Instruction Leaflet IL01210003E

Effective January 2012

Instructions for Digitrip RMS 310+ Trip Unit For Use with R-Frame Breakers

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WARNING

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH, SEVERE PERSONAL INJURY, OR SUBSTANTIAL PROPERTY DAMAGE CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING WITH THE TASK, AND ALWAYS FOLLOW GENERALLY ACCEPTED SAFETY PROCEDURES.
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1.0 GENERAL INFORMATION

1.1 Protection

The digitrip RMS 310+, illustrated in Figure 1, is an electronic trip unit that incorporates a microprocessor-based custom application specific integrated circuit design for use with R-Frame Molded Case Circuit Breaker.

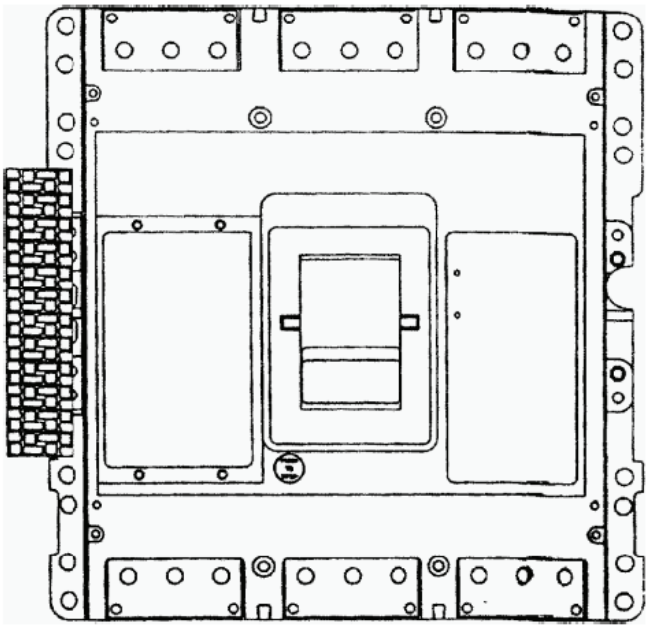

Fig. 1 Digitrip RMS 310+ Trip Unit for use with R-Frame Circuit Breakers

The Digitrip RMS 310+ provides true RMS current sensing for proper correlation with thermal characteristics of conductors and equipment. An Ir switch is provided to establish the continuous current rating of each circuit breaker.

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Molded Case Switches: The Molded Case Switch is similar to the Circuit Breaker except that it has a different tripping characteristic. There is a fixed instantaneous trip at 15,000 Ampere but there is no overload short delay or ground fault trip. In the remaining sections the term circuit breaker shall also include the molded case switch.

100 Percent Rated R-Frame Circuit Breaker:

Circuit Breakers with a "C" prefix (CN...) in the catalog number are 100 percent rated circuit breakers and are suitable for continuous operation at 100 percent of the frame rating in an enclosure with: Minimum Enclosure size is 21.5H x 18W x 13D inches. Use rear connectors B2016RDL. Use only 90ºC wire with Ampacity Based on 75ºC Rated Conductors if cabling to rear connectors.

Overload Trip: In accordance with standards requirements, the trip unit initiates a trip of the circuit breaker within two hours of an overload of 135 percent, and a trip in less time for high overloads.

A "Thermal Memory" effect prevents the breaker from being re-energized immediately after an overload. A "cooling off" period of the up to 5 minutes is required, which allows time for the cabling to cool off.

Short delay/Instantaneous Trip: For short circuit conditions that exceed the short delay pick-up settings, the trip units initiate a trip after a delay prescribed by the I^2t ramp function for trip units designated LS and LSG. A flat response time delay action is provided by trip units designated LSI and LSIG unless the instantaneous (I) setting is selected.

Table 1.1: Electronic (Digitrip 310+) Trip Unit Types

Trip Unit Functions		Digitrip RMS 310+ Trip Unit				
		LS	LSI	LSG	LSIG	K
Long Time	Adjustable Ampere Rating (Ir) Refer to Fig.1.0 with Adjustable Long Delay (tr)	.	.	.	.	
Short Time	Adjustable Short Time Pick-Up (Isd)③ with Short Time Delay I2t Ramp					
	Adjustable Short Time Delay ① (tsd) with Adjustable short Time Pick-Up		.		.	
Instantaneous	Fixed Instantaneous (Override) ②	.	.	.	.	.
Ground Fault	Adjustable Ground Fault Pick-up (Ig)			.	.	
	Adjustable Ground Fault Time (tg)				.	

① Using the trip unit with adjustable delay (LSI, LSIG), instantaneous pick-up is achieved when the lowest time setting of tsd is set to Inst. for RMM (Remote Maintenance Mode) trip units, this setting is 50ms. is selected for non-RMM trip units.

② Override setting fixed at frame withstand rating.

③ For non-RMM trip units, the last setting is labeled 8i; & 6i; respectively for 1600A/2000A & 2500A trip units. This signifies that the last setting acts as both instantaneous and short delay settings only when $I_r = I_n$, which is at the max I_r setting .

K = Molded Case Switch

The Digitrip RMS 310+ Trip Unit is completely self-contained and when the circuit breaker is closed, requires no external control power to operate its protection systems. It operates from current signal levels and control power derived through current sensors integrally mounted in the circuit breaker.

Digitrip RMS 310+ Trip Units are suitable for 50/60 Hz AC applications only.

The Digitrip RMS 310+ Trip Unit is available in 4 different types. Each trip unit contains an adjustable long delay time function, and may be equipped with a maximum of two phase and two ground (time-current) adjustments to meet specific application requirements. The types of adjustments available for each model include the following, which are illustrated in Figures 1.0 through 4.0.

Table 1.2:

	Adjustment	Type	Refer to Figure
1)	Short Delay Pick-Up	RT3xxx33(LS)	4.0
2)	Short Delay (Inst.) Pick-up/Short Delay Time	TR3xxx32(LSI)	3.0
3)	Short Delay Pick-up/ Ground Fault Pick-up/ Ground Fault Time	RT3xxx35 (LSG)	2.0
4)	Short Delay (Inst.) Pick-up/Short Delay Time/ Ground Fault Time	RTxxx36 (LSIG)	1.0

1.2 Testing

2.0 UL LISTED DEVICE

The Digitrip RMS 310+ Trip Unit is listed in accordance with Underwriters Laboratories, Inc. Standard UL 489, under file E7819 and satisfies the applicable requirements of the International Electrotechnical Commission (IEC) recommendations for molded case circuit breakers.

3.0 PRINCIPLE OF OPERATION

In open air at 40ºC, an R-Frame circuit breaker with a Digitrip RMS 310+ Trip Unit installed will carry continuously up to 1600, 2000, or 2500 amperes without exceeding a 50ºC rise at the terminals. The calibration of the trip unit is insensitive to ambient temperatures over a range of -20º to +55ºC. However the trip unit contains thermal temperature protective circuitry that initiates a trip operation for self-protection if the internal ambient temperature at the printed circuit board (PCB) reaches approximately 100ºC. This may occur for open-air-temperatures above 40ºC with circuit breaker currents near full load.

For ambient conditions above 40ºC and where the maximum ampere Ir, derating of the circuit breaker frame should be considered to avoid exceeding a safe terminal temperature operating range. Consult Eaton for recommendations.

3.1 General

The digitrip RMS 310+ Trip Unit provides a tripping signal to the flux transfer shunt trip when current and time delay settings are exceeded. This is accomplished by employing the Eaton designed integrated circuit ON SEMI chip, which includes a microcomputer to perform its numeric and logic functions.

In the Digitrip RMS 310+ Trip Unit, all required sensing and tripping power to operate its 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 voltages across the appropriate calibrating resistors.

The microcomputer, in cyclic fashion, repeatedly scans the voltage values across each calibrating resistor and enters these values into memory. These data are used to calculate true RMS current values, which are then repeatedly compared with the protection function settings and other operating data stored in memory. The software program then determines whether to initiate protection functions, including tripping the breaker through the flux transfer shunt trip device in the circuit breaker.

A green status light indicates the operational status of the trip unit. If the load current through the circuit breaker exceeds approximately 20% of the maximum current rating of the trip unit, the status light will blink on and off once each second. A blinking status light is an indication of a properly functioning trip unit. If the status light is not blinking, the current through the breaker may be less than 20% of the maximum current rating of the trip unit.

CAUTION

LACK OF ILLUMINATION OF THE STATUS LED DOES NOT INDICATE THE TERMINALS OF THE BREAKER ARE DE-ENERGIZED.

3.2 Overload Trip: In accordance with standards requirements, the trip unit initiates a trip of the circuit breaker within two hours for an overload of 135 percent, and will trip in less time for higher overload currents.

A "Thermal Memory" effect prevents the breaker from being re-energized immediately after an overload trip. A "cooling off" period of up to 5 minutes is required, which allows time for cabling to cool off.

3.3 Short Delay/Instantaneous Trip: For short circuit conditions that exceed the short delay pick-up settings, the trip unit initiates a trip after a delay prescribed by the I^2t ramp function for trip units with catalog number suffixes LS and LSG. A flat response time delay action is provided by trip units with catalog number suffixes LSI and LSIG unless the instantaneous (Inst) setting is selected.

3.4 Ground Fault Protection: When selected, ground fault pickup and time delay settings shown in Table 1-2 allow selective ground fault coordination with other circuit protection devices.

4.0 PROTECTION SETTINGS

4.1 General

Prior to placing any circuit breaker in operation, each trip unit protection setting must be set tot he values specified by the engineer responsible for the installation. The available settings are illustrated in figures 1.0 to 4.0.

4.2 Long Delay Time Settings

There are eight long delay time settings: 2, 4, 7, 10, 12, 15, 20, and 24 seconds.

4.3 Short Delay-up Setting,

There are nine short delay pick-up settings: 2500A frame - 2, 2, 2, 3, 4, 5, 6, 6, 6, and for the 1600A\2000A frame - 2, 3, 4, 5, 6, 7, 8, 8, 8, All settings are dependent on the Ir value and are related: (I_{sd} x I_r).

4.4 Short Delay Time Setting

For catalog numbers describing an LS or LSG trip unit, the time response is an I^2t function.

For catalog numbers describing an LSI or LSIG trip unit, the time function is a flat time response dependent on the Short Delay Time switch setting. There are three settings: INST, 120 ms, and 300 ms.

4.5 Ground Fault Pick-up Setting

All three frames have the same pick-up settings: 200A, 400A, 600A, 800A, 1000A, and 1200A. (I_g x 1000A).

4.6 Ground Fault Time Setting

The ground fault time delay is a flat response determined by the Ground Fault Time switch setting. This switch is a dual function switch that controls the short delay time, as well as the ground fault time. The available settings are: INST, 120ms, and 300ms.

5.0 TESTING

A test receptacle is built inot each trip unit to allow use of the 70C1056 Portable Test Kit. The Test Kit performs a test of the Long Delay, Short Delay and Ground Fault functions.

6.0 FRAME RATINGS .

The **Frame Rating** of a circuit breaker is the maximum RMS curerent it can carry continuously (I_n). The maximum short-circuit Current Ratings of the circuit breaker are usually related to the Frame Rating as well.

It is often desirable to be able to choose a current value (I_r), less than the full frame rating, to be the basis for the coordination of the circuit breaker's protection functions, without affecting its short-circuit current capability. For the Digitrip 310+ Trip Unit this is implemented by changing the **I_r Switch**.

For I_r settings (I_r settings lower than I_n), the primary current carrying conductors used with the breaker must be sized to correspond with the maximum setting of the rating plug, in accordance with National Electric Code requirements.

The current rating, (I_n) is the basis for the trip unit current settings:
1) The long delay (pick-up) protection function of the trip unit is set by the I_r switch.

2) The short delay pick-up setting Iso is a multiple of I_r.

3) The ground pick-up setting is independent of I_r and is defined as: (I_g x1000A) for all frames.

7.0 REFERENCES

7.1 Digitrip RMS Trip Assemblies

I.L. 29-C883E Instructions for Digitrip RMS 310 Trip Unit
I.L. 29-885 Instrucitons for Digitrip RMS 510 Trip Unit
I.L. 29-886 Instructions for Digitrip RMS 610 Trip Unit
I.L. 29-888 Instructions for Digitrip RMS 810 Trip Unit
IL01210003E Instructions for Digitrip RMS 310+ Trip Unit

7.2 R-Frame Molded Case Circuit Breakers

29-107 Frame Instruction Leaflet

29C713 Supplementary instructions for R-Frame used with Digitrip RMS Trip Units.

AD29-167R Typical Time-Current characteristic Curve for R-Frame Circuit Breakers.

I.L. 29C714 Master Connections Diagram for R-Frame Circuit Breaker with Digitrip RMS Trip Units.

TC01210019E Series G RG-Frame
310+ Circuit Breaker time current curves

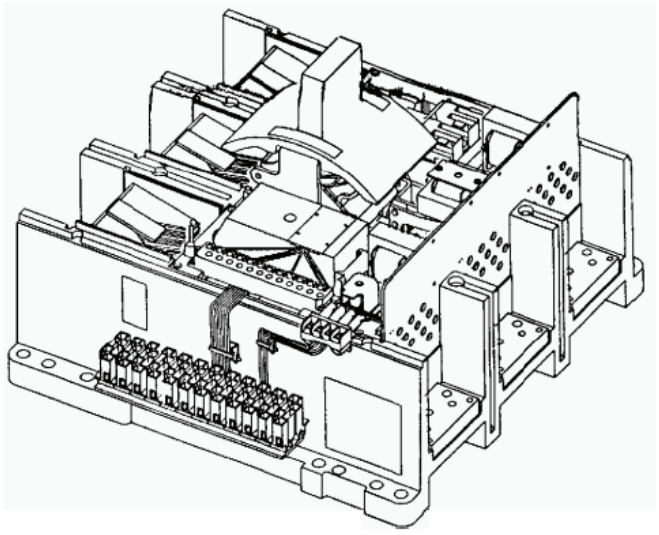

Fig. 2 Ground Fault Breaker with Cover Removed

Table 1-2. Digitrip RMS 310+ Trip Unit Trip Function and Rating Settings	
Trip Function	Rating/Setting Description
Sensor Ampere Trip Ratings In: 1600A 2000A 2500A	
	Trip Unit Ampere Rating I_r Settings
	1600A, 800A, 900A, 1000A, 1100A, 1200A, 1400A, 1500A, 1600A
	2000A, 1000A, 1200A, 1400A, 1600A, 1700A, 1800A, 1900A, 2000A
	2500A, 1600A, 1700A, 1800A, 2000A, 2100A, 2200A, 2400A, 2500A
Short Delay Pick-up (Adjustable	There are nine settings: for the 1600A\2000A - 2, 3, 4, 5, 6, 7, 8, 8,; for the 2500A - 2, 2, 2, 3, 4, 5, 6, 6, 6, (I_{sd} x I_r).
Short Delay Time (Fixed)	I^2t ramp configuration
Short Delay Time (Adjustable)	Flat response with time delay settings at Inst, 120 ms, and 300 ms
Ground Fault Pick-up (Adjustable	Settings 200A, 400A, 600A, 800A, 1000, 1200A (for all frames) (I_gx1000A)
Ground Fault time Delay	Settings at: INST, 120ms, and 300ms

7.3 310+ TRIP UNIT FUNCTIONS & ADJUSTMENTS

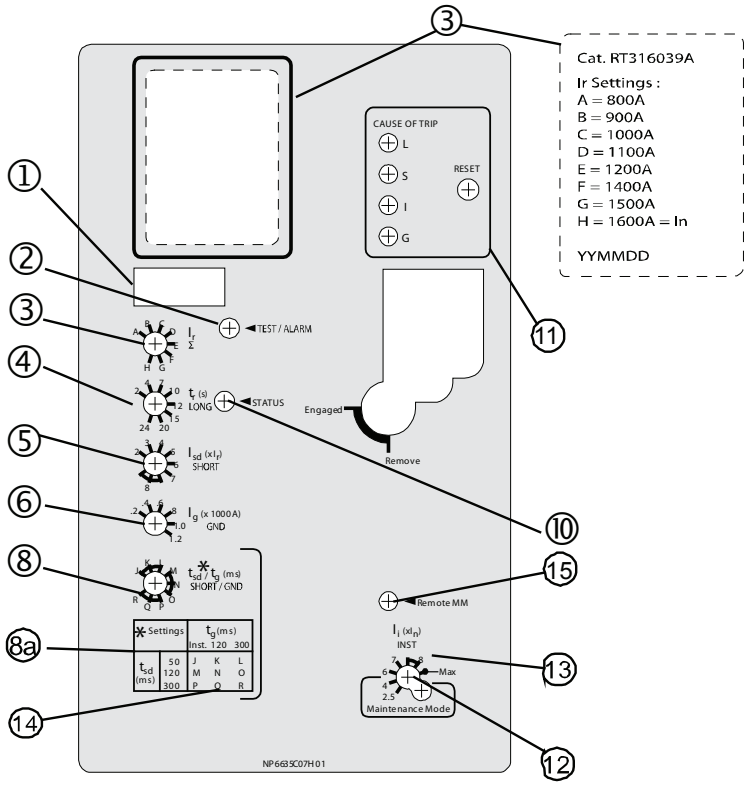

Figure 1.0

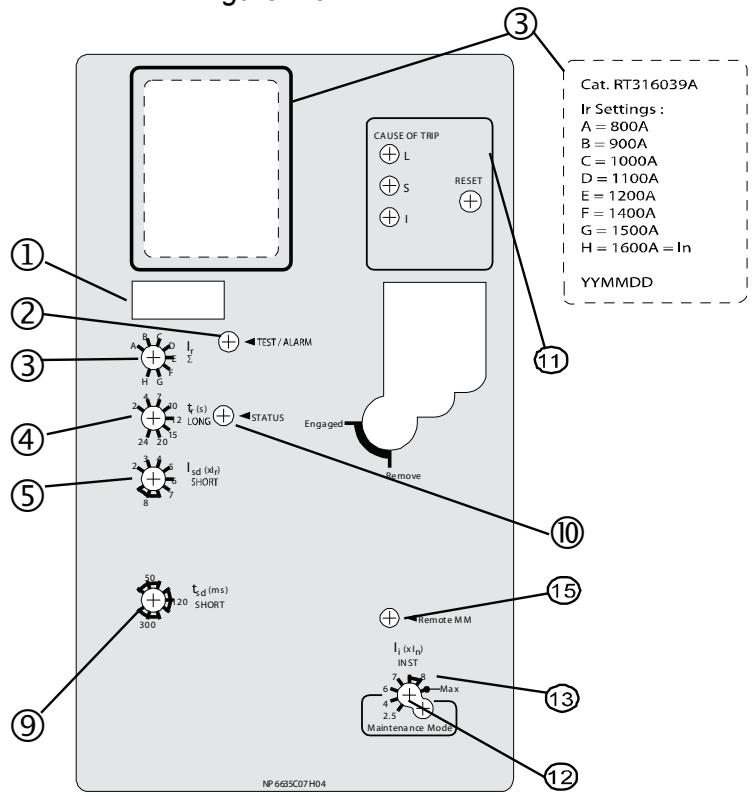

Figure 2.0

7-1 . Test Port - a test port is built into each trip unit to allow use of a functional test kit. The test kit performs a test of the Long Delay, Short Delay, and Ground Fault functions.

7-2 . Test LED - to be used with a no trip functional test. This LED is a dual function light. As previously stated, the LED is used as a no trip indicator when using the test port. In normal modes, this LED indicates a high load alarm. It will light if the continuous current is 95% of the setting and must be present for a 38 second duration.

7-3 . I_r - Continuous Current Setting. In accordance with standards requirements, the trip unit initiates a trip of the circuit breaker within 2 hours for an overload of 135% and will trip as a function of I^2t for higher currents. Continuous Current Values for each lettered setting are indicated by the chart shown here on the right side of the trip unit.

7-4 . t_r - The number of seconds required to trip @ 6x. For example, I_r@800A, tr=7sec, load current @4800A(6X). The breaker will trip in 7 seconds. NOTE: There is a thermal memory capacitor that will affect the LDT time. If the breaker has tripped on LD, this capacitor must be discharged or it will self discharge after five minutes. If neither one of these choices has been done, the LD trip time will be shorter.

7-5 . I_{sd} - Setting in multiples of I_r. For short circuit conditions that exceed the short delay pick-up setting, the trip unit initiates a trip after a predetermined delay.

7-6 . The - I_g switch is the ground fault pick-up switch and is used on the LSIG & LSG styles to set the ground fault pick-up all frames have the same pick-ups: 200A, 400A, 600A, 800A, 1000A, and 1200A. (I_gx1000A)

7-7 . For the LSI style, the Short Delay time is a flat response determined by the t_{sd}/t_g switch setting of INST, 120ms or 300ms. For the LS style, the short delay time is an I^2t function.

7-8 . For the LSIG style, the short delay is a flat response determined by the tsd/tg switch settings of INST, 120ms or 300ms. This switch is a dual switch that also determines

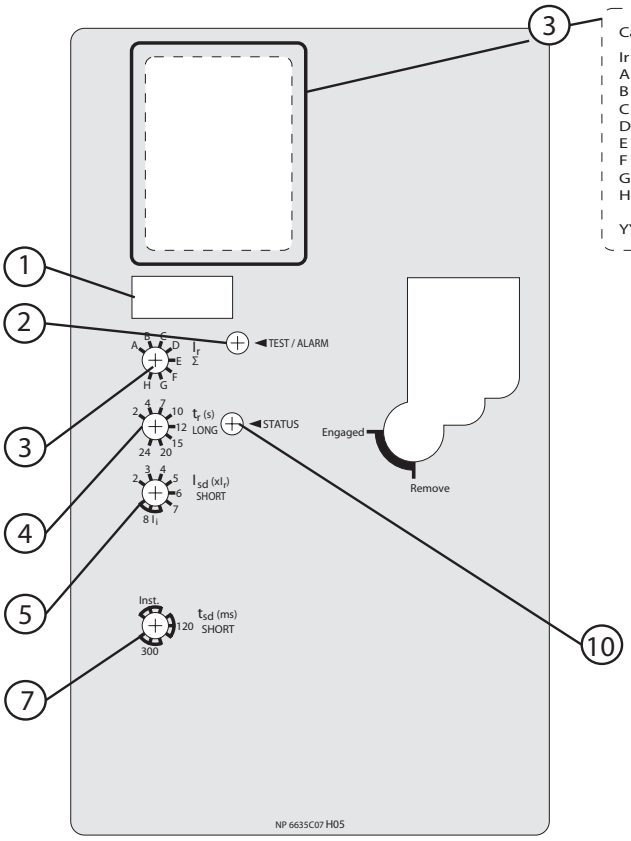

Figure 3.0

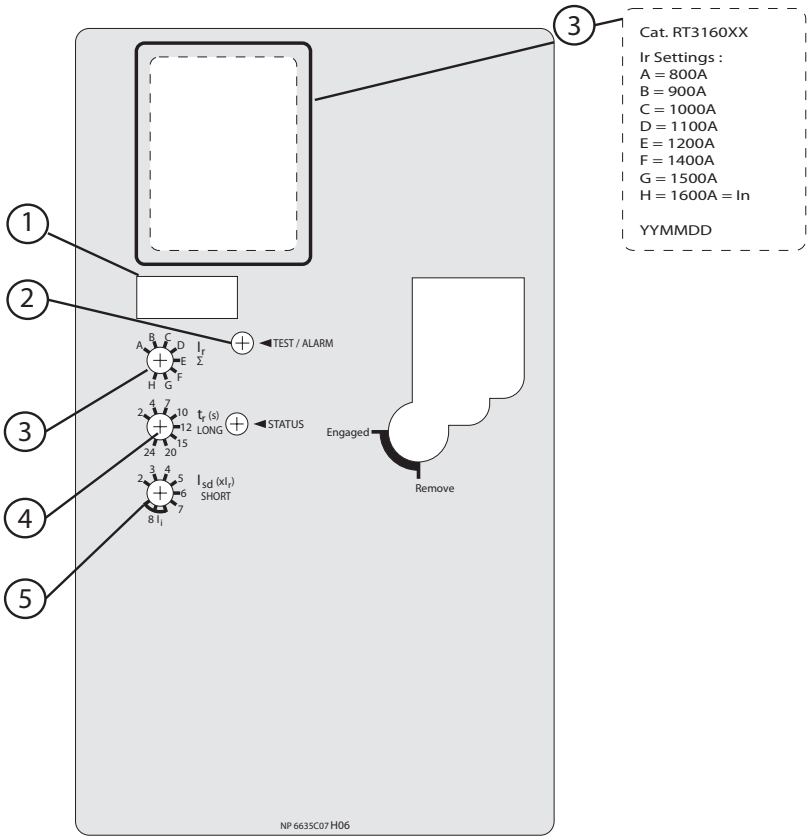

Figure 4.0

the ground fault time settings of INST, 120ms or 300ms. As an example, if the t_{sd}/t_g switch is set at a position J, then both short delay time and ground fault time are an INST flat. A second example would be to set the t_{sd}/t_g switch at position L, then the short delay flat time is INST and the ground fault flat time is at 300ms. The LSIG label (see balloon 8A) should be used in conjuction with the tsd/tg switch to set any one of nine possible combinations of short delay and ground fault flat times. The LSIG label is found on all LSIG trip unit name plates.

7-9 . For the LSG style, the short delay time is an I^2t function while the ground fault flat time is set by the tg switch. For the LS style, the short time is an I^2t function.

7-10 . Status LED - A green status light indicates the operational status of the trip unit. If the load current is approximately 20% of the maximum current rating (I_n) of the breaker, the status light will blink on and off once each second.

7-11 . The Cause of Trip module provides an LED visual indication of why the breaker tripped. Possible causes are: Long, Short, Ground Fault and Instantaneous. Please refer to IL01219086E for more information.

7-12 . The Maintenance Mode and adjustable INSTantaneous features are only available on LSI and LSIG styles. Please refer to the labeling to the left of the test kit connector. The Maintenance Mode consists of the two lowest settings of the INST switch: 2.5x and 4.0x. For example, a 1600A (I_n) RG breaker with the switch set to 2.5x would trip instantaneously when the current exceeded 4000A.

7-13 . The adjustable INSTantaneous (I_i) Mode has five settings. The last setting is labeled as Max and corresponds to the frame over ride setting of 17,500A. The other four settings vary according to frame rating: for the 2500A frame the settings are 5x, 6x, 6x, and for the 1600A/2000A frames the settings are 6x, 7x, 8x, and 8x.

7-14 . On an RG without Maintenance Mode, the lowest labeled SDT setting is labeled INSTaneous. The lowest SDT setting with Maintenance Mode is labeled as 50ms.

7-15 . The Remote Maintenance Mode (RMM) is enabled by applying 24VDC to the proper two terminals on the CD block on the left side of the breaker. (C5-Rmm+ and C4-Rmm-).

A blue colored LED on the right bottom side of the trip unit will light when RMM is enabled. A contact (SPST) on the CD block will close in order to provide on additional positive feedback to the customer that RMM has been enabled.

The lighted blue LED indicates that the lowest setting of the Maintenance Mode is enabled. This setting corresponds to 2.5x of I_n. Turning the adjustable switch on the trip unit has no affect on either the Maintenance Mode or the INST Mode settings while the blue LED is lit.

7-16 . The High Load Alarm Relay option will provide a SPST contact closure when the trip unit current equals or is greater than 95% of In for a period of 38 seconds. The Ground Fault Alarm Only option operates in a similar fashion: the SPST contact will close if the ground fault pick-up setting is exceeded and will open when below the ground fault pick-up setting.

7-17 . The Ground Fault Relay option will provide a SPST contact closure immediately before the breaker will trip on a ground fault over current detect. This closure is momentary (50ms) and the customer must provide the necessary external circuitry in order to latch this signal. The contacts: Common (C) and normally open (NO) are available from the CD block on the left side of the breakers. (C7-COMAlarm, D3-Alarm NO)

NOTE: Either the high Load Alarm Relay or the Ground Fault Alarm Relay option can be selected but not both. The High Load Alarm Relay can only be selected with LS and LSI trip unit styles. If the trip unit is a Ground Fault style, the GFA Only Relay, by default, will be selected.

NOTE: The contact rating of the relay is: 250VAC@ 8 AMPS resistive load.

7-18A . The Zone Selective Interlock (ZSI) option provides a wired method of coordinating Upstream and Downstream breakers. The coordinating signals are provided by the White/Red stripe (Zin), White/Black stripe (Zout), and Black (common ground) wires that exit the right side of the breaker.
A typical connection (two breaker system is accomplished by connecting the Zout wire of the Downstream breaker to the Zin of the Upstream breaker. The common black wires of both breakers must also be connected.
If a high current fault is sensed from the load on the Downstream breaker, both breakers will sense the fault. However, the Downstream breaker will send the interlock signal to the Upstream breaker informing it not to trip defined by the SD time settings of both breakers. This delay allows the Downstream breaker to clear the fault without the Upstream breaker tripping.
However, if for some reason the Downstream breaker does not clear the fault in the set delay time, the Upstream breaker will then clear the fault.

NOTE: this option must be ordered from the factory.
NOTE: Please see Balloon 8A and refer to 5.0.

7-18B Zone selective interlocking is provided for the short dealy and the ground fault delay tripping functions for improved system protection. The G310+ Trip Unit zone selective interlocking feature is compatible with OPTIM and Digitrip Trip Units, Model 510 and higher. It will also be compatible with Series G LG & JG Trip Units, as well as, with FDE breakers.

The zone selective interlocking feature is a means of communications over a pair of wires between two or more compatible trip units. Zone selective interlocking makes it possible for programmed trip unit settings to be altered automatically to respond to different fault conditions and locations, thereby localizing the effects of an interruption and providing positive coordination between circuit breakers.

Three wires exit the breaker with the following color code and function: White/with Black Stripe=Zone Out, White/with Red Stripe=Zone In, and Black=Common.

An example of a Zone Interlock system would be a RG 310+, A breaker used as the upstream breaker and a 225A FDE breaker used as the downstream breaker. The Zout wire (white/black stripe) of the 225A breaker would be connected to the Zin wire (white/red stripe) of the RG310+ breaker. Also both common wired (black must be connected). There could be more breakers added in a similar fashion to form a zone of protection.

For faults outside the zone of protection, the trip unit of the circuit breaker nearest the fault sends an interlocking signal (Zout) to the trip unit of the up-stream circuit breaker (Zin). This interlocking signal restrains immediate tripping of the upstream circuit breaker until its programmed coordination times is reached. Thus zone selective interlocking applied correctly can reduce damage due to circuit or ground fault conditions. A table of the settings of the two breakers versus the outcomes (Both trip, Downstream (Dn) trips) of the breakers is indicated below for the conditions mentioned in the Table heading.

		Upstream		
		INST	120ms	300ms
Downstream	INST	Both 43ms	Dn 43ms	Dn 43ms
	120ms	Both 52ms	Dn 52ms	Dn 52ms
	300ms	Both 43ms	Dn 43ms	Dn 43ms

Fig. 5.0

NOTE: A single RG310+ breaker with the Zone Interlocking feature enabled will not trip at the programmed time settings, unless Self Interlocked. That is, the Zout wire should be connected to the Zin wire..

NOTES

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