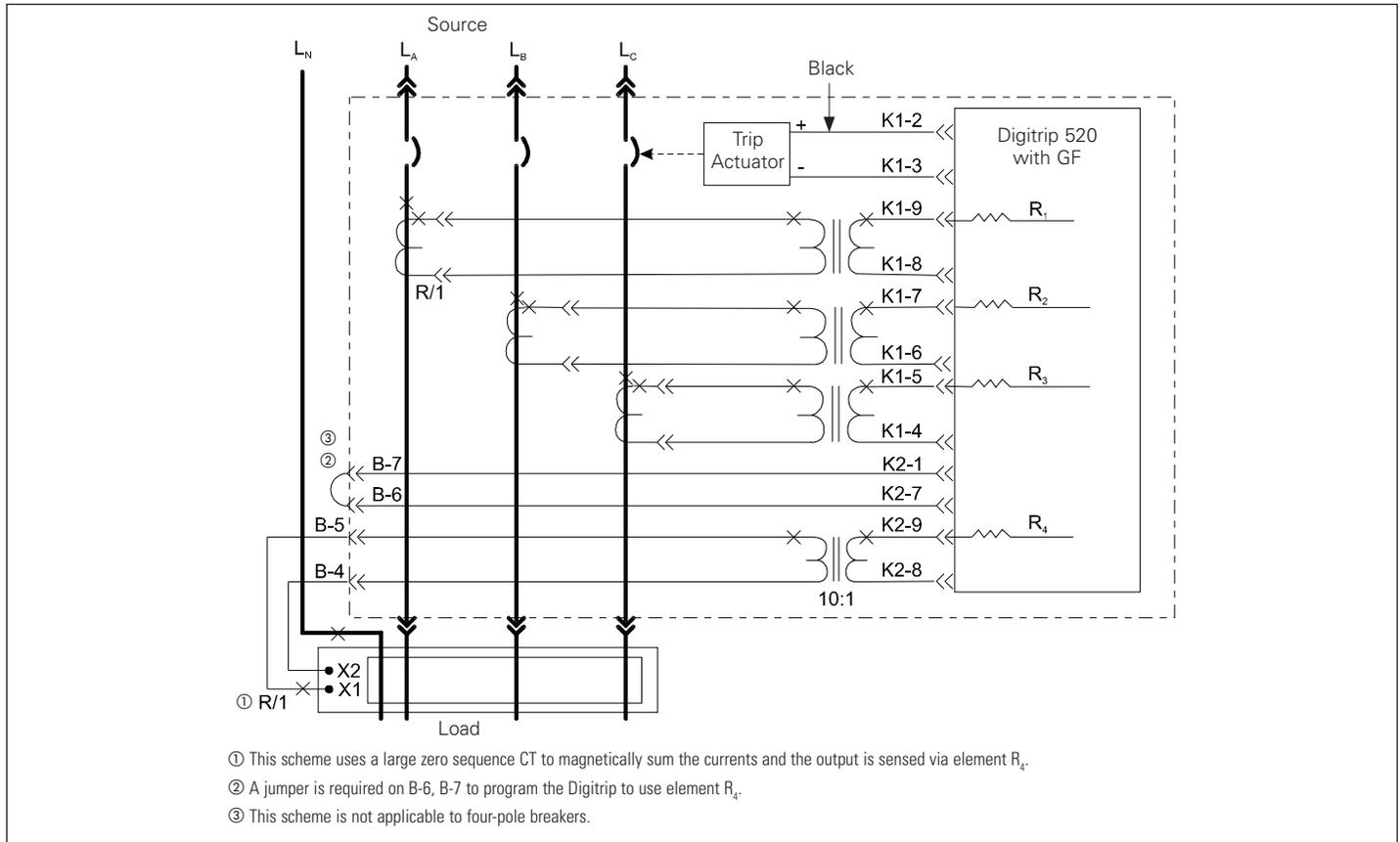


Figure 13. Zero Sequence Sensing Scheme for 3200A Frame

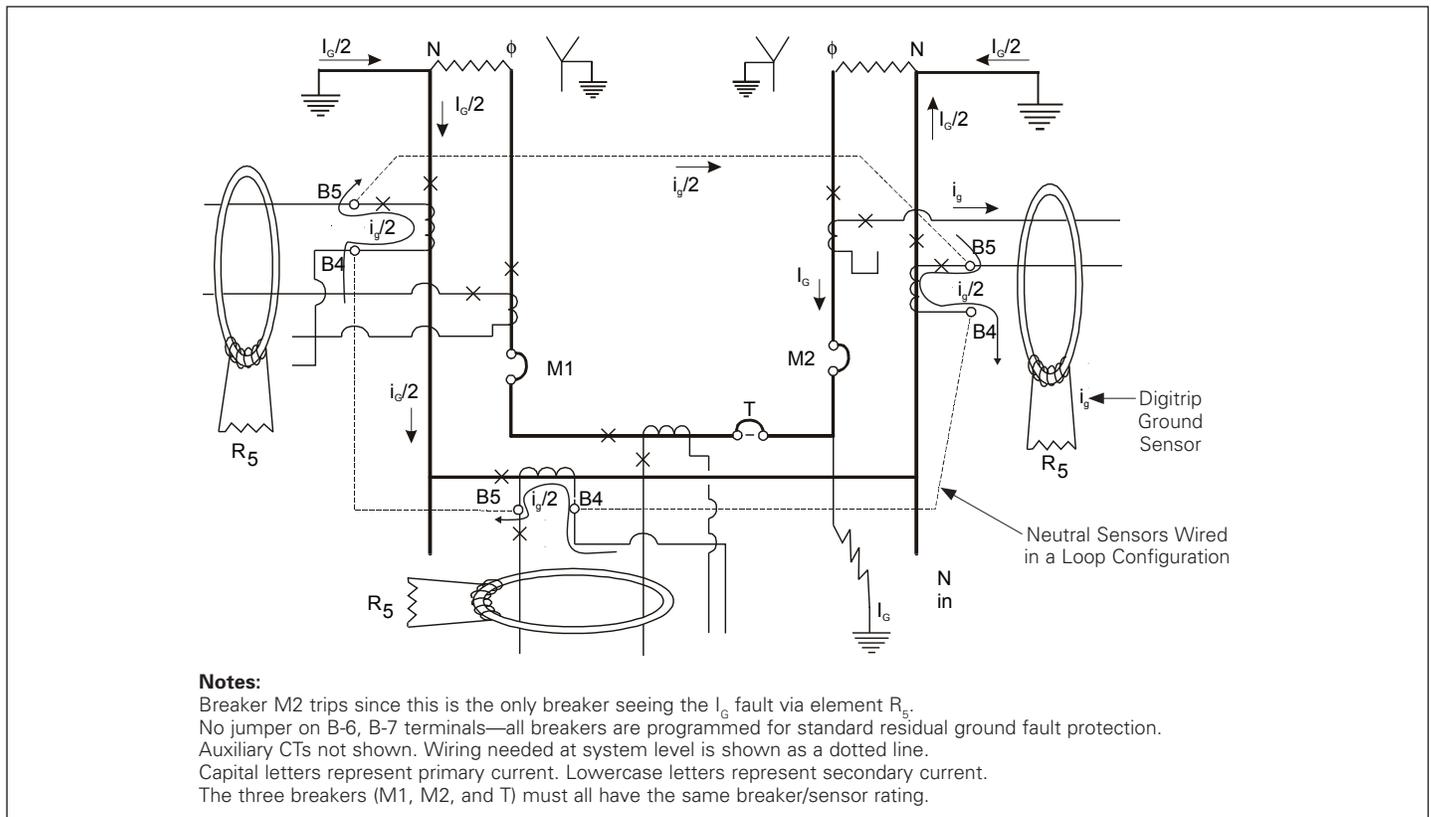


Figure 14. Multiple Source/Multiple Ground Scheme

### Current sensors (Magnum standard frames)

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

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

If a set of current sensors with a different ratio are installed in the field, the rating plug must also be changed. The associated rating plug must match the current sensor rating specified on the plug label. The current sensor rating can be viewed through openings in the back of the breaker.

### Current sensors (Magnum double-wide frames)

The six (three-pole) or eight (four-pole) current sensors installed in the circuit breaker are located on the lower conductors. The poles are paralleled and the corresponding current sensors are also paralleled (see **Figure 8**). For example, a 4000A breaker phase rating has two 2000:1 current sensors wired in parallel, which provides an overall ratio of 4000:2. The auxiliary current transformers have a ratio of 20:1 for this size breaker that further step down the rated current to 100 milliamperes and is equivalent to 100% ( $I_n$ ) to the Digitrip.

## Section 3: Principles of operation

### General

All models of trip units are designed for industrial circuit breaker environments where the ambient temperatures can range from  $-20^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  but rarely exceed  $70^{\circ}\text{C}$  to  $75^{\circ}\text{C}$ . If, however, temperatures in the neighborhood of 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 overtemperature condition, the microcomputer chip has a built-in overtemperature protection feature, factory set to trip the breaker if the chip temperature is excessive. If overtemperature is the reason for the trip, the red Long Delay Time LED will flash.

The Digitrip uses the Eaton custom-designed CHip™ (Cutler-Hammer 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 15**.

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

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

### Trip and operation indicators

The LEDs on the face of the trip unit, shown in **Figure 1** and **Figure 16** to **Figure 27**, flash red to indicate the reason for any automatic trip operation. Each LED is strategically located in the related segment of the time-current curve depicted on the face of the trip unit. The reason for the trip is identified by the segment of the time-current curve where the LED is illuminated. Following an automatic trip operation, the backup battery continues to supply power to the LEDs as shown in **Figure 15**. The LED pulse circuit, shown in **Figure 15**, 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, shown in **Figure 1**, to turn off the LEDs. A green LED, shown in **Figure 1**, indicates the operational status of the trip unit. Once the load current through the circuit breaker exceeds approximately 10% (three-phase power) of the current sensor rating, the green LED will flash on and off once each second to indicate that the trip unit is energized and operating properly.

**Note:** A steady green Status LED typically indicates that a low level of load current, on the order of 5% of full load, exists.

### Making Current Release

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 nonadjustable release is preset at to a peak current of  $25 \times I_n$ , which correlates to approximately  $11 \times I_n$  (rms) with maximum asymmetry.

The Making Current Release is enabled only for the first two cycles following an initial circuit breaker closing operation. The Making Current Release will trip the circuit breaker instantaneously and flash the Instantaneous LED.

### Zone interlocking

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#### NOTICE

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**THE PROVISION FOR THE ZONE SELECTIVE INTERLOCKING FUNCTION IS STANDARD ON CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS FOR SHORT TIME AND GROUND FAULT (EARTH FAULT) FUNCTIONS. FOR ANSI/UL CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS, THE APPROPRIATE JUMPER TO TERMINAL B8 AND B9 MUST BE ADDED ON THE CIRCUIT BREAKER IF ZONE INTERLOCKING IS NOT DESIRED OR FIELD TESTING IS DESIRED.**

**FOR IEC CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS, THE ZONE INTERLOCKING FUNCTION IS NOT WIRED OUT TO THE CIRCUIT BREAKER SECONDARIES (I.E., ZONE FUNCTIONALITY IS NOT PRESENT IN SECONDARIES B7, B8, AND B9). THE TRIP UNIT WILL ALWAYS FOLLOW THE PROGRAMMED SHORT TIME OR GROUND TIME SETTING. THIS IS ACCOMPLISHED VIA A WIRING HARNESS INTERNAL TO THE CIRCUIT BREAKER. IF THE ZONE INTERLOCKING FUNCTION IS DESIRED FOR IEC CIRCUIT BREAKERS WITH DIGITRIPS, PLEASE REFER TO EATON FOR APPROPRIATE INSTRUCTIONS ON HOW TO ADJUST THE INTERNAL WIRING HARNESS TO ACTIVATE THE ZONE INTERLOCKING FUNCTION ASSOCIATED WITH SECONDARIES B7, B8, AND B9 OF THE CIRCUIT BREAKER.**

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Zone selective interlocking (or zone interlocking) is available for the Digitrip 520 family on the Short Delay and Ground Fault Protection functions (see **Figure 15**). The zone interlocking signal is wired via a single set of wires labeled Zone In (Zin) and Zone Out (Zout) along with a zone common wire. The Zone Selective Interlocking function on the Digitrip 520 family 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  $2 \times (I_s)$  is exceeded. Zone selective interlocking provides the fastest possible tripping for faults within the zone of protection of the breaker and yet also provides positive coordination among all breakers in the system (mains, ties, feeders, and downstream 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 cause the Digitrip 520 family of units to:

- Trip the affected 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 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.

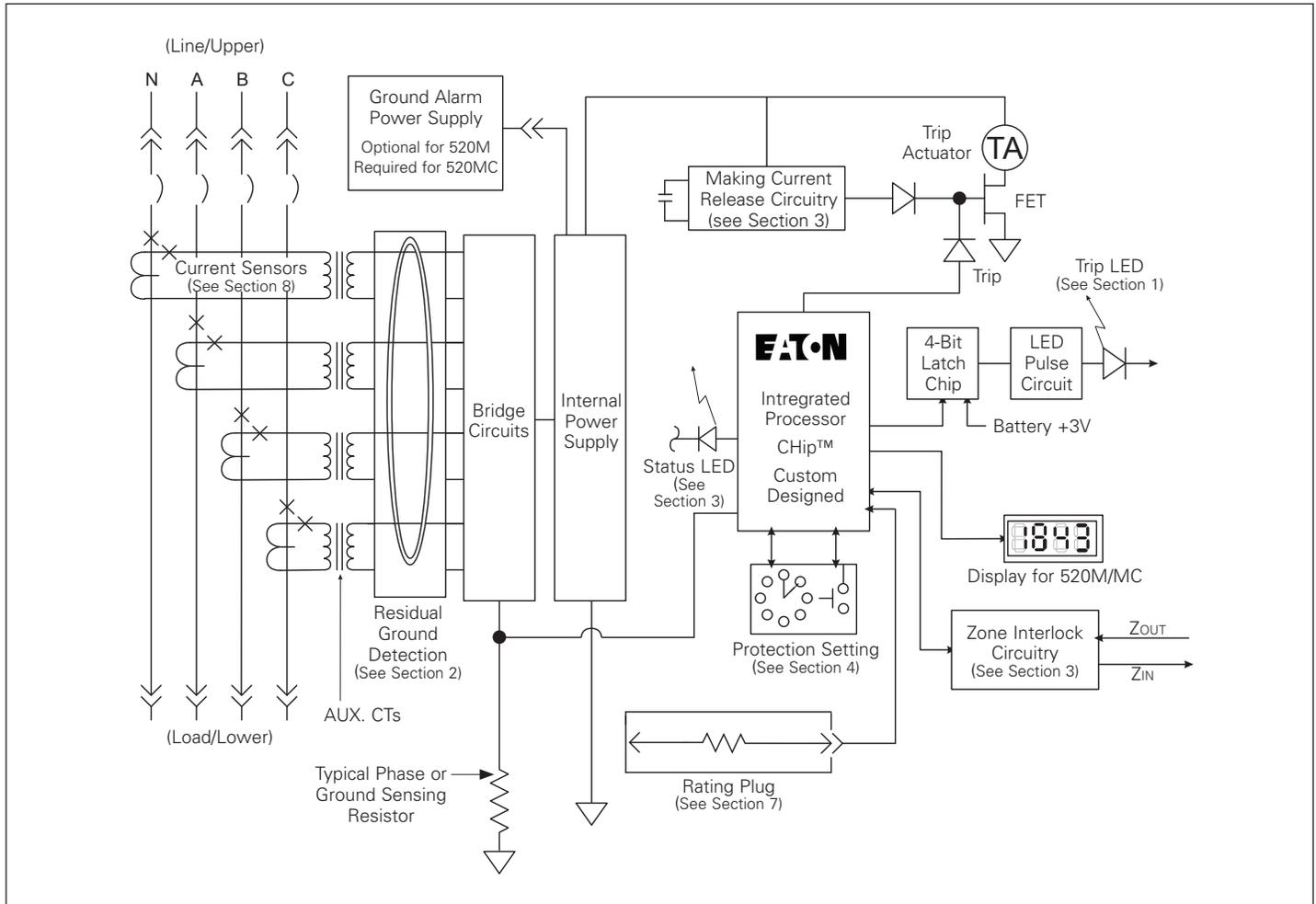


Figure 15. Block Diagram with Breaker Interface

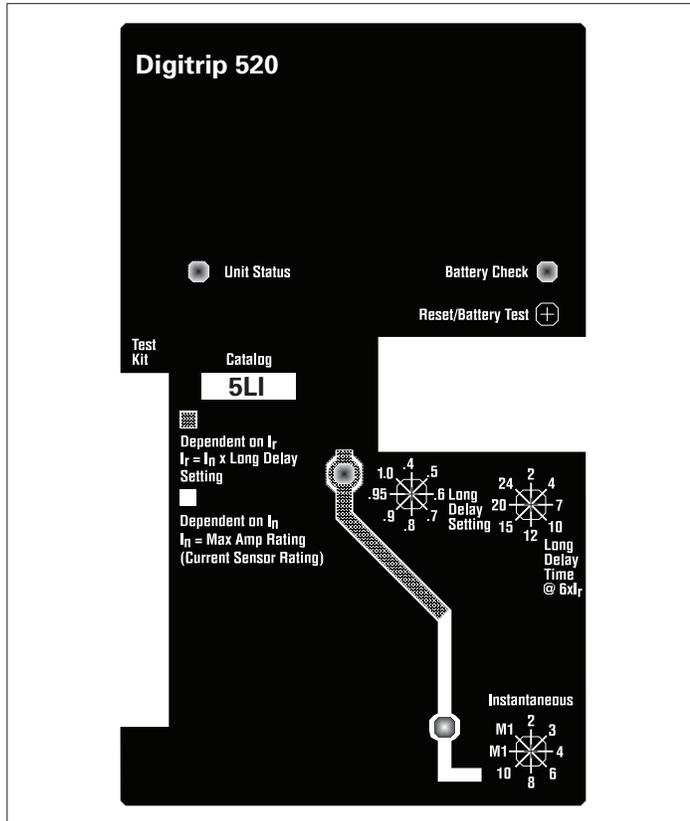


Figure 16. Digitrip 520 LLI

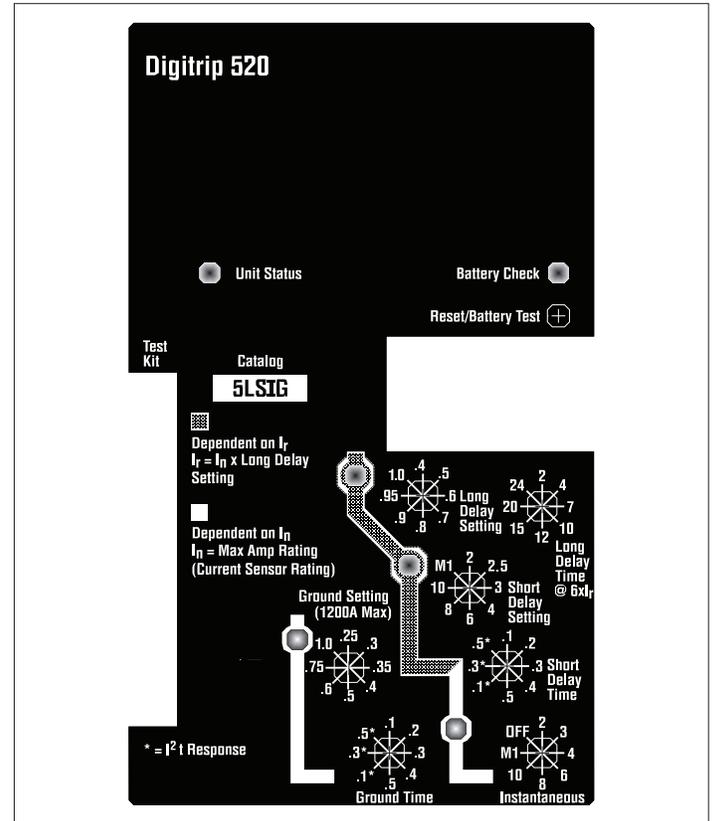


Figure 18. Digitrip 520 LLSIG

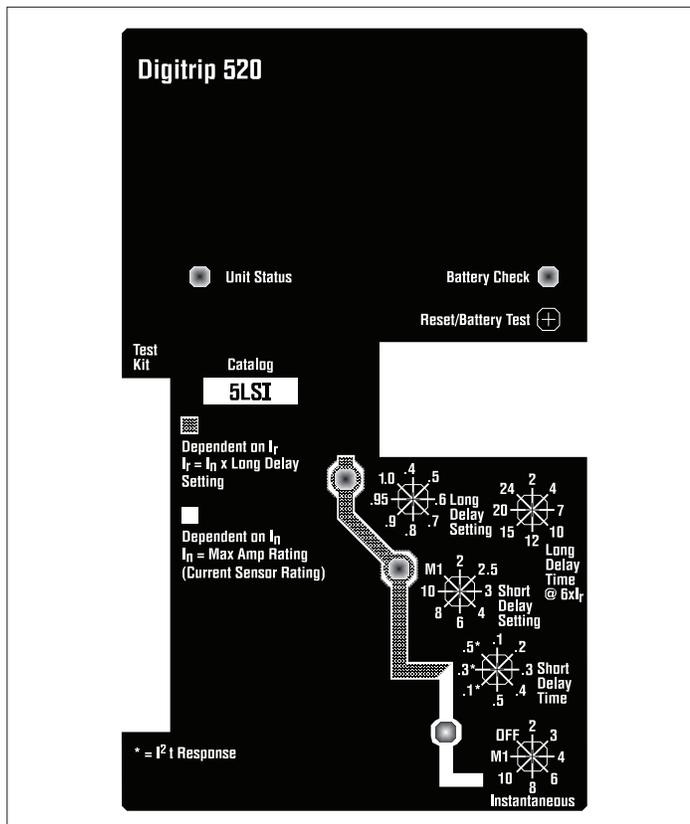


Figure 17. Digitrip 520 LSI

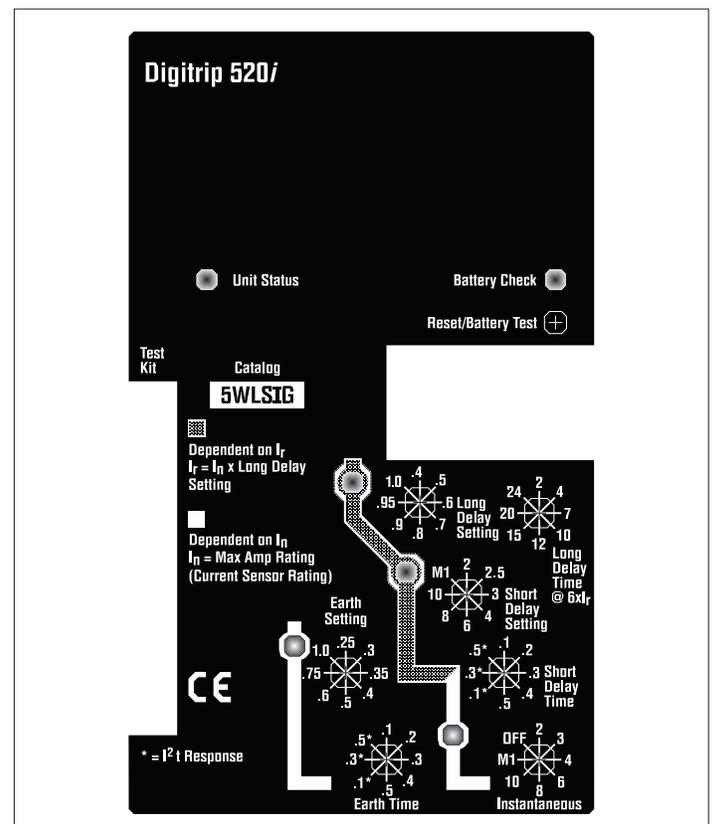


Figure 19. Digitrip 520i WLSIG

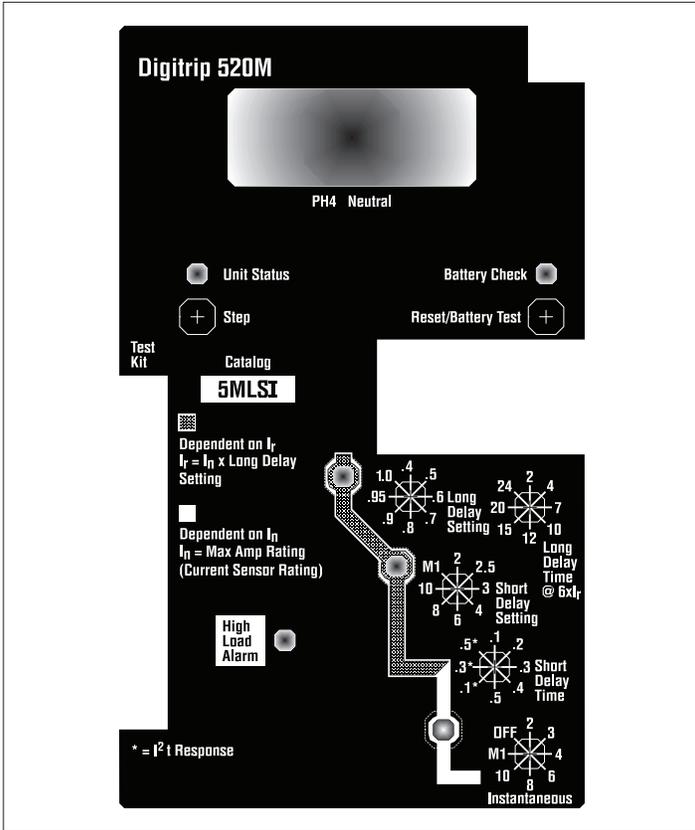


Figure 20. Digitrip 520M MLSI

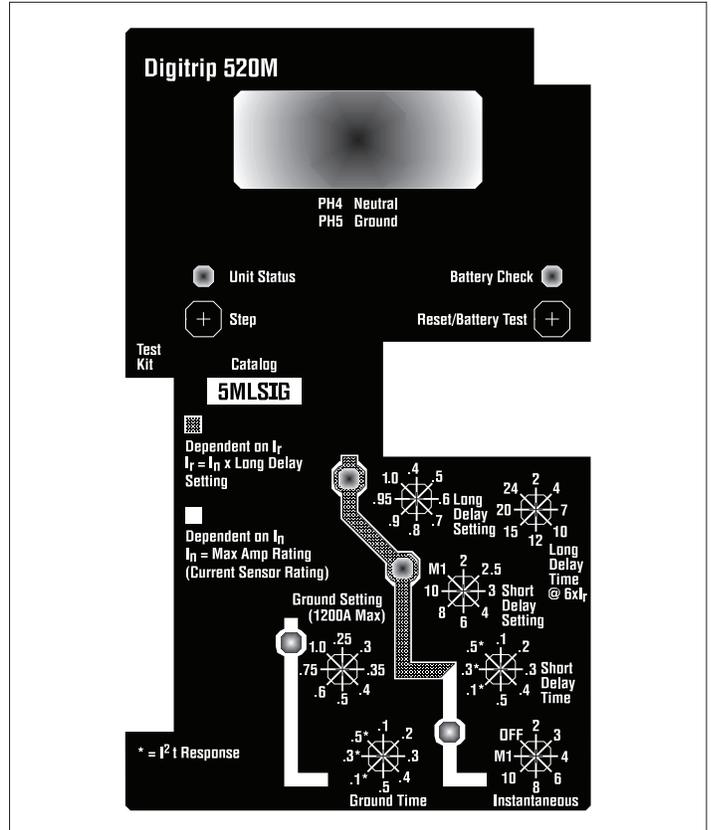


Figure 22. Digitrip 520M MLSIG

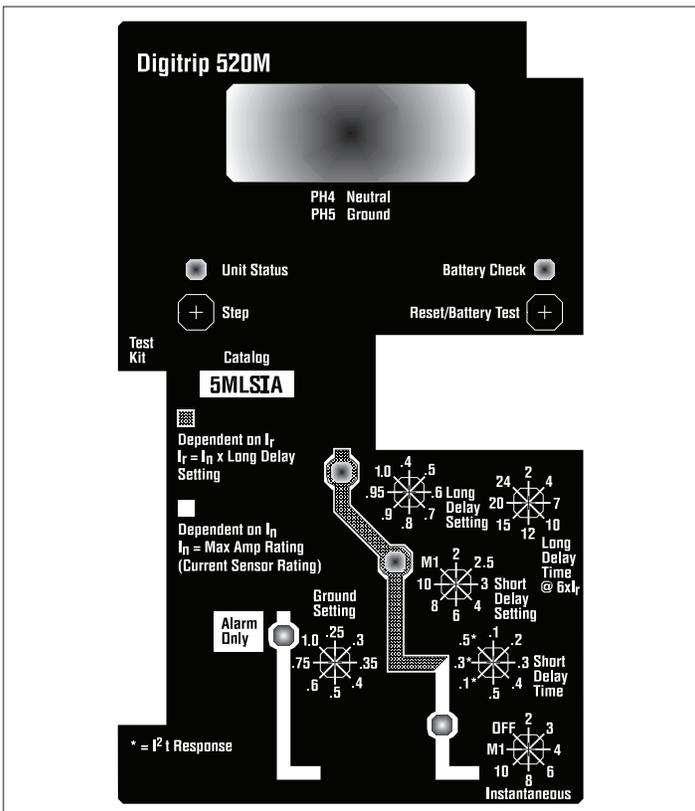


Figure 21. Digitrip 520M MLSIA

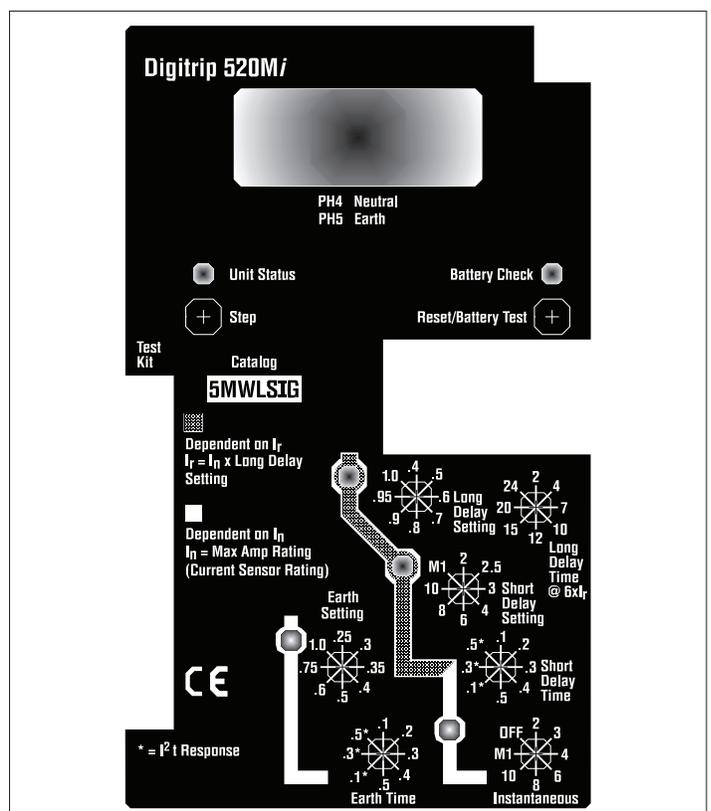


Figure 23. Digitrip 520Mi MWLSIG

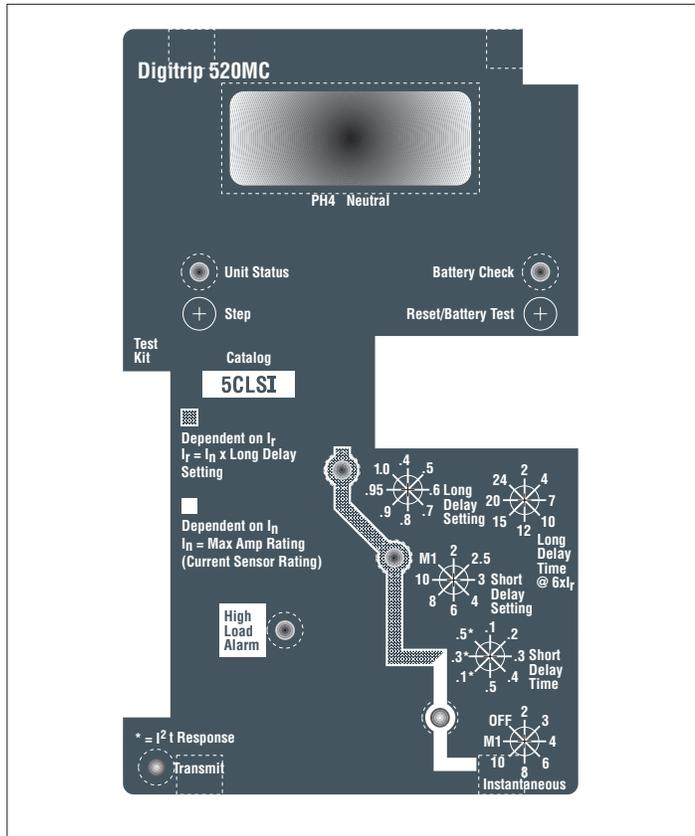


Figure 24. Digitrip 520MC CLSI

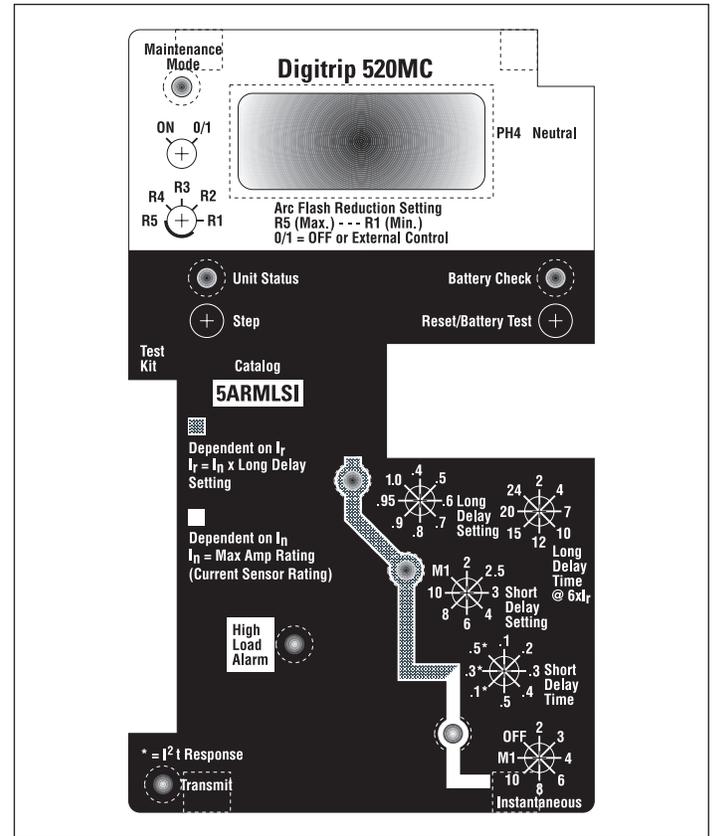


Figure 26. Digitrip 520MC ARMSLI

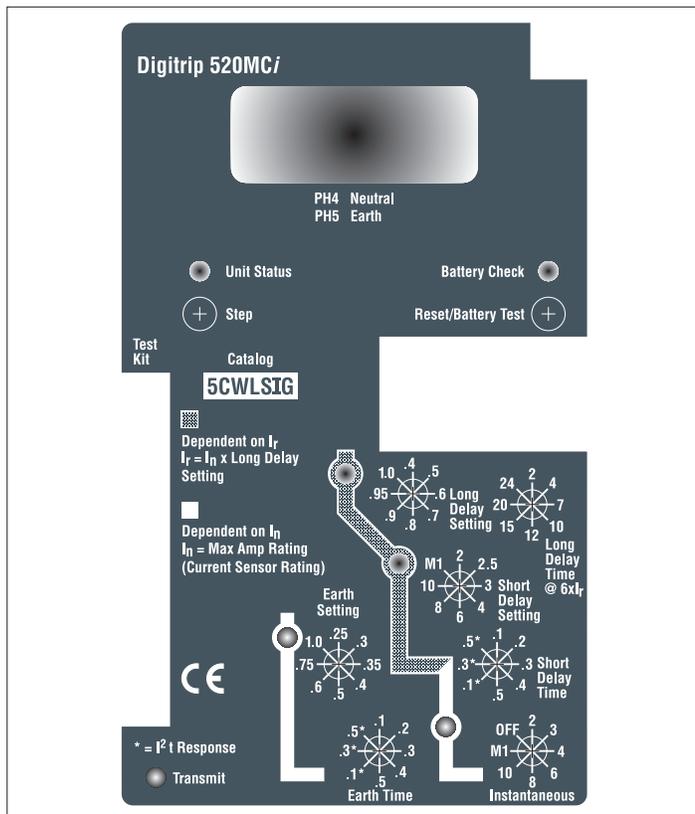


Figure 25. Digitrip 520MC CWLSIG

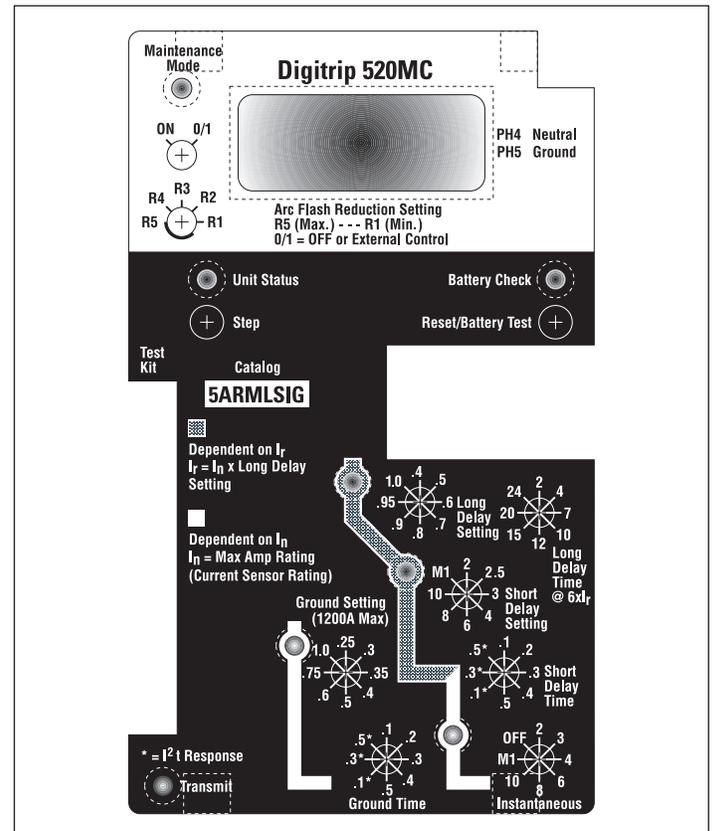


Figure 27. Digitrip 520MC ARMSIG

## Section 4: 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, as illustrated in **Figure 16** through **Figure 27**. Each setting is made by turning a rotary switch, using a small screwdriver. The selected setting for each adjustment appears on the trip unit label.

The installed rating plug must match the current sensors that establish the maximum continuous current rating of the circuit breaker ( $I_n$ ). Instantaneous and ground current settings are defined in multiples of ( $I_n$ ).

To illustrate the effect of each protection curve setting, simulated time-current curves are pictured on the face of the trip unit. Each rotary switch is located nearest the portion of the simulated time-current curve that it controls. Should an automatic trip occur (as a result of the current exceeding the pre-selected value), the LED in the appropriate segment of the simulated time-current curve will light red, indicating the reason for the trip.

The available settings, along with the effects of changing the settings, are given in **Figure 30** through **Figure 37**. Sample settings are represented in boxes [2].

### Long delay current setting

There are eight available long delay settings, as illustrated in **Figure 30**. Each setting, called ( $I_r$ ), is expressed as a multiple (ranging from 0.4–1) of the current ( $I_n$ ). The nominal current pickup value is 110% of the setting.

**Note:** ( $I_r$ ) is also the basis for the short delay current setting (see page 23).

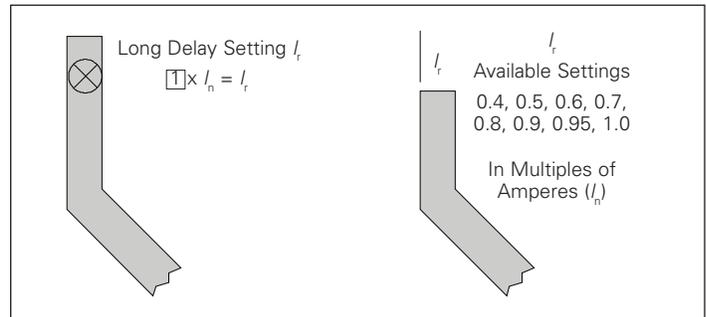


Figure 30. Long Delay Current Settings

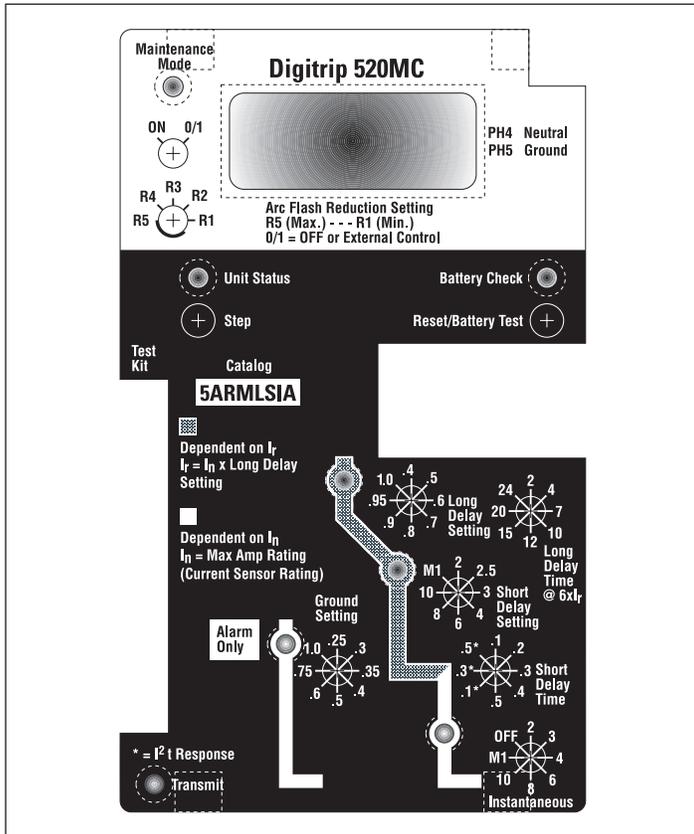


Figure 28. Digitrip 520MC ARMLSIA

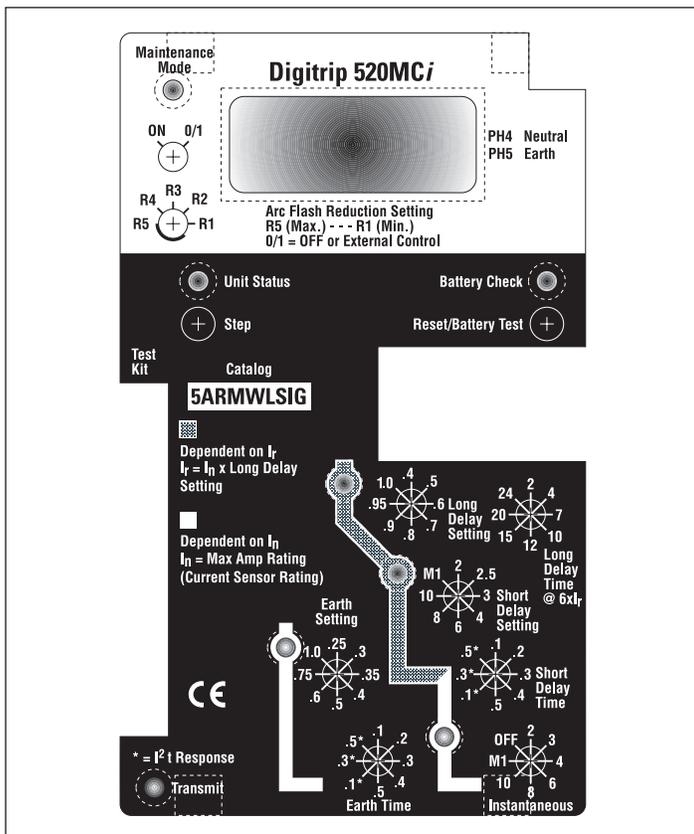
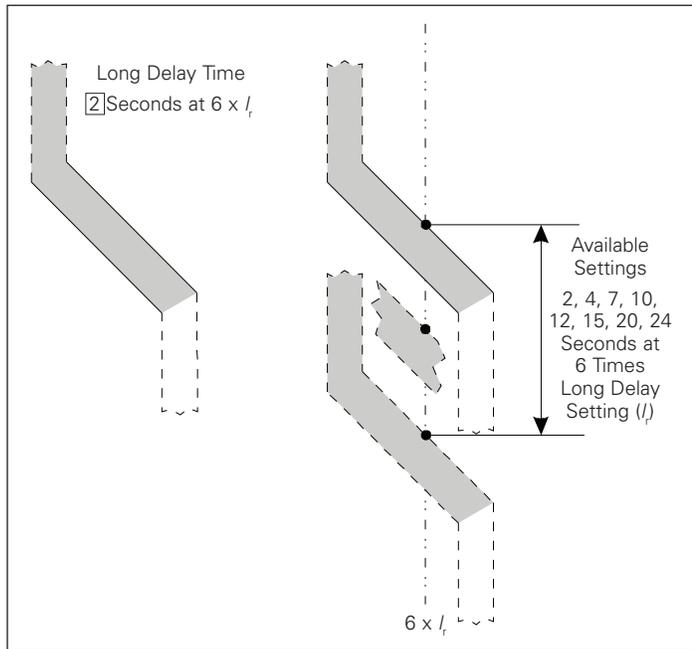


Figure 29. Digitrip 520MC ARMWLSIG

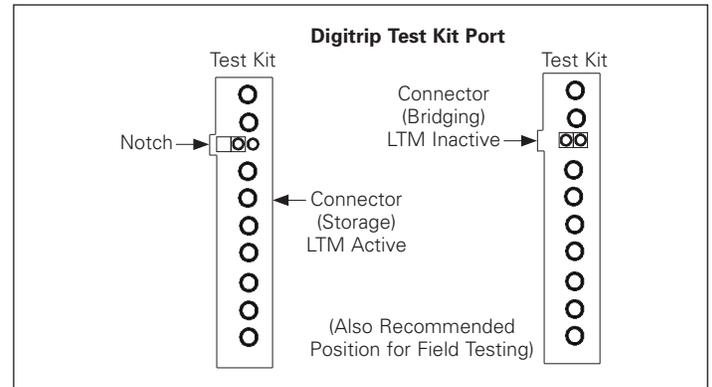
### Long delay time setting

There are eight available long delay time settings, as illustrated in **Figure 31**, ranging from 2–24 seconds. These settings are the total clearing times when the current value equals six times ( $I_L$ ).



**Figure 31. Long Delay Time Settings**

**Notes:** 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 breaker is reclosed soon after a long delay trip, and the current again exceeds the long delay setting, ( $I_L$ ), 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 breaker to trip in a progressively shorter time. When the load current returns to normal, the LTM begins to reset; after about 10 minutes it will have reset fully, so the next long delay trip time will again correspond to the setting value. In certain applications, it may be desirable to disable the LTM function. Open the test port located at the lower left-hand front of the trip unit and use small, long nose pliers to move the LTM jumper inside the test port (see **Figure 32**) to its inactive position. (The LTM function can be enabled again at any time by moving the LTM jumper back to its original active position.)

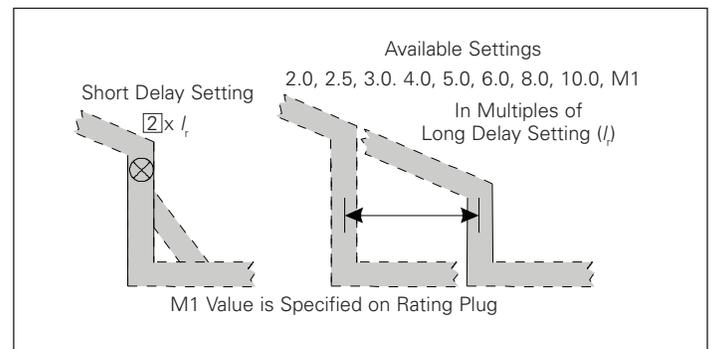


**Figure 32. Long Time Memory (LTM) Jumper**

The action of the LTM must be considered when performing multiple long delay time tests (see Section 5).

### Short delay current setting

There are eight available short delay current settings, as illustrated in **Figure 31**. Seven settings are in the range from 2–10 times ( $I_L$ ). (Remember: ( $I_L$ ) is the long delay current setting.) The maximum value M1 is based on the ampere rating of the circuit breaker and is listed in Note 4 of **Table 1**.

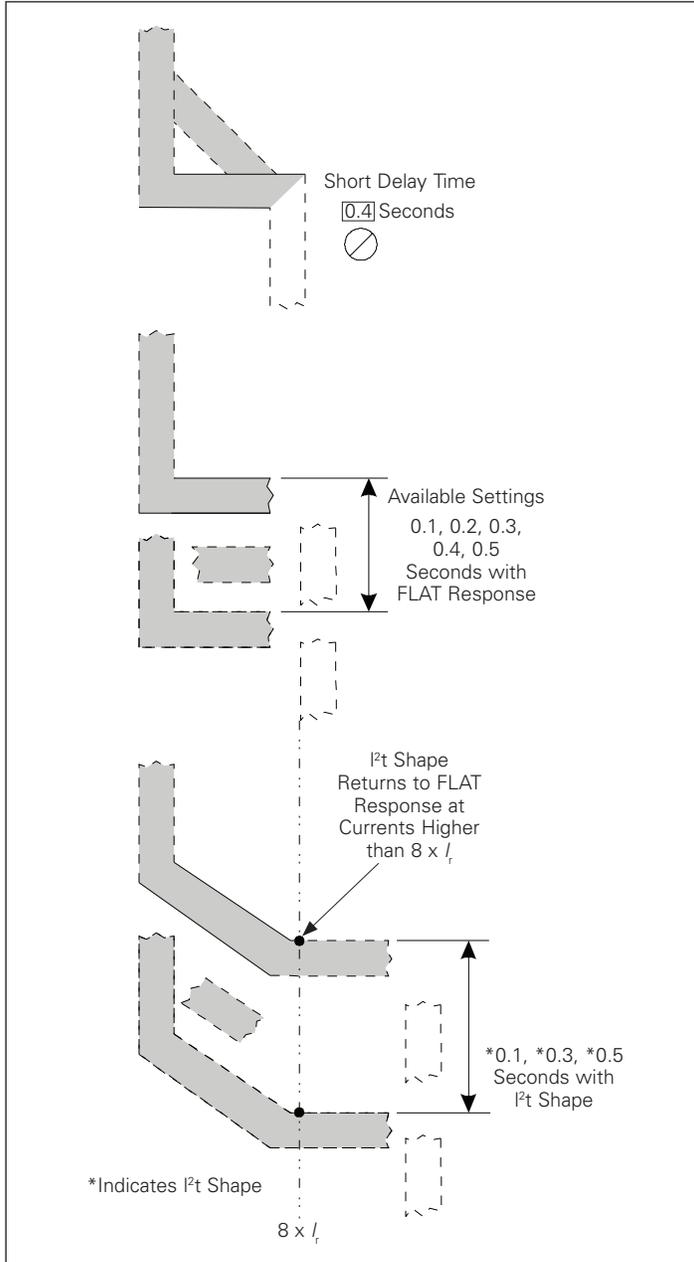


**Figure 33. Short Delay Current Settings**

### Short delay time setting

As illustrated in **Figure 34**, 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  $8 \times I_L$  than will the FLAT response curve.



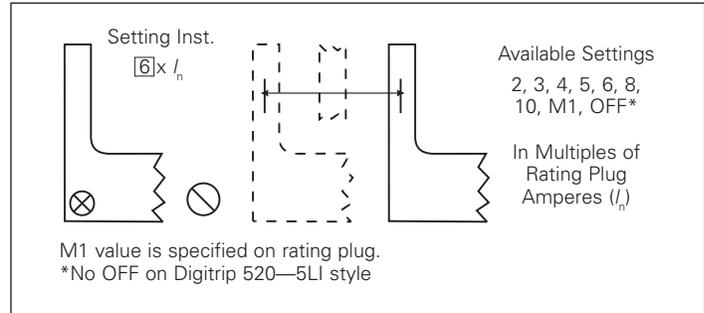
**Figure 34. Short Delay Time Settings**

Five FLAT (0.1, 0.2, 0.3, 0.4, 0.5 seconds) and three I<sup>2</sup>t (0.1\*, 0.3\*, 0.5\* seconds) response time delay settings are available. The I<sup>2</sup>t response settings are identified by an asterisk (\*). The I<sup>2</sup>t response is applicable to currents less than eight times the ampere rating of the installed rating plug (I<sub>n</sub>). For currents greater than 8 x (I<sub>n</sub>), the I<sup>2</sup>t response reverts to the FLAT response.

**Notes:** Also see Section 3, zone interlocking.

### Instantaneous current setting

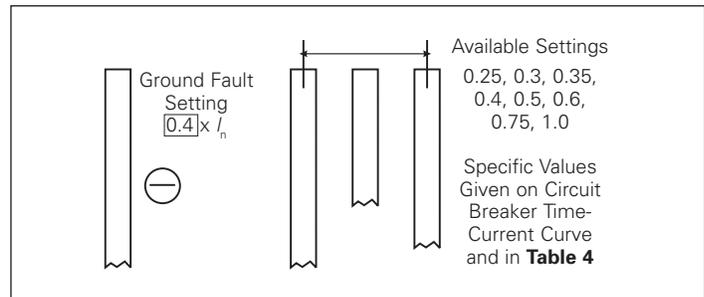
There are eight available instantaneous current settings, as illustrated in **Figure 35**. Six settings are in the range from 2–10 x (I<sub>n</sub>) the rating plug value, and the other two settings are M1 x (I<sub>n</sub>) or OFF. The value that M1 has depends upon the sensor rating of the circuit breaker and is specified both on the rating plug label and on the applicable time-current curves referenced in Section 9.



**Figure 35. Instantaneous Current Settings**

### Ground fault current setting

The eight ground fault current settings are labeled with values from 0.25 to 1.0 x (I<sub>n</sub>) (see **Figure 36**). The domestic (U.S.) models have a maximum of 1200A, limited by the firmware of the unit, as shown in **Table 1** and **Table 4**. The specific ground current settings for each model are listed in **Table 4** and on the applicable time-current curve for the breaker.



**Figure 36. Ground Fault Current Settings**

### Ground fault time delay setting

As illustrated in **Figure 37**, there are two different ground fault curve shapes: fixed time (FLAT) or I<sup>2</sup>t response. The shape selected depends on the type of selective coordination chosen. The I<sup>2</sup>t response will provide a longer time delay for current below 0.625 x I<sub>n</sub> than will the FLAT response.

Five FLAT (0.1, 0.2, 0.3, 0.4, 0.5 seconds) and three I<sup>2</sup>t (0.1\*, 0.3\*, 0.5\* seconds) response time delay settings are available. The I<sup>2</sup>t response settings are identified by an asterisk (\*). The I<sup>2</sup>t response is applicable to currents less than 0.625 times the ampere rating of the installed rating plug (I<sub>n</sub>). For currents greater than 0.625 x (I<sub>n</sub>), the I<sup>2</sup>t response reverts to the FLAT response.

**Note:** Also see Section 3, zone interlocking.

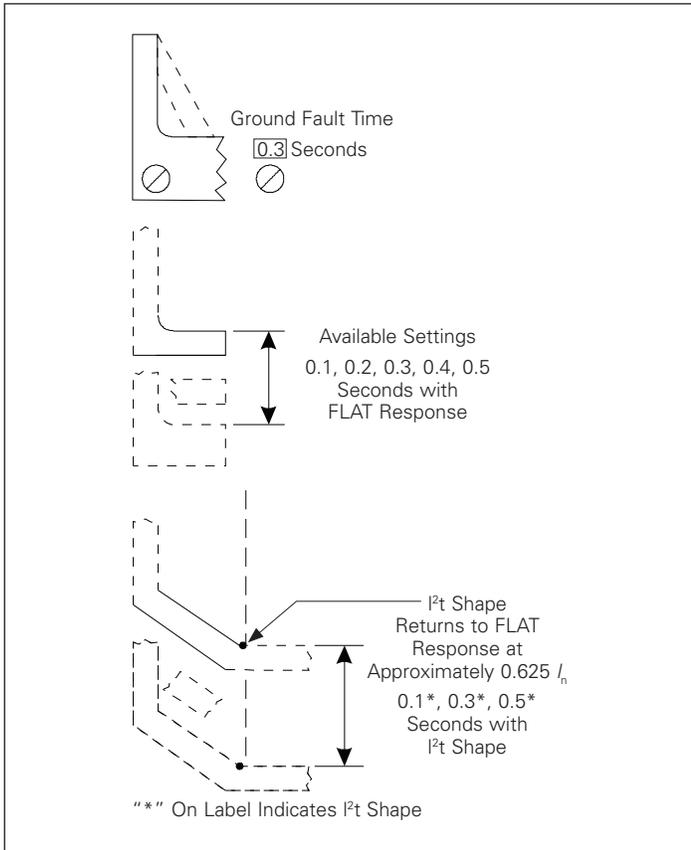


Figure 37. Ground Fault Time Delay Settings

**INCOM (Digitrip 520MC models only)**

INCOM communication to a host computer or a BIM is possible with the Digitrip 520MC unit. The address range is 001–999. The factory default address is 999 hex.

To set the desired address or to view the address, depress and hold the Reset/Battery Test button for five seconds. Depress the Step button to select a new address. Users may simultaneously depress and hold in the Step and Reset/Battery Test buttons for fast advance.

**Breaker Interface Module (BIM)**

The Breaker Interface Module (BIM) can be used to monitor up to 31 Digitrip 520MC trip units. The acceptable addresses are 001–031.

**Remote master computer**

When desired, Digitrip 520MC trip units can communicate with a BIM or remote master computer (IBM PC compatible with Eaton CONI card or MINT ) and using PowerNet communication software Version 3.20 or greater (see **Figure 38** for typical wiring.)

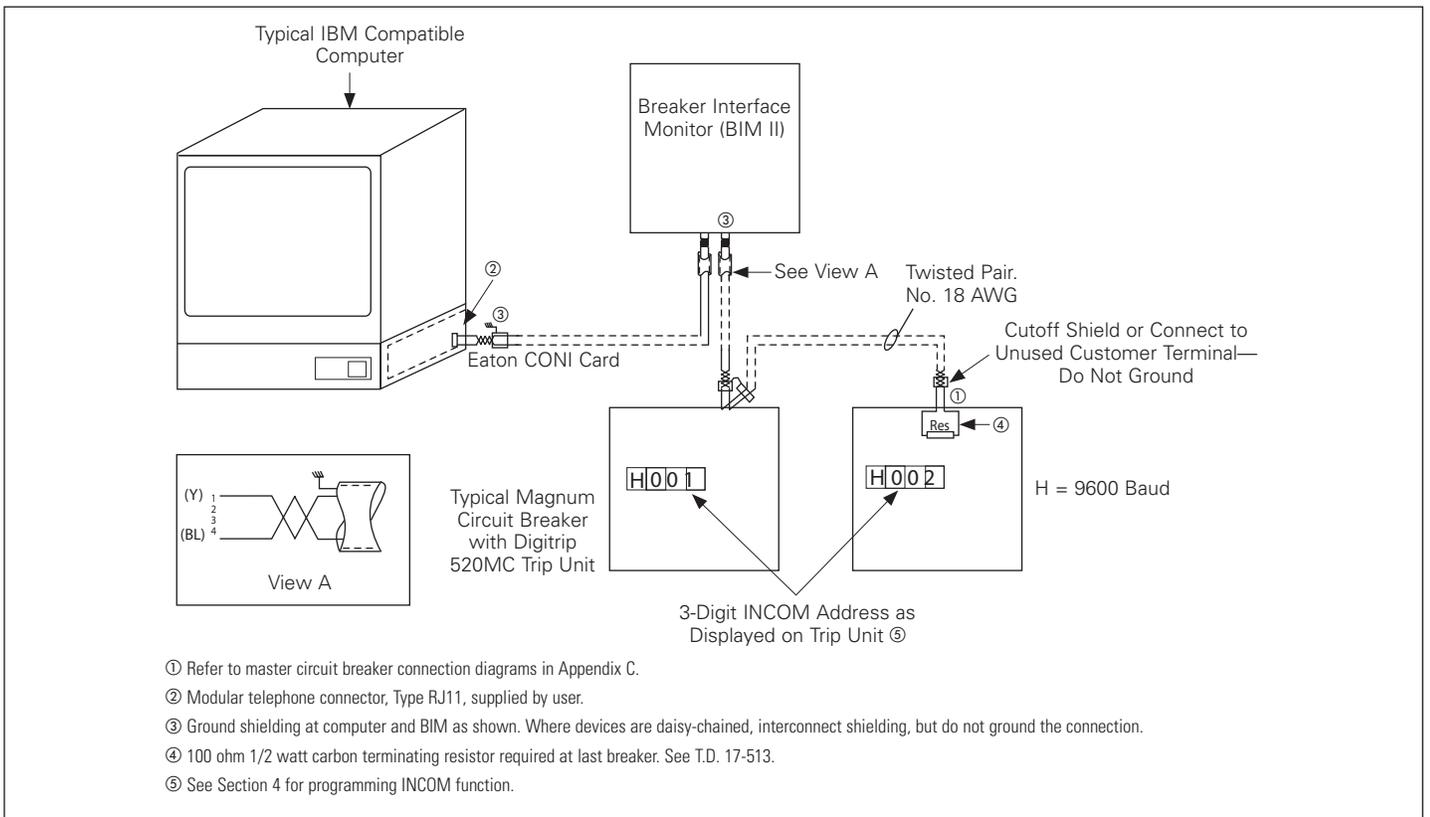


Figure 38. INCOM Network with Remote Master Computer or BIM

- ① Refer to master circuit breaker connection diagrams in Appendix C.
- ② Modular telephone connector, Type RJ11, supplied by user.
- ③ Ground shielding at computer and BIM as shown. Where devices are daisy-chained, interconnect shielding, but do not ground the connection.
- ④ 100 ohm 1/2 watt carbon terminating resistor required at last breaker. See T.D. 17-513.
- ⑤ See Section 4 for programming INCOM function.

### INCOM network interconnections

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

The Digitrip 520MC will light the red LED shown in **Figure 1** when transmitting on INCOM.

Recommended cable specifications:

- Eaton cable catalog #IMPCABLE, Style #2A95705G01
- Belden 9463 cable family
- Identical Commscope or Quabbin cables

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

## Section 5: Test procedures

### General

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#### **⚠ 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.**

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#### **⚠ WARNING**

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

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#### **⚠ CAUTION**

**TESTING A CIRCUIT BREAKER WHILE IT IS IN-SERVICE AND CARRYING LOAD CURRENT IS NOT RECOMMENDED. TESTING OF A CIRCUIT BREAKER THAT RESULTS IN THE TRIPPING OF THE CIRCUIT BREAKER SHOULD BE DONE ONLY WITH THE CIRCUIT BREAKER IN THE TEST OR DISCONNECTED CELL POSITIONS OR WHILE THE CIRCUIT BREAKER IS ON A TEST BENCH.**

---

### When to test

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

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

### Functional field testing

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#### **⚠ CAUTION**

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

---

### Field test kit

Use the test receptacle to verify a functional load test of a major portion of the electronic circuitry of the Digitrip and the mechanical trip assembly of the breaker. The testing can determine the accuracy of the desired trip settings by performing long delay, short delay, and ground fault functional tests. The Eaton-approved test kit is listed below.

Model	Test Kit
Digitrip 520 family	Test kit (140D481G02R, 140D481G02RR, 140D481G03, or G04) with test kit adapter 8779C02G04 or PACB test kit 87C0270

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The test port is located on the front left-hand corner of the trip unit (see **Figure 1**). To access the port, remove the plexiglass cover from the front of the circuit breaker. Using a small screwdriver, gently pry up on the test port cover to remove this item.

---

**⚠ CAUTION**

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**BEFORE PLUGGING A TEST KIT INTO THE TEST PORT, PLACE THE LTM JUMPER IN THE INACTIVE POSITION (SEE FIGURE 30). AFTER TESTING, RETURN THE LTM JUMPER TO ITS ORIGINAL POSITION.**

---

The test kit authorized by Eaton for use with the Digitrip units plugs into the test port of the unit and provides a secondary injection test that simulates the current transformer. Existing test kits, styles 140D481G02R, 140D481G02RR, 140D481G03 or G04, along with the Magnum test kit adapter 8779C02G04, can be used to test the trip unit and breaker.

**Functional test kit (handheld)**

**Description of handheld test kit**

A battery-powered test kit is also available and capable of testing trip elements for Digitrip units 520/520M/520MC and Digitrip 220+, 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 (see **Figure 39**). The test currents are not adjustable for this test kit.

The style number of this device is #70C1056.

**Test procedure**

Complete procedural instructions for the Eaton functional test kit can be found in I.L. #5721B13, which is packaged with each test kit.



**Figure 39. Functional Test Kit**

**Note:** After completion of testing, perform a power-up by depressing Reset pushbutton, which will clear the trip memory. Disconnect cable from test kit to prevent accidental operation and battery drainage. Reset the Instantaneous setting to its original condition. Reposition the LTM jumper to the as-found condition. Install the small cover on the Digitrip and install the breaker's plexiglass cover.

**Currents**

Each test selected by the Select Test switch on the test kit supplies a fixed milliampere current value. The long delay setting will affect the per unit (I<sub>p</sub>) 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. This battery has a much longer lifespan to accurately perform the selected tests. The remaining six batteries are located on a separate board in the test kit and serve to power up the display on the 520M trip unit.

LEDs A and B function to represent sufficient battery voltage from both the single lithium cell and the six alkaline batteries, respectively. If either LED does not light or lights only dimly, replace the appropriate battery or batteries within the functional test kit case. To do this, open the back of the case using a screwdriver and remove the battery or batteries from their respective locations. For best results, replace lithium battery (Battery A) with ULTRALIFE® U9VL battery. When replacing battery sixpack (Battery B), replace all batteries at the same time using standard 9V alkaline batteries.

**Performance testing for ground fault trip units—primary injection**

**Code requirements**

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

**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 (General test instructions), plus a copy of the record forms (**Figure 44**, **Figure 45**, and **Figure 46**), 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.

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**⚠ WARNING**

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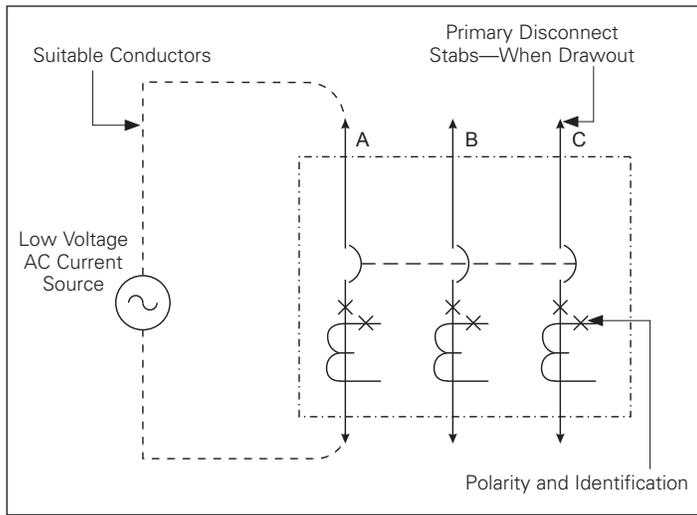
**PERSONAL INJURY CAN OCCUR WHEN WORKING ON POWER SYSTEMS. ALWAYS TURN OFF POWER SUPPLYING BREAKER BEFORE CONDUCTING TESTS. TEST OUT OF THE CELL, IF POSSIBLE. THERE IS A HAZARD OF ELECTRICAL SHOCK OR BURN WHENEVER WORKING IN OR AROUND ELECTRICAL EQUIPMENT.**

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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.

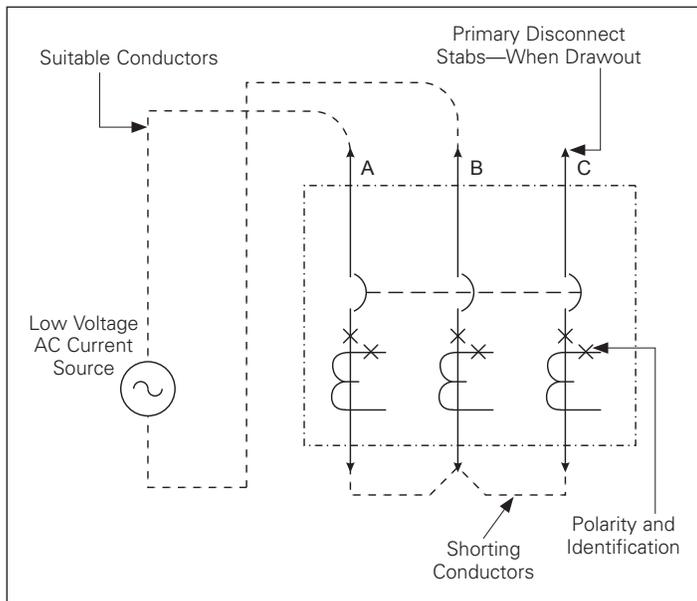
Use a low voltage (0–24V), high-current, AC source to apply a test current of 125% of the Digitrip unit pickup setting through one phase of the circuit breaker. This should cause the breaker to trip in less than 1 second and operate the alarm indicator, if one is supplied. Reset the breaker and the alarm indicator. Repeat the test on the other two phases (see **Figure 40**).

Apply the same current as described above through one phase of the 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.



**Figure 40. Connection Details for Conducting Single-Pole, Single-Phase Current Tests with the Breaker Removed from the Cell**

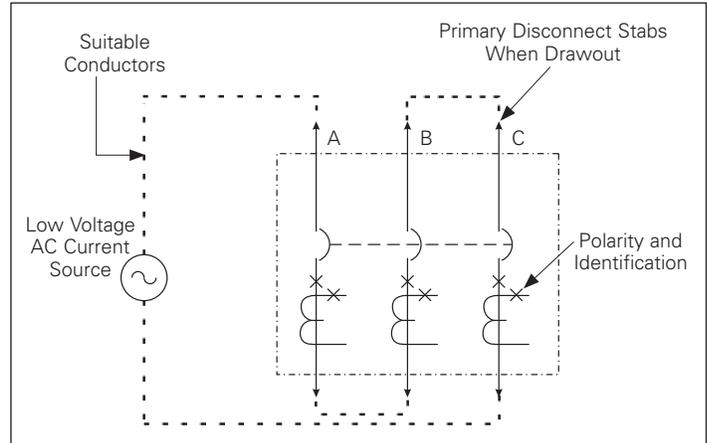
Apply the same current as described above through any two phases of the breaker. The breaker should not trip, and the alarm indicator, if one is supplied, should not operate. Repeat the test using the other two combinations of breaker phases (see **Figure 41**) or through a breaker pole and the neutral that employs a neutral sensor.



**Figure 41. Connection Details for Conducting Single-Phase Current Tests with the Breaker Removed from the Cell**

**Digitrip models 520, 520i; and 520M, 520Mi, 520MC, 520MCi trip units for use only in Magnum and Magnum DS circuit breakers**

An alternative test setup is shown in **Figure 42**. This three-pole in series hookup should be employed when a low ground pickup setting is to be tested like 0.24x and 0.3x, and if auxiliary power to Digitrip can not be provided. The test circuit does provide a net residual ground current excitation of "1." Two of the phases cancel each other out as far as ground fault, but now the Digitrip is provided with three-pole power-up current simulating three-phase power.



**Figure 42. Alternate Connection Details Using Three Poles to Develop a Ground Fault Condition**

**CAUTION**

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

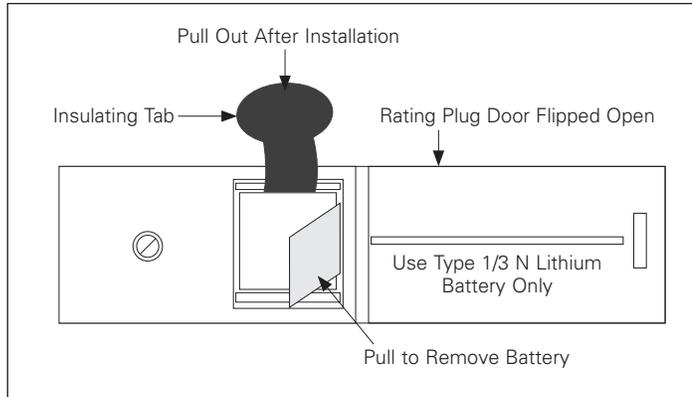
Record the test results on the test form provided with the equipment (see **Figure 46**).

## Section 6: Trip unit battery

### General

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

As indicated in **Figure 15**, the battery is provided to maintain the red LED indication of the cause of trip. The battery is located under the rating plug door. 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 discard the insulating tab and then replace battery (see **Figure 43**). This will activate the battery. Check the battery status by depressing the Battery Test pushbutton.



**Figure 43. Digitrip Battery**

### 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 breaker in accordance with its settings. However, without the battery, the Cause of Trip LED will not flash red. 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 4-bit latch chip and associated Cause of Trip LEDs (see **Figure 15**).

### Battery installation and removal

The 3V lithium cell battery (see **Figure 43**) is easily removed and replaced. The battery is located in the cavity adjacent to the rating plug mounting screw, but is not part of the rating plug. Insert a small screwdriver at the left side of the rating plug, and to the left of the word OPEN, to open the rating plug door. Remove the old battery by pulling up on the removal tab that wraps under the battery cell. When inserting the new cell, pay special attention to ensure that the proper polarity is observed. The main body of the battery is the positive (+) side.

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

### **CAUTION**

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

The replacement battery should be the same type as that already in the trip unit or an equivalent. Acceptable 3V lithium batteries may be obtained from the following companies:

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



## Section 7: Frame ratings (sensor ratings and rating plugs)

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

A current value, ( $I_n$ ), that is less than the full frame rating may be chosen to be the basis for the coordination of the protection function of the breaker without affecting its short-circuit current capability. For the Digitrip 520 family of trip units, this is implemented by changing the current sensors and the corresponding rating plug. These sensors and rating plugs are available in kit form.

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

This value, ( $I_n$ ), is the basis for the trip unit current settings:

1. The Instantaneous and Ground Current Settings (if provided) are multiples of ( $I_n$ ) (see Section 4).
2. The Long Delay Current Setting, ( $I_L$ ), is a fractional multiple of ( $I_n$ ): Long Delay Current Setting = ( $I_L$ ) = LD x ( $I_n$ ) (see Section 4).
3. The Short Delay Current Setting is a multiple of ( $I_n$ ): Short Delay Current Setting = SD x ( $I_n$ ) = SD x [LD x ( $I_n$ )] (see Section 4).

### ⚠ CAUTION

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

**Note:** Rating plugs from Digitrip models 210, 500, or 510 CANNOT be used with 520 family model trip units.

## Section 8: Record keeping

Use the forms shown in **Figure 44** and **Figure 45** for record keeping. Fill in these forms, giving the indicated reference information and initial time-current trip function settings. If desired, make a copy of the form and attach it to the interior of the breaker cell door or another visible location. **Figure 46** 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.

DIGITRIP 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 44. Typical Trip Function Record Nameplate

DIGITRIP AUTOMATIC TRIP OPERATION RECORD				
Circuit No./Address		Circuit 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 45. Automatic Trip Operation Record

<b>GROUND FAULT TEST RECORD FORM</b>			
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.			
<b>Test Date</b>	<b>Circuit Breaker Number</b>	<b>Results</b>	<b>Tested By</b>

Figure 46. Typical Performance Test Record Form

## Section 9: References

### Magnum and Magnum DS circuit breakers

- I.B. 2C12060 Magnum DS Breaker Instructions
- I.B. 2C13060 Magnum I. Breaker Instructions
- 4A36346 Zone Interlocking Application with Non-Magnum Breakers
- I.L. 66A7508 Instruction for mMINT Modbus Translator Module

### Time-current curves

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

- 70C1295 Digitrip 220P or 520 (LI) (L) curve
- 70C1296 Digitrip 220P or 520 (LI) (I) curve
- 70C1006 Digitrip 520 (LS) curve
- 70C1007 Digitrip 520 (I) curve
- 70C1008 Digitrip 520 (G) curve
- 70C1446 Digitrip 520MC Maintenance Mode trip

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### **⚠ NOTICE**

**THE PROVISION FOR THE ZONE SELECTIVE INTERLOCKING FUNCTION IS STANDARD ON CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS FOR SHORT TIME AND GROUND FAULT (EARTH FAULT) FUNCTIONS. FOR ANSI/UL CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS, THE APPROPRIATE JUMPER TO TERMINAL B8 AND B9 MUST BE ADDED ON THE CIRCUIT BREAKER IF ZONE INTERLOCKING IS NOT DESIRED OR FIELD TESTING IS DESIRED. FOR IEC CIRCUIT BREAKERS WITH DIGITRIP TRIP UNITS, THE ZONE INTERLOCKING FUNCTION IS NOT WIRED OUT TO THE CIRCUIT BREAKER SECONDARIES (I.E., ZONE FUNCTIONALITY IS NOT PRESENT IN SECONDARIES B7, B8, AND B9). THE TRIP UNIT WILL ALWAYS FOLLOW THE PROGRAMMED SHORT TIME OR GROUND TIME SETTING. THIS IS ACCOMPLISHED VIA A WIRING HARNESS INTERNAL TO THE CIRCUIT BREAKER. IF THE ZONE INTERLOCKING FUNCTION IS DESIRED FOR IEC CIRCUIT BREAKERS WITH DIGITRIPS, PLEASE CONTACT EATON FOR APPROPRIATE INSTRUCTIONS ON HOW TO ADJUST THE INTERNAL WIRING HARNESS TO ACTIVATE THE ZONE INTERLOCKING FUNCTION ASSOCIATED WITH SECONDARIES B7, B8, AND B9 OF THE CIRCUIT BREAKER.**

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## Section 10: Digitrip 520MC with Maintenance Mode

### **⚠ WARNING**

**ONLY CERTIFIED AND COMPETENT PERSONNEL SHOULD ATTEMPT TO INSTALL OR MAINTAIN POTENTIALLY HAZARDOUS EQUIPMENT. 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.**

### **⚠ 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.**

### **⚠ CAUTION**

**A FLASH HAZARD ANALYSIS SHOULD BE DONE TO DETERMINE PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS.**

#### General

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

For situations that arise where this is not possible, the Maintenance Mode function of the Digitrip 520MC family (*Cat. 5ARMLSI, 5ARMLSIG, 5ARMLSIA*) can reduce arc flash incident energy that is generated on a fault condition. This is accomplished by an analog trip circuit which, 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 is separate from the normal system protection setting of Instantaneous. The Maintenance Mode is located in the upper, white portion of the unit.

#### Maintenance Mode settings

The Maintenance Mode settings (labeled R5, R4, R3, R2, R1) provide the Arc Flash Reduction setting. R5 is the maximum reduction setting, which correlates to the lowest pickup value.

Nominal trip current of Maintenance Mode settings:

Setting R5	2.5 x Rating Plug Amperes
Setting R4	4.0 x Rating Plug Amperes
Setting R3	6.0 x Rating Plug Amperes
Setting R2	8.0 x Rating Plug Amperes
Setting R1	10.0 x Rating Plug Amperes

#### Arming Maintenance Mode

There are three ways to arm the Maintenance Mode Arc Flash Reduction setting. One method is locally via the two-position 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 other two methods of arming the Maintenance Mode function, this switch must be in the position labeled 0/1. With this setting, a remote switch wired through the breaker secondary contacts 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. (See wiring diagram **Figure 47**.)

A third method to arm the Maintenance Mode setting is via a communication device. A Palm Pilot along with an IR MINT device can be employed to arm the setting. By initiating the ENABLE setting, the Maintenance Mode selection in the control screen of the Palm, Maintenance Mode is set. There is a confirmation screen that verifies the arming. A BIM (Breaker Interface Module) is another communication method to arm the setting. When Maintenance Mode setting is enabled via device communications, this setting must be disabled by device communications.

#### Remote indicator

The Magnum circuit breaker will be wired with secondary contacts A9 and A12. Circuit breakers built after September 2005 have a normally open contact available to customer use. This contact can be used to indicate remotely that the Maintenance Mode setting is armed. Refer to diagram below for a wiring of this remote (blue light) indicator.

#### Choosing the reduction setting

The Arcflash Reduction Maintenance System is an eight-position rotary switch that has five unique settings. Setting R5 is repeated four times. From the factory, the Magnum circuit breaker is shipped with the Digital unit set to the R5 setting and with its arming switch set to the 0/1 position. The 0/1 position means that it is locally OFF, but can be remotely turned ON. The blue LED, if illuminated, provides indication that the Maintenance Mode setting is armed per one of the three methods described on page 32. In general, the selection of one of the Reduction Settings (R5 through R1) should be determined and selected by a person who is experienced in power system analysis.

This setting choice normally does not change unless there are future system modifications that could increase or decrease fault levels at the circuit breaker location.

#### 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 or secondary injection current testing.

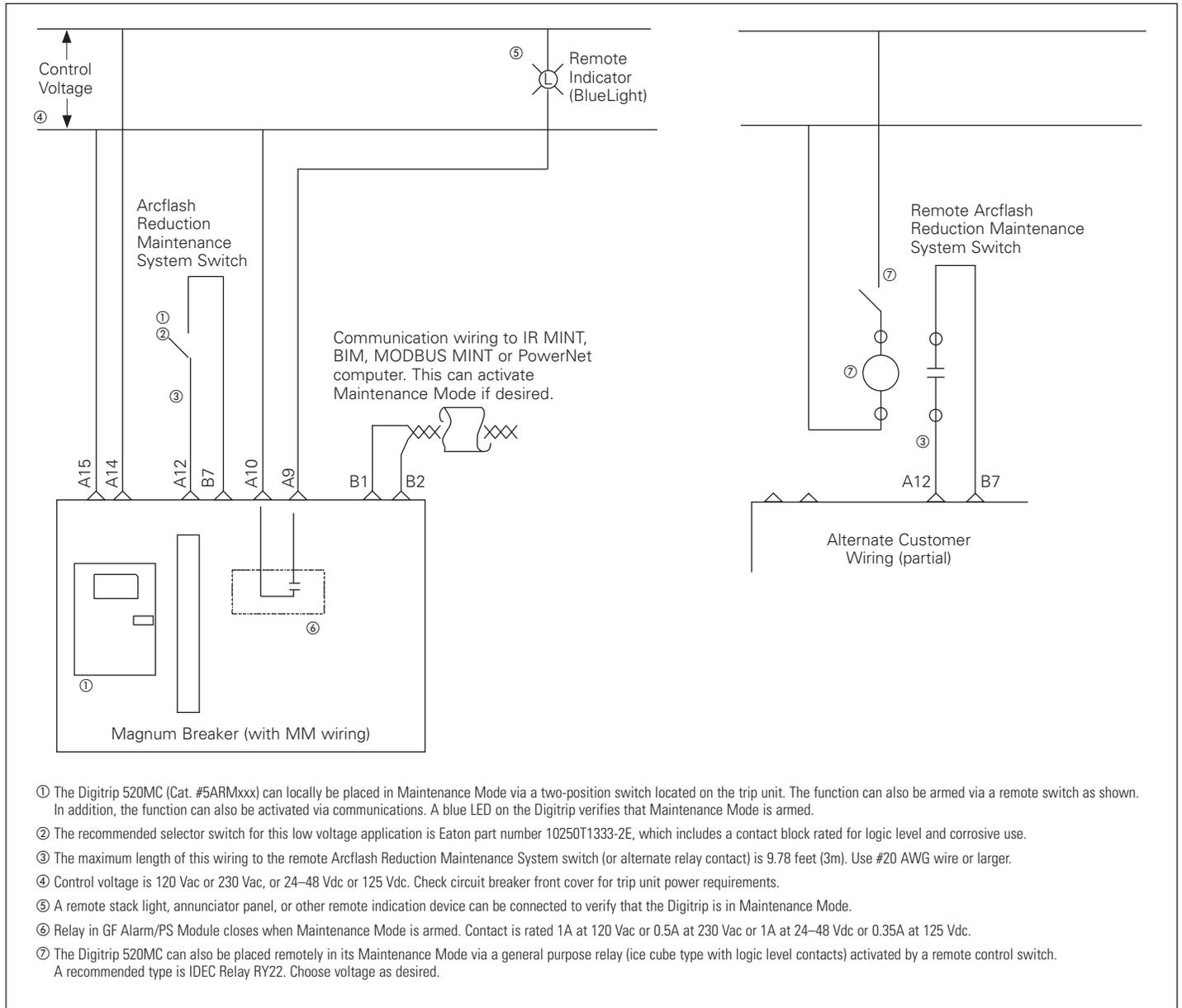


Figure 47. Maintenance Mode Wiring—Digitrip 520MC

## 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 48**.

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

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

Fault at location 1  
The main 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 48**.

Fault at location 3  
The branch 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.

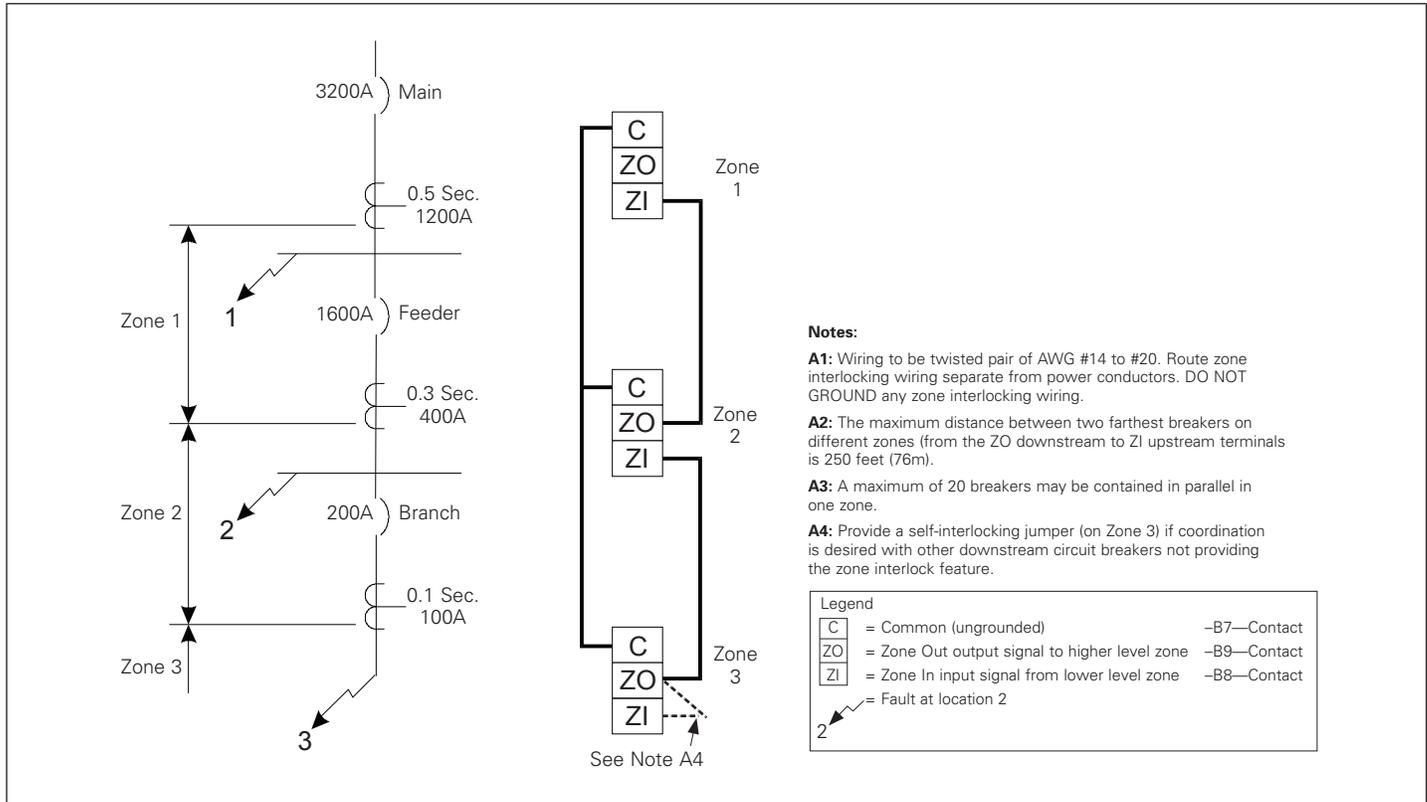
Main and feeder trip units will begin to time out and, in the event that the branch breaker does not clear the fault, the feeder breaker will clear the fault in 0.3 seconds (as above). Similarly, in the event that the feeder breaker does not clear the fault, the main breaker will clear the fault in 0.5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

Fault at location 2  
The feeder 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 breaker Z2 does not clear the fault, the main breaker will clear the fault in 0.5 second (as above).

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

**Figure 49** presents a zone selective interlocking connection diagram for a system with two main breakers from incoming sources and a bus tie 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 48. Typical Zone Interlocking**

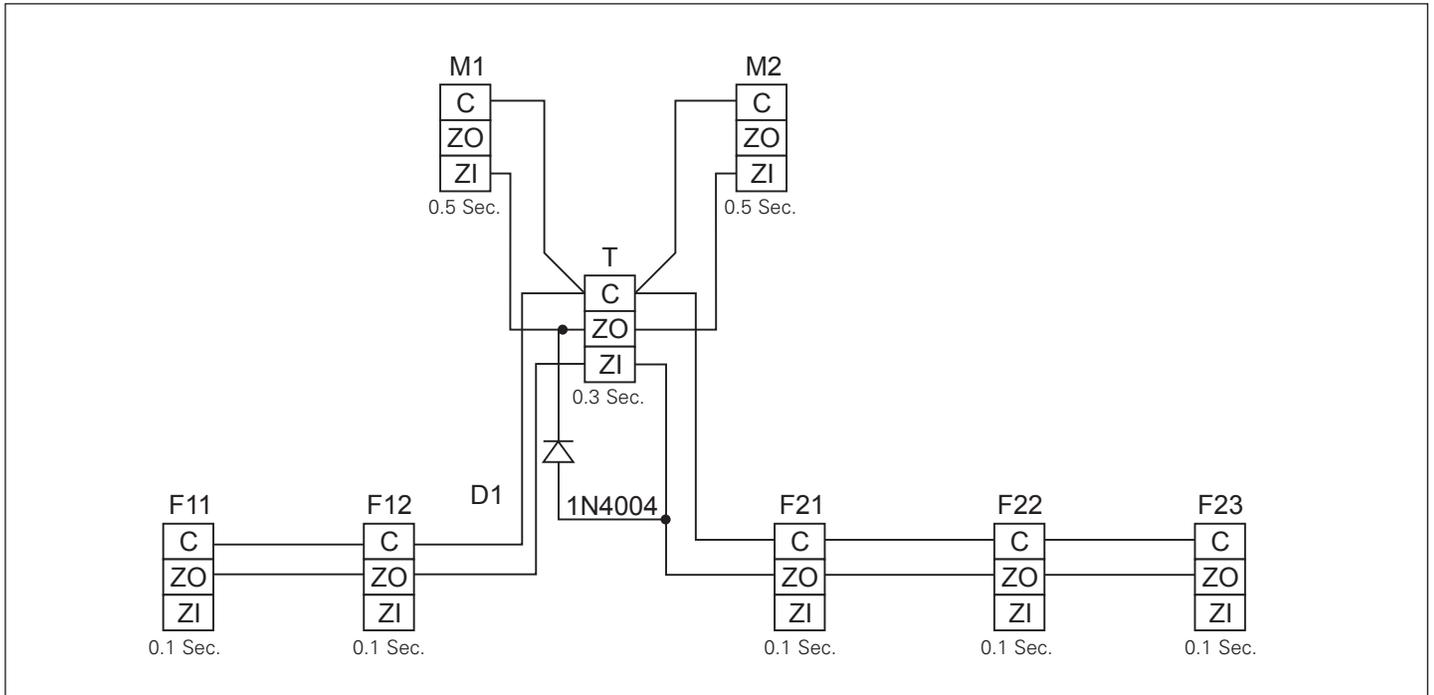
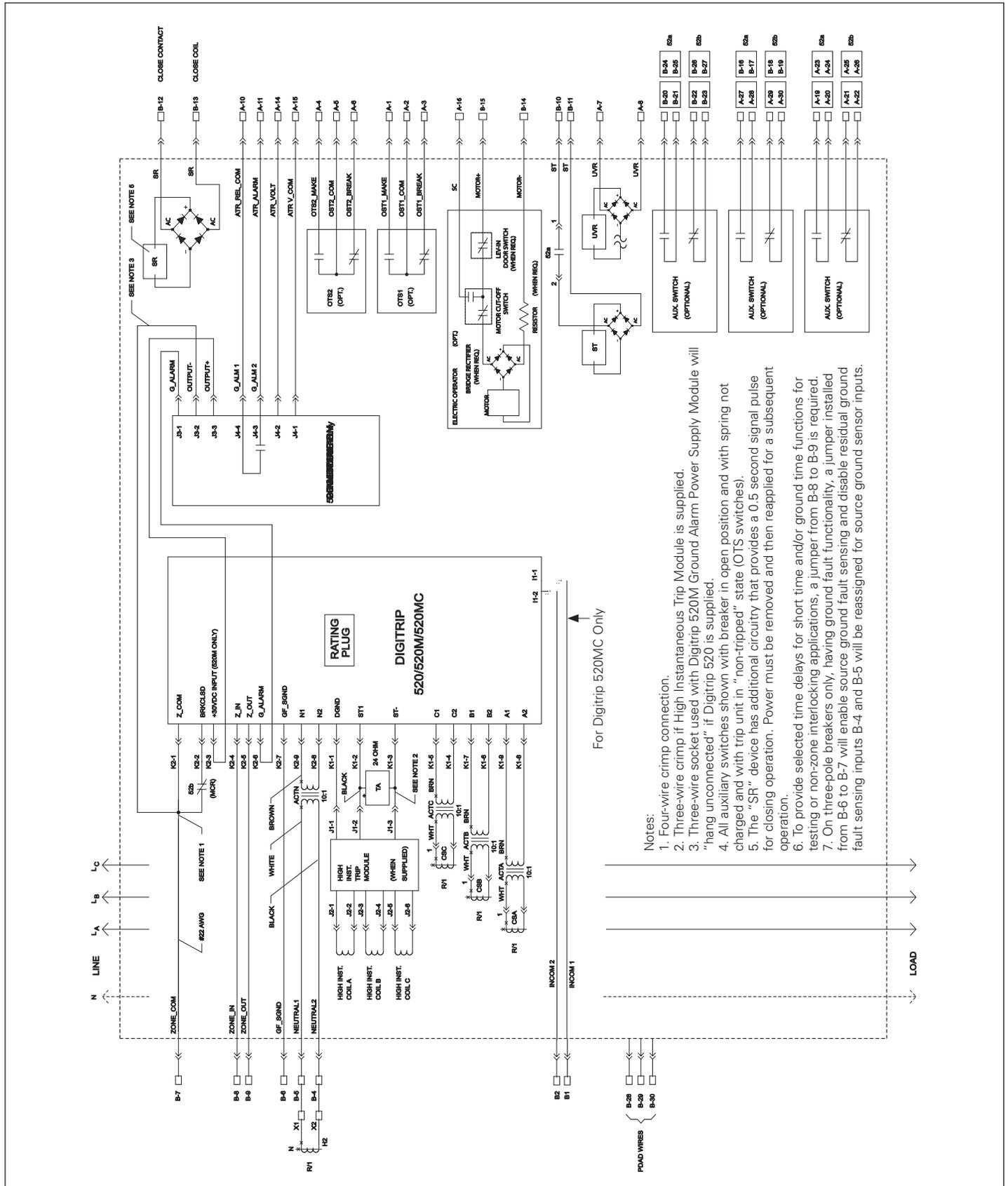


Figure 49. Typical Zone Interlocking Connections with Two Main Breakers (M1, M2) and a Tie Breaker (T)

## Appendix B: Troubleshooting guide

Symptom	Probable Cause	Possible Solution(s)	References
Unit Status LED is not blinking	Current through breaker is <25% of sensor rating	No problem, Status LED will not operate with breaker currents <25% of sensor rating	
	Trip unit is malfunctioning	Replace trip unit	
Unit Status LED is steady on	Light loading	No problem, Status LED will not flash until 25% of sensor rating	See Section 3 Note
	Trip unit is malfunctioning	Replace trip unit	
As soon as current starts to flow through 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	
	Rating plug is open internally	Replace rating plug	
	Trip unit is malfunctioning	Replace trip unit	
LED does not come on when Battery Check button is pressed or Cause of Trip does not light after a trip via Digitrip	Battery installed backwards.	Install correctly	
	Dead battery.	Replace battery	
	Trip unit is malfunctioning	Replace trip unit	
Breaker trips on ground fault	There actually is a ground fault	Find location of the fault	
	On four-wire residual systems, the neutral current sensor may not have the correct ratio or be properly connected	Check connections at terminals B-4 and B-5, check that the neutral current sensor ratio matches the breaker, check that the connections from the neutral current sensor to the breaker are not reversed, check B-6, B-7 for correct programming of jumper	See Section 2 Notes
	Trip unit is malfunctioning	Replace trip unit	
	High inrush phase currents may cause fictitious ground pickup momentarily	Connect Zout to Zin jumper to provide some time delay, see Caution in Section 3	
Breaker trips too rapidly on ground fault or short delay (zone selective interlocking not used)	Connection from Zout to Zin is missing.	Make connections B-8 to B-9	Refer to Appendix A
	Trip unit settings are not correct	Change settings	
	Trip unit is malfunctioning	Replace trip unit	
Breaker trips too rapidly on Long Time Memory function long delay	Disable Long Time Memory	Refer to Section 4	
	Trip unit settings are not correct	Change settings, Long Time Delay setting is based on $6 \times I_r$	
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	
	Battery voltage too low to reset latch chip and LEDs	Replace battery	See Section 6
A Cause of Trip LED keeps retriggering in the application (Digitrip 520M and 520MC)	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 also Note in Section 5
LCD Display is not energized	Light load	Check breaker ordering information	Refer to Section 1
	No auxiliary power unit	Check voltage input terminals—A14, A15	Refer to Section 1
Circuit breaker containing Digitrip 520MC* does not communicate with PowerNet or BIM. *Only Digitrip 520MC styles have communication features.	Wrong address	Check address	See Section 4
	No power	Check for auxiliary power—A14, A15	See <b>Figure 1</b> and refer to Section 1
		Check Status LED and Transmit LED	
	Hardware problem	Check communications wiring—B1, B2	See Appendix C
	Missing termination resistor	See <b>Figure 38</b>	

**Appendix C: Typical breaker master connection diagram**



- Notes:
1. Four-wire crimp connection.
  2. Three-wire crimp if High Instantaneous Trip Module is supplied.
  3. Three-wire socket used with Digitrip 520M Ground Alarm Power Supply Module will "hang unconnected" if Digitrip 520 is supplied.
  4. All auxiliary switches shown with breaker in open position and with spring not charged and with trip unit in "non-tripped" state (OTS switches).
  5. The "SR" device has additional circuitry that provides a 0.5 second signal pulse for closing operation. Power must be removed and then reapplied for a subsequent operation.
  6. To provide selected time delays for short time and/or ground time functions for testing or non-zone interlocking applications, a jumper from B-8 to B-9 is required.
  7. On three-pole breakers only, having ground fault functionality, a jumper installed from B-6 to B-7 will enable source ground fault sensing and disable residual ground fault sensing inputs B-4 and B-5 will be reassigned for source ground sensor inputs.

Figure 50. Typical Breaker Master Connection Diagram

## Appendix D: Modbus translator wiring

The Digitrip 520MC in a Magnum breaker can communicate its data using Modbus® RTU protocol by employing a mMINT device to act as a translator from INCOM™ communication to Modbus communications. A Modbus master device is shown wired to gather data.

The mMINT module Cat. No. MMINT uses DIN rail mounting. Connector types are plug-in-Phoenix. Power is 5-pin.

INCOM network uses a 3-pin. The RS-485 Modbus uses a 4-pin connector that consists of signals A, B, COMmon, and SHield.

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

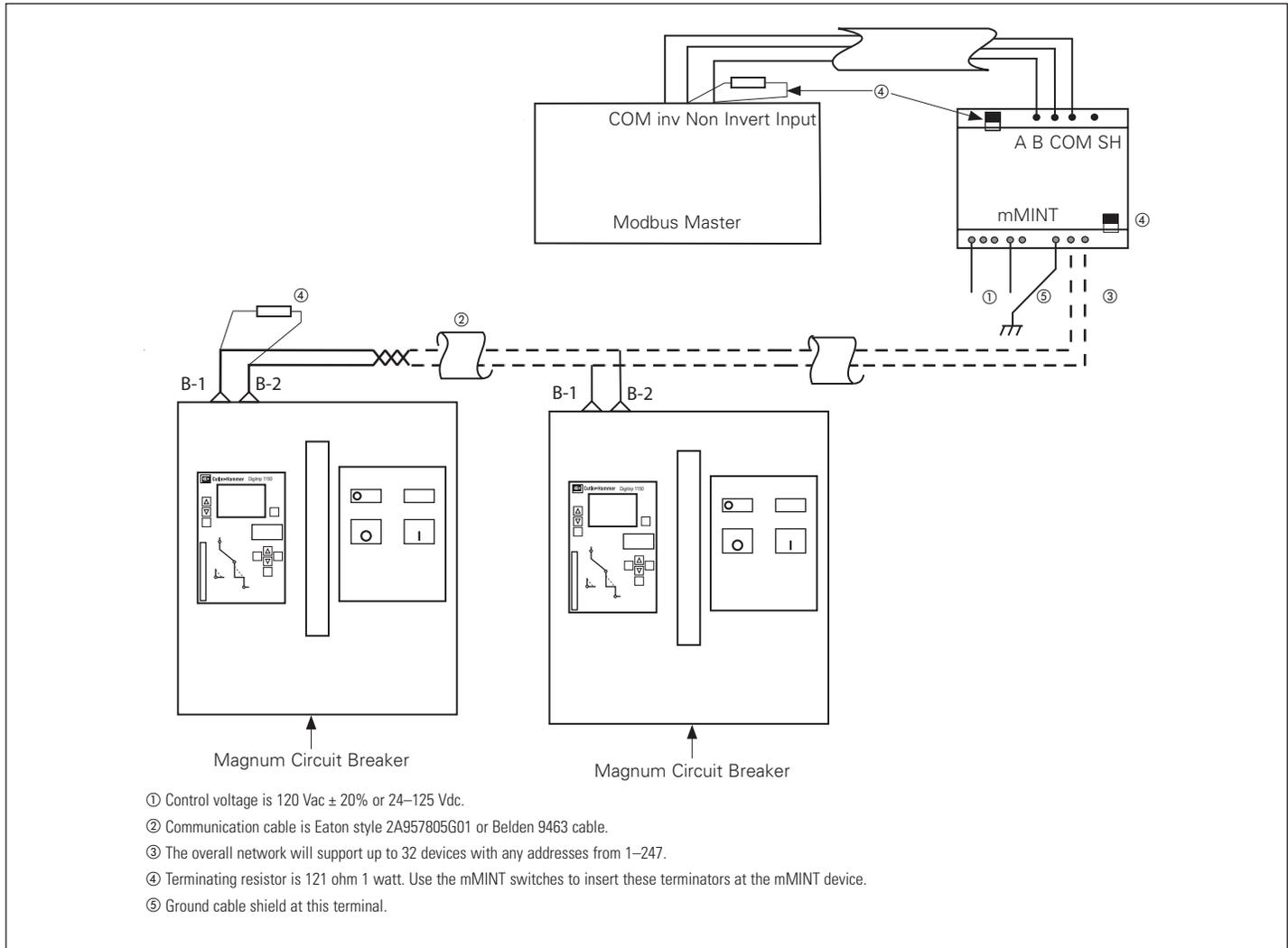


Figure 51. Modbus Translator Wiring

Digitrip models 520, 520i; and 520M, 520Mi,  
520MC, 520MCi trip units for use only in  
Magnum and Magnum DS circuit breakers

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