Instructions for Digitrip Models 220+, and 520, 520*i* and 520M, 520M*i*, and 520MC, 520MC*i* Trip Units for use only in Cutler-Hammer Magnum and Magnum DS Circuit Breakers

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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. CUTLER-HAMMER IS NOT LIABLE FOR THE MISAPPLICATION OR MISINSTALLATION OF ITS PRODUCTS.

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.

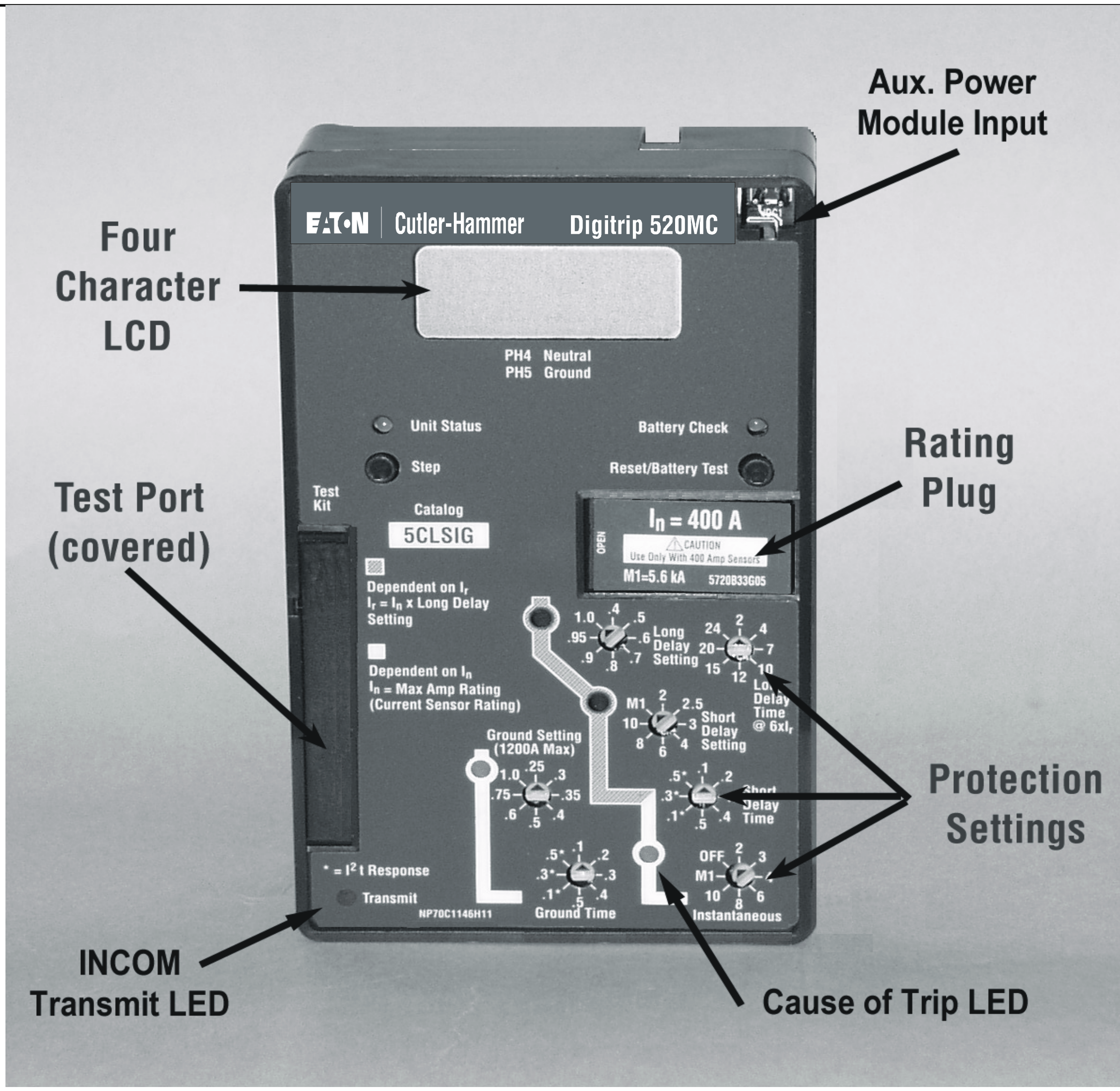


Figure 1.1 Digitrip 520MC Trip Unit with Rating Plug

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 which may arise.

If you have any questions or need further information or instructions, please contact your local representative or the Customer Support Center at 1-800-356-1243.

1.0 GENERAL DESCRIPTION OF DIGITRIP TRIP UNITS

The 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 instruction book specifically covers the application of Digitrip Trip Units *(see Figure 1.1)* 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 220+, 520, 520M and 520MC for UL standards and models 220+, 520*i*, 520M*i* and 520MC*i* for IEC standards. *(See Table 1.1a for available protection types.)* Only models 520MC and 520MC*i* provide communications. *(See Table 1.1b for data that will be communicated).*

The Digitrip 220+, 520, 520M and 520MC trip units may be applied on both 50 and 60 Hertz systems.

Table 1.1a Protection Types Available for Digitrip Trip Units

Digitrip Trip Unit Type		**220[+]**	**520/520*i***	**520M/520M*i***	**520MC/520MC*i***
Ampere Range		100A-3200A	100A-6300A	100A-6300A	100A-6300A
RMS Sensing		Yes	Yes	Yes	Yes
Communications		No	No	No	Yes[3]
Protection and Coordination					
Figure Number Reference		3.2.1	3.2.2, 3.2.3, 3.2.4	3.3.1, 3.3.3, 3.3.2, 3.3.4	3.4.1, 3.4.3, 3.4.2, 3.4.4
Protection	Ordering Options	PLI	LSI, LSIG, WLSIG	MLSI, MLSIG, MLSIA, MWLSIG	CLSI, CLSIG, CLSIA, CWLSIG
	Fixed Rating Plug (*I*n)	Yes	Yes	Yes	Yes
	Overtemperature Trip	Yes	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)	0.4-1.0 x (*I*n)
	Long Delay Time I^2t at 6 x (*I*r)	2-24 Seconds	2-24 Seconds	2-24 Seconds	2-24 Seconds
	Long Delay Thermal Memory	Yes	Yes	Yes	Yes
Short Delay Protection	Short Delay Pick-Up[4]	No	200-1000% x (*I*r)	200-1000% x (*I*r)	200-1000% x (*I*r)
	Short Delay Time I^2t at 8 x (*I*r)	No	100-500 ms	100-500 ms	100-500 ms
	Short Delay Time FLAT	No	100-500 ms	100-500 ms	100-500 ms
	Short Delay Time ZSI[5]	No	Yes	Yes	Yes
Instantaneous Protection	Instantaneous Pick-Up[4]	200-1000% x (*I*n)	200-1000% x (*I*n)	200-1000% x (*I*n)	200-1000% x (*I*n)
	Off Position	No	Yes	Yes	Yes
	Making Current Release	Yes	Yes	Yes	Yes
Ground (Earth) Fault Protection	Ground Fault Option	No	Yes	Yes	Yes
	Ground Fault Alarm	No	No	Yes[3]	Yes[3]
	Ground Fault Pick-Up	No	25-100% x (In)[1]	25-100% x (In)[1]	25-100% x (In)[1]
	Ground Fault Delay I^2t at .625 x (*I*n)	No	100-500 ms	100-500 ms	100-500 ms
	Ground Fault Delay Flat	No	100-500 ms	100-500 ms	100-500 ms
	Ground Fault ZSI[5]	No	Yes	Yes	Yes
	Ground Fault Memory	No	Yes	Yes	Yes
Neutral Protection		Yes	Yes Cat LSI only	Yes Cat MLSI only	Yes Cat CLSI only
System Diagnostics					
Status/Long Pick-up LED		Yes	Yes	Yes	Yes
High Load Alarm/ Alarm Contacts		No	No	Yes[3] Cat MLSI only	Yes[3] Cat CLSI only
Cause of Trip LEDs		Yes	Yes[2]	Yes[2]	Yes[2]
Magnitude of Trip Current		No	No	Yes[3]	Yes[3]
Remote Ground Trip/Alarm Contacts		No	No	Yes[3]	Yes[3]
System Metering					
Digital Display		No	No	4 Char. LCD	4 Char. LCD

Notes:
1. Limited to 1200 Amperes; this is only for UL versions, not for IEC models.
2. Four cause of trip LEDs–L, S, I, G. Making Current Release is indicated by the Instantaneous LED.
3. Requires Ground Alarm/Power Supply Module (see Section 1.6).
4. Additional setting is marked M1 where:

   800-3200A Frame: M1 = 14 x /n for Plug Amps 100 through 1250A
   M1 = 12 x /n for Plug Amps 1600, 2000, 2500A
   M1 = 10 x /n for Plug Amps 3000, 3200A

   4000-6300A Frame: M1 = 14 x /n for Plug Amps 2000, 2500A
   M1 = 12 x /n for Plug Amps 3200, 4000, 5000A (see Section 2.5)
   M1 = 10 x /n for Plug Amps 6000, 6300A
5. ZSI = Zone Selective Interlock *(See Section 3.4)*

Table 1.1b Communication Functions Available for Digitrip 520MC Units

Catalog Number	5CLSI	5CLSIG	5CLSIA	5WLSIG
REMOTE INFORMATION VIA COMMUNICATIONS	X	X	X	X
Breaker Status				
OPEN/CLOSED/TRIPPED	X	X	X	X
Address register	X	X	X	X
Trip Event Values:				
Protection Settings	X	X	X	X
Current Values				
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)②	X	X	X	X
Phase G Current (amperes)	NA	X	X	X
Remote Messages - Alarm				
OverLoad (Long Pickup)	X	X	X	X
HighLoad Alarm	X	NA	NA	NA
Ground Alarm	NA	X ⑦	X	X ⑦
Remote Messages - Trip				
Long Delay Trip	X	X	X	X
Short Delay Trip	X	X	X	X
Instantaneous Trip	X	X	X	X
Ground Trip	NA	X	NA	X
Over-temperature 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 INST Trip ⑥	X	X	X	X
Slave Action Commands				
Remote Reset	X	X	X	X

LEGEND

X = Function Included
NA = Not Applicable
② = Breaker must be 4 pole or neutral sensor wired
③ = Over-temp 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
⑦ = Breaker will trip and Alarm contact will operate

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 which 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 pick-up adjustments can be set for either FLAT or I^2t 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 1.1.

1.1 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 1.1 and Figures 3.2.1 through 3.4.4.

NOTE: The Digitrip 220+ (LI model - Fig. 3.2.1), 520 (LSI model - Fig. 3.2.2), 520M (MLSI model - Fig. 3.3.1) and 520MC (CLSI model - Fig. 3.4.1) can be used on 3-pole or 4-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 and can provide neutral metering. Refer to the National Electric Code (NEC) for the appropriate application for 4-pole breakers.

1.2 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 pick-up, 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.

1.3 Installation and Removal

1.3.1 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 1.2).*

1.3.2 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.

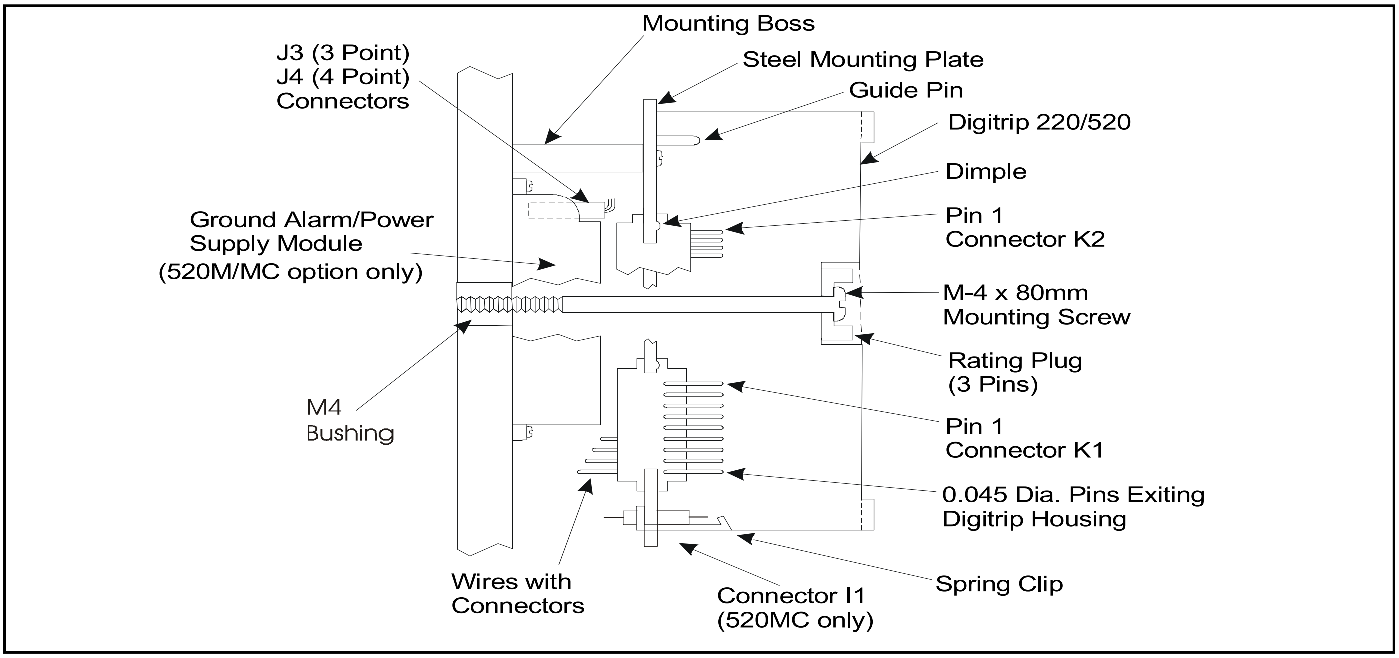


Figure 1.2 Installation of the Digitrip Unit into a Magnum Breaker (Side View)

CAUTION

DO NOT FORCE THE RATING PLUG INTO THE CAVITY.

Use a 1/8" (3 mm) wide screwdriver to tighten the M4 screw and secure the plug and the trip unit to the circuit breaker *(See Figure 1.3).* 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" (3 mm) WIDE SCREWDRIVER BLADE IS ADEQUATE.

1.3.3 Trip Unit/Rating Plug Removal

To remove the rating plug from the trip unit, open the rating plug door. Use a 1/8" (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 1.2).*

Figure 1.3 Installation of the Rating Plug and Mounting Screw

1.4 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.

1.5 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 insured 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.

1.6 Ground Alarm/Power Supply Module (520M/MC Models only)

The Ground Alarm/Power Supply Module *(See Figure 1.4)* is an optional accessory for the Digitrip 520M, 520M*i* and is a required accessory to enable communications on the Digitrip 520MC and 520MC*i* 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 (7802C83G01), 230 VAC (7802C83G02), and 24-48 VDC (7802C82G01). The burden of the Power/Relay Module is 10VA.

1.6.1 Auxiliary Power

When the module is wired as shown in Figure 1.5, it will provide an auxiliary power supply so that the 520M/520M*i* or 520MC/520MC*i* liquid crystal display (LCD) will be functional even when the circuit breaker has no load. A Digitrip 520M or 520MC tripunit **without** auxiliary power will not display data until load current reaches approximately 30% 1 phase or 10% 3 phase of the (*I*n) rating.

1.6.2 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.

1.6.3 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 1.5, Note 3)*.

Figure 1.4 Ground Alarm/Power Supply Module for the 520M or 520MC Trip Units

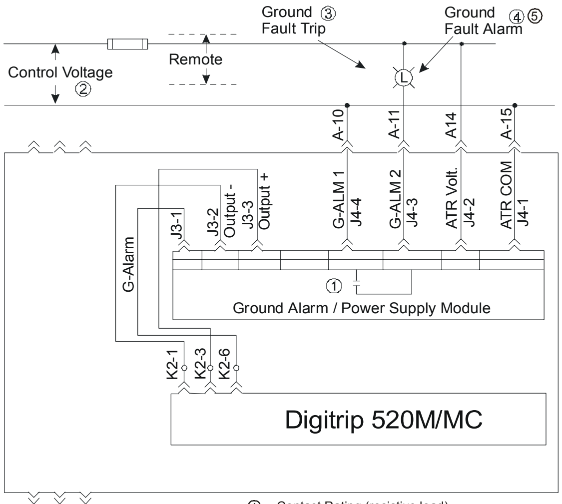
1.6.4 Ground Fault Alarm

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 1.5, Note 4).*

1.6.5 High Load Alarm (520M/520MC Models only)

The Digitrip 520M and 520MC models of the LSI style only, (Figures 3.3.1 and 3.4.1), the module shown in Figures 1.4 and 1.5 will provide a HighLoad 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 Ir setting.



Available Input Voltages	Style Number ②
120 VAC	7802C83G01
230 VAC	7802C83G02
24-48 VDC	7802C82G01

① Contact Rating (resistive load)
AC 0.5A @ 230VAC
AC 1A @ 120VAC
DC 1A @ 48VDC

② Verify input voltage rating before energizing circuit.

③ When used in conjunction with a T. U. Cat. 5MWLSIG, 5MLSIG, 5CWLSIG or 5CLSIG, will indicate GF trip.

④ When used in conjunction with T.U. Cat. 5MLSIA or 5CLSIA, will indicate GF alarm.

⑤ When used in conjunction with a Trip Unit Cat 5MLSI or 5CLSI, will indicate High Load alarm.

Figure 1.5 Wiring Diagram for 520M and 520MC Models with Ground Alarm/Power Supply Module

1.7 Display Feature (520M and 520MC only)

The Digitrip 520M/520M*i* and 520MC/520MC*i* 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	HighLoad Alarm (Cat 5MLSI and 5CLSI only)
HELP	This message can indicate more than one problem with the trip unit. If the rating plug is missing, a HELP message and an Instantaneous trip LED light will be observed. The rating plug needs to be installed and the Instantaneous trip LED must be cleared by pressing the Reset/Battery Test button. This message could also 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 Aux. Power Module input pins present- See Fig 1.1) will display and freeze the magnitude of the trip value after a trip event if auxilary 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 non volatile memory. A possible cause of this would be the lack or loss of auxilary power during the trip event.

1.8 Standards

The Digitrip 220+, 520 520M and 520MC Trip Units are listed by the Underwriters Laboratories, Inc.,® under UL File E52096, for use in Magnum 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 947-2 test program which includes radiated and conducted emission testing. As a result, all units carry the CE mark.

2.0 GENERAL DESCRIPTION OF MAGNUM CIRCUIT BREAKERS

2.1 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 2.1 shows this tripping circuit for a typical Magnum Breaker. This arrangement provides a very flexible system, covering a wide range of tripping characteristics described by the time-current curves referenced in Section 9.2.

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.

2.2 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 25 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.

2.3 Ground Fault Protection

NOTE: The Digitrip 220 is not available with ground fault protection. Only the 520 family has ground fault types available.

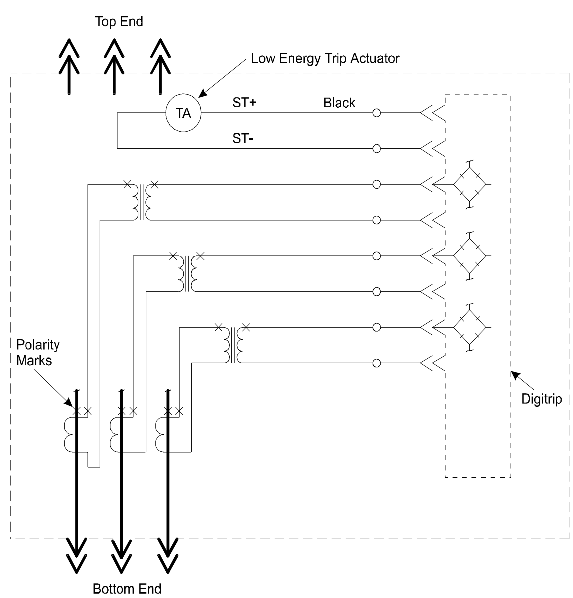


Figure 2.1 Tripping Circuit for a Typical Magnum Breaker (Partial)

2.3.1 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 Sections 2.3.3 through 2.3.6.

The Digitrip 520 uses three modes of sensing to detect ground fault currents: residual, source ground, and zero sequence (see Table 2.1). Magnum Circuit Breakers can accommodate all three types, except for 4-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.

Ground (Earth) Fault Sensing Method	Breaker Secondary Contacts Req'd	Applicable Breakers	Figure Reference	Digitrip GF Sensing Element Used
Residual	No Jumper	3 or 4 pole	2.2, 2.3, 2.5, 2.9	element R5
Source Ground	Jumper B6 to B7	3 pole only	2.7	element R4
Zero Sequence	Jumper B6 to B7	3 pole only	2.8	element R4

Note: This information applies to Trip Units with Ground

Table 2.1 Digitrip Sensing Modes

2.3.2 Residual Sensing

Residual Sensing is the standard mode of ground fault sensing in Magnum Circuit Breakers. This mode utilizes one current sensor on each phase conductor and one on the neutral for a 4-wire system (shown in Figures 2.2 and 2.3). 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 which are identical to the three internally-mounted phase current sensors. Available types of neutral sensors are shown in Figure 2.4. Residual ground fault sensing features are adaptable to main and feeder breaker applications. Available ground fault pick-up settings employing Residual Sensing are given in Table 2.2. Figure 2.5 shows a 4-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 INSURE CORRECT GROUND FAULT EQUIPMENT PERFORMANCE, CONDUCT FIELD TESTS TO COMPLY WITH NEC REQUIREMENTS UNDER ARTICLE 230-95(C).

2.3.3 Source Ground Sensing

Depending upon the installation requirements, alternate ground fault sensing schemes may be dictated (see Figures 2.6 and 2.7). 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 and all other equipment-grounding conductors.

The settings shown in Table 2.1 will apply when the neutral sensor is not the same as the frame rating in a ground return sensing scheme.

2.3.4 Zero Sequence Sensing

Zero Sequence Sensing, also referred to as vectorial summation (see Figure 2.8), is applicable to mains, feeders, and special schemes involving zone protection. Zero Sequence current transformers (4 ½" x 13 ½" [114 mm x 342 mm] rectangular inside dimensions) are available with 100:1 and 1000:1 ratios.

2.3.5 Multiple Source/Multiple Ground

A Multiple Source/Multiple Ground scheme is shown in Figure 2.9. In this figure, a ground fault is shown which 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.

Call Cutler-Hammer for more details on this scheme.

2.3.6 Ground Fault Settings

The adjustment of the ground fault functional settings (FLAT response or I^2t) is discussed in Section 4.8. The effect of these settings is illustrated in the ground fault time-current curve referenced in Section 9. Applicable residual ground fault pick-up settings and current values are given in Table 2.2 as well as in the ground time-current curve.

Table 2.2 Ground (Earth) Fault Current Settings

Ground Fault Current Settings (Amperes)[1]								
Installed Sensor and Rating Plug (Amperes) *I*n	**.25**	**.30**	**.35**	**.40**	**.50**	**.60**	**.75**	**1.0**
100	25	30	35	40	50	60	75	100
200	50	60	70	80	100	120	150	200
250	63	75	88	100	125	150	188	250
300	75	90	105	120	150	180	225	300
400	100	120	140	160	200	240	300	400
600	150	180	210	240	300	360	450	600
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 1200 amperes for NEC.
3. See Section 2.5.

2.4 Current Sensors (Magnum Frames less than or equal to 3200A)

The three (3-pole) or four (4-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 which 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.

2.5 Current Sensors (Magnum Frames greater than 3200A)

The six (3-pole) or eight (4-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 2.3). 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 which further steps down the rated current to 100 milliamperes and is equivalent to 100% (*I*n) to the Digitrip.

3.0 PRINCIPLES OF OPERATION

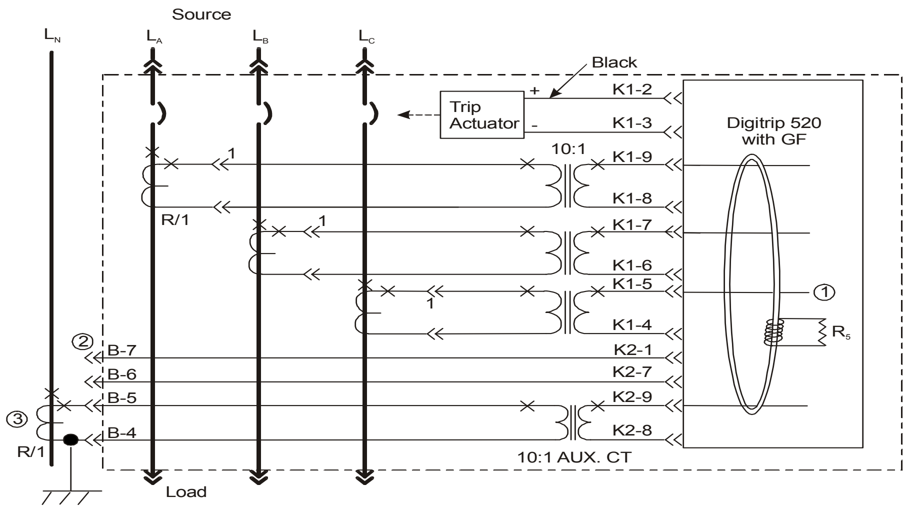
3.1 General

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° to 75° C. If, however, temperatures in the neighborhood of the trip unit exceed this range, the trip unit performance may be degraded. In order to insure 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 breaker if the chip temperature is excessive. If over-temperature 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 3.1.

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*™ (Cutler Hammer Integrated Processor) 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.



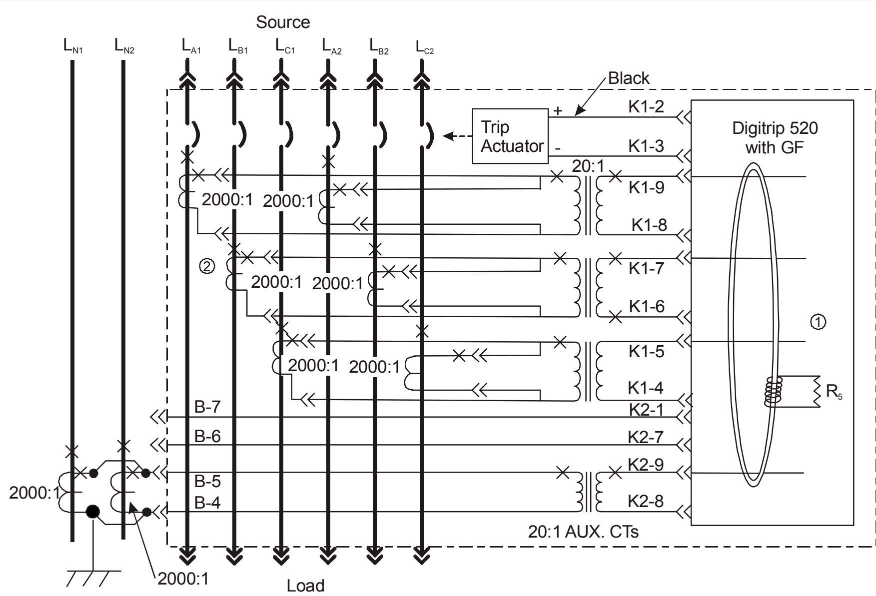
Notes:

① In this scheme, all breaker secondary currents (at the 100 mA level) are summed together at the PC board donut transformer to sense ground fault via element R_5.

② No jumper on secondary contacts B-6, B-7.

③ Neutral input (if 4-wire) is via contacts B-4, B-5. Neutral current input to secondary contacts is 1A, equivalent to 1 per unit ground.

Figure 2.2 3-Pole, 4-Wire Breaker with Neutral Sensor Connections for 3200A Frame Using Residual GF Sensing



Notes:

① In this scheme, all breaker secondary currents (at the 100 mA level) are summed together at the PC board donut transformer to sense ground fault via element R_5.

② In this scheme, the current sensors in the breaker poles are parallel-wired to achieve a 4000 amp breaker rating. Other available ratings in this double-wide configuration are 6300A, 5000A, 3200A, 2500A, and 2000A.

Figure 2.3 Neutral Sensor Connections for 4000A Frame Using Residual Ground Fault Sensing

ITEM	CURRENT RATIO
H01	200:1
H02	250:1
H03	300:1
H04	400:1
H05	600:1
H06	800:1
H07	1000:1
H08	1200:1
H09	1600:1
H10	2000:1
H11	2500:1
H12	3000:1
H13	3200:1
H14	630:1
H15	1250:1
H16	3150:1
H17	4000:1
H18	100:1

ALL SECOUNDARY CURRENTS TO BE
1.00 AMP NOMINAL AT FULL SCALE.

INSULATION LEVEL:
0.6 KV, BIL 10 KV full wave

CONTINOUS THERMAL CURRENT RATING FACTOR:
1.33 at 30°C. amb.; 1.0 at 55°C. amb.

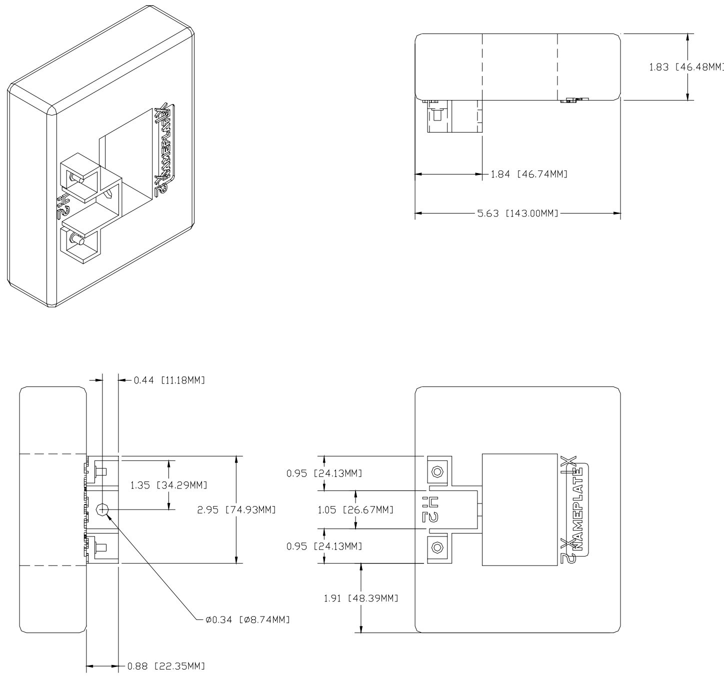
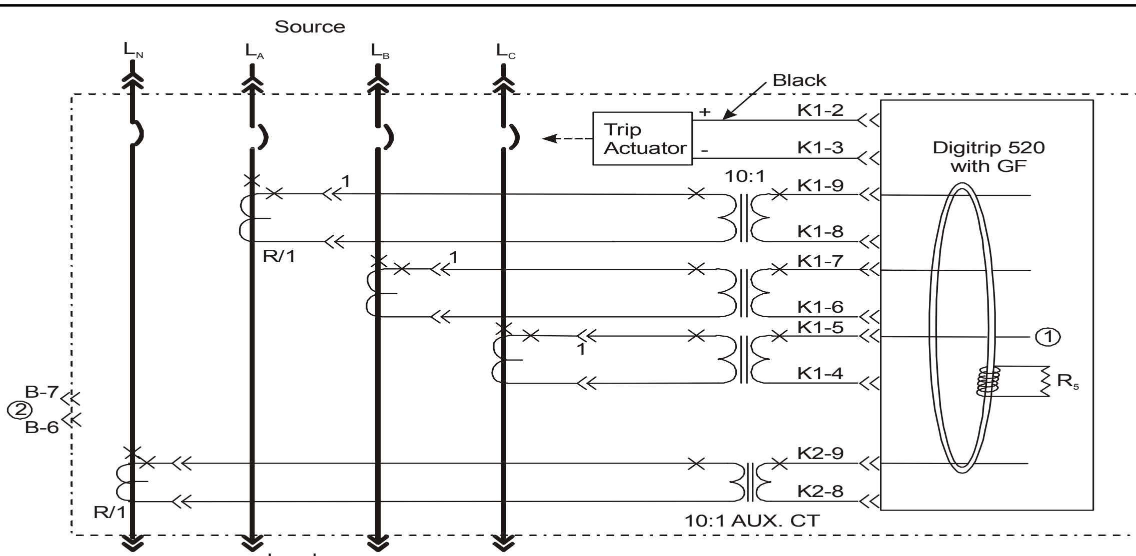


Figure 2.4 Digitrip Neutral Sensor Types



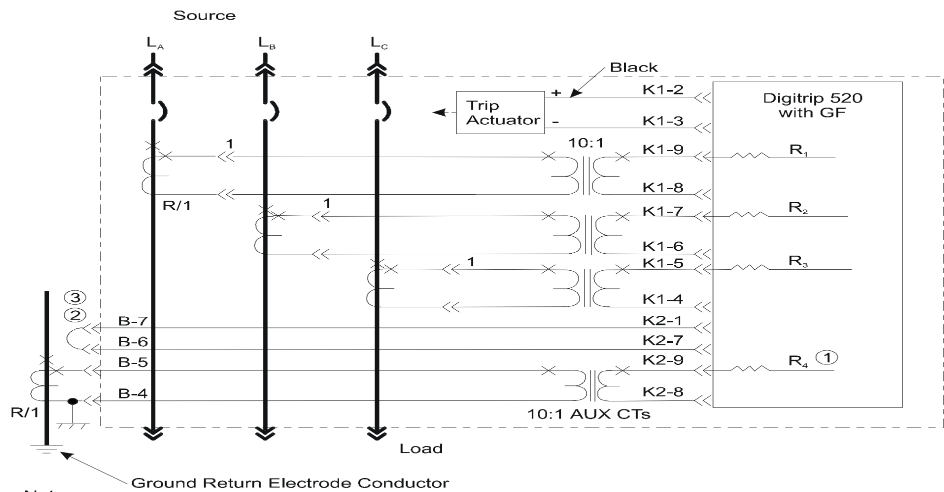
Notes:

① In this scheme, all breaker secondary currents (at the 100 mA level) are summed together at the PC board donut transformer to sense ground fault via element R_5.

② Do not jumper on secondary contacts B-6, B-7. This will defeat all ground fault protection in application for 4 pole breaker.

③ Ground fault style trip unit is installed.

Figure 2.5 4-Pole–3200A Frame Using Residual Ground Fault (Earth-Fault) Sensing



Notes

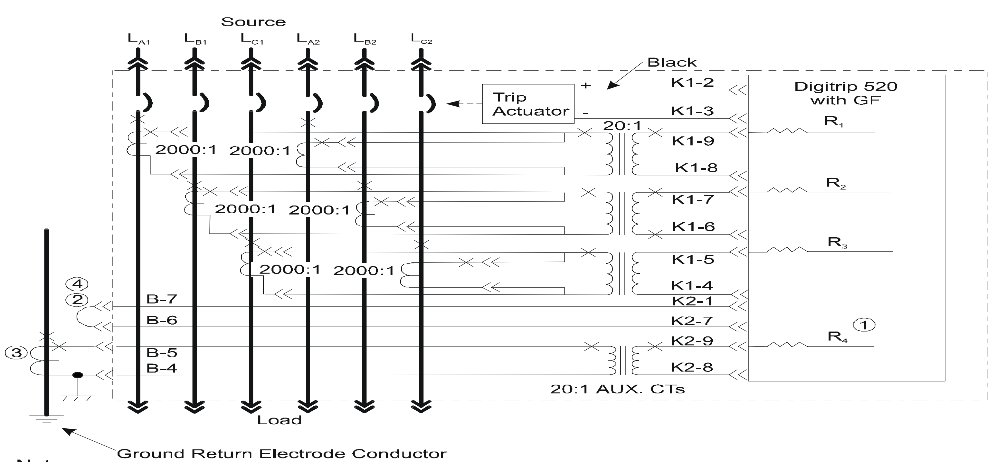
Typical Application - Main

① In this scheme, the residual sensing element R_5 is not used. The ground current is direct true ground current and is sensed directly via element R_4.

② A <u>jumper is required</u> on B-6, B-7 (secondary contacts) to program the Digitrip 520 to use element R_4 and input on B-4, B-5 directly for source ground sensing.

③ **This scheme is not applicable to 4-pole breakers. No secondary contacts (B-4 and B-5) are available on 4-pole breakers. Do not jumper B-6, B-7 in 4-pole applications.**

Figure 2.6 Source Ground Fault Sensing Scheme for 3200A Frame



Notes:

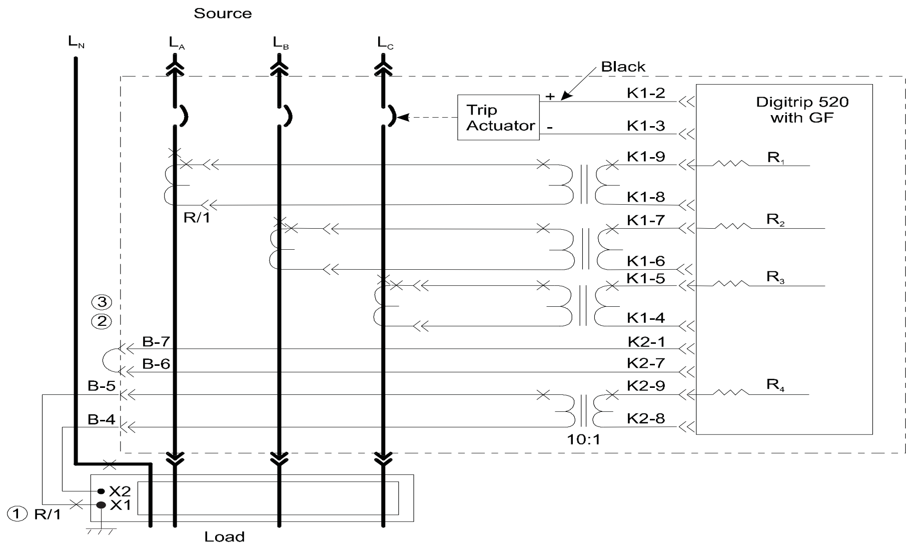
① In this scheme, the current sensors in the breaker poles are parallel-wired to achieve a 4000 Amp breaker rating. The ground fault is sensed directly via element R_4.

② A <u>jumper is required</u> on B-6, B-7 secondary contacts to program the Digitrip 520 to use element R_4 directly for source ground sensing.

③ Source ground sensor input is via B-4, B-5. Source ground current input to secondary contacts is 2A, equivalent to 1 per unit ground.

④ **The scheme is not applicable to 4-pole breakers. No secondary contacts (B-4 and B-5) are available on 4-pole breakers. Do not jumper B-6, B-7 in 4-pole applications.**

Figure 2.7 Source Ground Fault Sensing Scheme for 4000A Frame



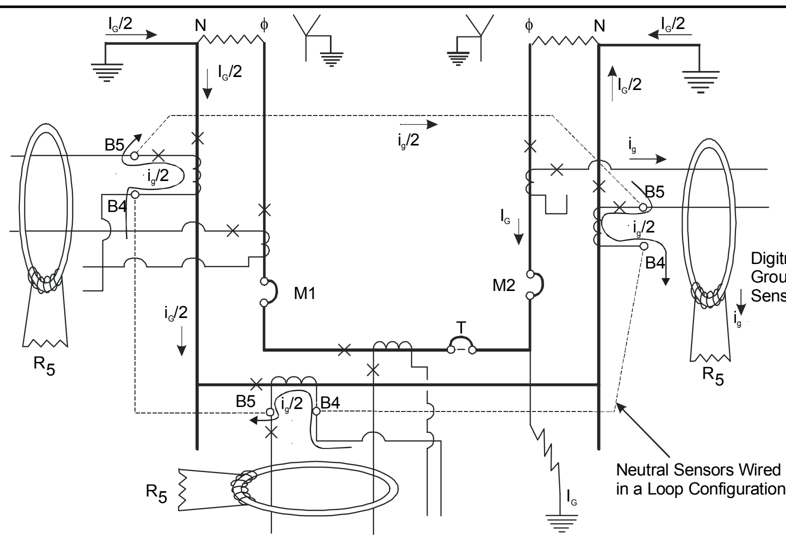
Notes:

① This scheme uses a large zero sequence CT to magnetically sum the currents and the output is sensed via element R_4.

② A jumper is required on B-6, B-7 to program the Digitrip to use element R_4.

③ The scheme is not applicable to 4-pole breakers.

Figure 2.8 Zero Sequence Sensing Scheme for 3200A Frame



Notes:

Breaker M2 trips since this is the only breaker seeing the I_G fault via element R_5 .

No jumper on B-6, B-7 terminals - all breakers are programmed for standard Residual Ground Fault protection.

AUX CTs not shown. Wiring needed at system level is shown as a dotted line.

Capital letters represent primary current. Lowercase letters represent secondary current.

The three breakers (M1, M2, and T) must all have the same breaker/sensor rating.

Figure 2.9 Multiple Source/Multiple Ground Scheme

3.2 Trip and Operation Indicators

The LEDs on the face of the trip unit, shown in Figures 1.1 and 3.2 to 3.4, 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 3.1. The LED pulse circuit, shown in Figure 3.1, is provided to reduce battery burden and will supply a quick flash of the trip LED approximately every 4 seconds. It is therefore important to view the unit for at least 5 seconds to detect a flashing cause of trip indicator.

Following a trip operation, push the Reset\Battery Test button, shown in Figure 1.1, to turn off the LEDs.

A green LED, shown in Figure 1.1, indicates the operational status of the trip unit. Once the load current through the circuit breaker exceeds approximately 10 percent (3 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.

3.3 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 x *I*n which correlates to approximately 11 x*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.

3.4 Zone Interlocking (520 family only)

⚠ CAUTION

IF ZONE INTERLOCKING IS NOT TO BE USED (I.E., ONLY STANDARD TIME-DELAY COORDINATION IS INTENDED), THE ZONE INTERLOCKING TERMINALS MUST BE CONNECTED BY A JUMPER FROM TERMINAL B8 TO B9 OF THE BREAKER SECONDARY TERMINALS SO THAT THE TIME-DELAY SETTINGS WILL PROVIDE THE INTENDED COORDINATION.

Zone Selective Interlocking (or Zone Interlocking) is available for the Digitrip 520 family on the Short Delay and Ground Fault protection functions (see Figure 3.1). 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 pick-up 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 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.

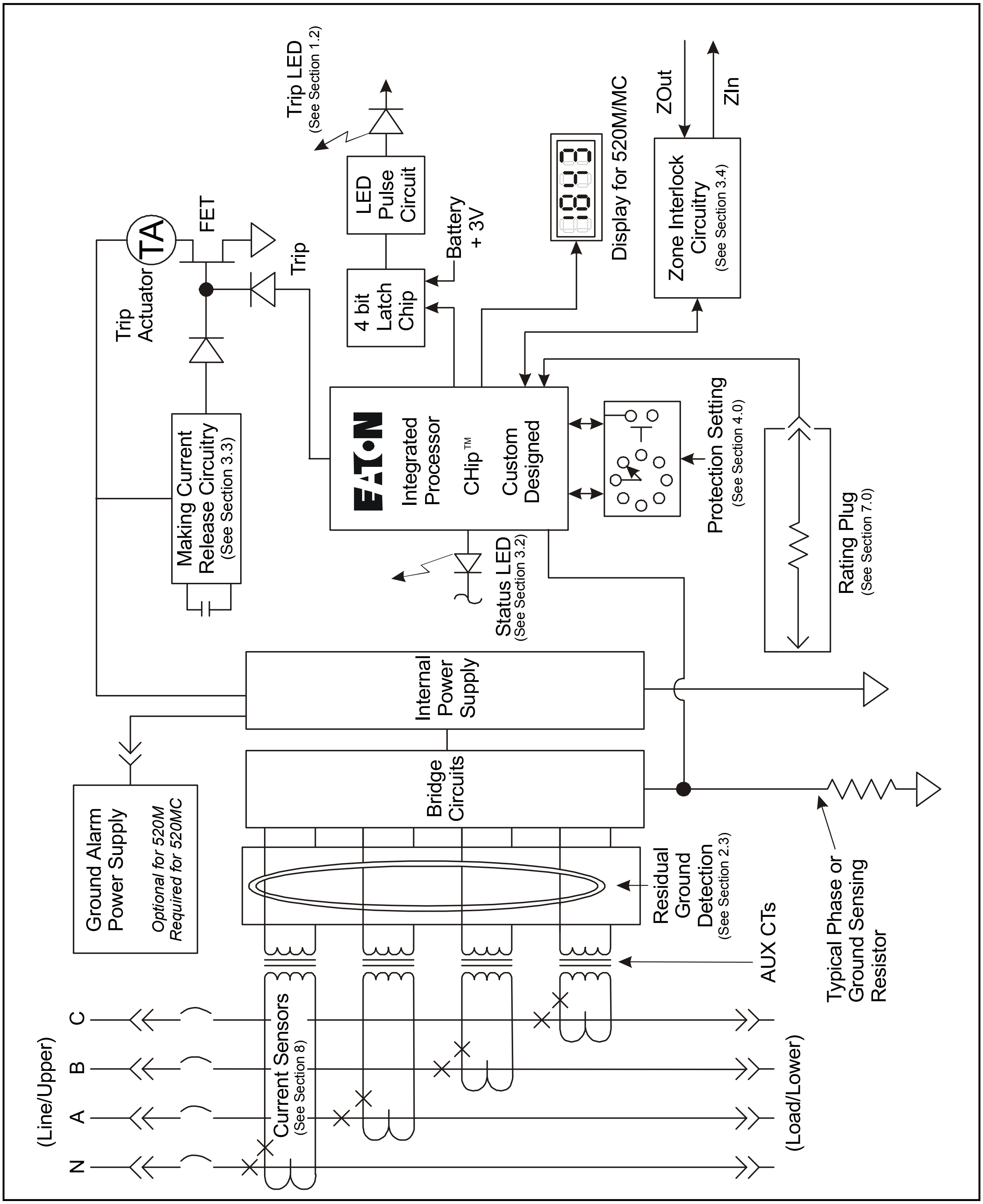


Figure 3.1 Block Diagram with Breaker Interface

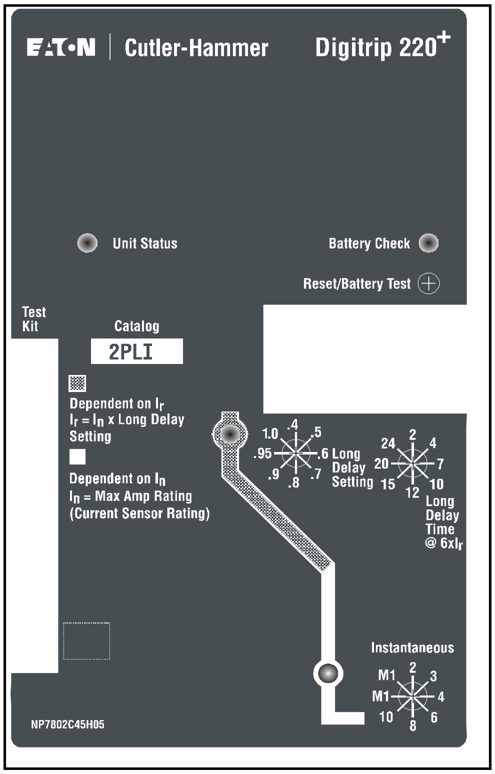


Figure 3.2.1 Digitrip 220 PLI

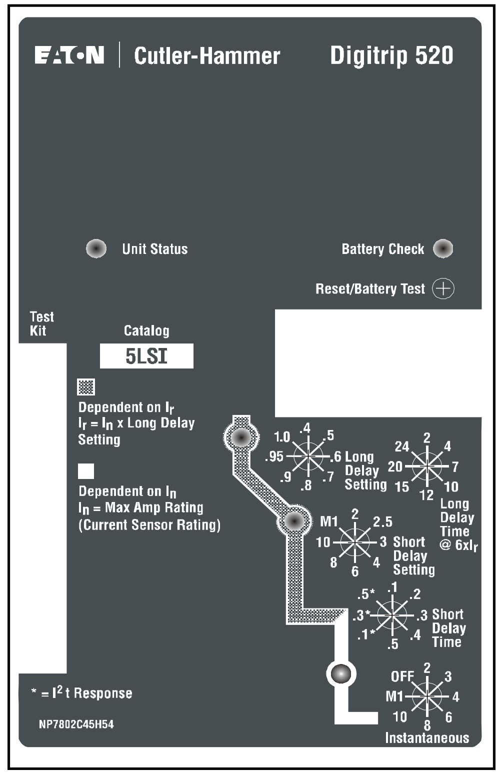


Figure 3.2.2 Digitrip 520 LSI

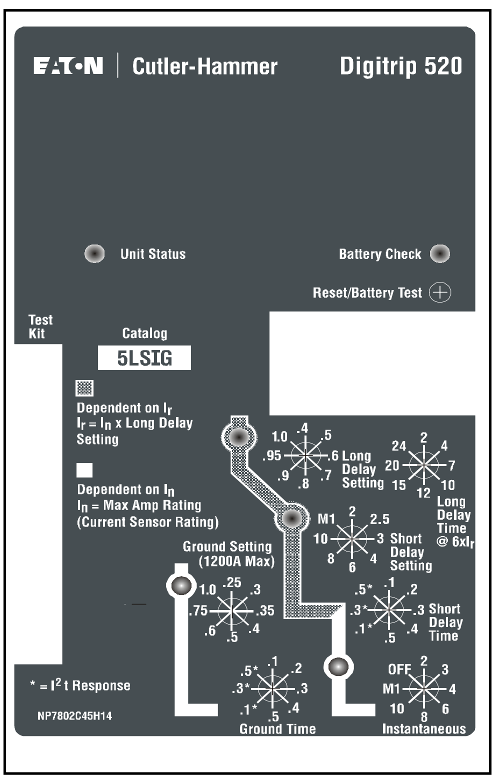


Figure 3.2.3 Digitrip 520 LSIG

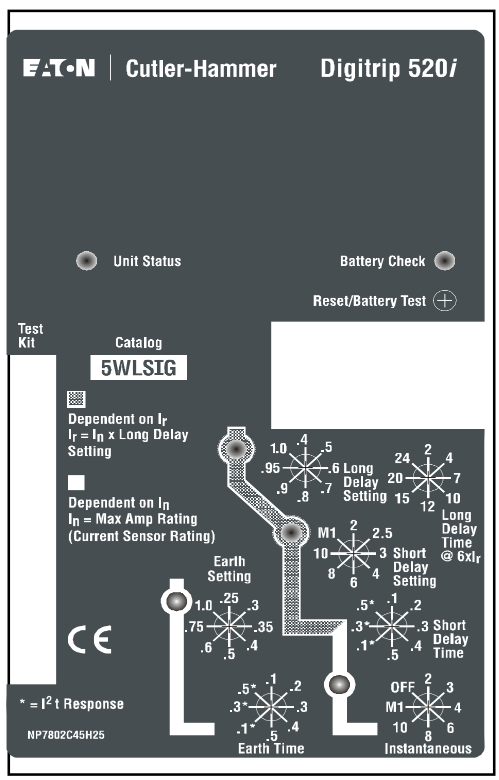


Figure 3.2.4 Digitrip 520i WLSIG

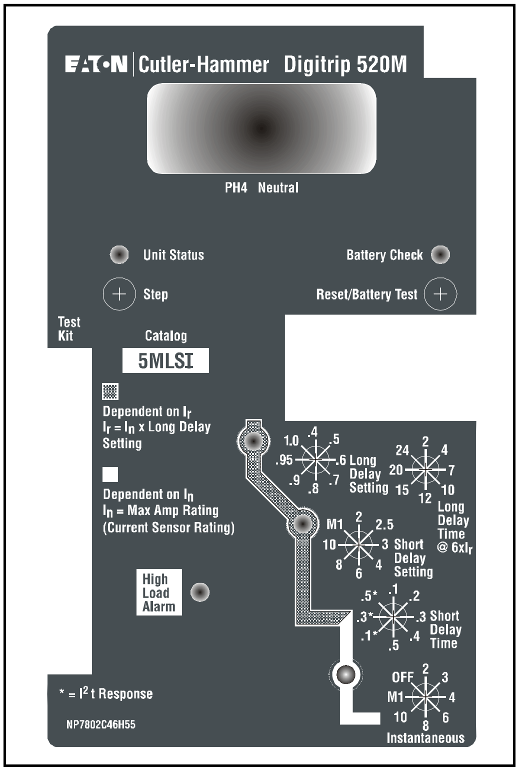


Figure 3.3.1 Digitrip 520M MLSI

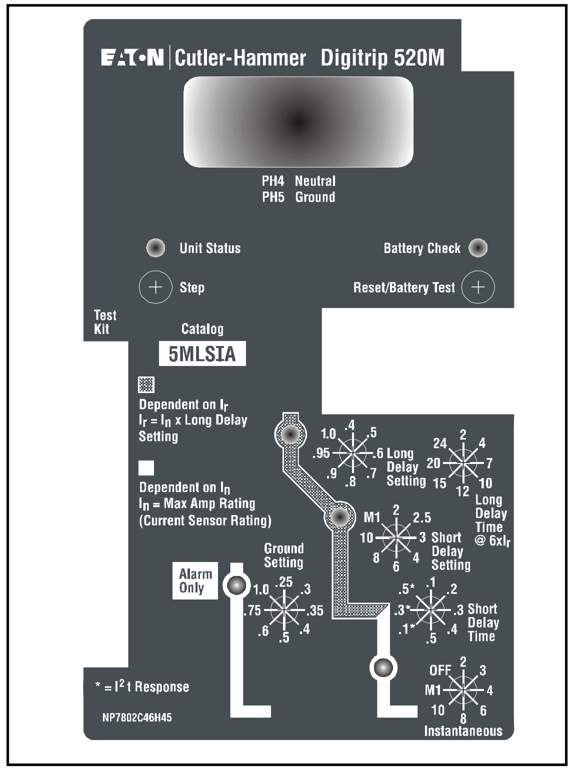


Figure 3.3.2 Digitrip 520M MLSIA

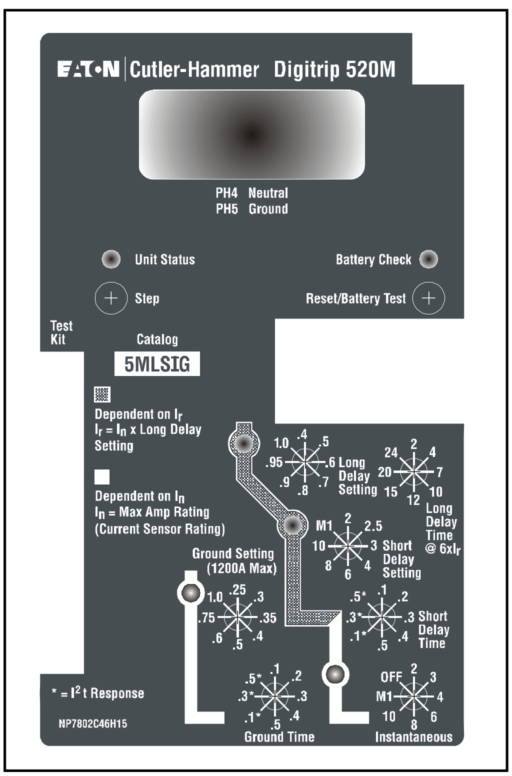


Figure 3.3.3 Digitrip 520M MLSIG

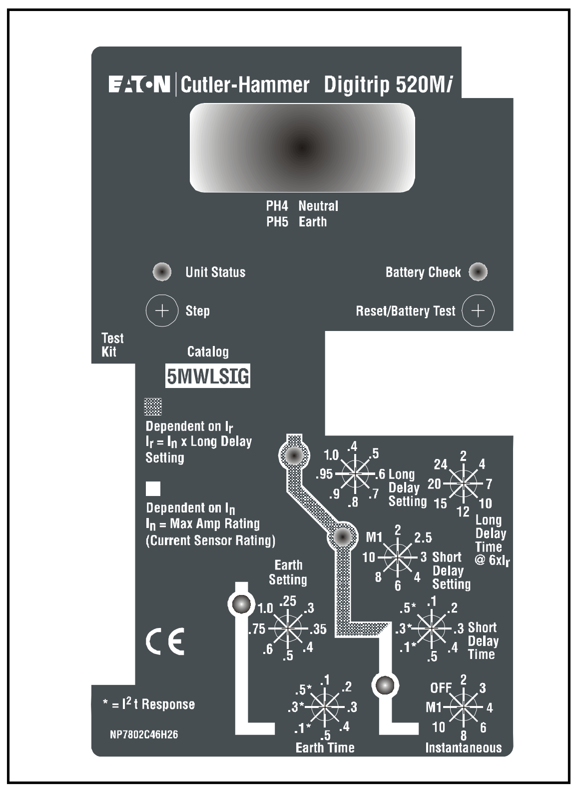


Figure 3.3.4 Digitrip 520Mi MWLSIG

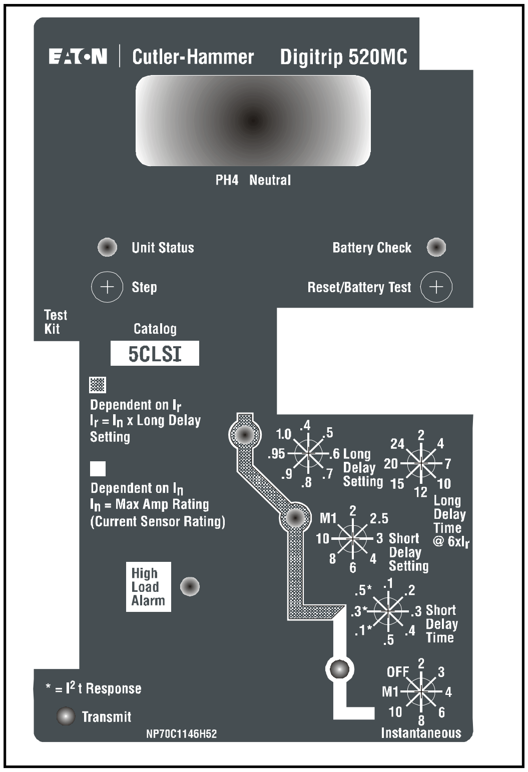


Figure 3.4.1 Digitrip 520MC CLSI

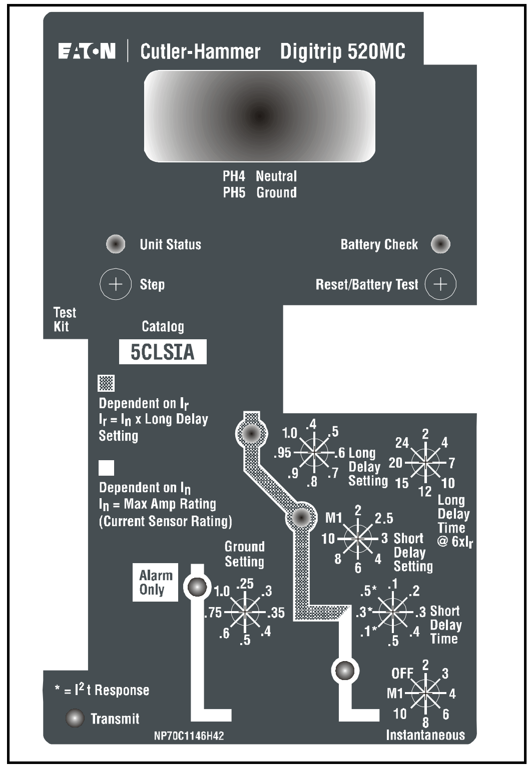


Figure 3.4.2 Digitrip 520MC CLSIA

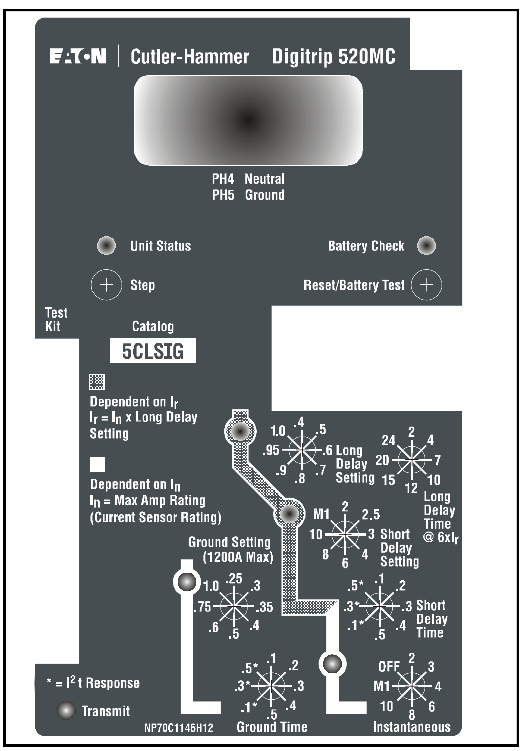


Figure 3.4.3 Digitrip 520MC CLSIG

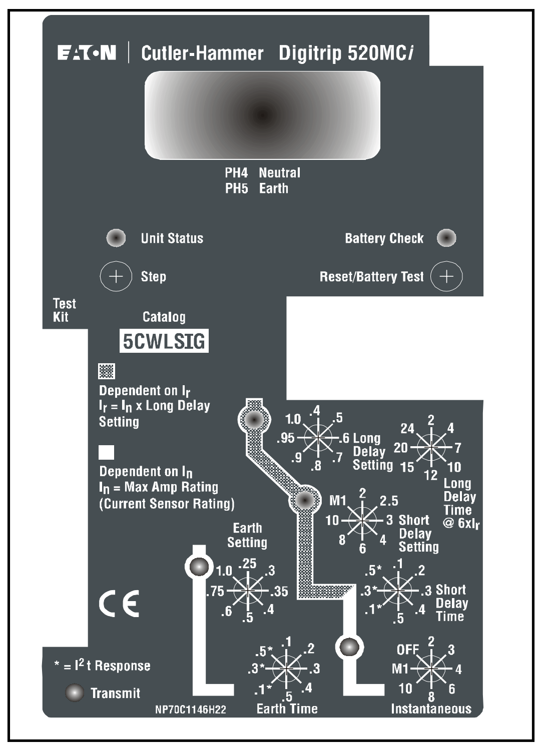


Figure 3.4.4 Digitrip 520MC CWLSIG

4.0 PROTECTION SETTINGS

4.1 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 Figures 3.2 through 3.4. 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 which 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 Figures 4.1 through 4.8. Sample settings are represented in boxes [2]

4.2 Long Delay Current Setting

There are eight available Long Delay Settings, as illustrated in Figure 4.1. Each setting, called (*I*r), is expressed as a multiple (ranging from .4 to 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 Section 4.4).*

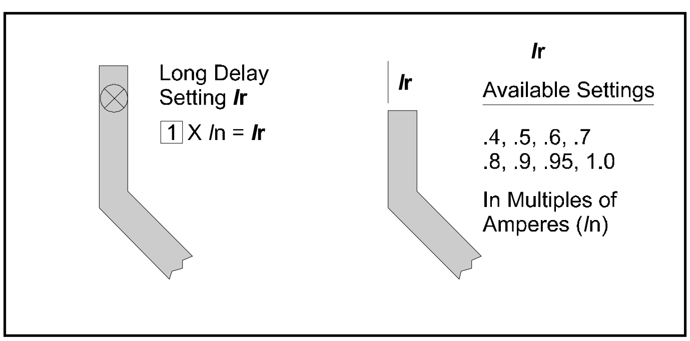


Figure 4.1 Long Delay Current Settings

4.3 Long Delay Time Setting

There are 8 available Long Delay Time Settings, as illustrated in Figure 4.2, ranging from 2 to 24 seconds. These settings are the total clearing times when the current value equals 6 times (*I*r).

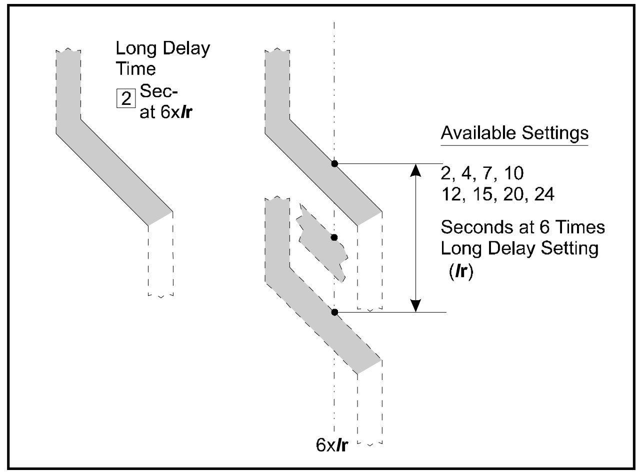


Figure 4.2 Long Delay Time Settings

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 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 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.

NOTE: 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 4.3) 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.)

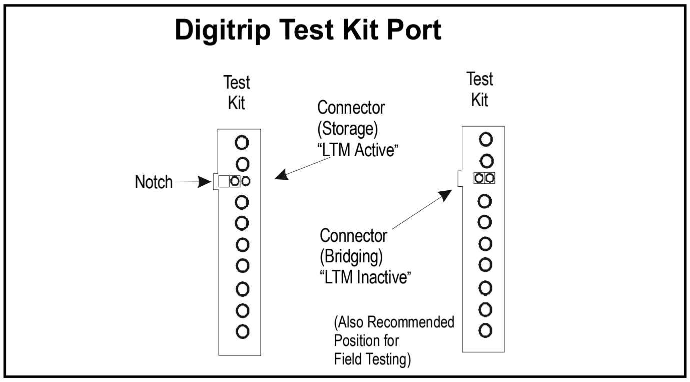


Figure 4.3 Long Time Memory (LTM) Jumper

The action of the LTM must be considered when performing multiple Long Delay Time tests *(See Section 5.4).*

4.4 Short Delay Current Setting

There are 8 available Short Delay Current Settings, as illustrated in Figure 4.4. Seven settings are in the range from 2 to 10 times (*I*r). (*REMEMBER:* (*I*r) *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 1.1.

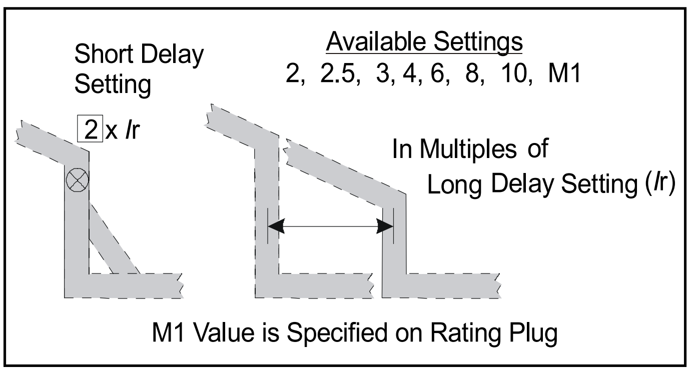


Figure 4.4 Short Delay Current Settings

4.5 Short Delay Time Setting

As illustrated in Figure 4.5, 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.

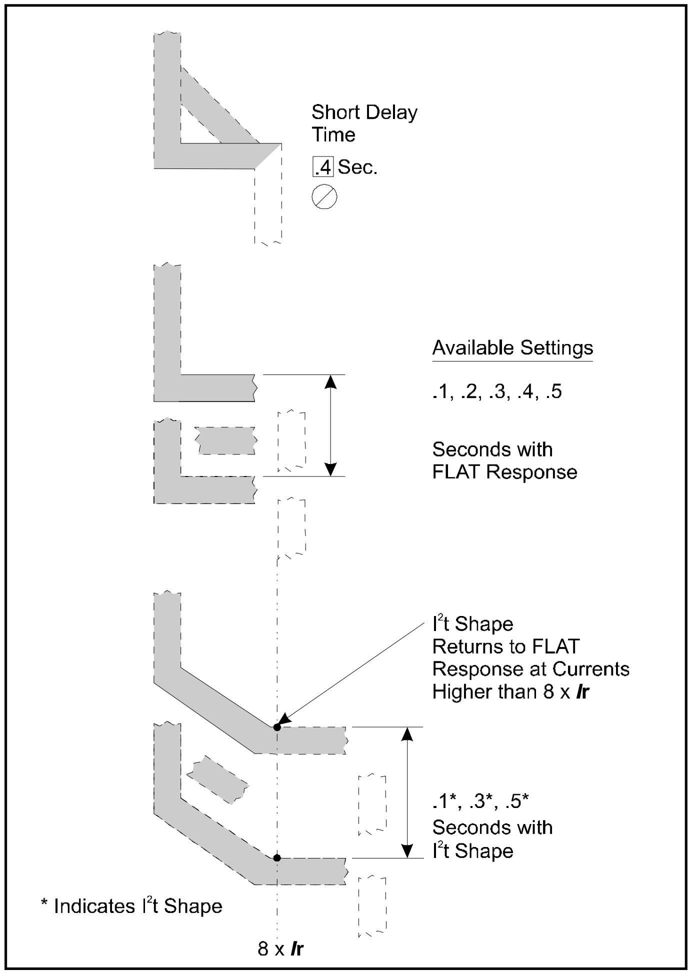


Figure 4.5 Short Delay Time Settings

Five FLAT (.1, .2, .3, .4, .5 seconds) and three I^2t (.1*, .3*, .5* seconds) response time delay settings are available. The I^2t response settings are identified by an asterisk (*). The I^2t response is applicable to currents less than 8 times the ampere rating of the installed rating plug (*I*r). For currents greater than 8 x (*I*r) the I^2t response reverts to the FLAT response.

NOTE: Also see Section 3.4, Zone Interlocking.

4.6 Instantaneous Current Setting

There are 8 available Instantaneous Current Settings, as illustrated in Figure 4.6. Six settings are in the range from 2 to 10 x (*I*n) the rating plug value, and the other two settings are M1 x (*I*n) 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.

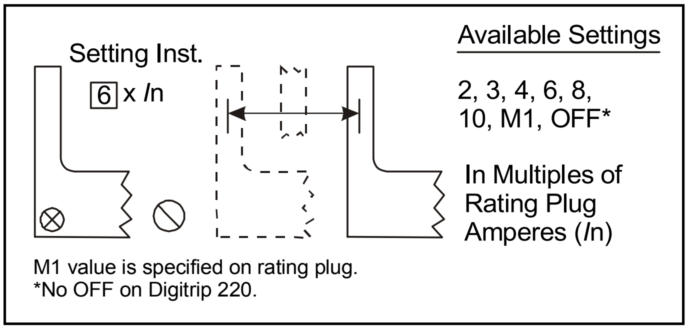


Figure 4.6 Instantaneous Current Settings

4.7 Ground Fault Current Setting

The 8 Ground Fault Current Settings are labeled with values from .25 to 1.0 x (*I*n) (see Figure 4.7). The domestic (U.S.) models have a maximum of 1200A, limited by the firmware of the unit, as shown in Table 1.1 and Table 2.2. The specific Ground Current Settings for each model are listed in Table 2.2 and on the applicable time-current curve for the breaker.

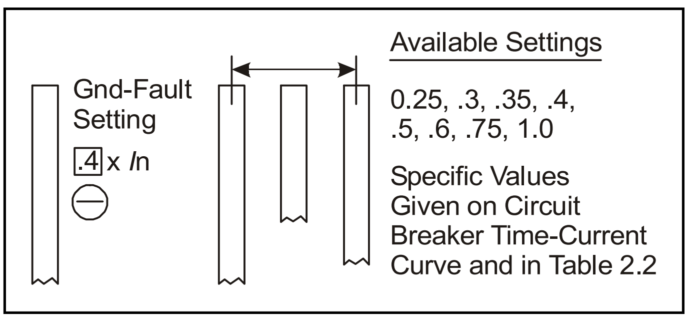


Figure 4.7 Ground Fault Current Settings

4.8 Ground Fault Time Delay Setting

As illustrated in Figure 4.8, 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.

Five FLAT (.1, .2, .3, .4, .5 seconds) and three I^2t (.1*, .3*, .5* seconds) response time delay settings are available. The I^2t response settings are identified by an asterisk (*). 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.

NOTE: Also see Section 3.4, Zone Interlocking.

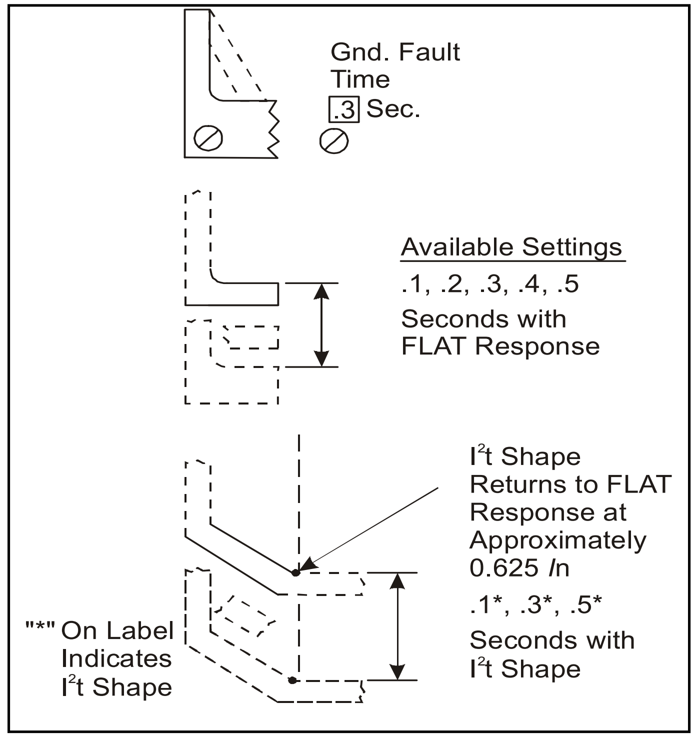


Figure 4.8 Ground Fault Time Delay Settings

4.9 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 through 999. The factory default address is 999 hex.

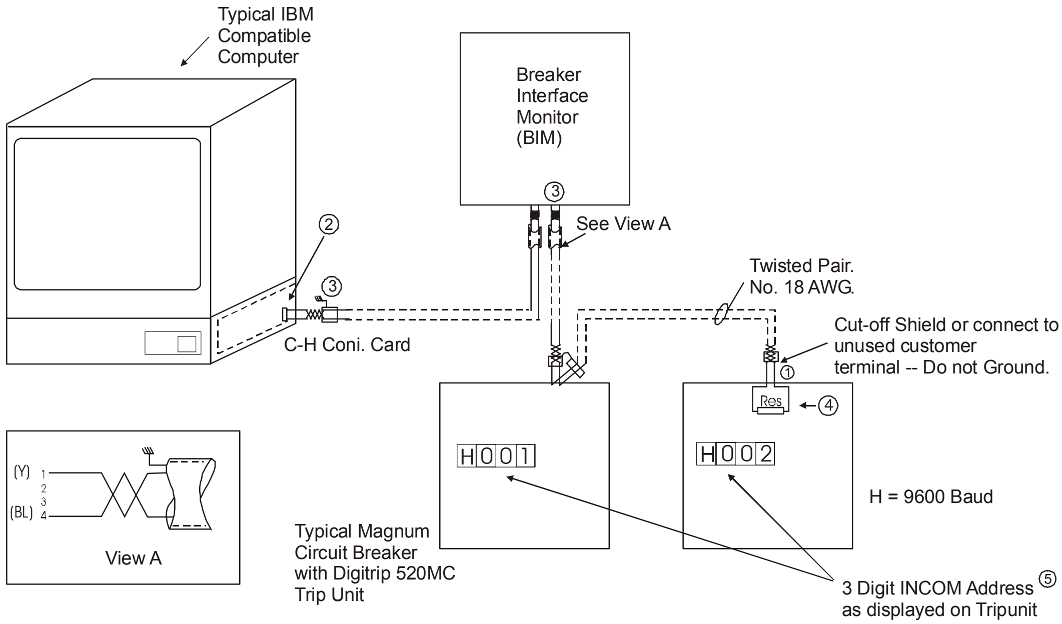
To set the desired address or to view the address, depress and hold the RESET/BATTERY TEST button for five seconds. Depress the STEP button to select a new address. Users may simultaneously depress and hold in the STEP and RESET/BATTERY TEST buttons for fast advance.

4.9.1 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 through 031.

4.9.2 Remote Master Computer

When desired, Digitrip 520MC Trip Units can communicate with a BIM or remote master computer (IBM PC compatible with Cutler Hammer Inc. CONI card or MINT) and using PowerNet communication software version 3.20 or greater. (See Figure 4.9 for typical wiring.)



Notes:

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 4.9 for programming INCOM function.

Figure 4.9 INCOM Network with Remote Master Computer or BIM

4.9.3 INCOM Network Interconnections

INCOM sends bursts of data on a 92 to 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 1.1 when transmitting on INCOM.

Recommended cable specifications:

- Cutler-Hammer Inc. 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 over-current 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.

5.0 TEST PROCEDURES

5.1 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.

WARNING

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

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.

5.2 When to Test

Testing prior to start-up 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.

5.3 Functional Field Testing

CAUTION

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

5.3.1 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 Cutler-Hammer-approved test kit is listed below.

Model	Test Kit
Digitrip 520 family	Test Kit (140D481G02R, 140D481G02RR, 140D481G03, or G04) with Test Kit Adapter 8779C02G04

The test port is located on the front left-hand corner of the trip unit *(See Figure 1.1)*. 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

BEFORE PLUGGING A TEST KIT INTO THE TEST PORT, PLACE THE LTM JUMPER IN THE INACTIVE POSITION (SEE FIGURE 4.3). AFTER TESTING, RETURN THE LTM JUMPER TO ITS ORIGINAL POSITION.

The test kit authorized by Cutler-Hammer 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.

5.3.2 Functional Test Kit (handheld)

5.3.2.1 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 5.1).* The test currents are not adjustable for this test kit.

The Style number of this device is # 70C1056

5.3.2.2 Test Procedure

Complete procedural instructions for the Cutler Hammer Functional Test Kit can be found in I.L. # 5721B13 which is packaged which is packaged with each test kit.

Figure 5.1 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.

5.3.2.3 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 (Ir) current value and the response of the Digitrip unit.

5.3.2.4 Batteries

The Functional Test Kit contains a total of seven 9-Volt 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 life span 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.

LED's 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 six-pack (Battery B), replace all batteries at the same time using standard 9V alkaline batteries.

5.4 Performance Testing for Ground Fault Trip Units - Primary Injection

5.4.1 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.

5.4.2 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 *(Section 5.4.3)*, plus a copy of the record forms *(Figures 8.1, 8.2, and 8.3),* are included as part of this Instructional Leaflet.

5.4.3 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

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.

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 Digitrip unit pick-up 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 5.2).*

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.

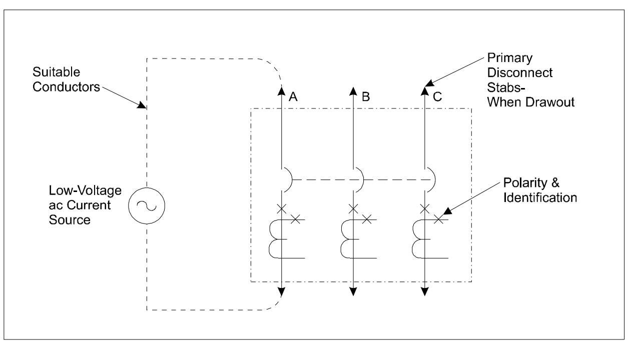


Figure 5.2 Connection Details for Conducting Single Pole, Single Phase Current Tests with the Breaker Removed from the Cell

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 5.3)* or through a breaker pole and the neutral that employs a neutral sensor .

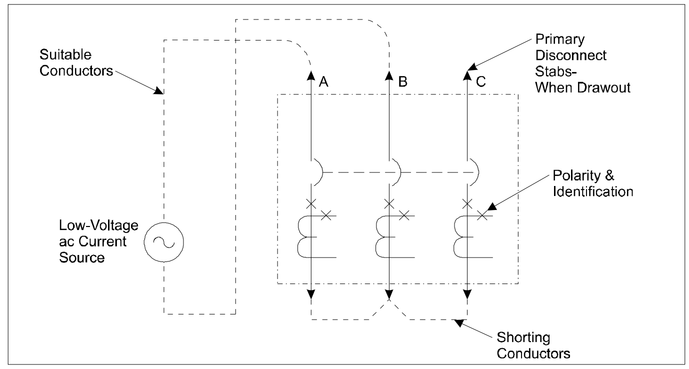


Figure 5.3 Connection Details for Conducting Single Phase Current Tests with the Breaker Removed from the Cell

An alternative test setup is shown in Fig. 5.4. 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 Aux 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.

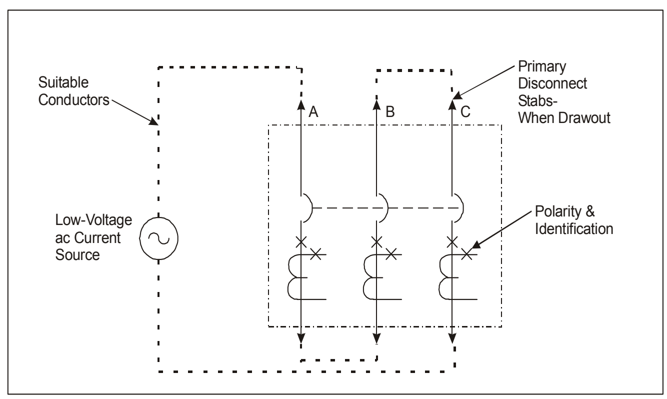


Figure 5.4 Alternate Connection Details using three poles to develope a Ground Fault Condition.

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 8.3).*

6.0 TRIP UNIT BATTERY

6.1 General

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

As indicated in Figure 3.1, 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 6.1) This will activate the battery. Check the battery status by depressing the battery test pushbutton.

6.2 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 3.1).

6.3 Battery Installation and Removal

The 3-volt lithium cell battery *(See Figure 6.1)* 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.

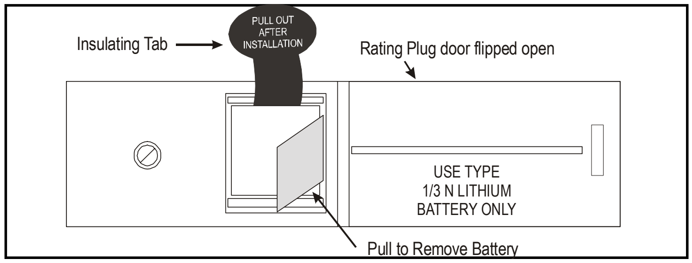


Figure 6.1 Digitrip Battery

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 3.0 volt lithium batteries may be obtained from the following companies:

Company	Model
VARTA Batteries, Inc. 300 Elmsford Boulevard Elmsford, N.Y. 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

7.0 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 Sections 4.6 and 4.7).

2. The Long Delay Current Setting, (*I*r), is a fractional multiple of (*I*n): Long Delay Current Setting = (*I*r) = LD x (*I*n) (see Section 4.2).

3. The Short Delay Current Setting is a multiple of (*I*r): Short Delay Current Setting = SD x (*I*r) = SD x [LD x (*I*n)] (see Section 4.4).

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.

8.0 RECORD KEEPING

Use the forms shown in Figures 8.1 and 8.2 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 8.3 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.

9.0 REFERENCES

9.1 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

9.2 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.

70C1009	Digitrip 220 (LI) Curve
70C1295	Digitrip 220+ (L) Curve
70C1296	Digitrip 220+ (I) Curve
70C1006	Digitrip 520 (LS) Curve
70C1007	Digitrip 520 (I) Curve
70C1008	Digitrip 520 (G) Curve

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		X
Long Delay		*I*n		Sec.
Short Delay		*I*r		Sec.
Ground Fault		*I*n		Sec.
Date ________________		By ________________		

Figure 8.1 Typical Trip Function Record Nameplate

DIGITRIP

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 8.2 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 8.3 Typical Performance Test Record Form

NOTICE

THE PROVISION FOR ZONE INTERLOCKING IS STANDARD ON MAGNUM CIRCUIT BREAKERS WITH DIGITRIP 520 FAMILY TRIP UNITS FOR SHORT TIME AND GROUND FAULT FUNCTIONS. THE APPROPRIATE JUMPER TO TERMINAL B8 AND B9 MUST BE ADDED ON THE BREAKER IF ZONE INTERLOCKING IS NOT DESIRED OR IF FIELD TESTING IS DESIRED.

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 2000 Amperes occurs and refer to Figure A.1.

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 2000 Amperes occurs and refer to Figure A.1.

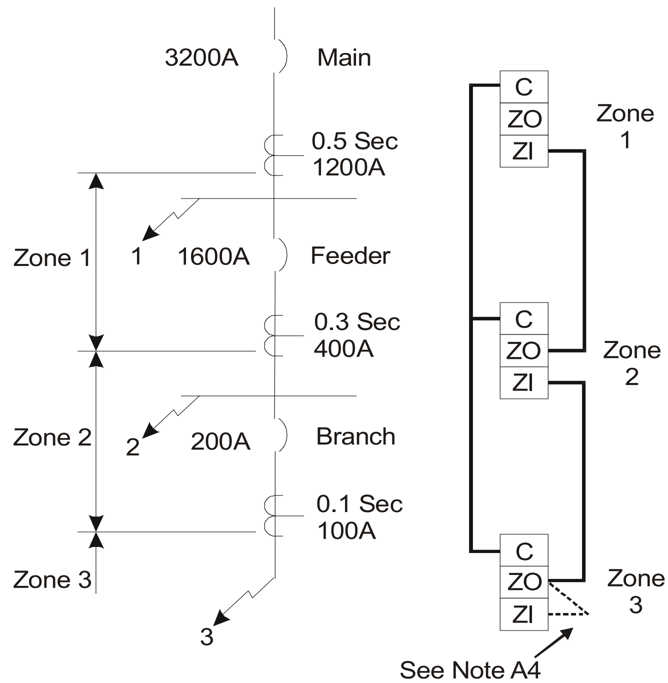
Fault at location 3
The branch breaker trip unit will initiate the trip in 0.045 seconds to clear the fault and the branch will send a restraint signal to the feeder trip unit; the feeder will send a restraint interlocking signal to Z1.

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 seconds (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 A.2 presents a Zone Selective Interlocking connection diagram for a system with two main breakers from incoming sources and a bus tie breaker. Note that 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.



Notes:

A1: Wiring to be twisted pair of AWG #14 to #20. Route Zone Interlocking wiring separate from power conductors. DO NOT GROUND any Zone Interlocking wiring.

A2: The maximum distance between two farthest breakers on different zones (from the ZO downstream to ZI upstream terminals) is 250 feet (76m).

A3: A maximum of 20 breakers may be contained in parallel in one zone.

A4: Provide a self interlocking jumper (on Zone 3) if coordination is desired with other downstream breakers not providing the zone interlock feature.

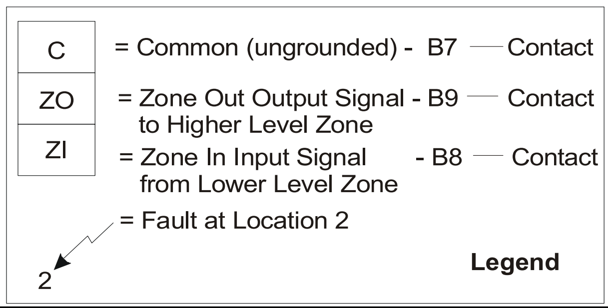


Figure A.1 Typical Zone Interlocking

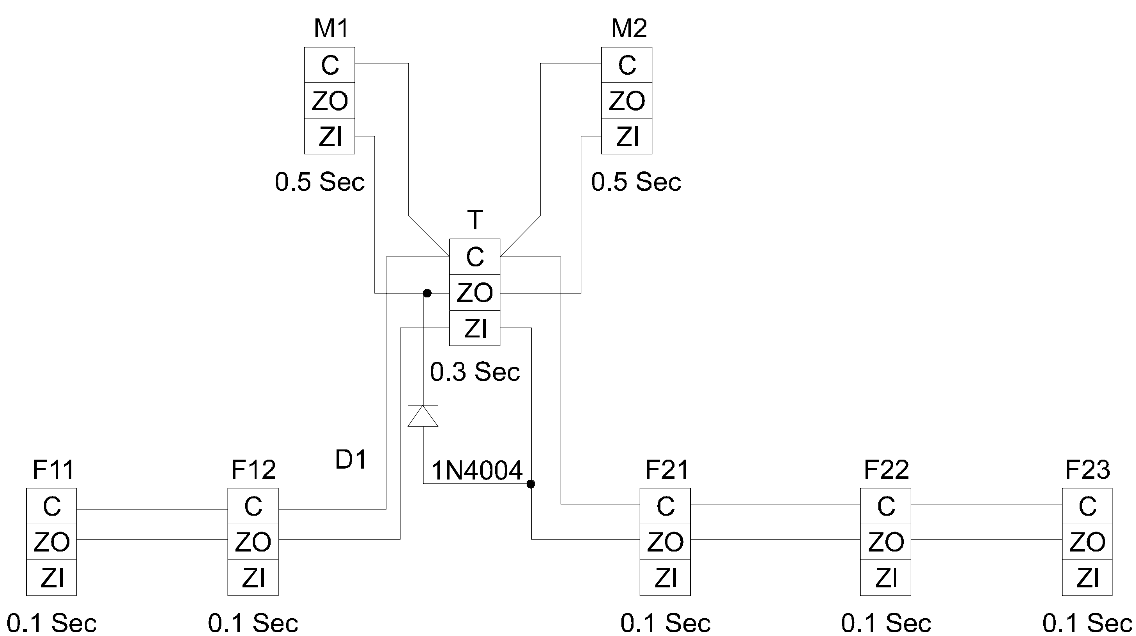


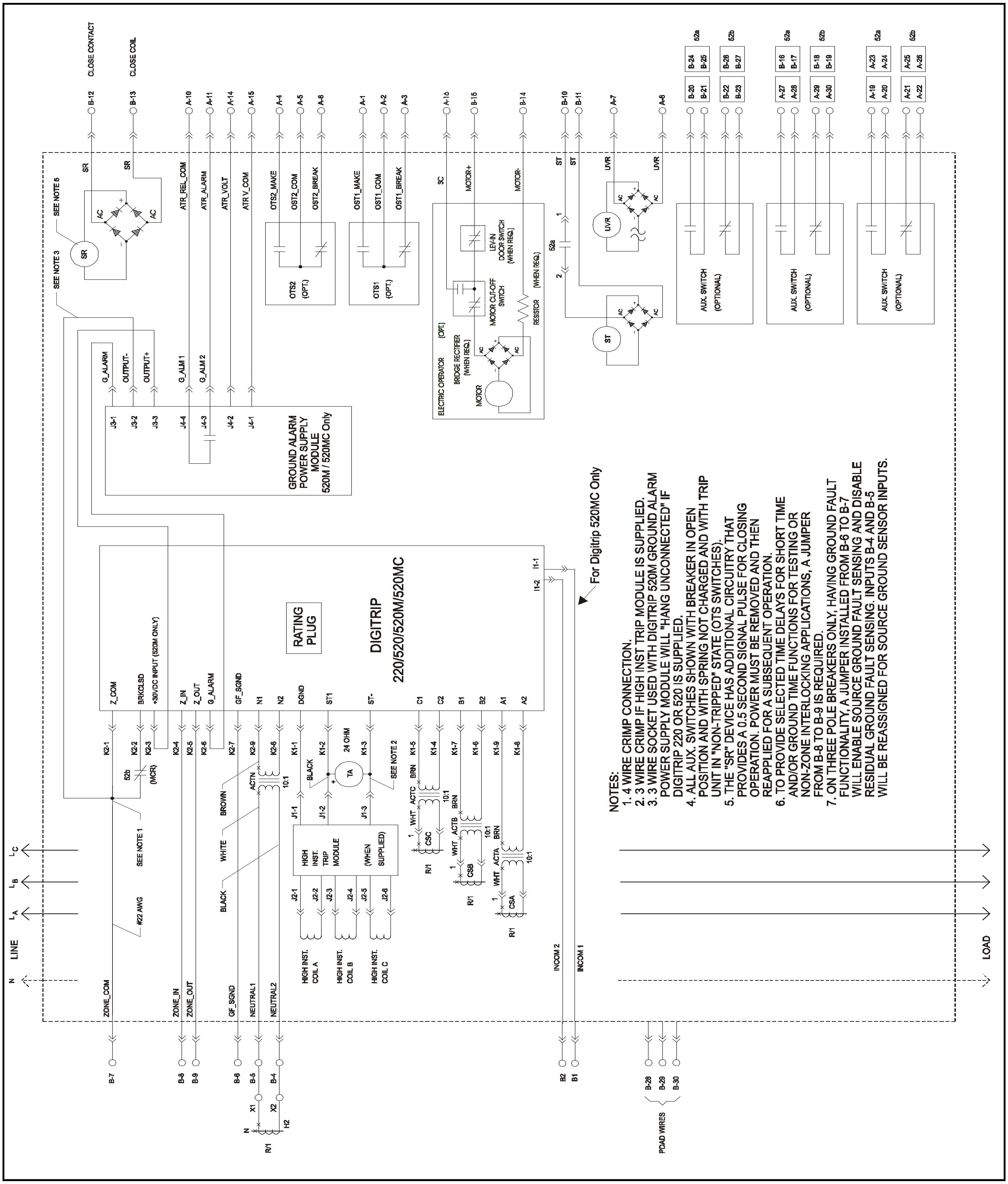
Figure A.2 Typical Zone Interlocking Connections with Two Main Breakers (M1, M2) and a Tie Breaker (T)

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 3.2 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 4-wire residual systems, the neutral current sensor may not have the correct ratio or be properly connected.	Check connections at terminals B4 and B5. 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 B6, B7 for correct programming of jumper.	See Section 2.3, 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 3.4
Breaker trips too rapidly on ground fault or short delay (Zone Selective Interlocking not used).	Connection from Zout to Zin is missing.	Make connections B8 to B9.	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 delay.	Long Time Memory function.	Disable Long Time Memory.	Refer to Section 4.3.
	Trip unit settings are not correct.	Change settings. Long Time Delay setting is based on 6×*I*r.	

Symptom	Probable Cause	Possible Solution(s)	References
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 6.2
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 Aux Power and then depress Reset pushbutton to fully clear trip buffer.	See also Note in Section 5.3.2.2
LCD Display is not energized.	Light load.	Check breaker ordering information.	Refer to Sections 1.6 and 1.6.1
	No auxiliary power unit.	Check voltage input terminals A14 – A15.	Refer to Sections 1.6 and 1.6.1
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 4.9
	No Power	Check for Aux. Power – A14, A15	See Figure 1.1 and Refer to Section 1.6
		Check Status LED and Transmit LED	
	Hardware Problem	Check Communications Wiring – B1, B2	See Appendix C
		Missing Termination Resistor	See Figure 4.9

Appendix C Typical Breaker Master Connection Diagram

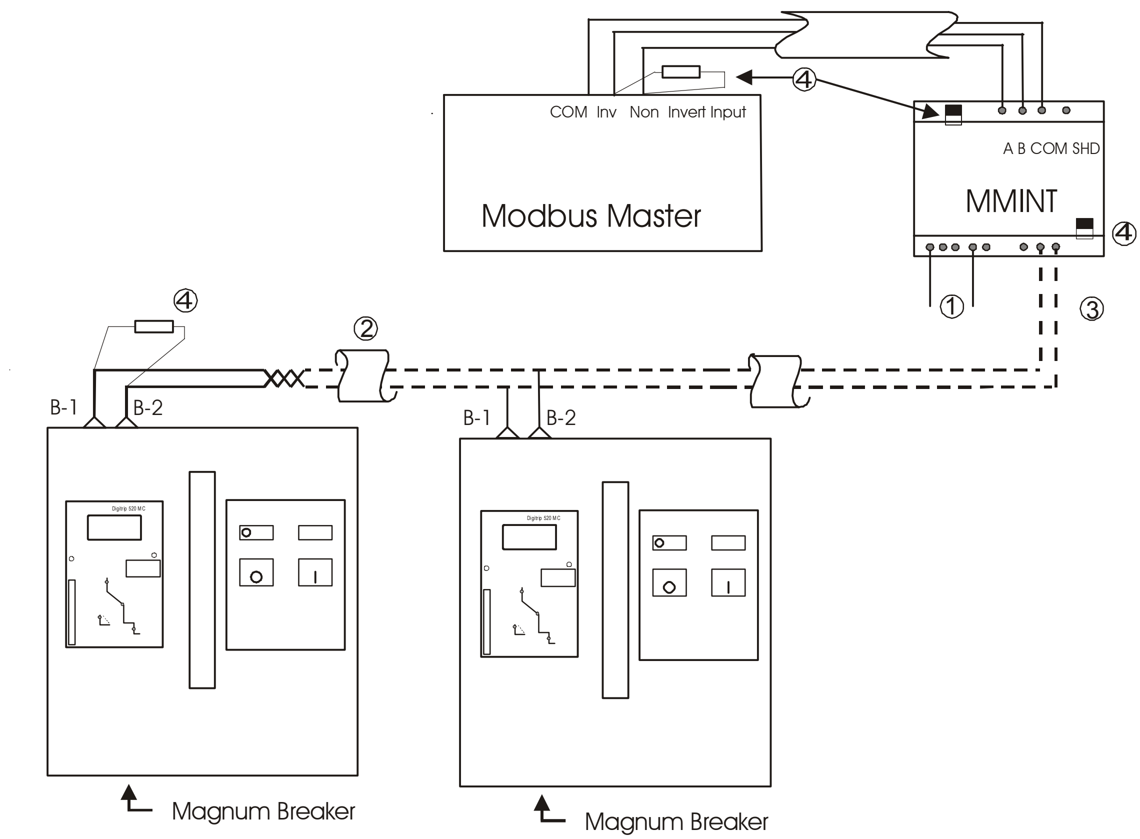


Appendix D MODBUS TRANSLATOR Wiring

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 communicationto MODBUS communications. A Modbus master device is shown wired to gather data.

The mMINT module CAT # MMINT use 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 which consist 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.



Notes:
① Control voltage is 120 VAC ± 20% or 48 - 125VDC.
② Communication Cable is C-H style 2A957805G01 or Belden 9463 cable.
③ The overall network will support up to 32 devices with any addresses from 1 to 247
④ Terminating resistor is 121 ohm 1 watt. Use the mMINT switches to insert these terminators at the mMINT device.

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