SIEMENS-ALLIS

Switchgear

INSTRUCTIONS

STATIC TRIP II
OVERCURRENT TRIP DEVICES
USED WITH
TYPE LA POWER CIRCUIT BREAKERS

18X4827-04
May, 1979

INDEX

ILLUSTRATIONS

INTRODUCTION

This instruction manual contains descriptive, operating, testing and maintenance information for *Static Trip II* static overcurrent trip devices, several of which are shown in Figure 1. *Static Trip II* devices are used with 600-volt class, Type LA power circuit breakers.

WARRANTY

The sales contract carries all information on warranty coverage.

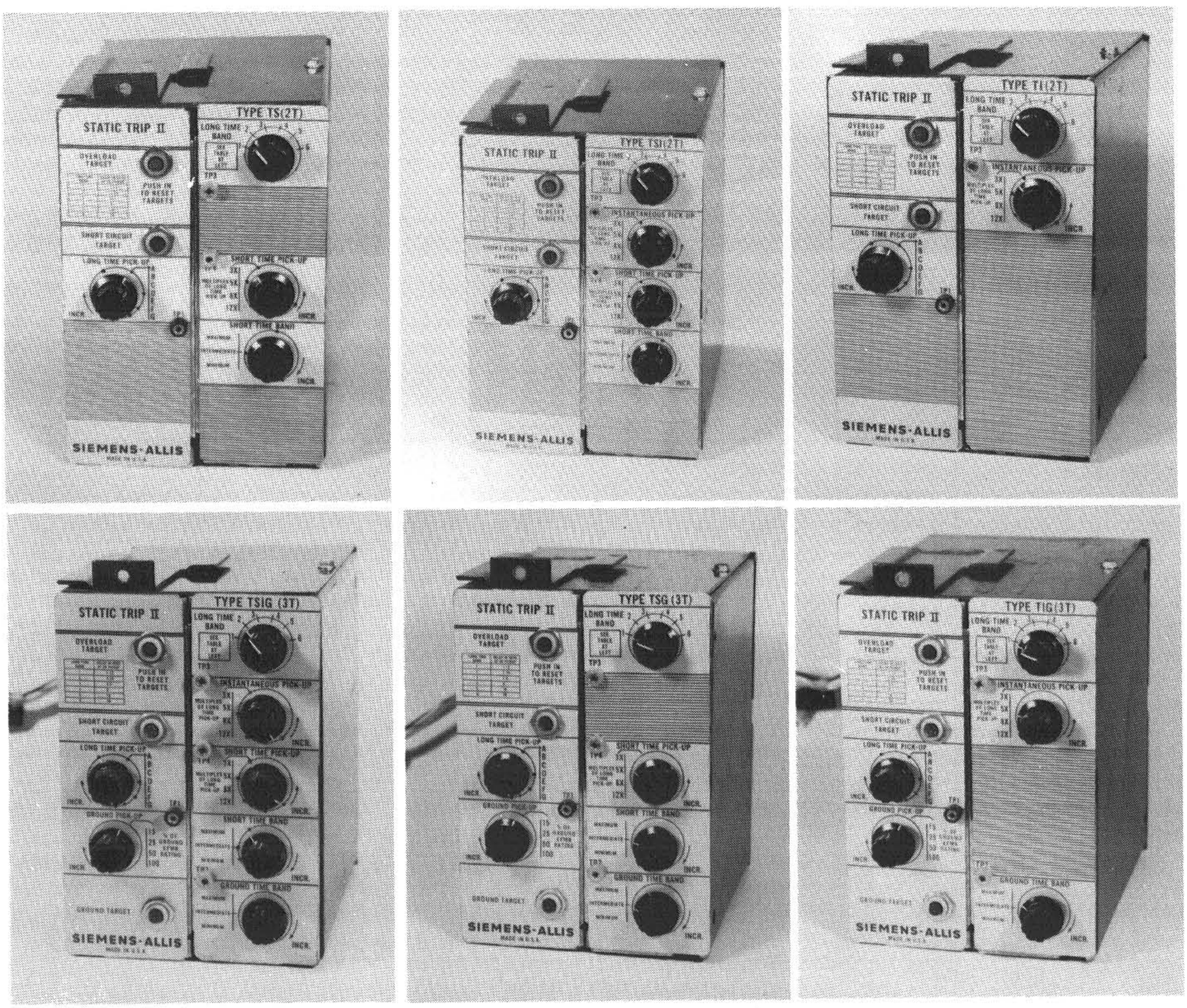

Figure 1. — Static Trip II Static Trip Devices

DESCRIPTION

General

Static Trip II overcurrent trip devices are completely static — there are no moving parts or contacts. Components used are semi-conductors, integrated circuits, capacitors, transformers, etc. The circuits are designed for conservative loading of components for long life and little maintenance.

Static Trip II 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.

SERIAL NO.__________
DATE MFG.__________
VOLTAGE MTR.______CLO.______
TRP.______ TRIP XFMR______/1A.
WIRED PER __________
LONG TIME PICKUP IN AMPERES
A_____ B_____ C_____ D_____
E_____ F_____ G_____
MAX CONT CURRENT__________ AMPS
SIEMENS-ALLIS MILWAUKEE, WI. MADE IN USA

Figure 2. — Breaker Rating Plate

The complete static overcurrent trip system consists of three parts — (1) primary circuit current transformers (2) the *Static Trip II* device (3) a magnetically held circuit breaker latch release device called the tripping actuator.

Current Transformers

Toroidal current transformers, similar to standard bushing current transformers, are mounted, one-per-phase on the primary studs of the circuit breaker. Also called tripping transformers, they provide a signal to the static trip device proportional to the primary current, and are used only for that purpose. The tripping transformers selected for a specific circuit breaker establish the maximum continuous current rating of that breaker and the adjustment range. Each transformer provides a choice of seven continuous current settings which are listed on the breaker rating plate (Figure 2). The highest setting is 2½ times the lowest setting.

Static Trip II Trip Device

A metal enclosure, attached to the breaker, houses the trip device and its electronic circuits. The static trip device receives the signal from the tripping transformers. It monitors the signal, senses overloads and faults, and determines the required action in accordance with preselected control knob settings. On the front of the metal enclosure is a calibration plate with the necessary adjusting knobs (Figure 1).

Tripping Actuator

When the static trip device senses a circuit condition that requires the circuit breaker to open, it produces an output that is fed to the tripping actuator. The actuator then causes the circuit breaker contacts to open and isolate the circuit.

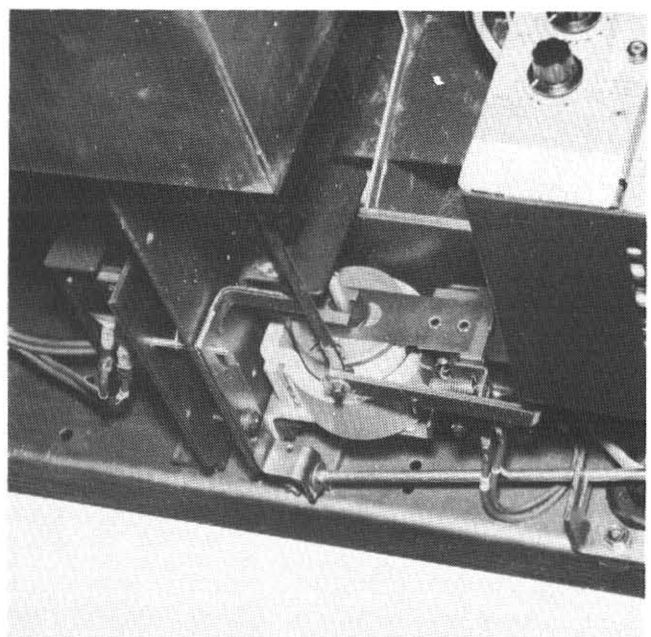

Figure 3. — Tripping Actuator

Mounted on the circuit breaker, 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, the coil causes the magnetic flux to shift to a new path, releasing the stored energy of a spring located inside the tripping actuator. The spring provides the energy to trip the breaker. See Figure 3.

Removing Static Trip II From The Breaker

Static Trip II units are easily removed from the circuit breaker for replacement or for bench testing.

1. Remove the two screws holding the terminal block cover bearing the terminal numbers 1, 2, 3, 4, 7, 8, 9. This exposes the terminal block that connects the static trip device to the wiring on the breaker.
2. Loosen the seven screws in the bottom row of the terminal block (it is not necessary to remove the screws completely) and slide out the connecting strip from under the screws.
3. Removing the connecting strip exposes one screw just above the name "*Static Trip II*" on the face plate. Remove this screw and slide the static trip unit out by pulling it toward you.
4. To install a unit, reverse steps 1-3. Be sure to tighten all screws. It is important to replace the terminal block cover because it guards against accidental contact with the live terminals. Also, the terminal numbers on it are helpful in testing.

Available Types

Six types of *Static Trip II* devices are available. Similar in many respects, they differ only in their specific application. All use identical tripping transformer inputs and provide output signals to the tripping actuator. Several types are shown in Figure 1.

The type designation is coded to indicate the functional elements: T = LONG-TIME delay element, S = SHORT-TIME delay element, I = INSTANTANEOUS element, G = GROUND current element, (T) a single TARGET that indicates tripping on ground current, (2T) two TARGETS that indicate tripping on SHORT CIRCUIT or OVERLOAD (Long Time) current, and (3T) for three TARGETS that indicate tripping on OVERLOAD, SHORT CIRCUIT or GROUND current. For each element except INSTANTANEOUS there are two adjustment knobs on the front of the device, one for pick-up setting and one for delay setting. The instantaneous element has only one knob for pick-up setting. See Figure 9. Following are brief descriptions of the different types.

TYPE TI & TI (2T) — A dual trip device normally used for phase overcurrent protection. The long time pick-up range is selected from the trip rating table and is continuously adjustable from "A" thru "G" in the field. The instantaneous element is continuously field adjustable from 3 to 12 multiples of the long time pick-up setting selected. The long time delay is field adjustable with a choice of six bands.

TYPE TIG — TIG (T) & TIG (3T) (optional) — A dual trip device which provides phase overcurrent protection same as Type TI plus sensitive ground fault protection for 3-wire and 4-wire circuits on systems with either phase-to-phase or phase-to-neutral loading. Ground current pick-up settings are independent of the phase pick-up settings, and continuously adjustable in the field from 15% through 100% of the tripping transformer rating. When used on 4-wire circuits, a fourth tripping transformer is required. It is mounted in the cubicle, and wired to the breaker through secondary disconnects.

TYPE TS & TS (2T) (optional) — A selective trip device used for phase overcurrent protection which provides time delay tripping only. It allows complete field adjustment of the long time band and pick-up plus the short time band and pick-up. The short time pick-up can be adjusted from 3 to 12 multiples of the long time pick-up setting. Any one of the three short time bands can be chosen to be used with any of the six long time bands.

TYPE TSG — TSG (T) & TSG (3T) (optional) — A selective trip device which provides phase overcurrent protection same as Type TS plus sensitive ground fault protection for 3-wire and 4-wire circuits on systems with either phase-to-phase or phase-to-neutral loading. Ground current pick-up settings are independent of the phase pick-up settings, and continuously adjustable in the field from 15% through 100% of the tripping transformer rating. When used on 4-wire circuits, a fourth tripping transformer is required. It is mounted in the cubicle, and wired to the breaker through secondary disconnects.

TYPE TSI & TSI (2T) (optional) — A triple selective trip device used for phase overcurrent protection which provides long time delay, short time delay, and instantaneous elements. It allows complete field adjustment of the long time band and pick-up, the short time band and pick-up and the instantaneous pickup. Both the short time and instantaneous elements can be adjusted to pick up at 3 to 12 multiples of the long time pick-up setting. Any one of the three short time bands can be chosen to be used with any of the six long time bands.

TYPE TSIG — TSIG (T) & TSIG (3T) (optional) — A triple selective trip device which provides phase overcurrent protection same as Type TSI plus sensitive ground fault protection for 3-wire and 4-wire circuits on systems with either phase-to-phase or phase-to-neutral loading. Ground current pick-up settings are independent of the phase pick-up settings, and continuously adjustable in the field from 15% through 100% of the tripping transformer rating. When used on 4-wire circuits, a fourth tripping transformer is required. It is mounted in the cubicle, and wired to the breaker through secondary disconnects.

Time-Current Curves

Figure 4 is a set of curves for the *Static Trip II* devices. The long-time element has a characteristic represented by:

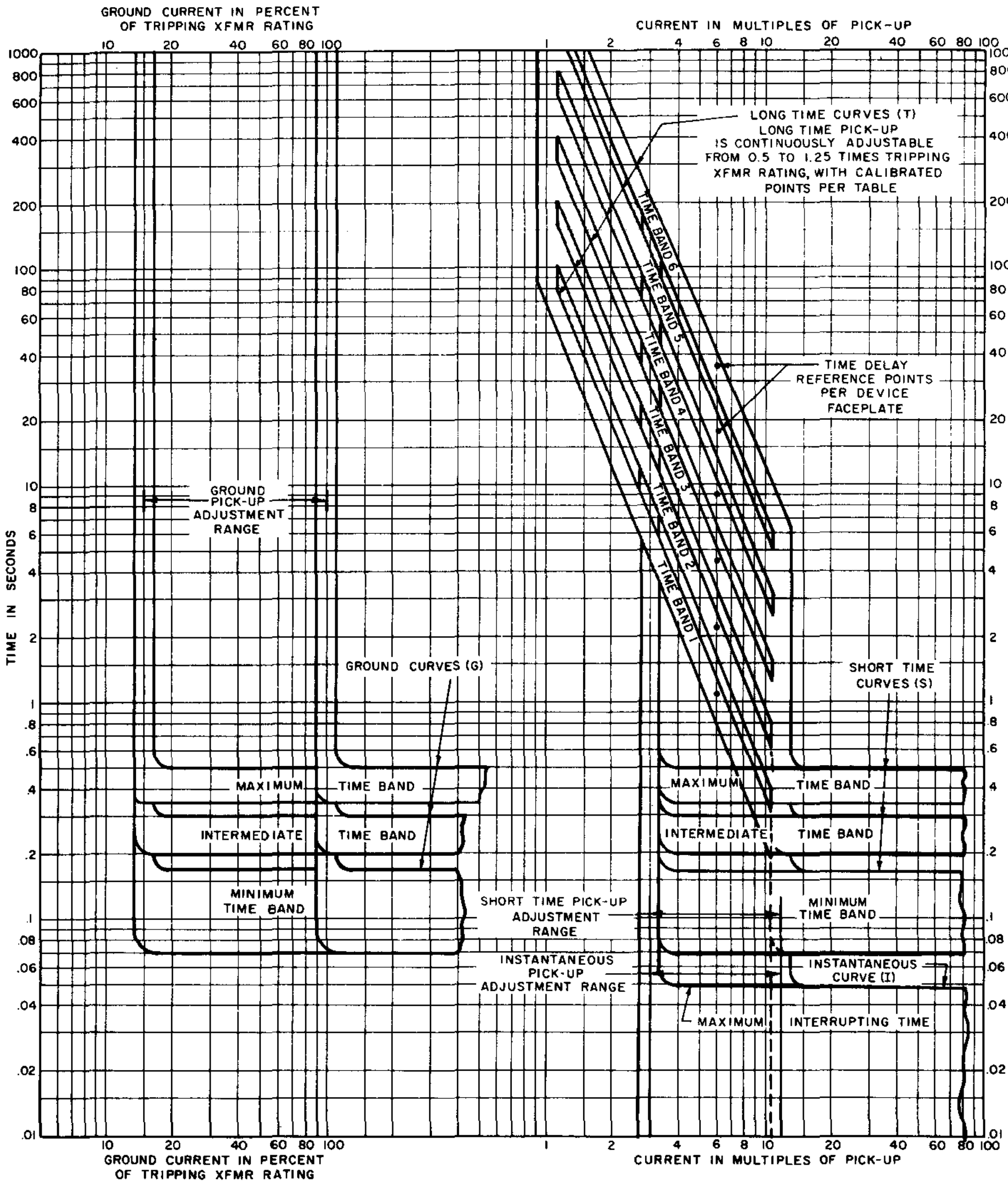

Figure 4. — Static Trip II Time-Current Curves

$$t_D = K \frac{1}{I^n}$$

where t_D = time delay, I = current expressed in multiples of the long-time pick-up, n is a constant dependent on the circuit design (slightly over 2 for *STATIC TRIP II*), and K is a constant depending on the delay band selected. In other words, the delay for a given band setting varies approximately inversely as the square of the current. When plotted on log-paper this relationship is a straight line as shown by the sloping bands on Figure 4. Six discrete long-time bands are available, any one of which may be selected by the band control switch on the front. Each band has a delay exactly twice the delay of the next lower band.

The short-time element has a definite delay which is independent of current as shown by the fact that the short-time bands are horizontal on Figure 4. There are three calibrated short-time delay bands — MINIMUM, INTERMEDIATE, and MAXIMUM which have nominal delays of 0.1, 0.25, and 0.45 seconds, respectively. However, short time delay is continuously adjustable and can be set at other values if suitable testing equipment is available.

The ground element has a definite delay characteristic just like the short-time element and with the same calibrated points. It is independently adjustable.

The width of the time bands on Figure 4 is due principally to differences between devices caused by normal commercial tolerance of components in the circuits. Repeated tests on any one unit will fall in a much narrower band.

The band width also includes breaker interrupting time. The upper limit represents the 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. This representation, which is necessary to demonstrate coordination between breakers set on contiguous time bands, widens the SHORT TIME bands significantly.

Performance In Service

Ambient conditions and length of service will have little effect on the performance of static overcurrent trip devices. 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 II devices are tolerant of dusty conditions and will function properly in many areas that would affect the performance of electro-mechanical trip devices.

The temperature at the static trip device does have some effect on the characteristics due to changes in response of some of the components. However, the changes are small and will not be a factor in most applications. Over the range of −40 C to 55 C (−40 F to 131 F), the variation from performance at room temperature is very small, amounting to less than 5% of LONG TIME, INSTANTANEOUS and SHORT TIME PICK-UP values, and 10% in timing of all time bands. Operation is not recommended beyond this range. If necessary, control of the temperature should be provided by heaters or ventilation.

Connection Diagrams Figures 5 through 8 show in schematic form the pre-wired connections from the breaker mounted tripping transformers to the static trip device. This wiring varies with the application. The four 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 bus CT or ground strap CT are separate from the breaker and are connected to the static trip through secondary drawout contacts on the breaker.

SETTINGS

Static Trip II devices have a number of knobs and switches that can be arranged to select specific load current conditions that will cause the breaker to open. Selection of settings is 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.

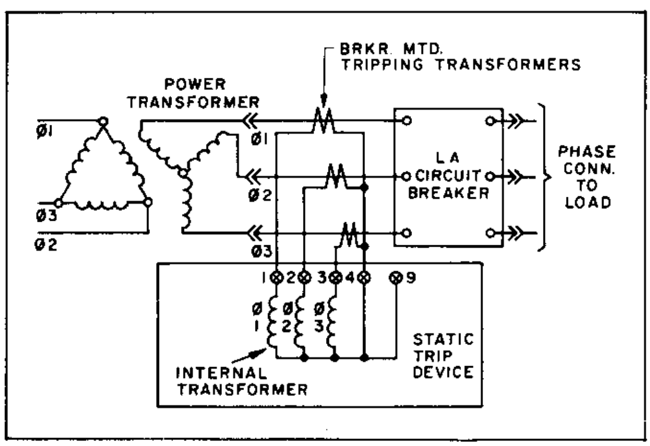

Figure 5. — Breaker Wiring for Types TI, TS, and TSI (non ground)

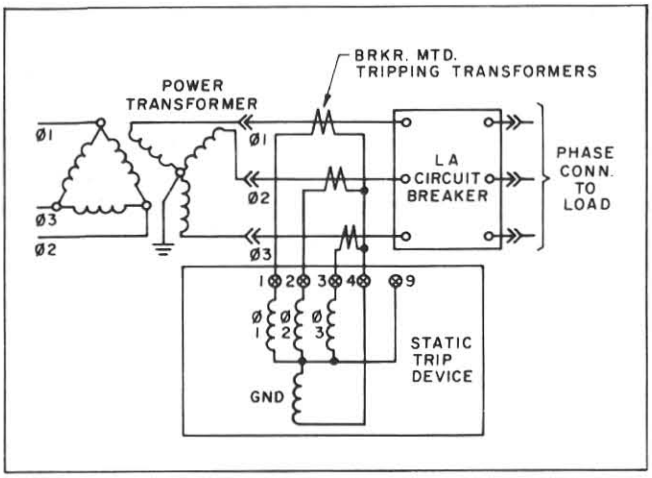

Figure 6. — Breaker Wiring for Ground Protection on 3-Wire Systems, Residual Sensing

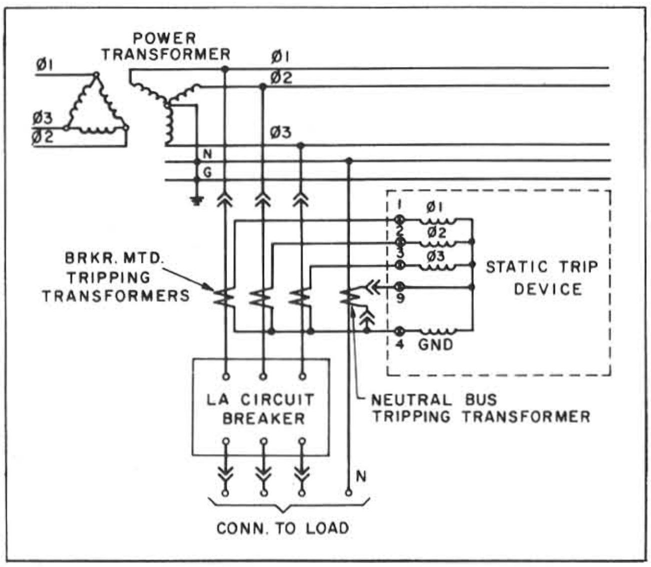

Figure 7. — Breaker Wiring for Ground Protection on 4-Wire Systems, Residual Sensing.

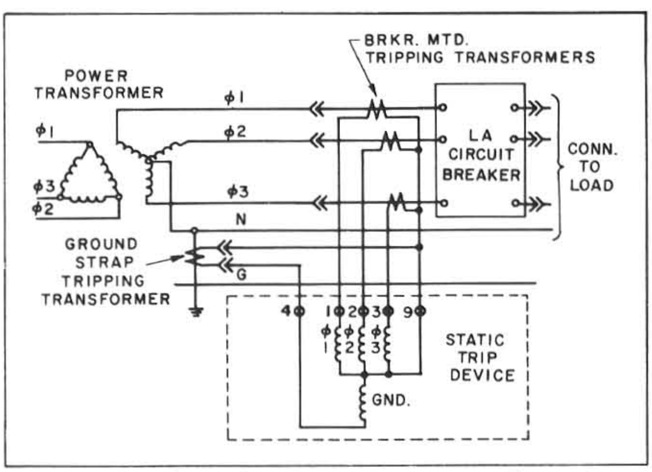

Figure 8. — Breaker Wiring for Ground Protection on 4-Wire Systems, Ground Strap Current Sensing.

Figure 9 is an illustration of the type TSIG (3T) device which contains all Static Trip II control options. The following paragraphs discuss the calibration and use of these controls.

LONG TIME PICK-UP has 7 calibration marks. The black reference dot on this and all other knobs marks the fully CCW (counter clockwise) position of the control and enables calibration to be restored if the knob should inadvertently be turned on the shaft. (See the section on Maintenance.)

When turning the knob in the clockwise (increase) direction from the black dot, the first red dot is setting "A" in the vertical column of letters A through G. The second red dot is setting "B", etc. The values of the settings in amperes depend upon the tripping transformer rating and are shown on the breaker rating plate (Fig. 2) just above the static trip.

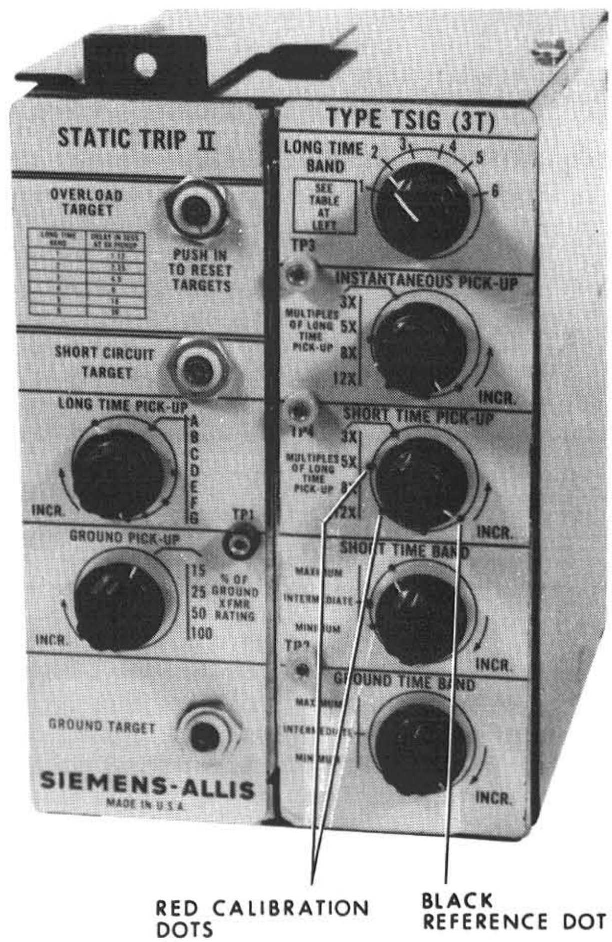

Figure 9. — Calibration Marks

Figure 10 is a table of settings in amperes for all the standard tripping transformer ratings.

The tripping transformer rated secondary current is one ampere. Because setting E, Figure 10 table corresponds to rated tripping transformer current, one ampere input to the static trip will cause it to pick up and start timing if LONG TIME pick-up setting is on "E".

Example: Suppose it is desired that the breaker shall trip whenever sustained current exceeds 600 amperes, and suppose that the tripping transformer rating is 800 amperes. The LONG TIME pick-up setting should be "C", Figure 10 table. At 600 amperes, current input to the static trip will be 600 ÷ 800 = 0.75 ampere.

Long time pick-up control is continuous and other settings between calibrated points may be used if suitable test equipment is available.

INSTANTANEOUS PICK-UP has four calibrated points, 3X, 5X, 8X, and 12X, calibrated in multiples of the LONG TIME pick-up setting. Again the black reference dot is at the fully counter-clockwise end of rotation. Starting from the reference dot, the first red dot when rotating clockwise (decrease) is the 12X point. This control is also continuous, permitting field calibration of additional settings if suitable equipment is available. For special applications, settings as low as 1.0X can be field calibrated.

Example: Referring to the previous example, if LONG TIME pickup is on "C" and INSTANTANEOUS pick-up is on 5X, the breaker will trip instantaneously at 3000 amperes (5 x 600) or more.

SHORT TIME PICK-UP is calibrated just like instantaneous, and control is also continuous. It can also be field calibrated as low as 1.0X.

GROUND PICK-UP is calibrated in percent of the tripping transformer rating with four calibrated points, and is also continuous.

Example: If the tripping transformer rating is 600 amperes and GROUND PICK-UP is at 25%, a ground current of 150 amperes will cause the ground circuit to trigger. If the ground current persists as long as the

Breaker Type and Frame Size	Tripping XFMR Rating (Primary)	Long Time Element Calibrated Pickup Settings							Max Cont Rating	Ground Element Calibrated Pickup Settings			
		A	B	C	D	E	F	G		15%	25%	50%	100%
LA-600A and LA-800A	80	40	50	60	70	80	90	100	100	MAY NOT TRIP		40	80
	200	100	125	150	175	200	225	250	250	30	50	100	200
	400	200	250	300	350	400	450	500	500	60	100	200	400
	600	300	375	400	525	600	675	750	600	90	150	300	600
	800	400	500	600	700	800	900	1000	800	120	200	400	800
LA-1600A	200	100	125	150	175	200	225	250	250	—	50	100	200
	400	200	250	300	350	400	450	500	500	60	100	200	400
	800	400	500	600	700	800	900	1000	1000	120	200	400	800
	1600	800	1000	1200	1400	1600	1800	2000	1600	240	400	800	1600
LA-3000A	2000	1000	1250	1500	1750	2000	2250	2500	2500	300	500	1000	2000
	3200	1600	2000	2400	2800	3200	3600	4000	3000	480	800	1600	3200
LA-4000A	4000	2000	2500	3000	3500	4000	4500	5000	4000	600	1000	2000	4000

Figure 10. — Static Trip II Rating Table — Amperes.

GENERAL NOTES

1. The "Tripping XFMR Rating" values represent the primary value of the current transformer ratio is amperes. The secondary value is one ampere.
2. The pick-up settings of the long time element are continuously adjustable, and are calibrated at points "A" thru "G" as shown in the rating table.
3. The pick-up settings of the instantaneous and short time delay elements are continuously adjustable, and are calibrated at 3, 5, 8 and 12 multiples of the long time pick-up setting.
4. The pick-up settings of the ground element are continuously adjustable, and are calibrated in percent of the tripping transformer rating as shown in the rating table.
5. The long time element has 6 bands that are field selectable. The time delay at 6 multiples of pickup is as follows:

   Band 1 – 1.12 seconds
   Band 2 – 2.25 seconds
   Band 3 – 4.5 seconds
   Band 4 – 9 seconds
   Band 5 – 18 seconds
   Band 6 – 36 seconds
6. The short time element and ground element have 3 time delay bands which are calibrated at minimum, intermediate and maximum, but are continuously adjustable.
7. The maximum interrupting time is the maximum length of time that fault current flows, including arcing time.
8. 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.

GROUND TIME BAND setting, the breaker will trip, and if there is a ground target, the red plunger will pop out. The target is reset by pushing it back in so that the permanent magnet holds it in the reset position.

As explained previously, the tripping transformer secondary current rating is 1.0 ampere so the ground current input currents to the static trip device at pick-up are the same as the calibration value divided by 100. (E.G.: when set on 25%, pick-up current is 25% of 1.0 ampere, or 0.25 ampere.)

Time Bands

There are six LONG TIME BANDS numbered 1 through 6, and three SHORT TIME BANDS marked MAXIMUM, INTERMEDIATE, and MINIMUM.

The GROUND TIME BANDS on devices with ground trip are the same as the short time bands, but are independently adjustable.

The control for selecting the LONG TIME BAND is a very small switch and the detent is not strong. Therefore, be very careful that the white dot on the knob lines up with the desired number.

On STATIC TRIP II devices built to accept multiple targets the GROUND tripping circuits are prevented from operating if either the SHORT TIME or INSTANTANEOUS pick-up currents are exceeded.

The control for selecting the LONG TIME BAND is a very small switch and the detent is not strong. Therefore, be very careful that the white dot on the knob lines up with the desired number.

All the LONG TIME, SHORT TIME and GROUND TIME bands are shown on the TIME CURRENT CHARACTERISTICS curve, Figure 4. The curve sheet is self-explanatory. In addition, a table printed on the face plates of *Static Trip II* units lists the time delay at six times pick-up current for each LONG TIME band. The delay for each band is twice the delay of the next lower band.

The SHORT TIME and GROUND TIME band controls are continuous so that settings other than factory calibrations may be used if suitable testing equipment is available.

TESTING

General

STATIC TRIP II can be field tested either with primary current through the breaker or with secondary current applied directly to the static trip device. The ease of testing with secondary current is one of the advantages of static trip devices. With comparatively inexpensive and readily available equipment, described in the following, it is possible to demonstrate that the tripping system will open the breaker, and to verify that the device conforms to the published time-current curves. However field testing cannot be expected to be as accurate as factory calibration. Therefore, slight discrepancies between field tests and factory calibration marks can be regarded as normal. If large deviations or improper operation should occur, it is recommended that the nearest Siemens-Allis office be contacted for advice.

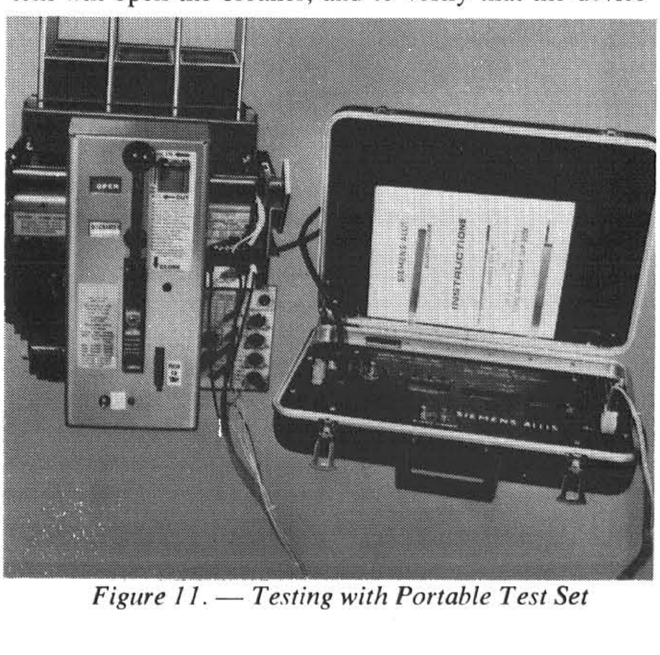

Figure 11. — Testing with Portable Test Set

Secondary Current Testing

A portable test set is available for secondary testing that is designed to plug into a standard 115 volt outlet, Figure 11. With this test set, *Static Trip II* can be tested by itself without a circuit breaker, or on a circuit breaker with the breaker away from the cubicle, or inside the cubicle in the TEST or DISCONNECT position.

CAUTION

The static trip input is capacitively coupled to the circuit breaker frame, through a surge capacitor. Therefore to insure against electrical shocks be sure to ground the frame when testing with the circuit breaker out of the cubicle.

There is a terminal block on the circuit breaker just above the trip device. This terminal block accepts leads with banana plugs when testing with the device on the breaker. Such leads are furnished with portable test sets purchased after March 1972.

Connections for the test set are shown in Figure 12. If test leads with banana plugs are not available, connections can be made with small alligator clips after removing the terminal block cover bearing the numbers 1, 2, 3, 4, 7, 8, 9.

CAUTION

Avoid even a momentary short circuit between terminals 4 and 7 or terminals 8 and 9. Such a short circuit, with any input current to the trip device, will damage it.

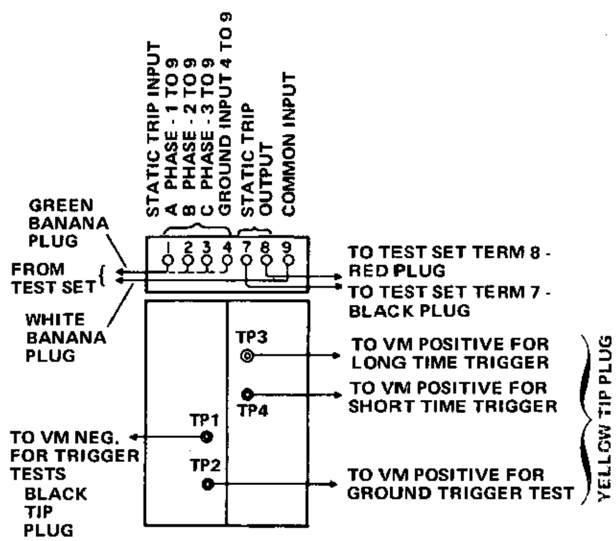

Figure 12. — Testing with Portable Test Set, Connection Diagram

Be careful to make connections correctly as shown on Figure 12. There is a terminal marker strip above the terminal block which can be seen although it is partly covered by wiring.

When testing with the *Static Trip II* device off the circuit breaker connections must be made to the spade type terminals of the connecting strip. Making these connections with clip leads involves the risk of shorting between clips which can damage the trip device. A terminal block assembly, 18-657-506-585 and special leads, 18-657-489-852 are available for making the connections to old model test sets. The terminal block assembly accepts the connecting strip just like the one on the circuit breaker and the leads are designed to make connections from the test set to the jacks on the terminal block.

Late model test sets have a terminal block on them just like the one on the circuit breaker. In that case it is only necessary to connect the static trip connecting strip to this terminal block and make connections with the banana plugs just as if the unit were mounted on a breaker.

Test points, TP1, TP2, TP3, and TP4 are on the *Static Trip II* face plate. They are for connection to a dc voltmeter of 25 to 50 volts full scale, to observe triggering (pick-up). The portable test set contains such a voltmeter. TP1 is common negative, TP3 is the LONG TIME trigger, TP4 is the SHORT TIME TRIGGER, and TP2 is the GROUND trigger. These test points are designed to accept standard tip plugs which are furnished with the portable test set. However, if tip plugs are not available, any solid metal wire, nail, or pin of O.D. .080 ± .002 inches may be used to make the connection. A number 46 or 47 twist drill is satisfactory. See Figure 12 for connections.

Detailed test instructions are given in the portable test set instruction book. Instruction books for test sets purchased prior to 1973 were written for older style static trip devices, not for STATIC TRIP II. However, with the information contained in this book, the necessary changes in test procedure when testing STATIC TRIP II units are easily understood. One difference that should be noted is that STATIC TRIP II has two more LONG TIME PICK-UP points than older static trips. The LONG TIME pick-up current values for secondary testing are given in Table I below.

TABLE I

LONG TIME PICK-UP SETTING	A	B	C	D	E	F	G
PICK-UP CURRENT, AMPS	.50	.625	.75	.875	1.00	1.125	1.25

Testing Without a Portable Test Set

The portable test set has its own automatic timer which permits accurate testing of all time delays. If the test set is not available, however, it is possible to perform function tests and some timing tests if the following equipment is available.

1. One variable transformer (Variac) 115 or 120 volt, 60 Hertz, 2.5 amperes minimum.
2. One air core reactor, 30 to 50 milli-Henries, 2 amperes minimum. Maximum dc resistance — 20 Ohms.
3. One ac ammeter, 0-1 or 0-2 amperes — necessary for accurate checking of LONG TIME PICK-UP.
4. One ac ammeter, 0-5 amperes, for LONG TIME

delay tests and INSTANTANEOUS and SHORT TIME pick-ups.

5. One dc voltmeter, 0-25 or 0-50 volts, for trigger indication.

6. One stop watch, desirable but not essential, for timing tests.

7. One single pole — single throw, snap action switch rated 120 volts, 5 amperes ac or more.

The sudden appearance of this "trigger" voltage indicates that the timed delay has started. If the current drops slightly, causing the trigger voltage to disappear, the timing circuit resets instantly and timing will restart upon the next appearance of triggering.

Short Time Pick-up Test

Use the 0-5 ampere ammeter and connect the voltmeter to terminals TP1 and TP4 with TP1 negative. Set LONG

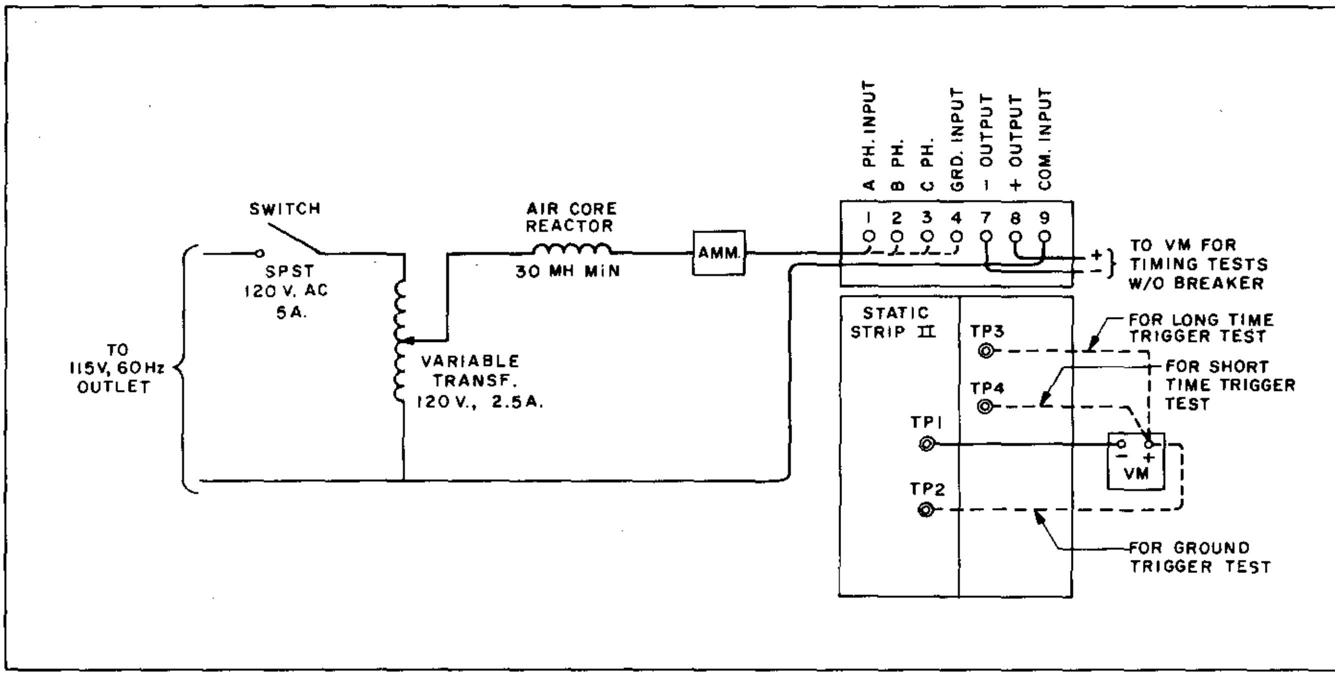

Figure 13. — Secondary Testing Without Test Set

Test Connections

See Figure 13 for test connections. Connect the input to terminals 1 and 9 to test A phase, to 2 and 9 for B phase, 3 and 9 for C phase, and 4 and 9 to test the ground circuit on devices with ground current tripping.

Long Time Pick-up Test

For this test a circuit breaker is not needed. If the static trip is mounted on a breaker, it is not necessary to close the breaker.

Use the 0-1 or 0-2 ampere ammeter. Connect the voltmeter to terminals TP1 and TP3 with TP1 negative. Refer to "Secondary Current Testing" for tips and cautions on making connections.

Set LONG TIME PICK-UP on "A". Raise the current gradually until the voltmeter needle jumps suddenly to 15 volts or more. The current at which this occurs should be 0.5 ampere ± 10%. Decreasing the current slightly should cause the voltmeter reading to drop to a low value. Repeat for the other LONG TIME PICK-UP settings and compare with Table I.

TIME PICK-UP on A and SHORT TIME PICK-UP on 3X. Raise the current until the voltmeter suddenly jumps up as before. This should occur at 1.5 amperes (3 x 0.5). Repeat for SHORT TIME PICK-UP settings of 5X and 8X which should give readings of 2.5 and 4.0 amperes respectively, (5 x 0.5 and 8 x 0.5). You may not be able to get the 6.0 amperes for the 12X setting even with the variable transformer at maximum output.

CAUTION

Do not allow current above 2 amperes to continue more than a minute or so at a time so as not to overheat the static trip, the variable transformer and the reactor.

Ground Pick-up Test

Ground pick-up cannot be checked accurately with this equipment because of excessive current wave distortion caused by the highly non-linear impedance of the static trip ground circuit. However, it is possible to verify that the circuit is operating and that pick-up is somewhere near the right value.

Use the 0-1 ampere ammeter and connect the voltmeter from TP1 to TP2 with TP1 negative. Set GROUND PICK-UP on 15% and gradually increase input current until the voltmeter jumps up. Input current should be somewhere near 0.15 ampere. Repeat for the other settings. Each setting should give a reading in amperes nearly equal to the calibration value divided by 100 (100% = 1.0 ampere).

Instantaneous Trip Test

There is no trigger output for INSTANTANEOUS, but tripping of the breaker will indicate operation when testing with the static trip unit on a breaker. When testing without a circuit breaker, connect the voltmeter from terminal 7 to terminal 8 with 7 negative to monitor the trip device output.

Use the 0-5 ampere ammeter. Set LONG TIME PICK-UP on "A" and INSTANTANEOUS on 3X. Gradually increase current until the voltmeter indication jumps up to 15 volts or more indicating that the instantaneous circuit has caused a tripping output. This should occur at about 1.5 amperes (3 x 0.5). Repeat for the 5X and 8X INSTANTANEOUS PICK-UP settings which should cause operation at 2.5 and 4.0 amperes respectively.

On models with two or three targets the SHORT CIRCUIT target should operate when the device trips on INSTANTANEOUS.

NOTE

Because of the load imposed by the actuator coil, the voltmeter indication will be much less, perhaps as low as 5 volts, if the static trip output, (7-8) is connected to a circuit breaker.

Long Time Delay Test

For currents less than 6 times pick-up setting and time bands 2 and higher, the delay is long enough to be checked fairly well with a stop watch or even an ordinary watch having a sweep second hand.

Use the 0-5 ampere ammeter.

1. Close the switch and adjust current to the desired value.
2. Open the switch and close the circuit breaker.
3. Without changing the variable transformer setting, close the switch and measure the time interval from switch closing to breaker tripping.

Example: Set LONG TIME PICK-UP on "A," LONG TIME BAND on 5, input current at 3.0 amperes (6 x 0.5). Set SHORT TIME and/or INSTANTANEOUS pick-up on 12X, above the input current value. The timed interval should be between 14 and 22 seconds. See the curves on Figure 4.

If the static trip is not mounted on a circuit breaker, connect the voltmeter across terminals 7 and 8 of the static trip and time the interval from switch closing to voltmeter indication.

On models with two or three targets the OVERLOAD target should operate when tripping occurs on LONG TIME.

NOTE

While timing out at values of input current not much above pick-up, normal fluctuations in supply voltage may cause the device to de-trigger (see the last paragraph under "Long Time Pick-Up Test") and prevent the device from timing out properly. To avoid this it is desirable to monitor LONG TIME trigger output with a voltmeter throughout the test.

Short Time Delay Test

The SHORT TIME delays are too short (0.5 second maximum) to be checked without a high speed automatic timer, but it is possible to perform a test to verify that the short time circuit will trip the breaker. To do this follow the instructions for testing INSTANTANEOUS as described previously, but set the INSTANTANEOUS, if there is one, above the input current level and the SHORT TIME PICK-UP below the input current level.

Example: Set LONG TIME PICK-UP on "A", SHORT TIME PICK-UP at 3X (1.5A.), and INSTANTANEOUS (if applicable) on 12X (6.0A.). Close the breaker and apply 2 to 5 amperes by closing the switch. The breaker should trip in about ½ second or less depending on the SHORT TIME BAND setting. If the static trip is not on a breaker, the voltmeter may be used as before to obtain an indication of the static trip output at terminals 7 and 8.

On models with two or three targets the SHORT CIRCUIT target should operate when the device trips on SHORT TIME.

Ground Time Delay Test

The GROUND time delay can be tested in the same way as the SHORT TIME except current is applied to terminals 4 and 9 instead of 1, 2, or 3 and 9. When the tripping output appears, the ground target should pop out.

Tripping Actuator Test

If the static trip device fails to trip the breaker, the question arises as to whether the trouble is in the static trip or the actuator. Substitution of another static trip may supply a quick answer.

If another static trip is not available, there is a simple test of the actuator. However, a dc power supply with output adjustable from three to 12 volts minimum at 0.3 ampere minimum is required. Such a power supply is contained in portable test sets built after late 1972.

Disconnect the static trip connecting strip from the terminal block. With an ohmmeter or resistance bridge measure and record the resistance of the actuator coil from terminal 7 to terminal 8 of the terminal block.

Disconnect the ohmmeter and connect the output of the power supply to terminals 7 and 8 of the terminal block with terminal 7 negative. Close the breaker and slowly increase the dc voltage from minimum. Note and record the voltage at which the breaker trips.

There are two types of actuators which have different coil resistances. If coil resistance is between 25 and 30 Ohms, the tripping voltage should not be over six volts. If resistance is between 30 and 40 Ohms tripping voltage should not be over 10 volts. Values above these indicate defective tripping actuators.

CAUTION

Although the tripping actuator can be easily disassembled, doing so may partially demagnetize it, and remagnetizing requires special equipment.

Failure of the circuit breaker to trip at any voltage even up to 12 volts may be due to the actuator plunger binding. This can be checked manually. USE EXTREME CAUTION WHEN WORKING ON THE CIRCUIT BREAKER. THE ENERGY STOED IN THE CLOSING AND/OR OPENING SPRINGS MUST BE RESPECTED. ALWAYS DISCHARGE ALL SPRINGS BEFORE PLACING HANDS NEAR THE MECHANISM. See the circuit breaker instruction book if any problem is evident in the mechanical portion.

Tripping Transformer Tests

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

The third link in the STATIC TRIP II protection system is the breaker-mounted tripping current transformers. When secondary current testing is done with the static trip on the breaker, the tripping transformers are subjected to approximately their normal excitation so that a transformer with shorted turns would show up in the form of pick-up values above tolerance. However, there would be no way of knowing whether the problem was in the static trip or the transformers. Moreover, an open circuit in the transformer winding or wiring would not show up at all. Therefore, it is desirable to test the tripping transformers as described in the following:

Connections

If the static trip device is on the breaker, disconnect it from the transformers by removing the connecting strip from the lower row of terminal block connections. The tripping transformers can now be tested by making connections to the banana jacks of the terminal block just as before.

Continuity Check

An ohmmeter is most suitable for checking continuity of the transformer secondary windings and wiring. Connect the ohmmeter to terminals 1 and 9 for A phase, 2 and 9 for B phase, and 3 and 9 for C phase. The value of the resistance (which can fall within a wide range depending on the transformer rating) is not important for this test because the purpose is solely to verify continuity.

When ground protection is provided, the ground strap transformer or neutral bus transformer, whichever is used, is mounted external to the circuit breaker and wired to the static trip terminal block through secondary draw-out contacts of the cubicle. Therefore, to check continuity of this tripping transformer and its secondary circuit, the breaker must be in the cubicle in the TEST or CONNECTED positions. Connect the ohmmeter between terminals 4 and 9 to check the ground strap or neutral CT continuity.

Excitation Test

The purpose of the excitation test is to reveal shorted turns in the tripping transformer winding. Sixty-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 perhaps by overheating of the winding. If a portable test set (PTS-2) is available, it may be used to furnish the applied voltage, and the ammeter on the set may be used to monitor exciting current. It is desirable, but not essential, to also have an ac voltmeter of 0-150 volts scale to measure the applied voltage. Many multitesters have such a voltmeter range as well as an ohmmeter range for continuity tests. In the absence of a voltmeter, the dial reading of the variable transformer may be used as an approximate voltage indicator. See Table II. If a portable test set (PTS-2) is not available, the equipment listed under "Testing Without a Portable Test Set" can be used.

Again, each phase must be tested in turn. Connect the ac supply to terminals 1 and 9 for A phase, 2 and 9 for B phase, and 3 and 9 for C phase. To test the ground strap or neutral bus CT for ground protected systems, it is necessary for the breaker to be in the TEST or CONNECTED position in the cubicle, as explained before, and apply voltage to terminals 4 and 9.

Table II gives applied voltage and test limits of exciting current for all the standard tripping transformer ratings. The figure .02 ampere in the table is used because that is about the lowest readable current on the test set ammeter, and transformers that meet this limit will give satisfactory performance. Normal exciting current for the 800:1 and up ratings may be well below this value. Therefore, it is essential, for ratings of 1000:1 and higher, to perform the continuity check. On the lower ratings the continuity check can be omitted since the deflection of the ammeter verifies continuity.

TABLE II
TRIPPING TRANSFORMER EXCITING CURRENT TEST

TRIPPING TRANSF. RATING	APPLIED VOLTS	APPROX. VARIABLE TRANSF. SETTING	MAXIMUM EXCITING CURRENT
80:1	33.5	25	0.25
150:1	67	50	0.15
200:1	67	50	0.15
250:1	67	50	0.15
400:1	67	50	.05
600:1	134	100	.05
800:1	134	100	.03
1000 and Up	134	100	<.02

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 transformer rated current.

Primary current testing can provide the ultimate 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 static trip power supply circuit. The transformers that supply power to the static trip circuit are designed to saturate to limit the input to an acceptable level. When supplied from a low voltage source that cannot provide a pure sine wave of current, the waveshape supplied to the static trip will be altered. This results in either insufficient power to properly operate the static 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 sensor transformers. A properly operating tripping system will be self protecting from thermal damage up to the circuit breaker short time and interruption rating provided that the duty cycle applicable for each rating is not exceeded. The standard duty cycle for the short time rating is demonstrated per ANSI C37.50 is 0.5 seconds ON, 15 seconds OFF followed by a second ON time of 0.5 seconds. The ON intervals generally are too short to read the ammeter for the current source. For the instantaneous interruption rating, the ON times are reduced to 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 sensing transformers may be damaged. Between tests, the unit must remain OFF long enough to allow the sensor transformers to cool. In addition, if there was a fault in the tripping system and the breaker could not trip within its rated time limits the system would not be self protecting.

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

1. Apply to one phase of the circuit breaker an input current of one-half sensor transformer rating and measure the trip device power supply voltage. This voltage is across the filter capacitor from its negative terminal to the red actuator lead. If this voltage exceeds 18 volts, the distortion of the input current can be disregarded except for its effect on the ammeter reading. Test all three poles of the circuit breaker in the same manner. This establishes that the device power circuits are operating.
2. Set the long time pick-up control to the "A" position, slowly increase the current from zero while watching the long time trigger output. Pick-up should occur at one-half the sensor transformer rating plus or minus 10% not including ammeter error. Pick-up is indicated by a sudden increase in the trigger voltage. Repeat for all three poles of the circuit breaker. When the trigger is present, the long time circuit timing oscillator is released and the device will time out on long time. Repeat calibration check on the other long time pick-up calibration points if desired.
3. Set long time pick-up on "A", long time band control on Band one (if adjustable), instantaneous and short time pick-up on 12X, and the input current equal to the sensor transformer rating. Remove and reapply power. Allow the device to time out and trip the breaker. The time to trip should meet the published curves for the device being tested. Repeat for all long time bands. Note that if the input current waveshape is distorted, the time delay may be less than expected. Some newer primary current test sets have peak responding ammeter

circuits that will properly indicate current magnitude when waveshape distortion is present.

4. Set instantaneous at 3X, short time at 12X, long time band on its maximum (if adjustable). The breaker should trip instantaneously at 1.5 times the sensor rated current. Repeat for all three poles of the breaker.
5. Set short time pick-up at 3X, instantaneous at 12X, long time band on its maximum (if adjustable), and short time band on minimum. Slowly increase current. The breaker should trip on short time at 1.5 times the sensor rated current. The short time "time delay" 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 "over shoot".
6. With the same settings as in Step 5, adjust the supply current to 3 times the sensor transformer rating. Apply the current and observe the breaker tripping time. Test all three short time bands and verify that the short time delay matches the published curves.
7. Increase the instantaneous and short time pick-up controls to their maximum and set the long time band on minimum (if adjustable). Adjust the supply current to twice the sensing transformer rating. Apply the current and observe the breaker tripping time. Test at the same current for all time bands, if bands are adjustable, and verify that the long time delay matches the published curves. Other values of current can be tested if overheating is prevented.
8. To demonstrate operation at normal control setting, reset all controls to their desired condition, set current to a value high enough to definitely cause tripping, apply current, and verify that tripping occurs.

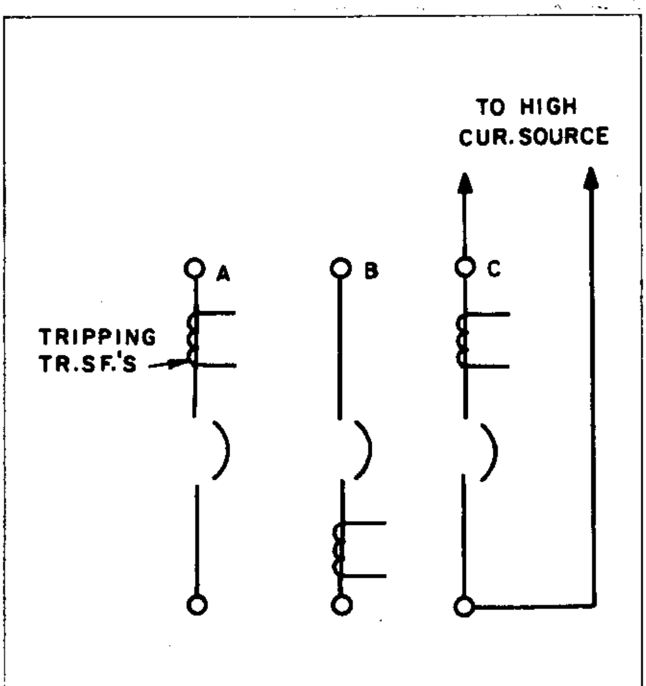

Figure 14. — Primary Current Testing

Because of the complexity of some of the semiconductor components, for example, the integrated circuits, we do not recommend field repair of STATIC TRIP II units. Moreover, component failure usually 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 indicate that a STATIC TRIP II device is defective, contact your Siemens-Allis representative for instructions on returning the unit to the factory for repair.

REPAIR

Because of the complexity of some of the semi-conductor components, for example, the integrated circuits, we do not recommend field repair of STATIC TRIP II units. Moreover, component failure usually 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 indicate that a STATIC TRIP II device is defective, contact your Siemens-Allis representative for instructions on returning the unit to the factory for repair.

MAINTENANCE

Each trip device is adjusted, calibrated, and tested before shipment. It is ready for use after the appropriate settings have been selected.

Because there are no moving parts, no readjusting, lubricating, etc. is required. The only maintenance that is required is periodic verification that the device is functioning. This may be supplemented as desired by checking the calibration, inspecting for loose or broken external wiring, restoring lost calibration, and where unusually dusty conditions exist, periodic cleaning.

Restoring Lost Calibration

Calibration of the trip device depends on the knobs being properly oriented on their shafts. If the knobs are forced by turning past the stops, calibration will be lost but can readily be restored.

A knob will be in proper calibration if, when turned counterclockwise as far as it can go, the pointer lines up precisely with the black reference dot on the dial. Refer to Figure 9. If the above check shows the calibration to be in error, remove the knob by loosening its set screw and slipping it off the shaft. Then turn the shaft counterclockwise as far as it will go. Keep the shaft in that position and replace the knob so that it is directly over the black reference dot and tighten the set screw. The LONG TIME BAND control knob has no stop, and the knob is keyed with a set screw to a flat on the shaft. If the set screw should loosen, it is only necessary to verify that the set screw is lined up with the shaft flat, and retighten the screw.

Cleaning

All the components in STATIC TRIP II except the targets are sealed against dust, and the insulation integrity of the printed circuit boards is protected by a varnish coating. However, in extremely dusty atmospheres, enough dust may in time accumulate to prevent adequate cooling of components. STATIC TRIP II units are easily disassembled for cleaning. Removing one hex head, self-threading screw at the top and one at the bottom allows removal of the right side cover of the case. The two modules consisting of the two printed circuit boards with front and back plates can then be slid out from the U-shaped sheet metal piece that forms the left side and top and bottom of the case. The two modules are held together mechanically. Either several banana plugs that also serve as the electrical connections or by three screws and a jumper cable.

To separate the modules with banana plugs, carefully pull them apart so that all plugs disengage at the same time, otherwise the plugs may be damaged. To separate the modules connected with the jumper cable the two screws holding the logic module to the back panel of the power module must be removed, along with the one screw at the center of the logic module. The two modules can then be separated mechanically but will remain connected together by the jumper cable.

With the modules apart, Figure 15, all components are exposed for cleaning. Cleaning can be done with a very soft brush or with compressed air. In the latter case, be sure the air is clean and dry and that the jet is not too strong.

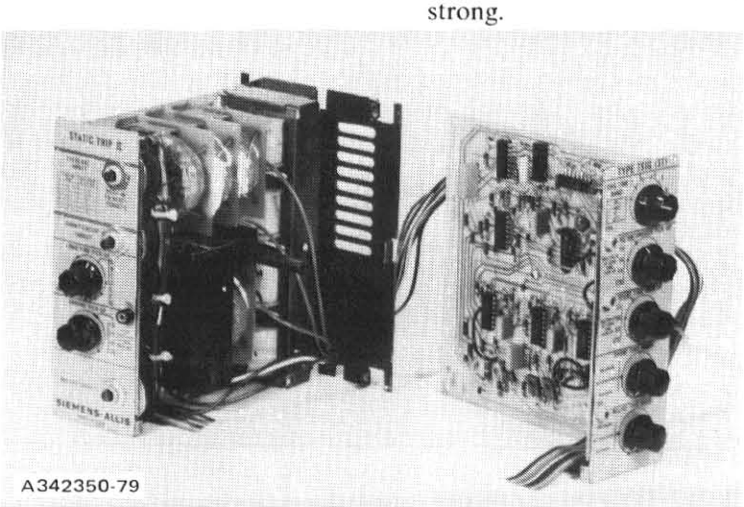

Figure 15. — Static Trip II Disassembled

INSTRUCTION BOOK REFERENCES

SIEMENS-ALLIS

Switchgear Division
P. O. Box 14505
West Allis, Wisconsin 53214
414 475-3600