

SIEMENS

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Page

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Overcurrent Trip Devices

Static Trip III

Instructions
Installation
Operation
Maintenance
SG-3118



Safety

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES. SEVERE PERSONAL INJURY OR PROPERTY DAMAGE CAN RESULT IF SAFETY INSTRUCTIONS ARE NOT FOLLOWED. ONLY QUALIFIED PERSONNEL SHOULD WORK ON OR AROUND THIS EQUIPMENT AFTER BECOMING THOROUGHLY FAMILIAR WITH ALL WARNINGS, SAFETY NOTICES, AND MAINTENANCE PROCEDURES CONTAINED HEREIN. THE SUCCESSFUL AND SAFE OPERATION OF THIS EQUIPMENT IS DEPENDENT UPON PROPER HANDLING, INSTALLATION, OPERATION AND MAINTENANCE.



Qualified Person



For the purpose of this manual and on product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment and the hazards involved. In addition, he has the following qualifications:



- a. Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- b. Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

Signal Words

Distinctive signal words (DANGER, WARNING, CAUTION) are used in this instruction book and on product labels to indicate degrees of hazard that may be encountered by the user. These signal words are defined below.

	 WARNING
	Indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

	 CAUTION
	Indicates minor personal injury or property damage can result if proper precautions are not taken.

	 DANGER
	Indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

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Note

The instructions contained within this manual are necessary for the safe installation, maintenance and operation of this equipment. If this manual is misplaced or lost, replacement manuals are available through the local Siemens Energy & Automation, Inc. sales office.

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency, to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens Energy & Automation, Inc. sales office.

THE CONTENTS OF THIS INSTRUCTIONAL MANUAL SHALL NOT BECOME PART OF OR MODIFY ANY PRIOR OR EXISTING AGREEMENT, COMMITMENT OR RELATIONSHIP. THE SALES CONTRACT CONTAINS THE ENTIRE OBLIGATION OR SIEMENS ENERGY & AUTOMATION, INC. THE WARRANTY CONTAINED IN THE CONTRACT BETWEEN THE PARTIES IS THE SOLE WARRANTY OF SIEMENS ENERGY & AUTOMATION, INC. ANY STATEMENTS CONTAINED HEREIN DO NOT CREATE NEW WARRANTIES OR MODIFY THE EXISTING WARRANTY.

If drawings or other supplementary instructions for specific applications are forwarded with the manual or separately, they take precedence over any conflicting or incomplete information in this manual.

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The information contained within is intended to assist operating personnel by providing information on the general characteristics of equipment of this type. It does not relieve the user of responsibility to use sound engineering and safety practice in the application, operation and maintenance of the particular equipment purchased.

If drawings or other supplementary instructions for specific applications are forwarded with this manual or separately, they take precedence over any conflicting or incomplete information in this manual.

The sales contract carries all the information on warranty coverage.

General

Static Trip III is the name of Siemens Energy & Automation, Inc. microprocessor based static overcurrent trip device for use on LA and RL series low voltage power circuit breakers. The breakers and trip device are listed and labeled by Underwriters Laboratories (UL).

With the exception of the selector switches and one potentiometer the Static Trip III overcurrent trip devices are completely static. There are no moving parts or mechanical contacts. Components used are semiconductors, integrated circuits, capacitors, transformers, etc. The selector switches are sealed binary coded decimal types with gold plated contacts. The device uses an eight bit single chip microprocessor, with its internal ROM (Read Only Memory) programmed to be a trip device. All the circuits are designed for conservative loading of components for long life and little maintenance.

Static Trip III overcurrent trip devices operate to open the circuit breaker when the circuit current exceeds a preselected current-time relationship. Depending on the magnitude of the overcurrent and the selected settings, tripping may be instantaneous or time-delayed.

Energy to operate the tripping system is obtained solely from the circuit being protected. Batteries or other power sources are not needed.

The basic static overcurrent trip system consists of three parts:

1. Primary circuit current sensors
2. The Static Trip III device.
3. A magnetically held circuit breaker latch release device called the tripping actuator.

In addition to the basic system, optional devices can be provided for additional functions. These include:

1. A Load Indicator mounted on the front cover of the breaker to display load currents and provide adjustable load alarm contacts.
2. Zone Interlock Coupler and Zone Interlock Expander devices to connect trip devices together for selective short time and ground fault interlocking.

Current Sensors

Toroidal current sensors, similar to standard bushing current transformers, are mounted, one-per-phase on the primary studs of the circuit breaker. They are special purpose current transformers that have the accuracy and output voltage capability needed to properly operate the static trip device. These provide a signal to the static trip device proportional to the primary current. The current sensors selected for a specific circuit breaker establish the maximum continuous current rating of that breaker and the adjustment range. Each sensor provides a choice of eleven selectable current settings.

The rated secondary current for the sensors is 0.5 amperes at rated primary current. All the sensors used with the Static Trip III device are encapsulated in polymeric material to protect the windings and prevent their motion during short circuits on the circuit breaker.

Static Trip III

A molded polyester enclosure, attached to the breaker, houses the trip device and its electronic circuits (**Figure 1**). The static trip device receives the signal from the current sensors. It monitors the signal, senses overloads and faults, and determines the required action in accordance with preselected control settings.

In the Static Trip III device the current signal is scaled to the proper value internally by small transformers, one per phase, rectified and converted to a voltage signal by a resistor. This voltage signal is converted to a digital signal by an analog to digital converter. All timing and logic decisions are then processed mathematically in the microprocessor, and are not affected by variations due to external influences, such as changes in temperature.

The Long Time Pickup and timing is based on the RMS value of the current. This is a major advantage over other types of trip devices when the load current is not a true sinusoid, such

as in the case with phase controlled drives or other processes. In like fashion, the I^2t ramp on Short Time uses an RMS calculation to establish timing.

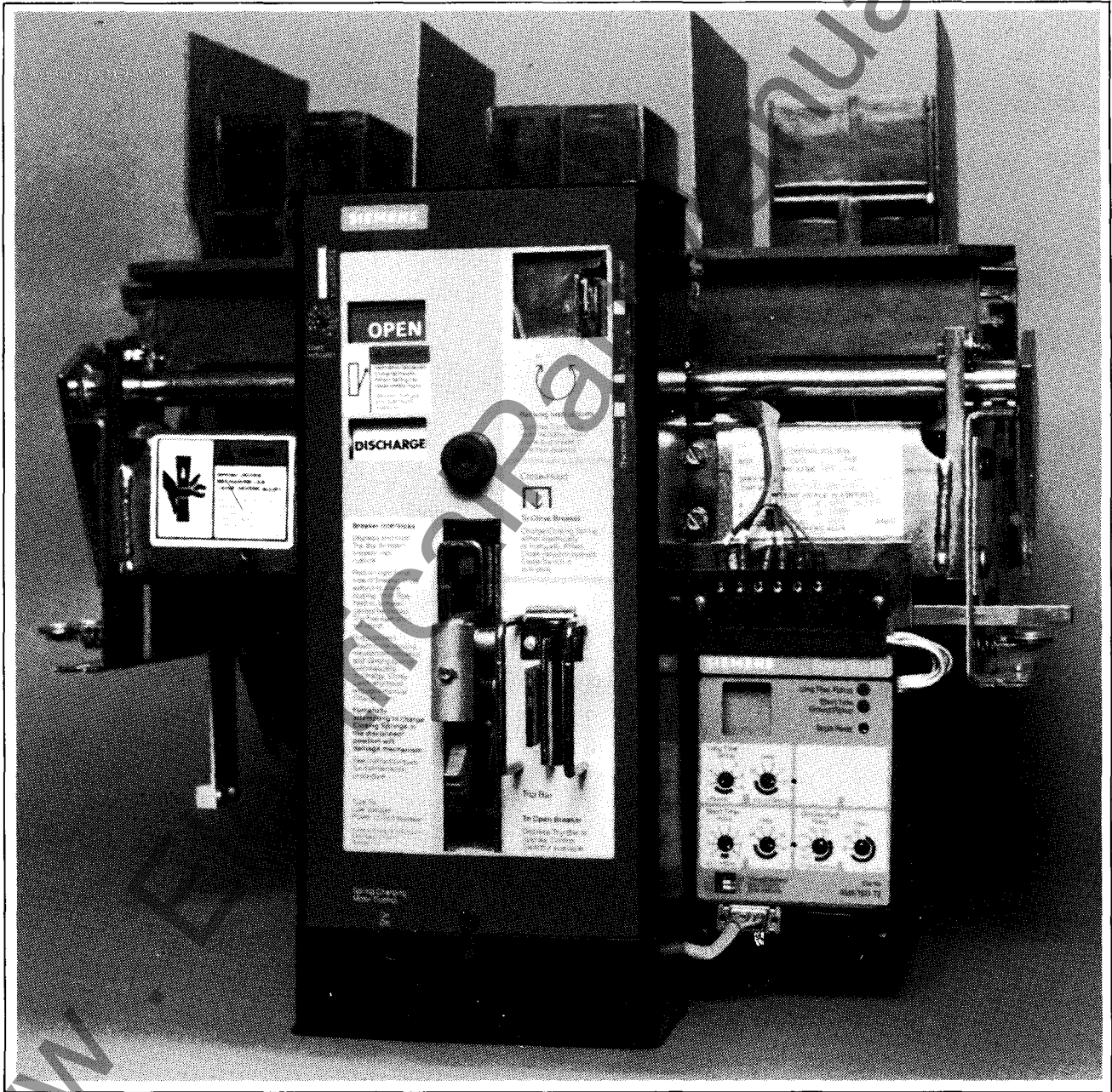


Figure 1. Static Trip III Device Attached to Circuit Breaker

Tripping Actuator

When the static trip device senses a circuit condition that requires the breaker to open, it provides an output to the actuator (**Figure 2**) which causes the circuit breaker contacts to open and isolate the circuit.

When the circuit breaker is closed, the tripping actuator is held in a charged position by a permanent magnet. It contains a coil that is energized by the output of the static trip device. When energized this coil causes the magnetic flux to shift to a new path, away from the holding pole faces. This releases the stored energy of a spring located inside the actuator. The spring provides the energy to trip the breaker. When the breaker mechanism opens, the actuator is returned to the charged and held position by a reset mechanism on the breaker.

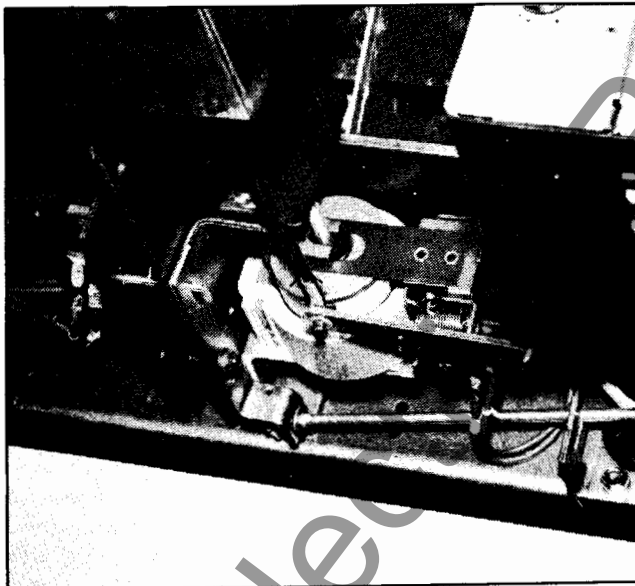


Figure 2. Tripping Actuator

The tripping actuator for use with the Static Trip III device contains an additional coil which, when energized by an additional output provided by the trip device, aids the permanent magnet in holding the actuator closed. This coil, called the hold-in coil, is to counteract the effects of the external magnetic fields produced by short circuit currents flowing through the breaker.

Targets

The target element consists of a custom LCD (Liquid Crystal Display), a modest amount of CMOS logic and a large capacitor (1 Farad) to store the power to operate the logic and LCD for an extended period of time. The LCD has four legends that become visible when the target is operated, either by the microprocessor or the "watchdog" circuit. The four legends are: OVERLOAD to signal long time tripping, SHORT CIRCUIT to signal either short time or instantaneous tripping, GROUND FAULT to signal when the device trips on ground current, and DISABLED to signal when the "watchdog" circuit determines that the microprocessor is not functioning properly.

Available Types

Various types of Static Trip III devices are available. Similar in many respects, they differ only in their specific application. All accept identical current sensor input and provide output signals to the tripping actuator, and to the optional devices.

The type designation is coded to indicate the functional elements and is preceded by RMS to denote the standard RMS sensing feature.

The type coding is two to four letters as shown below:

T = LONG TIME delay element.

S = SHORT TIME delay element.

I = INSTANTANEOUS element.

G = GROUND FAULT element.

For each element except INSTANTANEOUS, there are two adjustable selector switches, accessible through the front cover of the device, one for the current or pickup setting and one for the time delay setting. The INSTANTANEOUS has only one switch for pickup setting. All adjustments can be made in the field. Following are brief descriptions of the different types.

Type RMS-TI

A dual trip device used for phase overcurrent protection with instantaneous trip. The long time current setting range is selected from the trip rating table and is switch selectable in eleven steps from 0.5 to 1.0 times the current sensor rating. The pickup value is fixed at 1.1 times current setting. The LONG TIME delay is selectable with a choice of five bands. The long time circuit has a switch-selectable "Thermal Memory" function for motor protection. The instantaneous element is switch selectable in six steps from 2 to 15 times the current sensor rating. The instantaneous pickup setting is independent of the long time current setting.

Type RMS-TS

A selective trip device used for phase overcurrent protection which provides time delay tripping only. It allows complete field adjustment of long time delay and current setting plus the short time delay and pickup. The short time pickup can be selected in 8 steps from 2 to 12 times the long time current setting. Any one of the five short time delay bands can be chosen to be used with any of the five long time delay bands. The device contains in/out switches for short time I^2t ramp and long time "Thermal Memory."

Type RMS-TSI

A triple selective trip device used for phase overcurrent protection which provides long time delay, short time delay and instantaneous elements. It allows complete adjustment of the long time delay band and current setting, the short time delay band and pickup and the instantaneous pickup.

The short time pickup can be adjusted from 2 to 12 times the long time current setting. The instantaneous pickup can be adjusted from 2 to 15 times the current sensor rating. The instantaneous pickup current is not changed by a change in the long time current setting. The short time pickup varies with long time current setting. Any one of the short time delay bands can be chosen to be used with any one of the long time bands. The device contains in/out switches for short time I^2t ramp and long time "Thermal Memory."

Types RMS-TI-T, RMS-TS-T and RMS-TSI-T

Targets are provided by adding a "-T" suffix to the basic trip device catalog number. The same basic protective functions are provided as described above. In addition, a separate microprocessor "watchdog" circuit is included to monitor and indicate malfunction of the microprocessor.

Type RMS-TIG-T

A dual trip device which provides phase overcurrent protection same as the Type RMS-TI plus ground fault protection for three wire or four wire circuits on systems with either phase to phase or phase to neutral loading. Ground pickup settings are independent of the phase settings and are selectable in 5 steps from 20 to 60% of the ground sensor rating. When used on four wire circuits a fourth neutral sensor is required. It is mounted in the bus compartment and is wired to the breaker through the breaker secondary disconnects. Direct ground sensing can also be used, with the external neutral sensor mounted on the ground return conductor.

The Ground Fault function includes an I^2t ramp in the time-current delay characteristic and a built in memory for arcing ground fault protection. The device contains an in/out switch for long time "Thermal Memory."

Type RMS-TSG-T

A selective trip device which provides phase overcurrent protection same as Type RMS-TS plus ground fault protection for 3-wire or 4-wire circuits on systems with either phase to phase or phase to neutral loading. Ground current pickup settings are independent of the phase pickup settings and are adjustable from 20 to 60% the ground sensor rating. When used on 4-wire systems a fourth neutral sensor is required. It is mounted in the bus compartment is wired to the breaker through the breaker secondary disconnects. The ground element can also be connected for direct ground sensing by mounting the external neutral sensor on the switchgear ground return conductor.

The device contains an in/out switch that adds an I^2t ramp to the short time delay bands. The device contains an in/out switch for long time "Thermal Memory."

Type RMS-TSIG-T

A triple selective trip device which provides phase overcurrent protection same as Type RMS-TSI plus ground fault protection for 3-wire or 4-wire circuits on systems with either phase to phase or phase to neutral loading. Ground current pickup is independent of the phase current settings. The ground pickup settings are selectable from 20 to 60% of the ground sensor rating. When used on 4-wire circuits a fourth neutral sensor is required. It is mounted in the bus compartment and is wired to the breaker through the breaker secondary disconnects.

Types RMS-TS-TZ, RMS-TSI-TZ, RMS-TSIG-TZ and RMS-TSG-TZ

The "Z" suffix at the end of the trip device catalog number signifies Zone Interlocking capability for short time and/or ground fault functions. The same basic protective functions are provided as described above with the added capability of connecting trip devices together into a selectively Zone Interlocked system. The Zone Interlock circuit has an in/out switch to allow these trip devices to act as standard units. This facilitates testing and allows interchange with trip devices which are not Zone Interlocked.

NOTE

1. Devices that provide ground fault protection are not available without targets.
2. Optional Selective Zone Interlocking circuits are "hard wired" between trip devices. When this option is specified the trip device is provided with a cord to connect to a cubicle-mounted connector. The trip device provides an output signal whenever either the ground or short time element picks up. This output signal is connected from the downstream breaker to the input terminals of the upstream breaker.
3. With no signal applied to the Zone Interlocking input and the Zone Interlock switch "in," both the ground and the short time elements will operate on their shortest time delay bands, regardless of the band selected. When the signal is applied both the ground and the short time elements will operate on their selected delay bands.

Time-Current Curves

Figure 3 is a set of time-current curves for the Static Trip III devices. The long time element has a characteristic represented by:

$$T = KI^{-2} \text{ or } = K/I^2$$

where T = time delay, I = current expressed in multiples of the long time current setting, and K is a constant depending

on the band selected. In other words, the delay for a given band setting varies inversely as the square of the current. When plotted on log-log paper this relationship is a straight line as shown by the sloping bands in **Figure 3**. Five discrete long time delay bands are available in every device, any one of which may be selected by the delay band control switch.

The long time element has a "Thermal Memory" function that is selected by a switch on the front of the device. If this switch is "in," the delay counter of the long time circuit will not reset to zero when the current falls below the long time pickup value, but will slowly count down at a rate determined by the magnitude of the remaining current. When there is an intermittent overload that does not reach the pickup level of the short circuit elements, the intervals of overload current will be accumulated and tripping will occur when the accumulated value reaches the selected trip time. However, if the current drops to nearly zero the count will be reset and the timer will require the full delay before tripping will occur.

If the "Thermal Memory" switch is "out," the long time element will reset each time the current falls below the long time pickup value.

The minimum delays for each band, at six times the current setting are 3.5, 6.0, 10, 17 and 30 seconds, and are shown at the delay adjustment switch.

The short-time element has a definite delay which is independent of current as shown by the horizontal curves in **Figure 3**. There are 5 calibrated bands. These have nominal delays of 0.08, .15, .22, .30 and .40 seconds.

The short time element has an I²t ramp as shown in **Figure 3**. This function is selected in or out by a small switch on the front of the device labeled "Short Time I²t." This feature provides improved coordination with downstream devices such as time delay fuses, or molded case circuit breakers.

The ground fault time delay element has a definite delay similar to the short time element. There are three calibrated bands having delays of 0.1 second, 0.25 second and 0.4 second. The ground fault element also includes an I²t ramp as shown in **Figure 3**.

Both the short time and the ground fault elements can be supplied to be used with the Zone Interlock option. The ZI option allows the trip devices to be wired together to provide faster tripping for faults between breakers. When Zone Interlocking is specified, the trip device will operate on the minimum time delay curves for both short time and ground fault in the absence of an incoming ZI signal. When the trip device is supplied with an incoming ZI signal, both curves will shift to the bands selected by their respective delay band settings.

Trip devices with the Zone Interlocking option have an "in/out" switch to allow them to function as a standard trip unit when not wired into a ZI system.

Instantaneous trip has no intentional time delay, other than that provided by the power supply and for filtering purposes. The Instantaneous curves show the breaker rated clearing time for a three phase fault. For closing in on a single phase fault the total clearing time may be extended by as much as .02 seconds.

The width of the time bands in **Figure 3** is due principally to differences between devices caused by normal tolerance of commercial components in the circuits. Repeated tests on any one unit will fall in a much narrower band.

The band width also includes the breaker interrupting time. The upper limit represents the maximum total clearing time including breaker opening and arcing time, whereas the lower limit is the "resettable time"— the maximum time that the overload can persist without tripping the circuit breaker.

Note that the Instantaneous curves show no "resettable time," indicating that multiple breakers with instantaneous trip devices cannot be selectively coordinated for short circuits except by pickup settings.

Performance In Service

Ambient conditions and length of service have little effect on the performance of the Static Trip III trip device. The circuits are stable and will show excellent repeatability over long periods of time. Service involving frequent operations will not cause the characteristics to change or drift, since there are no moving mechanical parts to wear or bearings to lubricate.

Static Trip III devices are tolerant of dusty conditions and will function properly in many areas that would affect the performance of electro-mechanical trip devices. The circuit boards and components inside the trip device are coated with a con-

formal coating to exclude moisture and many corrosive atmospheres. However, the factory should be consulted when the application involves a particularly severe environment.

The temperature at the static trip device does have some effect on the characteristics and on the overall reliability of the system. The change in characteristics is small since most of the operations are carried out as mathematical manipulations within the microprocessor, so changes should not be a factor in most applications. Over the range of -40°C to $+55^{\circ}\text{C}$ (-40°F to 131°F), the variations from performance at room temperature is very small, amounting to less than 5% on pickup or time delay values. Operation is not recommended beyond this range. If necessary, control of the temperature should be provided by heaters or ventilation. Operation at increased ambient temperature seriously affects the reliability of all electronic devices.

Connection Diagrams **Figure 4** through **6** show in schematic form the pre-wired connections from the breaker-mounted current sensors to the Static Trip III device. This wiring varies with the application. The three most commonly used schemes are shown, and the diagrams with their captions are self-explanatory.

NOTE

For 4-wire systems with ground fault tripping the neutral sensor is connected to the neutral or ground return conductor in the bus compartment, and is connected to the Static Trip III trip device through secondary drawout contacts on the breaker.

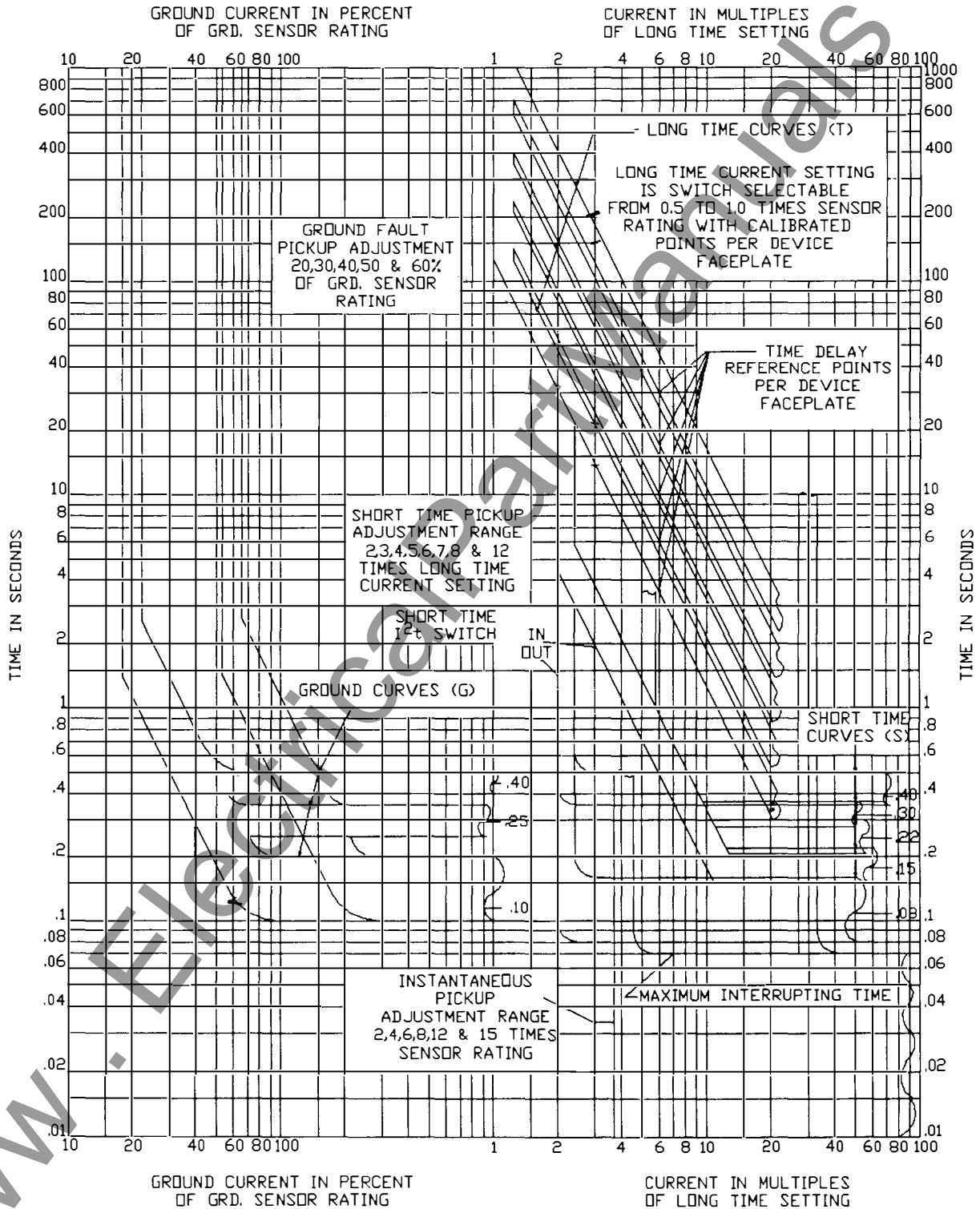
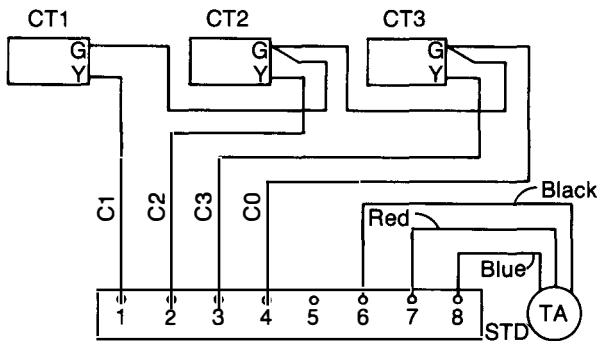
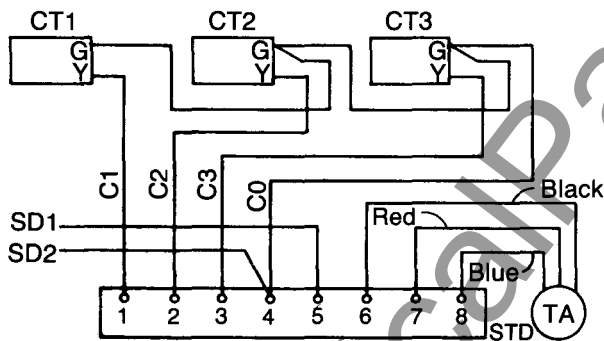


Figure 3. Static Trip III Trip Device Time-Current Curves



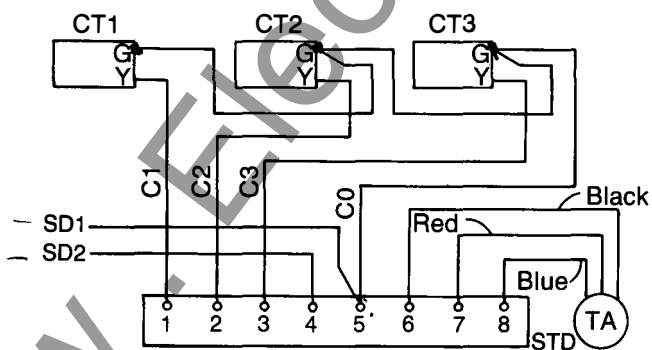
Wire No.	From	To	Size
C1	CT1-Y	STD 1	18
C2	CT2-Y	STD 2	18
C3	CT3-Y	STD 3	18
C0	CT1-G	CT2-G	18
C0	CT2-G	CT3-G	18
C0	CT3-G	STD 4	18
TA1	Black	STD 6	*
TA2	Red	STD 7	*
TA3	Blue	STD 8	*

Figure 4. Static Trip III "3WG" Connection Diagram



Wire No.	From	To	Size
C1	CT1-Y	STD 1	18
C2	CT2-Y	STD 2	18
C3	CT3-Y	STD 3	18
C0	CT1-G	CT2-G	18
C0	CT2-G	CT3-G	18
C0	CT3-G	STD 4	18
	SD 2	STD 4	18
	SD 1	STD 5	18
TA1	Black	STD 6	*
TA2	Red	STD 7	*
TA3	Blue	STD 8	*

Figure 5. Static Trip III "4WRG" Connection Diagram



Wire No.	From	To	Size
C1	CT1-Y	STD 1	18
C2	CT2-Y	STD 2	18
C3	CT3-Y	STD 3	18
C0	CT1-G	CT2-G	18
C0	CT2-G	CT3-G	18
C0	CT3-G	STD 5	18
	SD 2	STD 4	18
	SD 1	STD 5	18
TA1	Black	STD 6	*
TA2	Red	STD 7	*
TA3	Blue	STD 8	*

Figure 6. Static Trip III "4WDG" Connection Diagram

*Device Leads

Settings

Static Trip III devices have a number of switches that can be arranged to select discrete load conditions that will cause the breaker to open. The settings are usually made when the breaker is placed in service to match anticipated load conditions and coordination requirements. Future changes are unnecessary unless load conditions change or primary circuit changes are made.

Figure 7 is an illustration of the type RMS-TSIG-TZ device which contains all Static Trip III control options. The following paragraphs discuss the use of these controls.

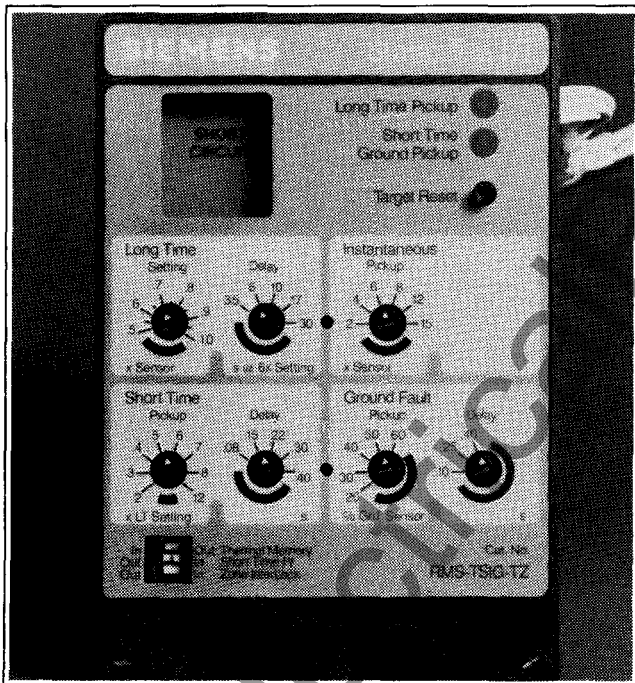


Figure 7. Static Trip III RMS-TSIG-TZ Device

LONG TIME CURRENT SETTING has 11 calibrated positions. These are marked .5 through 1.0 in increments of .05. Long time pickup is fixed at 1.1 times the long time current setting.

Figure 8 is a table of settings in primary circuit amperes for all the standard current setting ratings.

The current setting rated secondary current is 0.50 ampere. This current corresponds to long time current setting 1.0. If the

device is set on 1.0 it will pickup and start timing when secondary current exceeding 0.55 ampere is supplied by the current sensors.

EXAMPLE: Suppose it is desired that the breaker shall trip whenever sustained current exceeds 600 amperes, and suppose the current sensor rating is 800 amperes (800/0.5 ratio). The LONG TIME current setting should be .75.

Sensor Rating (Pri-Amps)	.5	.6	.7	.8	.9	1.0
150	75	82.5	90	97.5	105	112.5
200	100	110	120	130	140	150
300	150	165	180	195	210	225
400	200	220	240	260	280	300
600	300	330	360	390	420	450
800	400	440	480	520	560	600
1200	600	660	720	780	840	900
1600	800	880	960	1040	1120	1200
2000	1000	1100	1200	1300	1400	1500
3200	1600	1760	1920	2080	2240	2400
4000	2000	2200	2400	2600	2800	3000

Figure 8. Long Time Element Calibrated Current Settings

NOTE

There is a plus or minus 10% tolerance allowable on the accuracy of the trip device pickup values. This means that the breaker may trip for currents between current setting and plus 20%, therefore the breaker will always carry current setting without tripping.

INSTANTANEOUS PICKUP has six calibrated points, 2X, 4X, 6X, 8X, 12X and 15X calibrated in multiples of the current sensor rating. The instantaneous setting is independent of the long time current setting.

EXAMPLE: Referring to the previous example, suppose it is desired that the breaker open instantly when the current exceeds 3200 amperes. $3200/800 = 4$, so the instantaneous should be set on 4X. If the long time settings are changed the breaker will still trip at 3200 amperes instantaneous.

SHORT TIME PICKUP has 8 calibrated settings of 2X, 3X, 4X, 5X, 6X, 7X, 8X, and 12X. These calibrated values are in multiples of the LONG TIME current setting, and so change value when the long time setting is adjusted.

EXAMPLE: Refer to the previous example, suppose that it is desired to have the curves transfer from the long time curve to the short time curve for currents above 1800 amperes. $1800/600 = 3$, so the Short time pick-up should be set on 3X.

GROUND PICKUP has five calibrated settings of 20%, 30%, 40%, 50% and 60%, as shown in **Figure 9**. These are calibrated as multiples of the ground sensor rating. For current sensors through 2000A rating, the ground sensor and current sensor ratings are the same. For 3200A and 4000A current sensors, a separate 2000A ground sensor winding is provided.

EXAMPLE: In our example the ground sensor rating is 800 amperes, so for a Ground pickup setting of 20%, a ground current exceeding 160 amperes will cause the ground circuit to pickup. If the ground current persists for a longer time than the setting of the Ground Fault Delay Band setting the breaker will trip.

As explained earlier the rated secondary current for the sensors is 0.5 ampere, so the 20% setting is 0.100 ampere into the trip device ground terminal and the pickup tolerance is $\pm 10\%$ of this value.

Time Bands

There are five LONG TIME DELAY BANDS available on all Static Trip III overcurrent trip devices.

On devices with Short Time there are five SHORT TIME DELAY BANDS.

On devices with GROUND FAULT tripping there are three time delay bands for the ground elements.

On Static Trip III devices with both Short Time and Ground, the Ground circuits are prevented from tripping if the Short Time pickup currents are exceeded.

Devices with Short Time have a switch on the front of the device to add an I^2t ramp portion to the time delay curve for Short Time. These curve segments can be selected but are not otherwise adjustable.

All the LONG TIME, SHORT TIME INSTANTANEOUS and GROUND FAULT time delay bands are shown on the TIME-CURRENT CHARACTERISTICS curve **Figure 3**. The curve sheet is self explanatory, except for the extension of the LONG

TIME CURVE to 30X. This is only true for the LOWEST Long Time current setting. With the Long Time current setting at 1.0, the curves extend to only 15 times long time current setting. This is the maximum primary current allowed by the 15X maximum pickup setting of Instantaneous.

NOTE

The NEC does not allow settings above 1200 amperes for ground fault sensing on service entrance equipment. To comply special ground sensor windings with 2000/0.5 ratio for ground sensing are provided on 3200A and 4000A current sensors. The ground sensor rating appears on the sensor rating label above the trip unit terminal block connection.

Sensor Rating Primary Amps	20%	30%	40%	50%	60%
150	30	45	60	75	90
200	40	60	80	100	120
300	60	90	120	150	180
400	80	120	160	200	240
600	120	180	240	300	360
800	160	240	320	400	480
1200	240	360	480	600	720
1600	320	480	640	800	960
2000	400	600	800	1000	1200
3200	400	600	800	1000	1200
4000	400	600	800	1000	1200

Figure 9. Ground Element Calibrated Pickup Settings

General Notes

1. The "Current Sensor Rating" values represent the primary value of current for 0.5 ampere of secondary current.
2. The current settings are switch selectable and calibrated at points .5 through 1.0 as shown in the table.
3. The nominal long time pickup values are 1.1 times the current setting with a tolerance of $\pm 10\%$.

4. The pickup settings of short time are calibrated at 2, 3, 4, 5, 6, 7, 8, and 12 times the long time current setting with a tolerance of +20% -0.
5. The Instantaneous pickup settings are at 2, 4, 6, 8, 12 and 15 times the current sensor rated current.
6. The long time element has 5 time delay bands. The minimum time delays at 6X current setting are 3.5, 6, 10, 17 and 30 seconds.
7. Short time has 5 time delay bands.
8. Ground elements have three time delay bands.
9. The maximum interrupting time is the maximum length of time that fault current flows, including arcing time.
10. Instantaneous maximum interrupting time may be greater when breakers are closed in on a fault depending on actual fault conditions. The maximum potential increase for a 3-phase fault is 0.01 seconds and for a single phase ground fault is 0.02 seconds.

Load Indicator

This device is not a part of the basic overcurrent protection system but is an available option. The device mounts in the front cover of the circuit breaker and its input cord plugs into a receptical on the front of the trip device as shown in **Figure 10**. The device is powered by the trip device power supply and contains nine LEDs (Light Emitting Diodes) that are illuminated to indicate the relative magnitude of current that the trip device senses. These lights indicate current in multiples of device pickup value. The first light is illuminated at .6 times pickup, the next for .7 times pickup, and so forth, up to 1.4 times pickup.

In addition there is a remote overcurrent alarm "contact" that closes when the current equals or exceeds the value selected by a switch on the front of the Load Indicator. The switch selects any of the indicated current values, from .6 to 1.4 times Long Time Pickup. The "contact" is an optically isolated solid state switch. The rating of the arrangement is 1 ampere, 125V Nominal, AC or DC. These "contacts" are wired out through the secondary disconnects of the breaker.

Zone Interlock Coupler

This device is not part of the basic overcurrent protective system but is used to connect static trip devices together in a selective Zone Interlocking (ZI) System. The ZI coupler provides a means of interconnecting circuit breakers to provide closer coordination for the SHORT TIME and GROUND FAULT circuits. The ZI output of the downstream breaker is connected to the ZI in-

put of the upstream breaker.

The ZI coupler connects the 15 pin sub "D" connection on the trip devices to an external terminal block mounted in the breaker cubicle.

Zone Interlock Expander

The Zone Interlock Expander is used to connect the ZI output signals into a common upstream breaker. There are optical isolators inside the trip device that depend on power from either its own trip device, or from the one that it is connected to. This means that if multiple units are connected in parallel, the trip device power supplies would be interconnected. A fault in one unit could then disable the other trip devices. The ZI expander overcomes this potential problem. The input of the expander consists of optical isolators with their outputs connected in parallel to drive the ZI input of the upstream device. It derives its power from the upstream device. The power for each optical isolator input is supplied from its own downstream trip device. No external power is required.

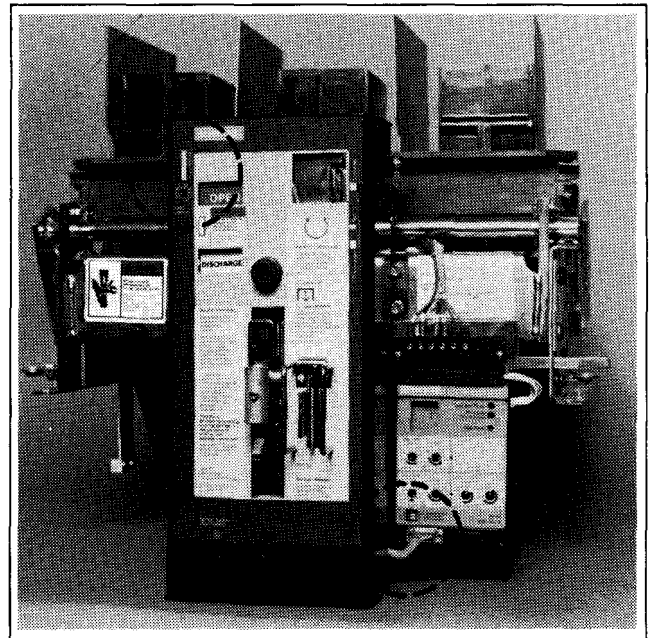


Figure 10. Optional Load Indicator Device Plugged into Static Trip III

Pin 8 is a signal called NOT RESET. This signal is used to enable the load indicator and is +5 volts DC when current supplied to the trip device is above approximately 100 milliamperes. Below this input level none of the data is accepted. All pins can be checked with a voltmeter while current is adjusted as desired. Flickering of the LED output is normal.

The load indicator assembly decodes the number and drives a light emitting diode bar display to indicate the magnitude of current. The indicator also contains an alarm setting switch and circuitry that selects any one of the current levels indicated and closes a solid state alarm contact when that level is exceeded.

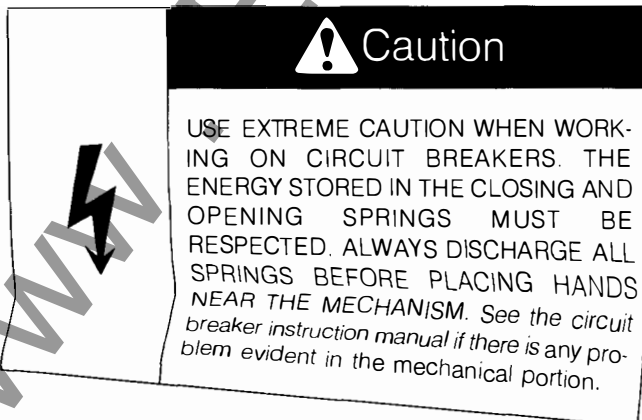
The solid state contact is rated 1 ampere, 125V nominal DC or AC.

Tripping Actuator Test

If the trip device fails to trip the breaker, the question arises as to whether the trouble is in the trip device or in the actuator. Substitution of a known good trip device is an easy way to supply a quick answer.

If another trip device is not available the actuator can be tested by applying voltage to its trip winding with the PTS4 test set. This winding connects to the terminal block with the positive terminal on number 7 and the negative terminal on number 6. The leads of the actuator are also color coded, red is positive, black is negative, and blue is the hold-in winding.

With the breaker closed, apply DC voltage to the terminals for the trip winding, start at zero voltage and slowly increase until the actuator trips. The voltage should be between 3 and 6 volts. Should the actuator fail to trip check the coil resistance. It should be between 15 and 25 ohms. Double check the polarity of the test voltage and check for any mechanical interference in or around the actuator.



Do not disassemble the tripping actuator, this may partially demagnetize it, and remagnetizing requires special equipment.

Current Sensor Test

The tests described in the preceding verify performance of the trip device and tripping actuator.

The third link in the Static Trip III protection system is the breaker mounted current sensors. These are special purpose current transformers. When secondary current testing is done with the trip device on the breaker, the current sensors are subjected to approximately their normal excitation so that a transformer with shorted turns may show up in the form of pickup values above tolerance. However, further testing is required to tell if the problem is in the static trip device or in the sensors. Moreover, an open circuit in the transformer winding or wiring would not show up at all. Therefore, it is desirable to test the current sensors as described in the following.

Connections

If the trip device is on the breaker, disconnect it by removing the connector strip from the lower row of terminal block connections. The current sensors can now be tested by making connections to the banana jacks on the top row of terminal block connections.

Continuity Checks

An ohmmeter is most suitable for checking the continuity of the sensor secondary windings and wiring. Connect the ohmmeter from terminal 1 to terminal 5 for Phase 1, from terminal 2 to terminal 5 for Phase 2, from terminal 3 to terminal 5 for Phase 3. The exact value of resistance is not important so long as there is continuity. The resistance should be approximately the same for all phases on a given breaker, but can vary widely for the various ratios of the sensors available.

When ground protection is provided, the ground strap or neutral sensor, whichever is used, is mounted external to the circuit breaker and is wired to the trip device through the breaker secondary disconnects on the side of the breaker. To check this circuit the breaker must be in the TEST position. Then the ohmmeter check can be made between terminal 4 and terminal 5 of the trip device terminal block. The circuit breaker wiring diagram should be checked for any special connections that may have been made.

Excitation Test

The purpose of the excitation test is to reveal shorted turns in the current sensor winding. Sixty (or 50) Hertz AC voltage is applied to the secondary winding and the exciting current is monitored. Short circuited turns will be revealed by excessive exciting current and possibly by overheating of the winding. A 120V variable transformer (Variat) and a low range ammeter is all that is required, although a 0-150 Volt AC voltmeter is desirable to monitor the applied voltage. The ammeter in the PTS4 test set can be used by passing current through the external current input.

In the absence of a voltmeter the dial reading on the variable transformer can be used as an approximate voltage indicator, See Table 5.

Table 5
Current Sensor
Exciting Current Test

Sensor Rating	Applied Volts	120 Volt Variac Setting	Maximum Exciting Current
150	33.5	25	0.25
200	67	50	0.15
300	67	50	0.10
400	67	50	0.10
600	67	50	0.05
800	134	100	0.03
1200 & Up	134	100	0.02

Again each phase must be tested in turn and the trip device must be disconnected. Connect the AC supply to terminals 1 and 5 for Phase 1, terminals 2 and 5 for Phase 2 and from terminals 3 and 5 for Phase 3. The output selector switch can be used to select each phase when the PTS4 test set is used. To test the Ground strap or neutral sensor it is necessary to have the breaker in the cubicle, in the TEST position. Again check the breaker wiring diagram, for any special connections that may have been made.

Table 5 gives the applied voltage and test limits of exciting current for all standard current sensor ratings.

The value of .02 ampere is about the lowest readable current using the ammeters in the PTS4 portable test sets, and the sensors that meet this limit will give satisfactory performance. Normal exciting currents for sensors rated 400 amperes and above may be well below this value. Therefore when checking high rating sensors it is essential to perform the continuity check.

For the lower ratios the continuity check can be omitted since the indicated magnetizing current would verify continuity.

Sensor Polarity

For the ground fault detection elements to operate properly the sensors must be connected with the proper polarity. The polarity of any given sensor can be checked by "flashing" the primary with a short duration pulse of known DC polarity and observing the polarity of the induced secondary voltage on make and break of the primary. A 6 volt dry cell can be used for the primary source and the polarity indicated by a DC voltmeter connected to the secondary winding. Refer to the three line diagram for the correct neutral or ground return sensor polarity.

Primary Current Testing

Testing with primary current applied to the circuit breaker requires a low voltage high current supply that can deliver currents up to 4 or 6 times the sensor rated current. There is commercially available equipment made for this purpose. This equipment generally includes the ammeters and timers needed to fully test the breaker.

Primary current testing can provide the ultimate in assurance that the entire protective system is functioning properly, since the entire system is tested at one time. However, primary current testing may present additional problems. One major difficulty arises from the non-linear impedance of the trip device power supply circuit. This circuit is designed to provide power to operate at low levels of current, then change impedance for higher levels of current to protect the trip device. When supplied from a low voltage source this changing impedance alters the waveshape of the current supplied to the trip device. This can result in insufficient power to properly operate the trip device, or it may affect the indication of the source ammeter, depending on the ammeter design, leading to the erroneous assumption that the trip device calibration is incorrect.

One other major difficulty with primary current testing is related to the duty cycle limitation of the circuit breaker and current sensors. A properly operating tripping system will be self-protecting from thermal damage up to the circuit breaker short time and interruption rating, providing that the duty cycle applicable for each rating is not exceeded. The standard duty cycle for the short time rating as demonstrated per ANSI C37.50 is 0.5 Seconds ON, 15 Seconds OFF followed by a second ON period of 0.5 Second. The ON intervals are too short to read the ammeter on the current source. For the instantaneous interruption rating each of the ON intervals are reduced to approximately 50 Milliseconds. Because of this, calibration of the

trip device high range settings cannot be accurately done with primary current.

The calibration can be verified safely at the lower settings and "operation only" verified at the higher set points.

If the duty cycle limits are exceeded during testing, the circuit breaker or current sensors as well as the trip device may be damaged. Between tests, the unit must remain OFF long enough to allow the current sensors to cool. In addition, if there is a fault in the system, the breaker may not operate within its rated time, and the system will not be self protecting.

Therefore to properly protect the tripping system from potential damage and still assure proper operation, the following procedure is recommended.

If the breaker has a ground fault sensing trip device connect a jumper between terminals 4 and 5 of the trip device.

1. Apply to one pole of the circuit breaker an input current of one half the current sensor rating and measure the trip device power supply voltage. This voltage can be measured with the negative lead of the voltmeter on any one of the following points: Pin 1 or 2 of the 15 pin connector or Pin 9 of the 9 pin connector. The positive lead is terminal block number 7, the red lead of the actuator. If this voltage exceeds 11 Volts with half rated current supplied, it can be assured that the wave shape distortion can be disregarded except for its possible effect on the ammeter indication. Test all three poles of the breaker in a similar manner, this establishes that the device power supply circuits are working.
2. Set the long time current setting to the .5 position. Slowly increase the current from zero while watching the long time pickup LED. Pickup should occur at one-half the current sensor rating x1.1 plus a tolerance of 20%, not including any ammeter error. Pickup is the lowest current at which the LED remains illuminated. Repeat for all three poles of the circuit breaker. This proves the input circuits are all working. When the pickup indication is present, the long time circuit timing element is released and the device will time out on LONG TIME.
Repeat calibration check on the other long time current settings as desired.
3. Set long time current setting on .5, long time delay band on 3.5, short time pickup and Instantaneous on 12X. Set the input current equal to the current sensor rating. Remove and reapply the power, allow the device to time out and trip the breaker. The time delay should meet the published curves for the device being tested. Repeat for all long

time bands. Note that the Static Trip III long time circuits respond to the RMS value of the input current, and depending on the type of ammeter being used the times may all appear to be longer than expected. If the test set has an RMS responding ammeter the time values should check properly.

4. Set instantaneous at 2X, short time pickup at 12X, long time delay band on its maximum. The breaker should trip instantaneous at twice the current sensor rated current plus or minus ten percent. Repeat for all three poles of the breaker.
5. Set short time pickup at 2X, instantaneous at 12X, long time delay band on its maximum, and short time delay band on minimum. Set long time current setting .5. Slowly increase the current. The breaker should trip at the current sensor rated current x1.1 minus zero plus 20 percent. The time delay circuit can allow the current to increase after tripping has been initiated, so the rate at which the current is increased must be limited to prevent "overshoot."
6. With the same settings as in step 5, adjust the supply current to 3 times the current sensor rating. Apply the current and observe the tripping time. Test all five short time delay bands. Note if the device contains Zone Interlocking, a ZI input signal must be supplied or the Zone Interlock switch moved to the "out" position in order to test other than the minimum time delay band.
7. Increase both instantaneous and short time pickup to 12X, set the long time delay band on 3.5, long time current setting on .5. Adjust the supply to twice current sensor rating. Apply this current and observe tripping time. Test at the same current for all long time delay bands. Verify that they meet the published values. Other values of current can be tested if overheating is prevented.
8. The operation of the Short Time I²t ramp, and time delay bands can also be checked as desired.
9. If the device has ground fault tripping, remove the jumper from terminals 4 and 5. Set Ground Fault pickup on 60%, increase the supply current from zero, verify that the ground circuit trips the breaker at 60% of the Ground Sensor rating. Lower settings can be tested. Depending on the amount of waveshape distortion there may not be enough power to trip the breaker at the lowest available ground fault pickup value with no other phase currents.
10. To demonstrate operation at normal control settings, reset all controls to the desired values, set current to a high enough value to definitely cause tripping, apply current, and verify that tripping does occur as expected.

Removing Trip Device From Breaker

The Static Trip III device mounts on a slide bracket on the circuit breaker. To remove the trip device, remove the terminal cover strip from the terminal block above the trip device. Loosen the 8 slotted head screws to remove the trip device terminal strip from the terminal block. This exposes one retaining screw. Remove this screw and slide the device toward the front to remove it from the bracket.

Repair

Because of the complexity of some of the semiconductor components, we do not recommend field repair of Static Trip III units. Moreover component failure does not show up as visual damage and locating the defective component or components requires specialized techniques. Therefore, if the tests described in the preceding section indicates that a Static Trip III device is defective, contact your Siemens representative for instructions on returning the unit to a service center for repair.

Cleaning

All the components are sealed against dust, and the insulation integrity of the printed circuit boards is protected by a conformal coating. However, in extremely dusty atmospheres, enough dust may in time accumulate to prevent adequate cooling of components. Static Trip III units are easily disassembled for cleaning. Removing two screws at the lower corners of the front cover allows its removal, exposing the circuit boards. These can then be withdrawn from molded-in guide slots in the enclosure. The three circuit boards are held together by flat cable jumpers so all three must be withdrawn at one time.

With the circuit boards removed they can be unfolded and cleaned with a soft brush or with compressed air. In the latter case, be sure the air is clean and dry, and the jet is not too strong.

SIEMENS

Siemens Energy
& Automation, Inc.
Switchgear Division
P.O. Box 29503
Raleigh, NC 27626
(919) 365-6660

www.ElectricalPartManuals.com