Instructions for Digitrip Models 520V and 520MCV for use only in Cutler-Hammer Type VCP-T, VCP-TR and T-VAC, T-VACR 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.

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.

NOTE: If you have any questions or need additional information or instructions concerning the operation or installation of this device, please contact your local representative or the Cutler Hammer Customer Support Center.

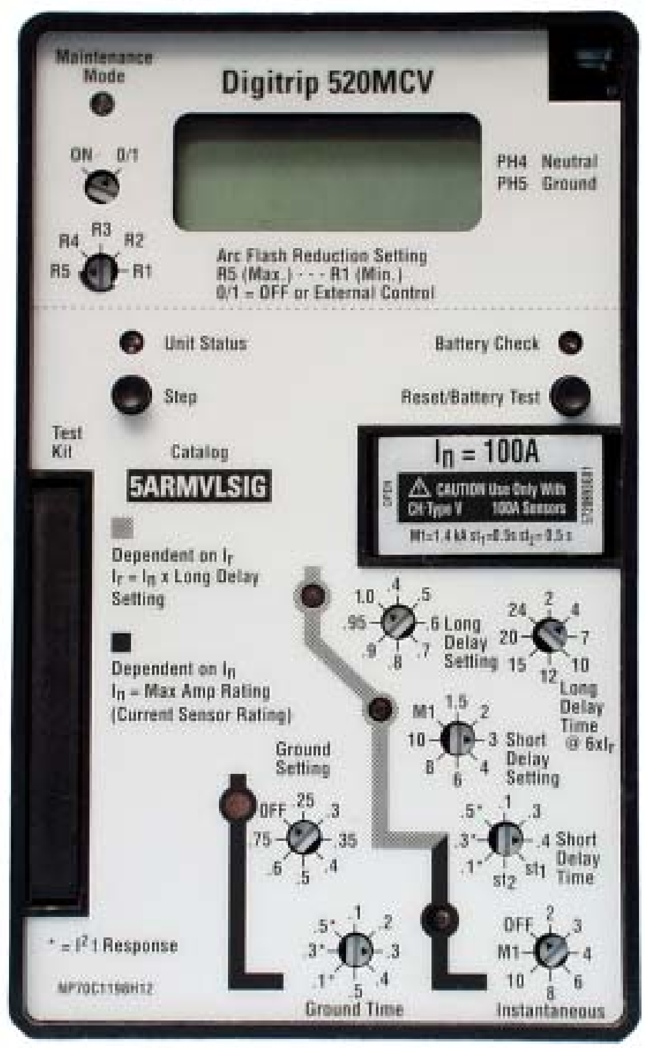


Figure 1.1 Digitrip Trip Unit with Rating Plug

1.0 GENERAL DESCRIPTION OF DIGITRIP TRIP UNITS

The Digitrip Trip Unit is a breaker subsystem that provides the protective functions for a circuit breaker. The trip units are in removable housings, installed in the circuit breaker, and can be replaced or upgraded in the field by the customer.

This instruction book specifically covers the application of the Digitrip Trip Units *(See Figure 1.1)* installed in Type VCP-T, VCP-TR, T-VAC or T-VACR Medium Voltage Circuit Breakers.

The Digitrip 520V and 520MCV trip units may be applied on both 50 and 60 Hertz systems. It detects the power and frequency and adjusts itself automatically.

The Digitrip 520V and 520MCV are self powered and self protecting trip units designed to function only with the associated CH Type-V current sensors.

CAUTION

CONNECTING THIS TRIP UNIT TO CURRENT SENSORS OTHER THAN CH TYPE-V MIGHT DAMAGE OR DESTROY IT.

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 this Digitrip trip unit is circuit protection. The Digitrip analyzes the secondary current signals from the CH Type-V 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, causing it to "open."

In addition to the basic protection function, the Digitrip 520V and 520MCV provide modes of trip indication such as:

- Long Time trip (overload)
- Short Time trip
- Instantaneous trip
- Ground (Earth) Fault trip

The CH Type-V current sensors provide the power to the trip unit. As current begins to flow through the breaker, the sensors generate a secondary current which powers the trip unit. No auxilary power is needed to trip the circuit breaker.

The Digitrip 520V and 520MCV trip units have 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 necessary. 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. The user chooses the settings according to the needs of his application. *(See Sections 4.0 & 9.2)*

1.1 Protection

The Digitrip trip system; including associated CH Type-V current sensors, require no external control power to operate their protection systems. They operate from current signal levels derived through the CH Type-V current sensors.

1.2 Mode of Trip and Status Information

A green light emitting diode (LED), labeled *Unit Status* in Figure 1.1, blinks approximately once each second to indicate that the trip unit is operating normally. This *Unit Status* LED will also blink at a faster rate if the Digitrip is in a "Long Pick-up" (overload) mode.

Four red LEDs on the face of the trip units flash to indicate the cause of trip for an automatic trip operation... i.e.: Long Delay (overload), Short Delay, Instantaneous or Ground (Earth) Fault. A battery, inside the rating plug compartment of the Digitrip unit, maintains the trip indication until the *Reset/Battery Test* button is pushed. The battery is satisfactory if its *Battery Check* LED lights green when the *Battery Check* button is pushed *(See Section 6).*

NOTE: The Digitrip unit provides all protection functions independant of the status of the battery. The battery is used only 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 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 Installation of the Rating Plug

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

WARNING

DO NOT CLOSE THE CIRCUIT BREAKER WHEN THE DIGITRIP IS REMOVED OR DISCONNECTED. DAMAGE TO ASSOCIATED CURRENT TRANSFORMERS MAY OCCUR DUE TO AN OPEN CIRCUIT CONDITION. THERE IS NO PROTECTION FOR THE LOAD CIRCUIT.

CAUTION

IF A RATING PLUG IS NOT INSTALLED IN THE TRIP UNIT, THE UNIT WILL INITIATE A TRIP WHEN IT IS ENERGIZED. IN ADDITION THE INSTANTANEOUS LED OF THE DIGITRIP TRIP UNIT WILL LIGHT DUE TO A MISSING OR BAD RATING PLUG.

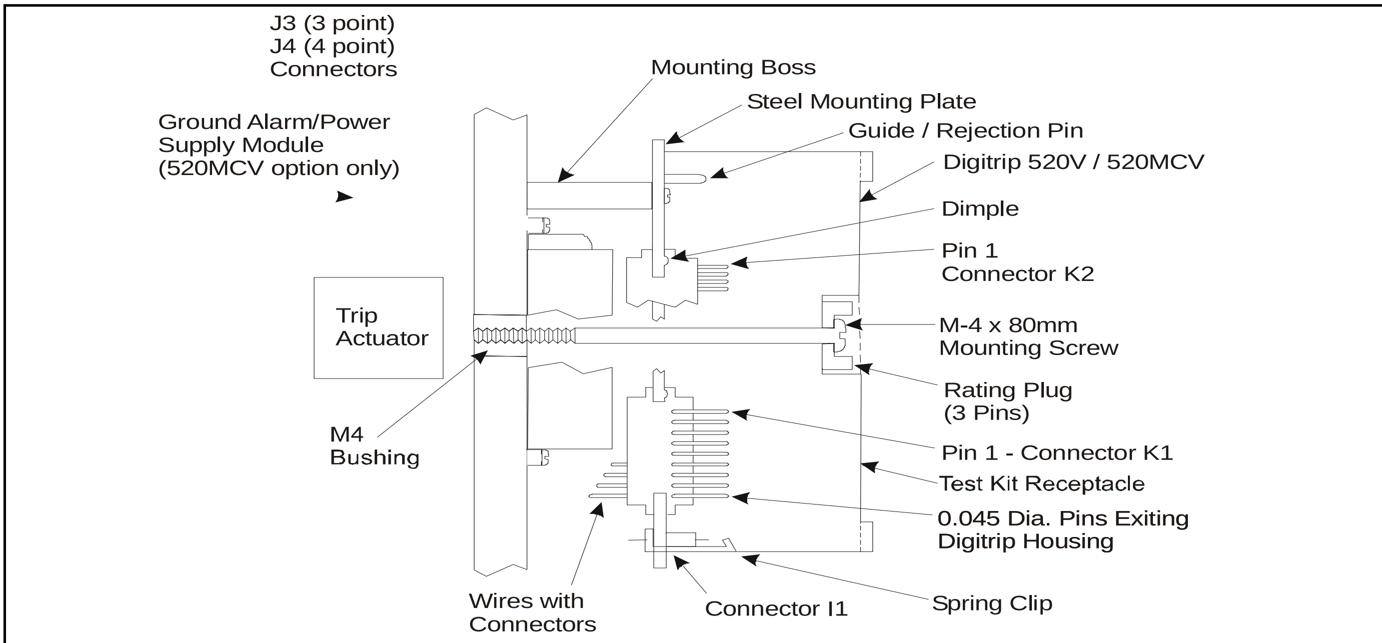


Figure 1.2 Installation of the Digitrip Unit into Breaker (Side View)

⚠ 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" (3mm) WIDE SCREWDRIVER BLADE IS ADEQUATE.

1.3.3 Trip Unit/Rating Plug Removal

To remove the rating plug from the trip unit, make sure the circuit breaker is open. Now open the left side of the rating plug door. Use a 1/8" (3mm) wide screwdriver to loosen and remove the M4x80mm mounting screw. Pull the rating plug from the trip unit.

To remove the trip unit from the circuit breaker, remove the breaker cover screws using a 10mm driver. Deflect the spring clip under the trip unit to release the unit from the steel mounting plate. Pull the unit straight forward to disengage the two 9-pin connectors from the circuit breaker control circuit. *(See Figure 1.2)*.

⚠ CAUTION

DO NOT FORCE THE RATING PLUG INTO THE CAVITY. USE A 1/8" (3MM) 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.

Figure 1.3 Installating the Rating Plug & Mounting Screw

1.4 Installing the CH Type-V Current Sensors

The internal components of the circuit breaker, and how they are wired out to the breaker secondary contacts are shown in Figures 1.4, 1.5, 1.6 and 2.3. Also refer to the master connection diagram provided in Appendix C.

1.4.1 Installation Procedure

The CH Type-V Current Sensors/Rating Plug Kit supplied with this breaker must be installed and wired by the user. The installation steps are as follows:

a. PRIMARY - Mount one CH Type-V current sensor on the insulated bushing behind the circuit breaker. The bushing must be rated for the system Lightning Impulse Withstand Voltage (LIWV), and the ground (earth) shield terminal or ground (earth) shield surface must be connected to the ground (earth) bus. Confirm that the polarity mark (red dot) on the front of the current sensor faces the circuit breaker.

b. SECONDARY - Connect secondary terminals of the current sensor to the correct terminals in the switchgear control circuit using #14 AWG Type SIS wire. Terminal X1 is the one nearest to the polarity mark. Refer to Appendix C for distinction between Fixed and Drawout variations. Consult manufacturer if length of wire to device exceeds 12 feet (3.7m).

c. Use ring terminals on current sensor terminals. Use AMP #66598-2 female sockets to connect to breaker's secondary connector.

d. Ground (Earth) the non polarity terminal of each sensor. Also Ground the bushing shield surfaces.

e. Install rating plug into the Digitrip 520V and 520MCV trip units for the matching CH Type-V current sensors. Also attach the additional rating plug label to the circuit breaker enclosure as a future reference indicating which CH Type-V current sensors used in this application.

1.4.2 CH Type-V Current Sensor Functionality

The three CH Type-V current sensors are installed external to the circuit breaker over the main circuit conductors by means of bushings equipped with a ground shield. The current sensor rating defines the breaker rating (*I*n)... i.e. 1200A:1A sensors are used on a 1200A rated breaker. There are four auxiliary current transformers with a ratio of 10:1 which further step down the rated current to 100 milli-amperes, which is equivalent to 100% (*I*n) to the Digitrip.

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

If the CH Type-V current sensors and circuit breaker enclosure label are changed to a different ratio, the rating plug must also be changed. The associated rating plug <u>must</u> match the current sensors installed and as specified on the circuit breaker enclosure label. Refer to Figure 2.3 for CH Type-V current sensors available.

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 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 *Reset/Battery Test* push button.

1.6 Ground Alarm/Power Supply Module *(520MCV Models Only)*

The Ground Alarm/Power Supply Module *(See Figure 1.7)* is a required accessory to enable communications on the Digitrip 520MCV model. 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 125VDC (7802C8213). The burden of the Power/Relay Module is 10VA.

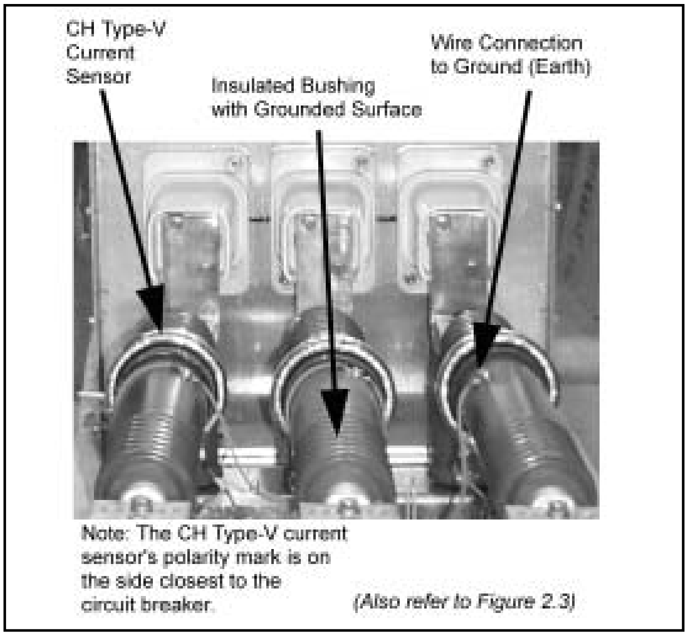


Figure 1.4 CH Type-V Current Sensor Installation

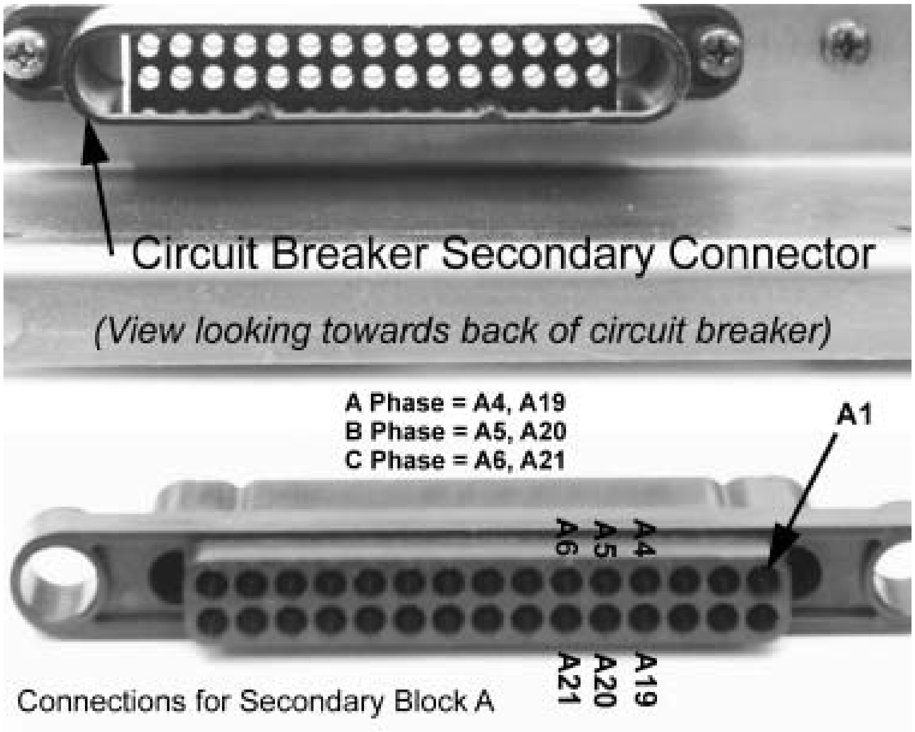


Figure 1.5 Secondary Block "A" Connections

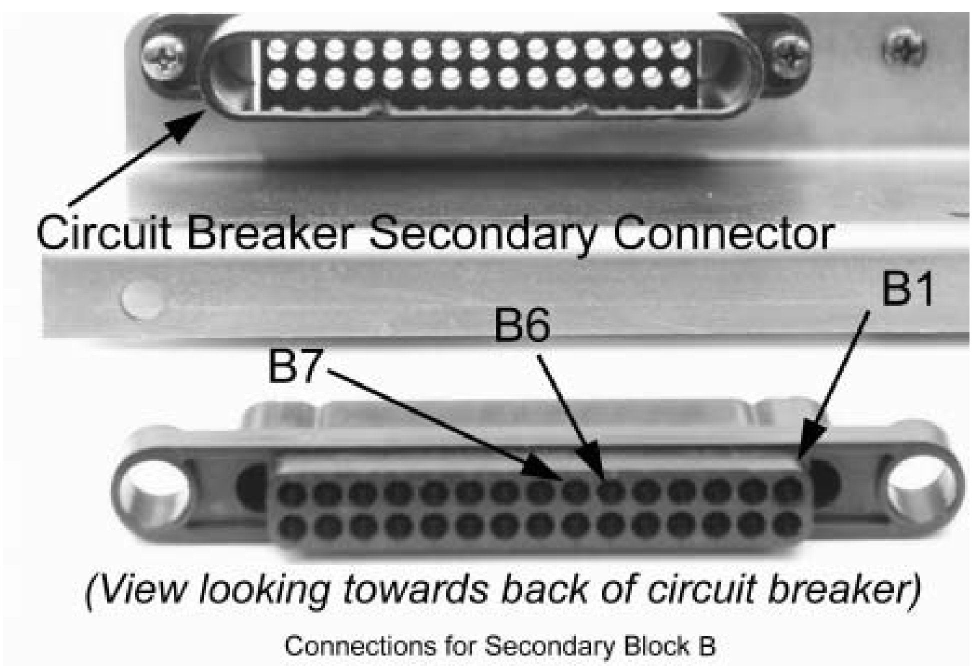


Figure 1.6 Secondary Block "B" Connections

1.6.1 Auxiliary Power

When the module is wired as shown in Figure 1.8, it will provide an auxiliary power supply so that the 520MCV liquid crystal display (LCD) will be functional even when the circuit breaker has no load. A Digitrip 520MCV 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. 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, 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 1.8, Note 3)*.

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 1.8, Note 4).*

1.7 Display Feature (520MCV only)

The Digitrip 520MCV model has 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 following sequence:

Figure 1.7 Ground Alarm/Power Supply Module for the 520MCV Trip Unit

PH 2 Phase 2 (B)

PH 3 Phase 3 (C)

PH 4 Neutral

PH 5 Ground

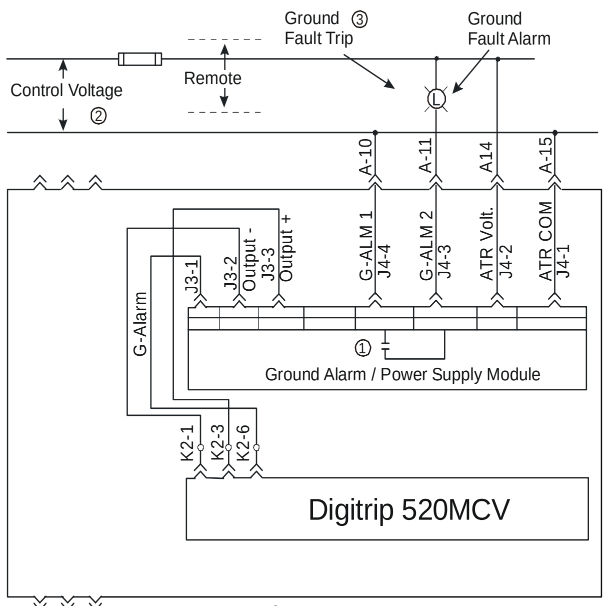
HI Highest phase current

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.

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.



Available Input Voltages	Style Number ②
120 VAC	7802C83G01
230 VAC	7802C83G02
24-48 VDC	7802C82G02
125 VDC	7802C82G03

① Contact Rating (resistive load)
AC 0.5A @ 230VAC
AC 1A @ 120VAC
DC 1A @ 48VDC
DC 0.35A@ 125VDC

② Verify input voltage rating before energizing circuit.

③ When used in conjunction with a T. U. Cat. 5ARMVLSIG will indicate GF trip.

Figure 1.8 Wiring Diagram for 520MCV with Ground Alarm/Power Supply Module

In addition, the Digitrip 520MCV 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 UL, CSA and CE Recognition

The Digitrip 520V and 520MCV Trip Units are a UL® (Underwriters Laboratories, Inc.) *Recognized Component* under File E146559 for use in Type VCP-T, VCP-TR and Type T-VAC, T-VACR Medium Voltage Circuit Breakers. They have also been tested by the Canadian Standards Association (CSA).

This Digitrip 520V and 520MCV have also passed the IEC 947-2 test program which includes radiated and conducted emissions testing. As a result, all units carry the CE mark.

2.0 GENERAL DESCRIPTION of VCP-T, VCP-TR or T-VAC, T-VACR CIRCUIT BREAKERS

2.1 General

The circuit breakers are tripped automatically on overload and 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.

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.

2.2 Low-Energy Trip Actuator

The mechanical force required to initiate the tripping action of the circuit breaker is provided by a special low-energy Trip Actuator. This device is located behind the molded platform on which the Digitrip units are supported. *(See Figure 1.2)* 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 automatically resets the Trip Actuator each time the circuit breaker opens.

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 trip unit. This pulse overcomes the holding effect of the permanent magnet, and the moving core is released to upset the trip latch of the circuit breaker mechanism.

2.3 Ground Fault Protection

2.3.1 General

When employing a ground fault scheme, the distribution system characteristics *(i.e. system grounding, number of sources, number and location of ground points, etc.)* 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 2.3.2 through 2.3.4.

The Digitrip uses two modes of sensing to detect ground fault currents: residual and zero sequence *(See Table 2.1)*. The breaker's secondary contact inputs B-6, B-7, that were shown in Figure 1.6, are used to configure the breaker cell positions for the two schemes. Having no jumper from B-6 to B-7 programs the unit for a residual ground fault scheme, while installing a jumper from B-6 to B-7 programs the unit for zero sequence configuration. If present, this jumper resides on the stationary side of the switchgear assembly. 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	Figure Ref	Digitrip GF Sensing Element Used
Residual	No Jumper	2.2	element R5
Zero Sequence	Jumper B6 to B7	2.3	element R4

Table 2.1 Digitrip Sensing Modes

2.3.2 Zero Sequence Sensing

Zero Sequence Sensing, also referred to as vectorial summation, is applicable to mains, feeders, and special schemes involving zone protection. An optional CH Type-V Zero Sequence current transformer *(See Figure 2.1)*, having taps for 100A and 200A ratings is available for this application. The torroidal sensor has a 4.8" I.D. (12.192cm) with a 7.6" O.D. (19.304cm). Its style number 69C3016G01. *(See Figure 2.3 and Appendix C)*

Figure 2.1 Zero Sequence Current Transformer

2.3.3 Residual Sensing

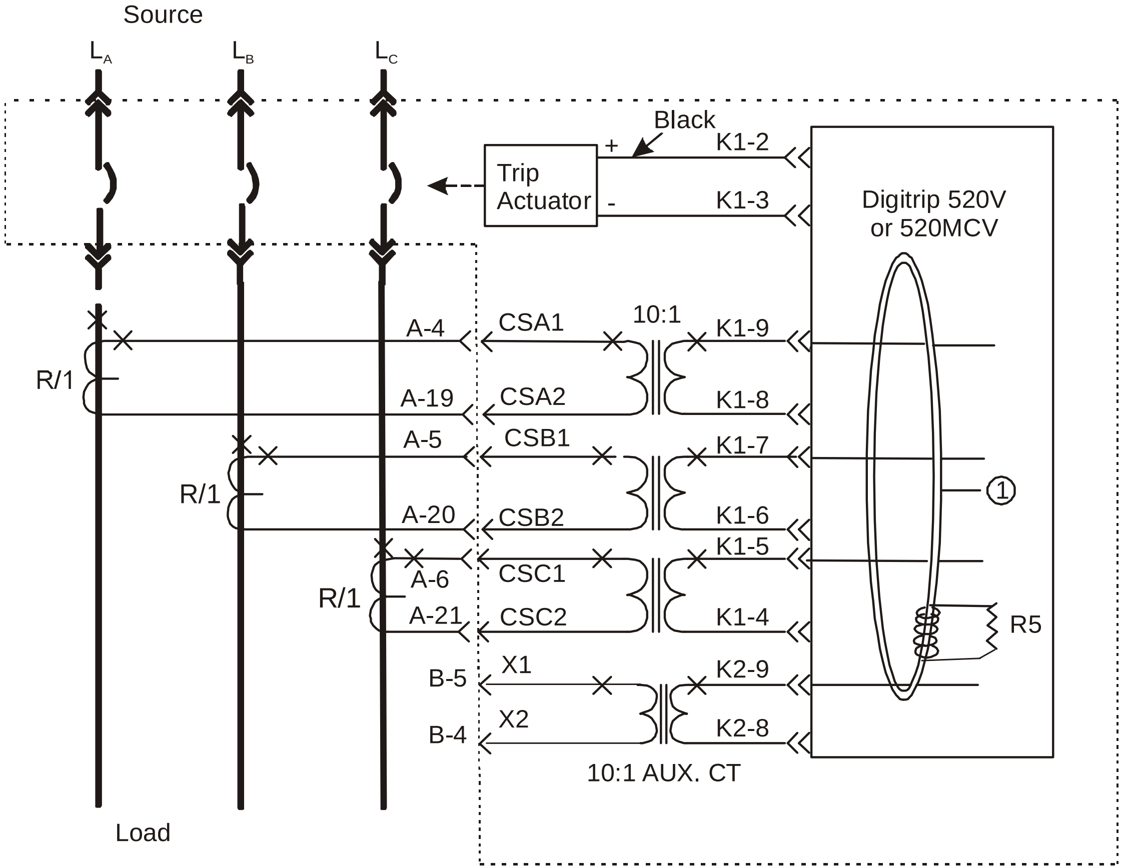
Residual is the standard operating mode of ground fault sensing. This mode utilizes one current sensor on each phase conductor *(See Figure 2.2)*. If the system neutral is grounded, but no phase to neutral loads are used, the Digitrip includes all of the components necessary for ground fault protection. This mode of sensing vectorily sums the outputs of the three or four individual CH Type-V current sensors. Residual ground fault sensing features are adaptable to main and feeder breaker applications.

2.3.4 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. The residual ground fault pick-up settings are from 0.25x, 0.3x, 0.35x, 0.4x, 0.5x, 0.6x, 0.75x and OFF.

CAUTION

IF THE PHASE 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 INSURE PROPER GROUND FAULT FUNCTIONALITY.

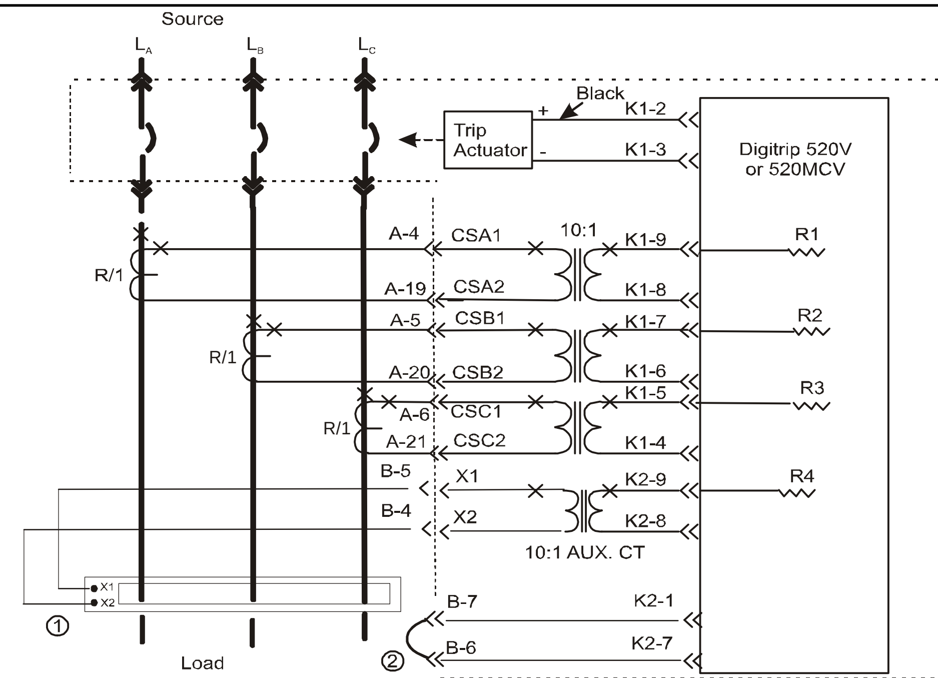


Notes:

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 R5.

② Do not jumper secondary contacts B-6, B-7. This will defeat the residual ground fault protection.

Figure 2.2 Breaker Using Residual GF Sensing

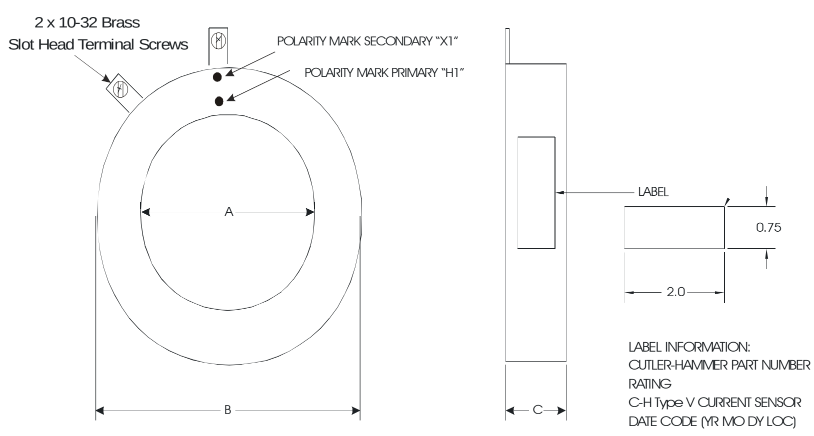


Notes:

① This scheme uses a large zero sequence CT with ratio 100:1 to magnetically sum the currents which senses ground fault via element R4.

② A jumper is required on contacts B-6, B-7 to program the Digitrip to use element R4 for ground fault..

Figure 2.3 Zero Sequence Sensing Scheme



DESCRIPTION		A (min)	B (max)	C (max)	WIRE GAUGE	RATIO	Rdc (Ohms +/-15%)
100A	69C3011H01	3.42	5.35	1.55	2 X 17	1:100	0.09
200A	69C3011H02	3.42	5.35	1.55	17	1: 200	0.31
250A	69C3011H25	3.42	5.35	1.55	18	1: 250	0.47
300A	69C3011H03	3.42	5.35	1.55	18	1: 300	0.56
400A	69C3011H04	3.42	5.35	1.55	17	1: 400	0.61
600A	69C3011H06	3.42	5.35	1.55	18	1: 600	1.17
630A	69C3011H63	3.42	5.35	1.55	18	1: 630	1.21
800A	69C3011H08	3.42	5.35	1.55	19	1: 800	1.87
1000A	69C3011H10	3.42	5.35	1.55	19	1:1000	2.29
1200A	69C3011H12	3.42	5.35	1.55	19	1:1200	2.93
1250A	69C3011H13	3.42	5.35	1.55	19	1:1250	3.06
1600A	69C3011H16	3.42	5.35	1.55	20	1:1600	4.67
2000A	69C3011H20	3.42	5.35	1.55	21	1: 2000	7.25
2500A	69C3011H52	3.42	5.35	1.55	21	1: 2500	8.90

Figure 2.4 Digitrip Phase Sensor (CH Type-V)

3.0 PRINCIPLES OF OPERATION

3.1 General

The Digitrip 520V and 520MCV trip units are designed for circuit breaker environments where the ambient temperatures can range from –30°C to +85°C, but rarely exceed 70° to 75°C. If, however, temperatures in the neighborhood of the trip unit exceed 85°C, 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 Digitrip trip unit 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 520V and 520MCV use 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 power required to operate the protection function is derived from the CH Type-V current sensors in the enclosure behind the circuit breaker. *(See Figure 1.4)* 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 microprocessor.

The microcomputer continually digitizes these signals. This data is used to calculate true RMS current values, which are then continually compared with the protection settings. The embedded software then determines whether to initiate protection functions, including tripping the breaker through the Trip Actuator.

3.2 Trip and Operation Indicators

The LEDs on the face of the trip unit, shown in Figures 1.1 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 and reset the trip unit.

The green *Unit Status* LED, shown in Figure 1.1, flashes at one second intervals to indicate 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 *Unit Status* LED typically indicates that a low level of load current, on the order of 5% of full load, exists.

3.3 Zone Interlocking

⚠ 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 standard for the Digitrip trip unit 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 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 pickup is exceeded. Zone Selective Interlocking provides the fastest possible tripping for faults within the zone of protection of the circuit 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 circuit breaker will cause the Digitrip 520V and 520 MCV to simultaneously:

1) Trip the affected circuit breaker immediately

2) 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.

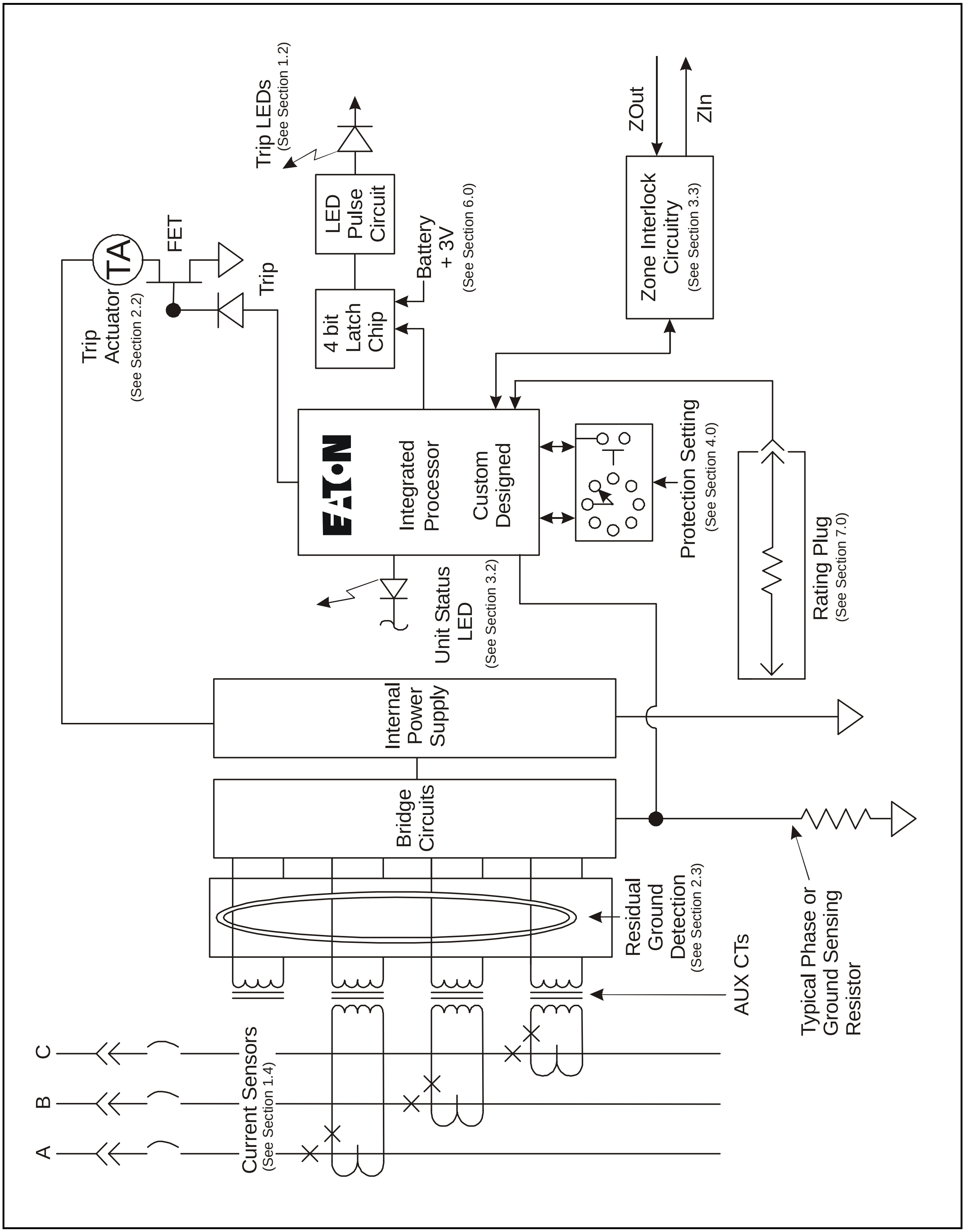


Figure 3.1 Block Diagram with Breaker Interface

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. 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.

NOTE: The installed rating plug must match the CH Type-V 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 box.

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).*

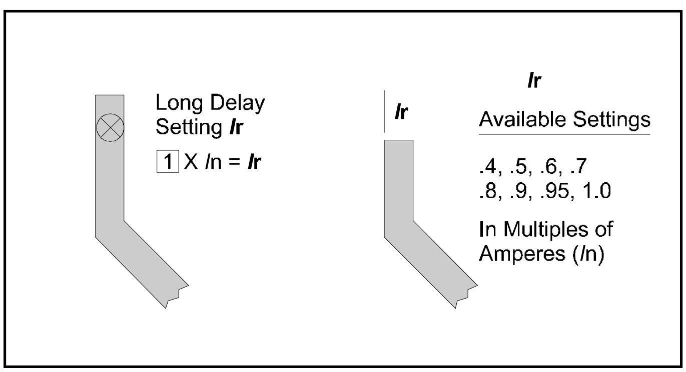


Figure 4.1 Long Delay Current Settings

4.3 Long Delay Time Setting

There are eight 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).

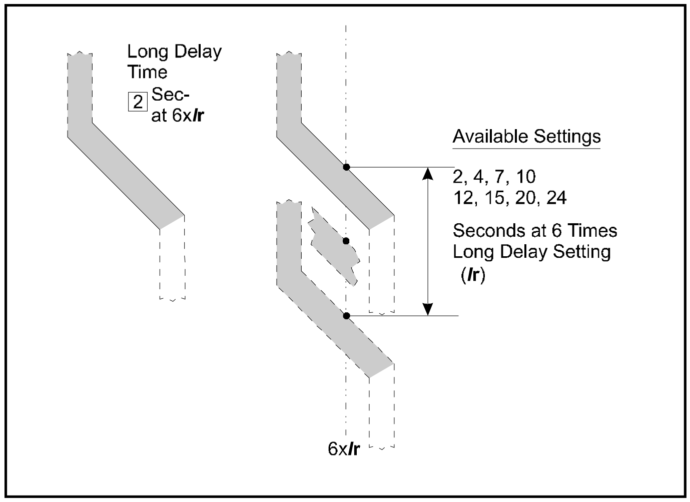


Figure 4.2 Long Delay Time Settings

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 circuit breaker is reclosed soon after a Long Delay Trip, and the current again exceeds the *Long Delay Setting*, (*I*r), the LTM automatically reduces the time to trip to allow for the fact that the load circuit temperature is already higher than normal because of the prior overload condition. Each time the overload condition is repeated, the LTM causes the 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.)

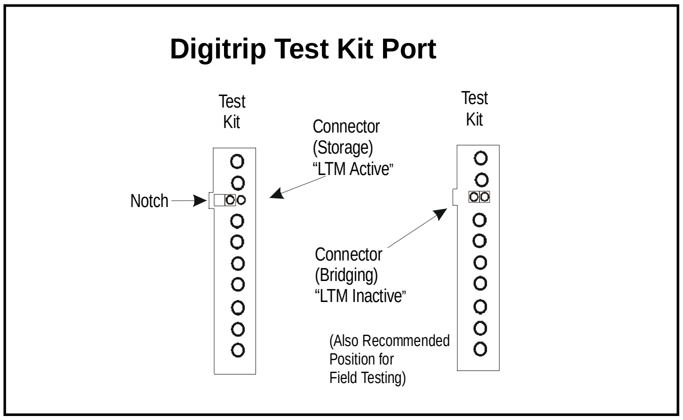


Figure 4.3 Long Time Memory (LTM) Jumper

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 eight available "Short Delay Current Settings," as illustrated in Figure 4.4. Seven settings are in the range from 1.5 to 10 times (*I*r). However there exists an additional maximum setting M1 that is based on *(In)*.It is set for 14x (*In)* for all rating plugs up to 1250A and 12X for 2000A, 2500A.

REMINDER: (Ir) is the "Long Delay Current Setting."

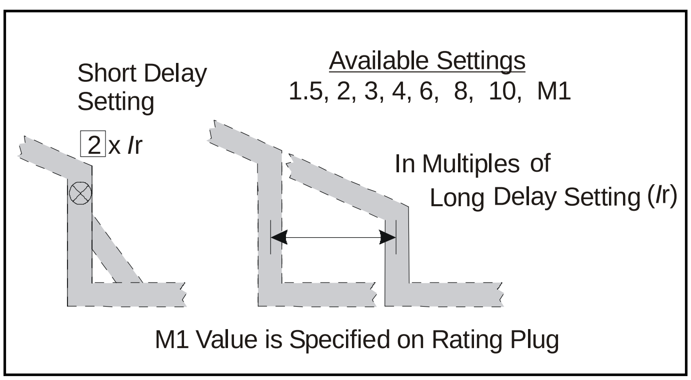


Figure 4.4 Short Delay Current Settings

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.

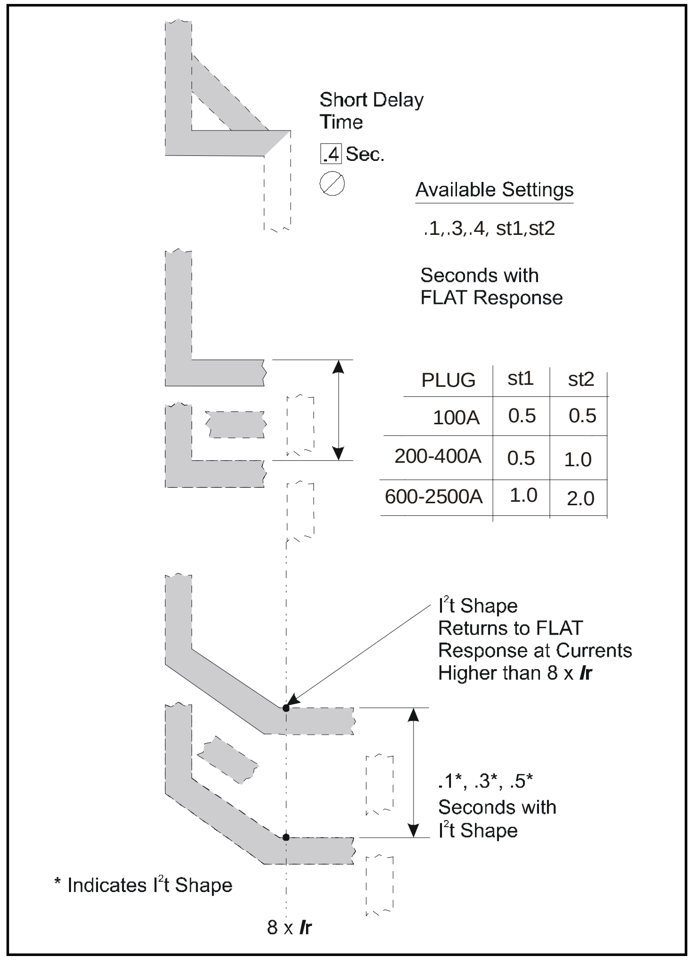


Figure 4.5 Short Delay Time Settings

Five FLAT (.1, .3, .4, .st1,st2 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 time settings labeled st1 and st2 are based on the rating plug. For 100A st1 and st2 =0.5s. For 200A through 400A, st1 = 0.5s and st2 = 1s. For rating plugs 600A and greater, st1 =1s and st2 = 2s.The I^2t response is applicable to currents less than 8 times the ampere value of *I*r rating. For currents greater than 8 x (*I*r) the I^2t response reverts to the FLAT response.

NOTE: Also see Section 3.3 - Zone Interlocking.

4.6 Instantaneous Current Setting

There are eight 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) and Off. The value that M1 has depends upon the plug 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.

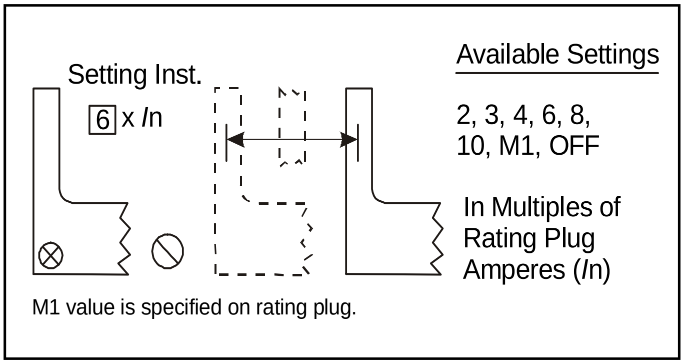


Figure 4.6 Instantaneous Current Settings

4.7 Ground Fault Current Setting

The eight “Ground Fault Current Settings” are labeled with values from .25 to .75 x (*I*n) and the other one is OFF. *(See Figure 4.7)*. The specific “Ground Current Settings” for each model are listed in Figure 4.7 and on the applicable time-current curve for the circuit breaker.

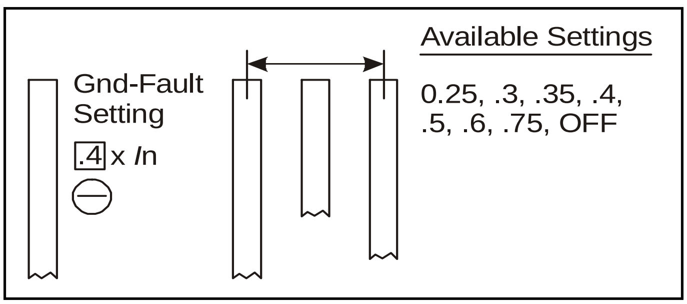


Figure 4.7 Ground Fault Current Settings

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 3.3 - Zone Interlocking.

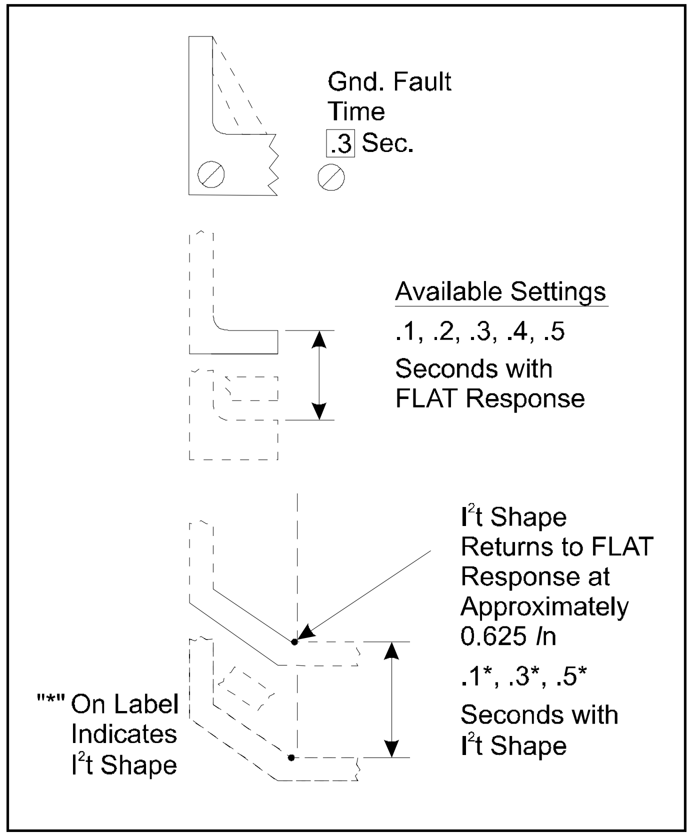


Figure 4.8 Ground Fault Time Delay Settings

4.9 INCOM (Digitrip 520MCV Models only)

INCOM communication to a host computer or a BIM is possible with the Digitrip 520MCV 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 520MCV trip units. The acceptable addresses are 001 through 031.

4.9.2 Remote Master Computer

When desired, Digitrip 520MCV 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.)*

4.9.3 INCOM Network Interconnections

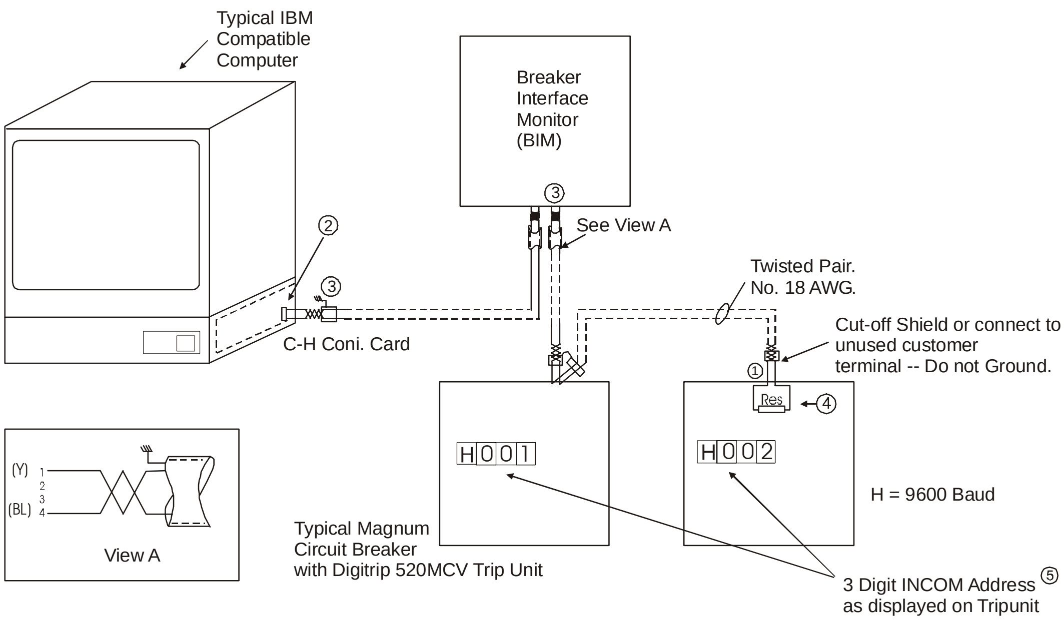
INCOM sends bursts of data on a 92 to 115.2 kHz carrier at a 9600 baud rate over twisted pair conductors to interconnect the many devices comprising the network.

The Digitrip 520MCV 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.



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

5.0 TEST PROCEDURES

5.1 Test Precautions

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

For Draw-Out Breakers, testing of the Digitrip trip unit prior to start-up can best be accomplished with the circuit breaker out of its cell or in the Test, Disconnected, or Withdrawn (or Removed) cell positions.

NOTE: Since time-current settings are based on desired system coordination and protection schemes, the protection settings selected and preset in accordance with Section 4.0 should be reset to their as-found conditions if altered during any routine test sequence.

CAUTION

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

5.3 Functional Field Testing

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 trip unit and the mechanical trip assembly of the circuit 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 520V and 520MCV	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 520V and 520MCV, plugs into the test port of the trip unit and provides a secondary injection AC test current that simulates the CH Type-V current sensors. Test kits styles 140D481G02R, 140D481G02RR, 140D481G03 or G04, along with the *Test Kit Adapter* 8779C02G04, can be used to test the trip unit and circuit breaker.

5.3.2 Handheld Functional Test Kit

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 520V and 520MCV units, 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 DC currents set at the factory and are not adjustable.

The style number of this device is # 70C1056G52 (120VAC) or #70C1056G53 (230VAC).

5.3.2.2 Test Procedure

Complete procedural instructions for the Cutler Hammer Mini Test Kit can be found in I.L. # 5721D13 which is packaged with each test kit.

Figure 5.1 Functional Test Kit

NOTE: After completion of testing,

1. Disconnect secondary connector with jumper
2. Disconnect test input cable
3. Reposition all trip unit settings to "as found"
4. Reposition the LTM (Long Time Memory) jumper
5. Reinstall the test port cover on the Digitrip
6. Reinstall plexiglass cover to circuit breaker

5.3.2.3 Currents

Each test chosen by the *Select Test* switch on the test kit supplies a fixed milliampere current value.

NOTE: The *Long Delay Setting* will affect the per unit (Ir) current value.

5.3.2.4 Batteries

This Functional Test Kit contains a total of seven 9-Volt batteries. A lithium ion cell is the preferred battery type for *Battery Voltage* (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 Digitrip trip unit.

Battery status LED's A and B function to represent sufficient voltage from both the single lithium cell and the six Alkaline batteries, respectively. If either LED does not light or lights dimly, replace the appropriate battery or batteries within the 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 of Digitrip 520V and 520MCV Trip Units

5.4.1 General

The complete circuit breaker should be tested after sensor wiring is completed. The AVO Multi-Amp® model MS-2 or equivalent current source can be used to perform this test *(See Figure 5.2)*.

5.4.2 Testing using MS-2 Multi AMP® Tester

5.4.2.1 Description of MS-2 Tester

The portable (33lb/15kg) AVO Multi AMP® tester, model MS-2 can be used to check out Digitrip 520V. There are two levels of testing that can be done. A primary or secondary injection test can be done. The primary injection test is good for verifying both CH Type-V current sensor polarity and hookup through the circuit breaker's secondary contacts and into the Digitrip trip unit. This is a complete system checkout and is strongly recommended after initial setup and before enerizating of the gear. Although the MS-2 source is limited to 600 amperes (momentary), it can verify that the trip unit powers up properly and perform a ground fault trip of the circuit breaker. This testing at the primary injection level is able to verify that the breaker's response to each primary phase current is correct. The secondary injection current source is able to deliver up to 5x (1 ampere is 1 per unit) into the breaker's secondary contacts. This can produce a 300% overload test and a 400% Short Time or Instantaneous test.

The following extra components are desirable additions for the testing.

1. For the primary injection testing, three separate flexable (welding type) cables (#2 AWG or larger) and each about 3' (.914m) long, are required to be fabricated. Connectors, with tabs, need to be attached on each end to connect to the tester's terminal studs. The flat tab extension will also provide a surface to attached to the gear's bus conductors using C-clamps. A typical connector style would be an ILSCO style SLS125.

2. For secondary injection tests, a separate True RMS ammeter with a "peak hold" feature is required *(See Figure 5.5).* The built in meter of the MS-2 tester is not True RMS and does not provide an accurate measurement of the secondary injection current. This is because of the trip unit's "chopper" power supply. The peak hold feature will hold the trip current level when an auxilary switch from the circuit breaker is wired back to the tester's terminals (white posts) labeled *Contacts*.

3. Also when performing low current secondary injection tests (less than 2 Amperes) it is desirable to insert an additional 25 ohm impedance (resistor or inductor) rated at 25 or 50 watts in series with the *5A* terminal post. This will provide proper impedance for the "chopper" and is useful in stablizing the current *(See Figure 5.5).*

5.4.2.2 Primary Injection Testing

Preliminary hookup:

a. Connect an Aux Switch or unused unused circuit breaker pole to the *Contacts* input terrminals of the MS-2 current source to hold current ramp value level and to stop the timer.

Figure 5.2 AVO MultiAmp® MS-2 Test Source

b. Set Digitrip *Ground Setting* to "0.4" and remove (if any) jumpers connected on secondary points B-6, B-7 *(See Figure 1.6).*

c. Connect one end of the primary current cables to the *240A* and *Common* posts of the MS-2 test source. Connect the other ends to the line and load side of the breaker's left pole(Phase "A"). This will provide a primary current through CH Type-V current sensor for the test.

d. Set MS-2 built-in meter to *750A* scale.

IMPORTANT: Do the following test even if ground fault is to be set to *OFF* or Zero Sequence Sensing is chosen for the final application.

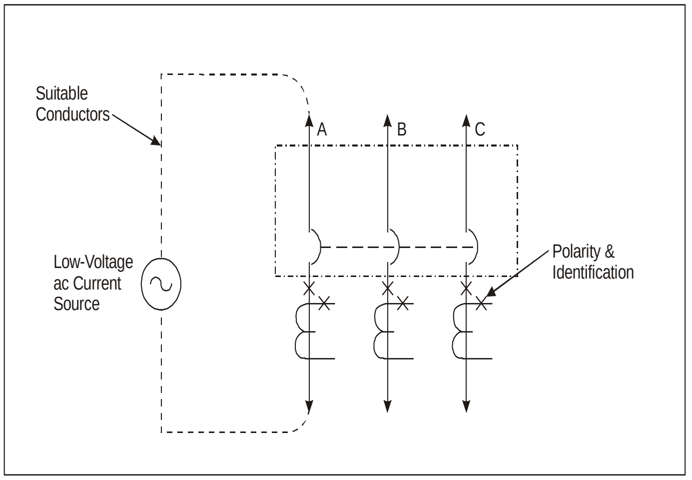


Figure 5.3 Connection Details to verify a trip (Ground)

Test Procedure:

TEST 1. Close circuit breaker and ramp up current using the *Output Control* knob of MS-2 and by setting selector switch to the *Maintain* position. At about 30% of the Rating Plug value, check for the green *Unit Status* LED to flash consistently at a one second interval. *(See Figure 1.1)*

TEST 2. Continue ramping up current and the circuit breaker should trip via ground element between 40 to 50% of plug rating.

This test arrangement checks both the phase current sensor and the residual ground element since a single pole is energized. *(See Figure 5.3)*

TEST 3. Repeat Test 1 and 2 on other two poles.

TEST 4. Connect primary current circuit such that two circuit breaker poles *(See Figure 5.4)* are in series and ramp current up to 40% of plug rating. The Digitrip's *Unit Status* LED should now flash at about 15% rating plug value with two poles energized. Continue ramping up current toward 40%. The circuit breaker should not trip. If the CH Type-V current sensor's polarities are incorrectly wired, the circuit breaker will trip out on ground fault at about 20%. If a ground fault trip occurs, check secondary wiring of CH Type-V current sensors for proper polarity.

Note: For circuit breakers with 100A thru 400A sensors the *Ground Fault Setting* could be raised or turned *OFF* and either "Long Time" or "Short Time" tests could be conducted. Adjusting the *Long Delay Setting* to 0.4x would help to minimize the current requirements to simulate to overload levels.

The above test essentually proves out the sensor wiring, the rating, the rating plug as well as polarity of the CH Type-V current sensors and tripping of the circuit breaker.

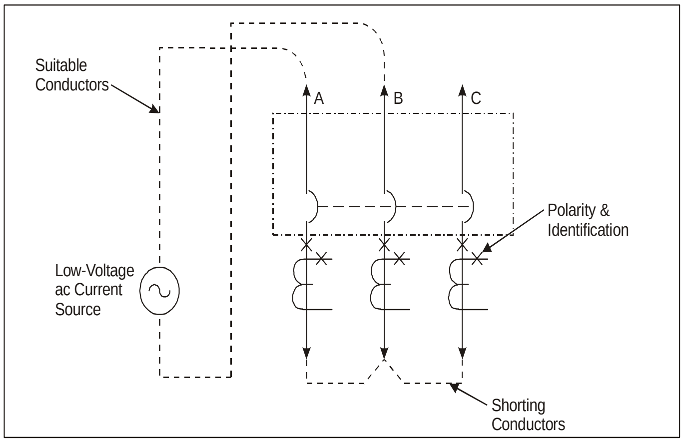


Figure 5.4 Connection Details to verify Sensor Polarities

5.4.2.3 Secondary Injection Testing

If desired, further testing can be done by injecting test current across the CH Type-V current sensor's output terminal screws or injecting directly into the circuit breaker's secondary contacts (A-4, A-19) or (A-5, A-20) or (A-6, A-21) *(See Figures 1.5 and 5.5)*

Note: If the circuit breaker is out of the cell, it may be beneficial to make a test harness. The test harness will have female AMP sockets (#66598-2) in one housing on the one end. The other should consist of spade terminations that connect to the *5A* and *Common* posts on the MS-2 current source.

An inductor (Signal Transformer CL-1-2) or 25 ohm resistor should be placed in series with the red terminal post to stablize the output for currents less than 1.5 amperes. Attach the separate True RMS ammeter in series with this component. The rest of the wiring is direct to the phase input secondary contacts.

Hook up a circuit breaker *Aux Switch* to the MS-2 tester's *Contacts* terminals to stop the clock and the source of current.

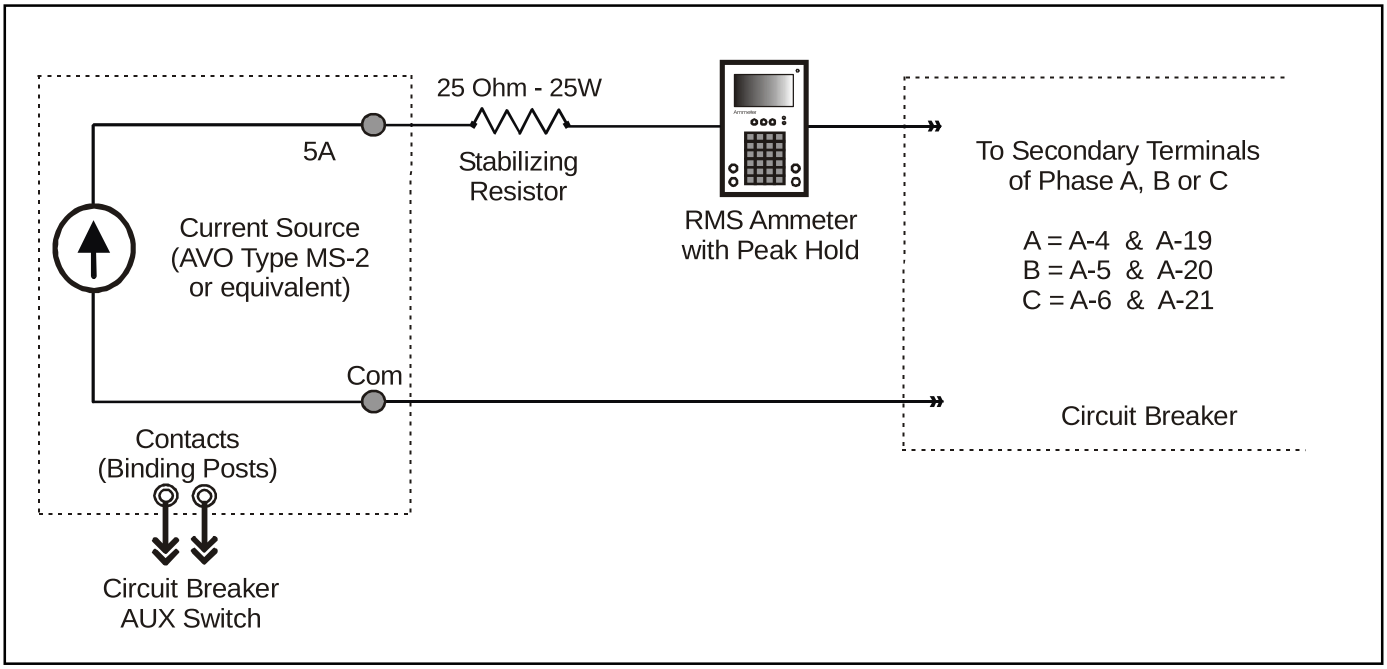


Figure 5.5 Secondary Injection Test Setup

Test Procedure:

TEST 1. Turn power switch *ON* and ramp up current slowly looking for the Digitrip's *Unit Status* LED to flash consistently at one second intervals. This power up should occur at 25 to 35% (about 0.3A for this single phase input).

TEST 2. Keep increasing current and note where the flashing *Unit Status* LED is about four times faster. This point is the "Long Delay Pickup Point" and is nominally 1.1x *Long Delay Setting*.

NOTE: The AVO MS-2 Test Source is not a perfect source, particularly when it encounters the "chopper" power supply of the Digitrip so the exact point may be difficult to determine.

TEST 3. Set the current to 300% which is 3A (+/- 0.1). Remove or short out the series resistor for the trip tests.

NOTE: Three Amperes is truly 300% only when the *Long Delay Setting* is set to 1x. Other 300% test current levels will need to be calculated if the *Long Delay Setting* is set other than 1x. Set *Ground Setting* to *OFF, Instantaneous* to 4x and *Short Delay Setting* to 8x.

Run 300% overload to trip the circuit breaker on "Long Time."

Equation for trip time @ 300%

"Max. Long Time" trip(sec) = *Long DelayTime* setting X 4

"Min. Long Time" trip(sec) = *Long Delay Time setting X 2.8*

The breaker should trip within the above range and "Long Time" trip LED should flash. Check battery if this cause of trip LED does not flash.

TEST 4. The "Short Delay" or "Instantaneous" trip elements (set @ 4x) can also be checked by ramping current. Close circuit breaker. Place the separate meter in the "Hold" mode. Ramp current until trip the circuit breaker trips (expected range of 3.6 to 4.4 A). Appropriate trip LED should flash.

NOTE: As the MS-2 tester has limited current source capabilities, testing of the Digitrip 520V and 520MCV could be assisted by the handheld tester shown on page 16. The handheld unit, when its connector is plugged into the test kit input pins of the Digitrip, provides external power to the trip unit to stabilize the "chopper" power supply. Use the *Power Up* switch position of the handheld and make sure there is a feedback *Aux Switch* present. This is required to shut off the MS-2 current source when tripping occurs. This will also enable higher per unit testing levels.

6.0 TRIP UNIT BATTERY

6.1 General

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

Activate the battery by removing the *Battery Insulating Tab* by taking out the battery and then removing and discarding the tab. *(See Figure 6.1)*.

As indicated in Figure 3.1, the battery is provided to maintain the red LED indication of the “cause of trip” in the Digitrip. The battery is located behind the rating plug door. A *Reset/Battery Test* pushbutton and a green *Battery Check* LED are located on the trip unit.

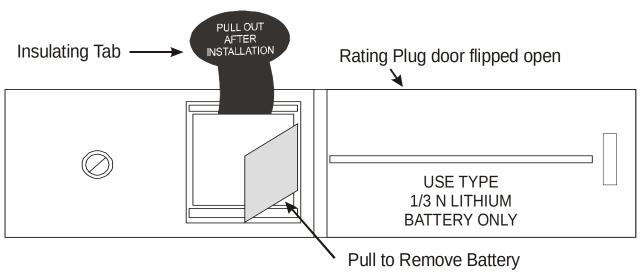


Figure 6.1 Battery located behind Rating Plug

6.2 Battery Check

The battery is a long-life, lithium, camera-type cell. Check the status of the battery at any time by pressing the *Reset/Battery Test* 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 now be ready to indicate the next cause of trip.

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.

The replacement battery should be the same type as found in in the trip unit or proper 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. USA 10523 1-914-592-2500 (www.varta.com)	CR 1/3N
Duracell, Inc. Berkshire Corporate Park Bethel, CT USA 06801 1-800-551-2355 (www.duracell.com)	DL 1/3N
Sanyo Energy Corporation 2055 Sanyo Avenue San Ysidro, CA USA 92173 1-619-661-6620 (www.sanyo.com)	CR 1/3N

6.3 Battery Installation and Removal

The 3-volt lithium cell battery *(See Figure 6.1)* can easily be 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*. Cover door should now flip open. Remove the old battery by pulling up on the removal tab that wraps under the cell. When inserting the new battery, pay special attention to ensure that the proper polarity is observed. The main body of the battery is the positive (+) side.

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.

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.

There are two frame ratings for this circuit breaker using the Digitrip 520V and 520MCV trip units as follows:

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 Digitrip units, this is implemented by changing the CH Type-V current sensors and the corresponding rating plug. These sensors and rating plugs are available in kit form.

The CH Type-V current sensor rating is the maximum current the circuit breaker can carry with the specified sensors installed. Their 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 Current Settings are multiples of (*I*n) *(See Sections 4.6).*
2. The Ground Current Settings are multiples of (*I*n) *(See Section 4.7)*. The one exception would be if the Zero Sequence sensor is employed. It is a tapped sensor with 100A and 200A selections.
3. 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).*
4. 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).*

WARNING

BEFORE YOU FIT THE RATING PLUG INTO THE TRIP UNIT, BE SURE TO CHECK THAT EACH BREAKER POLE HAS AN EXTERNALLY MOUNTED SENSOR THAT IS WIRED TO THE CIRCUIT BREAKER'S SECONDARY CONTACTS. THESE SENSOR RATINGS MUST MATCH THAT PRINTED ON THE RATING PLUG. INSTALLING A RATING PLUG THAT DOES NOT MATCH THE SENSOR RATING CAN PRODUCE SERIOUS MISCOORDINATION AND/OR FAILURE OF THE PROTECTION SYSTEM.

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 Medium Voltage Type VCP Circuit Breakers

I.B. *#69C3067*	ANSI Breaker Instructions
I.B. *#69C3066*	IEC Breaker Instructions

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.

#5720B80	Digitrip 520V/520MCV (LS) Curve
#5720B81	Digitrip 520V/520MCV (I) Curve
#5720B82	Digitrip 520V/520MCV (G) Curve
#5721B77	Digitrip 520MCV Maintenance Mode Trip Curve

DIGITRIP TRIP FUNCTION SETTINGS				
Circuit No./Address ______________		Breaker Shop Order Reference ______________		
PER UNIT MULTIPLIERS				
Rating Plug Amperes (In) ______________		Ir Continuous Ampere Rating = LDS x In ______________		
Trip Function	Per Unit Setting	Multi	Ampere Equivalent Setting	Time Delay
Inst.		In		X
Long Delay		In		Sec.
Short Delay		Ir		Sec.
Ground Fault		In		Sec.
Date ______________		By ______________		

Figure 8.1 Typical Trip Function Record Nameplate

<table>
<tr><td colspan="5">DIGITRIP
AUTOMATIC TRIP OPERATION RECORD</td></tr>
<tr><td>Circuit No./Address</td><td colspan="4">Breaker Shop Order Reference</td></tr>
<tr><td rowspan="2">Trip Function</td><td colspan="4">Settings Reference</td></tr>
<tr><td>Orig. 0</td><td>Rev. 1</td><td>Rev. 2</td><td>Rev. 3</td></tr>
<tr><td>Instantaneous</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Long Delay Setting</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Long Delay Time</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Short Setting</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Short Time</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ground Fault Setting</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ground Fault Time</td><td></td><td></td><td></td><td></td></tr>
</table>

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

APPENDIX A Zone Interlocking Examples

NOTICE

THE PROVISION FOR ZONE INTERLOCKING IS STANDARD ON CIRCUIT BREAKERS WITH DIGITRIP 520V 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.

EXAMPLE 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.

EXAMPLE 2: There is Zone Selective Interlocking.

Assume a ground fault of 2000 Amperes occurs and refer to Figure A.1.

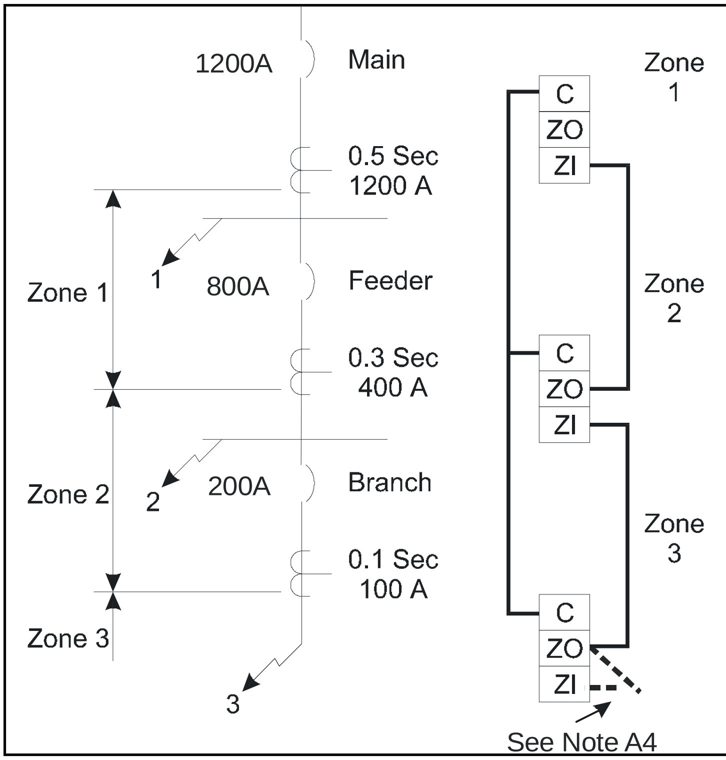
Fault at location 3
The branch breaker trip unit will initiate the trip in .045 seconds to clear the fault and the branch will send a restraint signal to the feeder trip unit; the feeder will send a restraint interlocking signal to Z1.

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 (EARTH) any Zone Interlock 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 connected in parallel in one zone.

A4: Provide a self interlocking jumper (on Zone 3) if coordination Is desired with other downstream breakers.

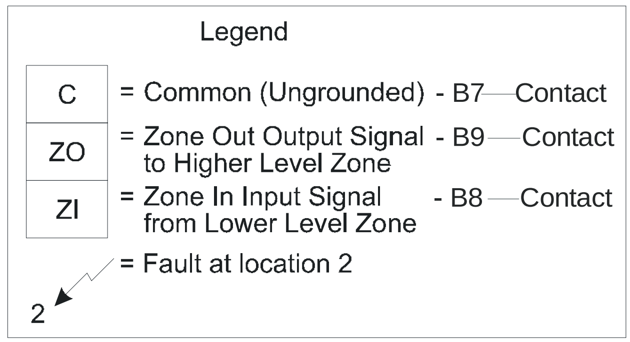


Figure A.1 Typical Zone Interlocking

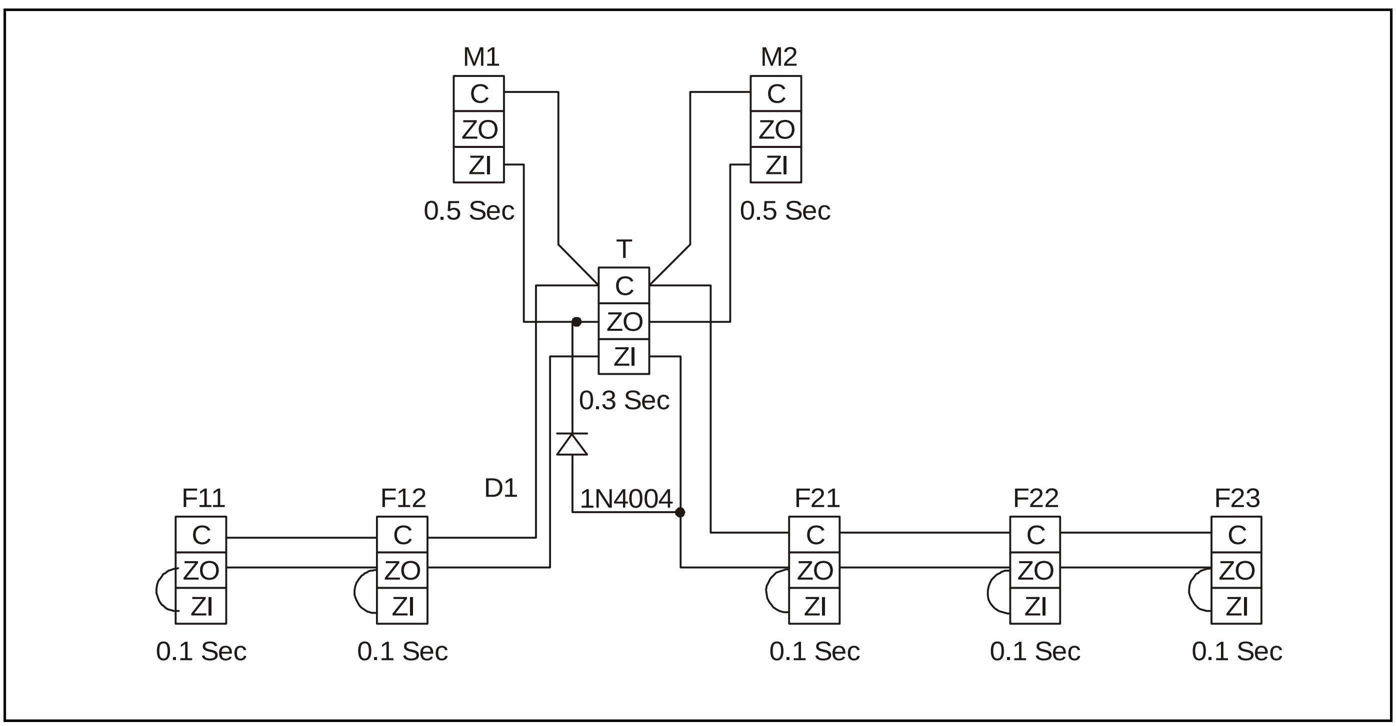


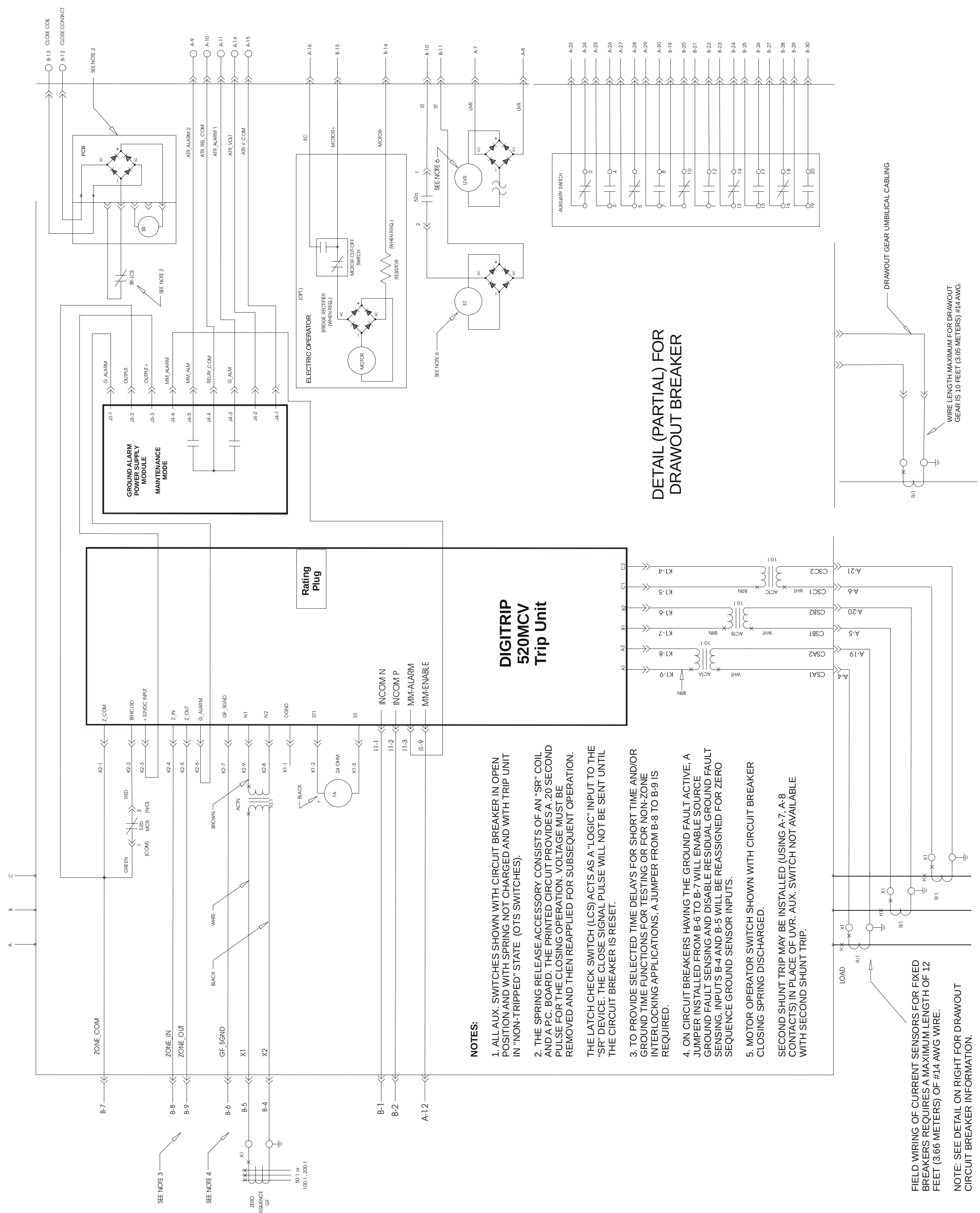
Figure A.2 Typical Zone Interlocking Connections with Two Main Breakers (M1, M2) and a Tie Breaker (T)

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. Unit Status LED will not flash until 25% of sensor rating	See Note in Section 3.2
	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	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	
	CH Type-V current sensors in one or more phases have incorrect polarity	Verify circuit breaker wiring	Refer to Appendix C
	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 3.3
Breaker trips too rapidly on ground fault or short delay (Zone Selective Interlocking not used)	Connection from Zout to Zin is missing	Make connections 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 selected	Turn off Long Time Memory	Refer to Section 4.3
	Trip unit settings are not correct	Change settings. Long Time Delay setting is based on 6×Ir	

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 520MCV)	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 520MCV* does not communicate with PowerNet or BIM. * Only Digitrip 520MCV 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

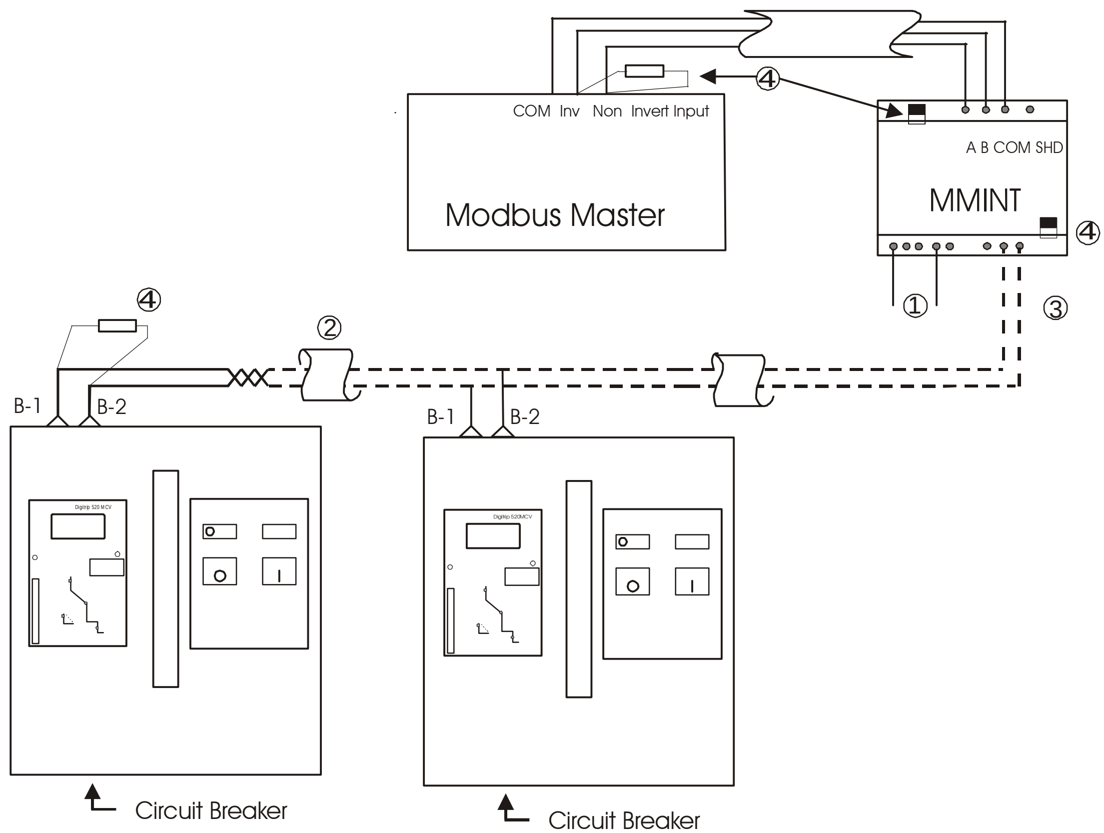


Appendix D MODBUS TRANSLATOR Wiring

The Digitrip 520MCV in a Medium Voltage Circuit Breaker can communicate its data using Modbus RTU protocol by employing an 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 #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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