Operation and Adjustment

Table of Contents

Qualified Persons

⚠ WARNING

Only qualified persons knowledgeable in the installation, operation, and maintenance of overhead and underground electric distribution equipment, along with all associated hazards, may install, operate, and maintain the equipment covered by this publication. A qualified person is someone trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of special precautionary techniques, personal protective equipment, insulated and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended only for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read this Instruction Sheet

NOTICE

Thoroughly and carefully read this instruction sheet and all materials included in the product's instruction handbook before installing or operating the S&C Type ZSD Overcurrent Relay. Become familiar with the Safety Information on page 3 and Safety Precautions on pages 4 through 6. The latest version of this publication is available online in PDF format at **sandc.com/en/contact-us/product-literature/**.

Retain this Instruction Sheet

This instruction sheet is a permanent part of the S&C Type ZSD Overcurrent Relay. Designate a location where users can easily retrieve and refer to this publication.

Proper Application

⚠ WARNING

The equipment in this publication is only intended for a specific application. The application must be within the ratings furnished for the equipment. Ratings for the S&C Type ZSD Overcurrent Relay are listed on the product's faceplate.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels attached to the S&C Metal-Enclosed Switchgear. Become familiar with these types of messages and the importance of these signal words:

⚠ DANGER

"DANGER" identifies the most serious and immediate hazards that will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

"WARNING" identifies hazards or unsafe practices that can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

"CAUTION" identifies hazards or unsafe practices that can result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE

"NOTICE" identifies important procedures or requirements that can result in product or property damage if instructions are not followed.

Following Safety Instructions

If any portion of this instruction sheet is unclear and assistance is needed, contact the nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C's website, **sandc.com**, or call the S&C Global Support and Monitoring Center at 1-888-762-1100.

NOTICE

Read this instruction sheet thoroughly and carefully before operating and adjusting the S&C Type ZSD Overcurrent Relay.

Replacement Instructions and Labels

If additional copies of this instruction sheet are required, contact the nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important that any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting the nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

⚠ DANGER

S&C Custom Metal-Enclosed Switchgear operate at high voltage. Failure to observe the precautions below will result in serious personal injury or death.

Some of these precautions may differ from your company's operating procedures and rules. Where a discrepancy exists, follow your company's operating procedures and rules.

1. **QUALIFIED PERSONS.** Access to S&C Custom Metal-Enclosed Switchgear must be restricted only to qualified persons. See the "Qualified Persons" section on page 2.
2. **SAFETY PROCEDURES.** Always follow safe operating procedures and rules.
3. **PERSONAL PROTECTIVE EQUIPMENT.** Always use suitable protective equipment, such as rubber gloves, rubber mats, hard hats, safety glasses, and flash clothing, in accordance with safe operating procedures and rules.
4. **SAFETY LABELS.** Do not remove or obscure any of the "DANGER," "WARNING," "CAUTION," or "NOTICE" labels.
5. **OPERATING MECHANISM AND BASE.** S&C Custom Metal-Enclosed Switchgear contain fast-moving parts that can severely injure fingers. Do not remove or disassemble operating mechanisms or remove access panels unless directed by S&C Electric Company.
6. **ENERGIZED COMPONENTS.** Always consider all parts live until de-energized, tested, and grounded. Voltage levels can be as high as the peak line-to-ground voltage last applied to the unit. Units that have been energized or installed near energized lines should be considered live until tested and grounded.
7. **GROUNDING.** The S&C Custom Metal Enclosed Switchgear must be connected to a suitable earth ground at the base of the utility pole, or to a suitable building ground for testing, before energizing the switchgear, and at all times when energized.
   - The ground wire(s) must be bonded to the system neutral, if present. If the system neutral is not present, proper precautions must be taken to ensure the local earth ground, or building ground, cannot be severed or removed.
8. **SWITCH POSITION.** Always confirm the **Open/Closed** position of each switch.
   - Switches and terminal pads may be energized from either side.
   - Switches and terminal pads may be energized with the switches in any position.
9. **MAINTAINING PROPER CLEARANCE.** Always maintain proper clearance from energized components.
10. **PADLOCKS.** Non-removable manual handles in high-voltage compartment doors and hinged-padlockable covers, as well as hinged-bolted panels, have provisions for padlocks that must be in place and secured at all times unless work is being performed inside the enclosure. Padlocks must be installed and secured on manual switch operating handles at all times unless the switch is being operated.
11. **SNAPLOCKS.** Snaplocks must be in place and the keys must be removed.
12. **KEY INTERLOCKS.** Key interlocks (if applicable) must be in place. Check the operating sequence of key interlocks to verify proper sequencing. After the switchgear is installed, destroy all duplicate keys or make them accessible only to authorized persons so the key interlock scheme will not be compromised. Key interlocks are not security locks.
13. **MECHANICAL CABLE INTERLOCKS.** Mechanical cable interlocks are provided to prevent access to fuses unless the switch is open and to prevent operation of stored-energy switch operators when the enclosure door is open. Do not attempt to operate any switch when the enclosure door is open. Periodically, verify these interlocks are functional. Refer to in the "Interlocks" section of Instruction Sheet 621-500 pages 34 through 36.

TABLE CONTINUED ►

⚠ DANGER

S&C Custom Metal-Enclosed Switchgear operate at high voltage. Failure to observe the precautions below will result in serious personal injury or death.

Some of these precautions may differ from your company's operating procedures and rules. Where a discrepancy exists, follow your company's operating procedures and rules.

14. **EXCESSIVE FORCE.** Do not apply undue force to any handle when attempting to open or close a door or cover. The use of undue force may damage the handle or latching mechanism, or an interlock mechanism may be jammed. Do not attempt to close doors to reset interlocks. Instead, follow the instructions in the "Interlocks" section of Instruction Sheet 621-500 pages 34 through 36.
15. **PANELS AND SCREENS.** Make sure screens and hinged-bolted panels are bolted closed unless work is being performed inside the enclosure.
16. **FUSES.** Make sure fuses are disconnected from all power sources (including backfeed) before inspection or replacement.
17. **VOLTAGE TRANSFORMERS.** Disconnect all voltage transformers and voltage sensors when external voltage is used to test any secondary-side wiring or when heaters are energized for temporary storage. Do not disconnect voltage limiters from voltage sensors when the switchgear is energized.

⚠ WARNING

Do not energize S&C Metal-Enclosed Switchgear furnished with Type ZSD Overcurrent Relays before relay has been set using the procedure outlined in this Instruction Sheet.

Setting should be determined and approved by qualified personnel who are familiar with the principles of selective coordination and system protection. S&C Electric Company is not responsible for the mis-operation or mis-coordination of Type ZSD Overcurrent Relays resulting from improper settings.

Make sure Type ZSD Overcurrent Relay settings are maintained in a secure manner by properly trained personnel.

Failure to properly set Type ZSD Overcurrent Relays in accordance with applicable codes and standards can result in mis-operation or mis-coordination, equipment damage, personal injury, or death.

NOTICE

The S&C Type ZSD Overcurrent Relay is not a general purpose overcurrent relay used to provide fault protection. It's typically applied in S&C Metal-Enclosed Switchgear in conjunction with switch-operator-driven S&C Mini-Rupter® Switches or Alduti-Rupter® Switches and S&C Closed-Gap Current Sensors, which sense the current in each phase of the circuit. The relay will trip the switch operator to open the load-interrupter switch—and achieve three-phase isolation of the circuit—after a fault downstream of the current sensors has been cleared by one or more feeder fuses.

NOTICE

S&C Type ZSD Overcurrent Relays are intended to operate selectively with feeder fuses provided in S&C Metal-Enclosed Switchgear. These fuses—like all medium-voltage fuses—are selected to provide fault protection; they are not designed to clear overload currents. Accordingly, the Type ZSD Overcurrent Relay should be set to trip at a current level that is slightly higher than the current level found on the total-clearing time-current characteristic (TCC) curve of the feeder fuse at a high value of time (300 seconds or above). If the relay is set based on load current, which can vary widely, a nuisance opening of the load-interrupter switch controlled by the Type ZSD Overcurrent Relay may occur.

Overview

The S&C Type ZSD Overcurrent Relay is designed for application in S&C Metal-Enclosed Switchgear rated 4.16 kV through 34.5 kV. It is typically applied on three-phase circuits in conjunction with a switch-operator-driven S&C Mini-Rupter® Switch or Alduti-Rupter® Switch and S&C Closed-Gap Current Sensors, which sense the current in each phase of the circuit. The relay will trip the switch operator to open the interrupter switch—and thus achieve three-phase isolation of the circuit—after a fault downstream of the current sensors has been cleared by a protective device. See Figure 1.

The Type ZSD Overcurrent Relay is superior to ordinary overcurrent relays because it can distinguish between fault current and transformer inrush current. After an over-current condition is sensed, the relay determines whether normal load current returns on all three phases. In instances where normal load current *does* return on all three phases, no trip signal is sent to the switch operator.

One Type ZSD Overcurrent Relay is required for each three-phase circuit to be protected. Control voltage is typically supplied by the switch operator power source. On dc-control-voltage models, a three-phase isolation transformer assembly is used to compensate for possible ground loops caused by differences in potential between the grounding point of the current sensors and the grounding point of the control power source.

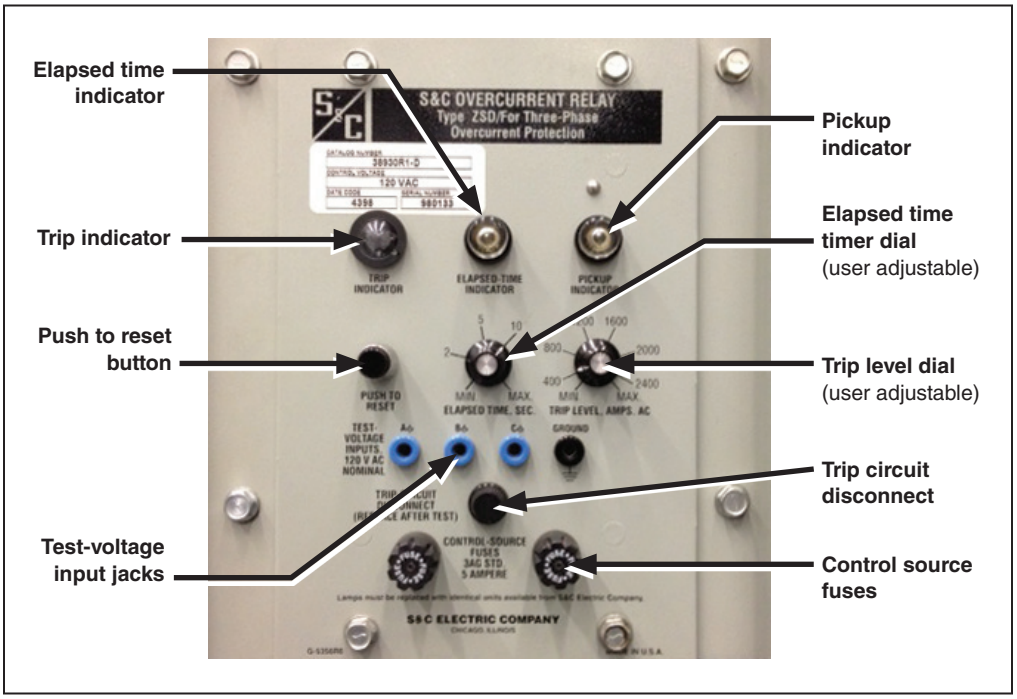

Figure 1. S&C Type ZSD Overcurrent Relay.

Under normal conditions in a typical load-feeder application, the feeder interrupter switch is closed, the PICKUP INDICATOR lamp and the ELAPSED TIME INDICATOR lamp on the Type ZSD Overcurrent Relay are not illuminated, and the TRIP INDICATOR target on the Type ZSD Overcurrent Relay is black. See Figure 2 on page 9.

A fault downstream of the feeder fuses will result in a large-magnitude current in one or more phases of the load-feeder circuit. If the current in any phase exceeds the setting of the user-adjustable 400- to 2400-ampere TRIP LEVEL dial, a 2-millisecond timer (which eliminates response to transient disturbances) will start. If the current remains above the trip level setting and the 2-millisecond timer times out, the latching circuit will pick up and the user-adjustable 1- to 35-second tripping circuit elapsed time timer will start.●

If normal load current—3.5 amperes or greater—returns on all three phases before the setting of the ELAPSED TIME timer dial on the Type ZSD Overcurrent Relay (as would be the case with transformer inrush), the latching circuit and elapsed time timer will reset and the PICKUP INDICATOR lamp will extinguish.

But if normal load current does not return on all three phases (as would be the case of a fault cleared by the feeder fuse(s) or the source-side protective device), the tripping-circuit timer will complete its cycle to pick up the output relay—thus tripping the switch operator—and the ELAPSED TIME INDICATOR lamp will light. Simultaneously, the TRIP INDICATOR target will appear red. After 0.75 second, the latching circuit will reset and the output relay will de-energize. The PICKUP INDICATOR and ELAPSED TIME INDICATOR lamps will extinguish.

A blocking circuit prevents pickup of the output relay (and thus tripping of the switch operator) if overcurrent exceeds the trip-level setting (or 600■ or 1200▲ amperes—whichever is lower) after the elapsed time timer has cycled. In this instance, the PICKUP INDICATOR and ELAPSED TIME INDICATOR lamps will remain illuminated. The TRIP INDICATOR target will remain black and the output relay will not pick up until the current drops below the trip-level setting (or 600 amperes—whichever is lower).

The Type ZSD Overcurrent Relay *does not* respond to source-side open-phase conditions. Protection of the feeder circuits from these conditions is, however, provided if the metal-enclosed gear is equipped with an S&C Micro-AT® Source-Transfer Control using the user-programmed unbalance detection feature.

Application Considerations

Like all overcurrent relays, the S&C Type ZSD Overcurrent Relay must be set with the optimal balance of sensitivity and security. Sensitivity refers to the relay's ability to detect an abnormal condition and respond to it by issuing a trip signal. Security refers to the relay's ability to operate only when it should, and not operate when it shouldn't. A relay that is too sensitive is not secure, and a relay that is overly secure may not be sensitive enough.

If the minimum trip-level setting of the Type ZSD Overcurrent Relay is too low (i.e., too sensitive), the relay might send a trip signal to the three-phase load-interrupter switch under high loading conditions *(but no fault)*, resulting in a nuisance outage. If the minimum trip-level setting of the relay is too high (i.e., not sensitive enough), the relay might not send a trip signal to the three-phase load-interrupter switch—*even if there is a fault*—resulting in a single-phase condition. The optimal balance between sensitivity and security can be achieved by setting the minimum trip level of the Type ZSD Overcurrent Relay to a current value that is slightly higher than the current value found on the total clearing time-current characteristic (TCC) curve of the feeder fuse at a high value of time (300 seconds or above). Additionally, the elapsed time timer should be set for a time delay sufficient to allow load current to return on all three phases (after an overcurrent is detected in excess of the minimum trip level set as just described).

● On relays bearing "-R1" catalog number suffix, a user-enabled inrush restraint feature can be used in applications where the relay must coordinate with a reclosing source-side protective device. This feature inhibits relay response to overcurrents occurring during initial energization or during reclosing by delaying, for one second, starting of the two-millisecond time delay.

■ Models with 38930R1 base catalog number.

▲ Models with 38932R1 base catalog number.

If the Type ZSD Overcurrent Relay is powered from a *single* ac control power source, it's possible that the relay might *not* issue a trip signal if coordination between the feeder fuse and the source-side circuit breaker or recloser is not achieved for all values of fault current. It's also possible that the Type ZSD Overcurrent Relay might issue an incorrect trip signal if there is miscoordination between the feeder fuse and the source-side circuit breaker or recloser, where automatic reclosing of the source-side device is enabled, and where the Type ZSD Overcurrent Relay is powered by a battery-based dc control power source.

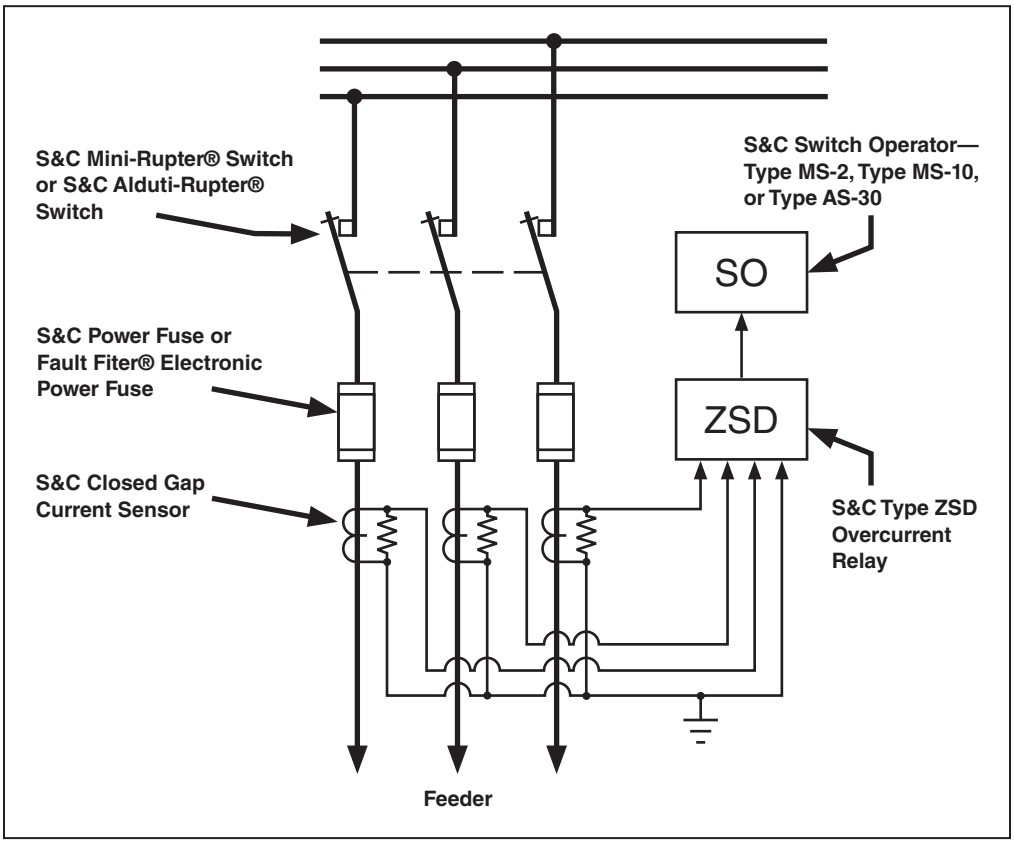

Figure 2. Schematic diagram of typical installation in feeder bay of S&C Metal-Enclosed Switchgear.

In most instances, the Type ZSD Overcurrent Relay is factory-installed in the S&C Metal-Enclosed Switchgear and all interconnections between the relay, its associated switch operator, and—in the case of dc-control-voltage relays—the isolation transformer assembly have been completed at the factory. If special field interconnections are necessary, perform Steps 1 through 3; otherwise proceed to Step 4.

STEP 1. Remove the CONTROL SOURCE FUSES from the front of the relay. See Figure 1 on page 7.

STEP 2. Complete field interconnections in accordance with the system wiring diagram and interconnection wiring diagram furnished with the metal-enclosed gear.

STEP 3. Replace the control source fuses removed in Step 1.

STEP 4. Attach each S&C Closed-Gap Current Sensor to its associated medium-voltage cable using the following procedure. See Figure 3 on page 11.

(a) Cut to the appropriate length and strip the current-sensor output wires, which have been factory-coiled and tied in the vicinity of the medium-voltage cable location. Attach the crimp-on connectors, furnished, to the output wires. Now attach the wires to the current-sensor output terminals. (The other ends of these wires have been factory-connected to the appropriate terminal block.)

(b) Remove the ¼—20 gap nut on the current sensor. Open the current sensor and slip it around the appropriate medium-voltage cable. Refer to the wiring diagram. Now replace and securely tighten the gap nut.

(c) Secure the current sensor to the medium-voltage cable *at a point below the cable terminator or stress cone* using the plastic wire ties furnished. The current sensor may be placed against the grounded concentric neutral of the cable, in which case the concentric neutral ***must*** be brought back through the sensor, or against the semiconducting jacket of the cable, in which case the drain wire of the terminator ***must*** be brought through the sensor. The current-sensor output wiring should be trained and shielded so that the rated BIL of the metal-enclosed gear is maintained.

NOTICE

The current sensor **must not** be used on unshielded cable or cable on which the insulation exposes the conductor.

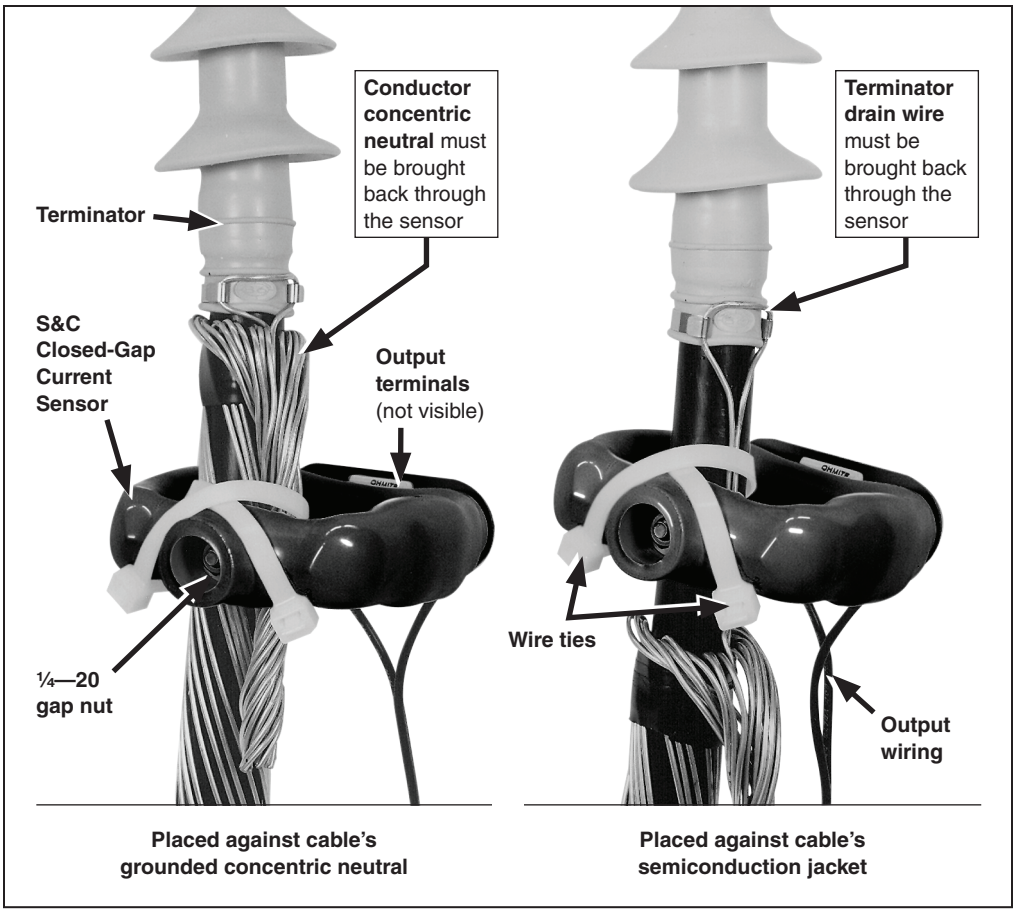

Figure 3. Typical methods for attaching S&C Closed-Gap Current Sensor to medium-voltage cable.

STEP 5. *For ac-control-power model:* Verify the S&C Closed-Gap Current Sensors have been properly installed by measuring the secondary-circuit resistance between Terminals 1 and 4, Terminals 2 and 4, and Terminals 3 and 4 on the back of the Type ZSD Overcurrent Relay. See Figure 4 (top) on page 12. Each resistance measurement should be between 75 and 95 ohms.

For dc-control-power models: Verify the S&C Closed-Gap Current Sensors have been properly installed by measuring the secondary-circuit resistance between Terminals 1 and 4, Terminals 2 and 4, and Terminals 3 and 4 on the Isolation Transformer Assembly. See Figure 4 (bottom) on page 12. Each resistance measurement should be between 65 and 85 ohms.

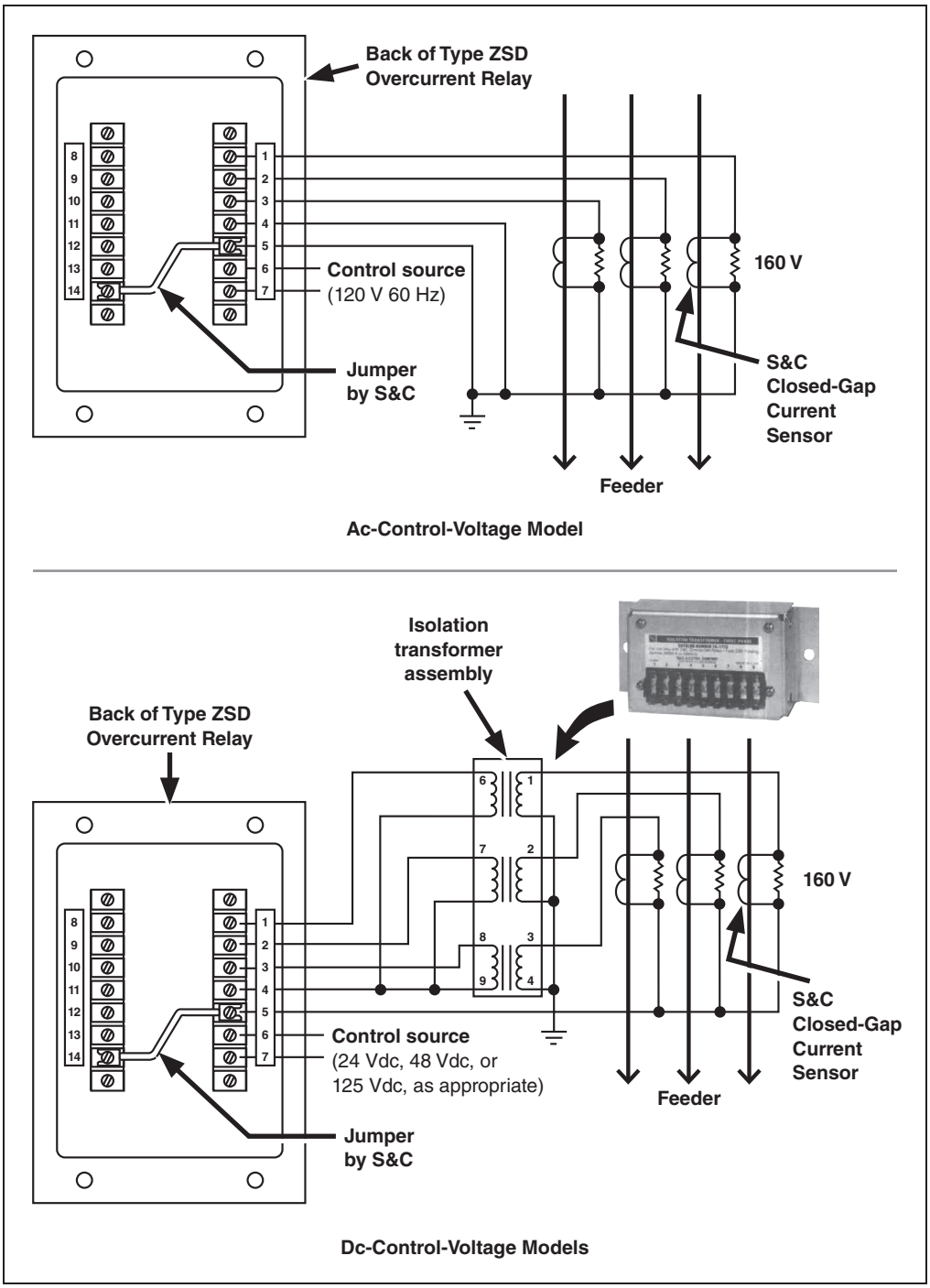

Figure 4. Three-line connection diagram.

Inrush Restraint Feature

For Type ZSD Overcurrent Relays with the "-R1" catalog number suffix, a user-enabled inrush restraint feature, shipped in the "out" (off) position, can be used in applications where the relay must coordinate with a reclosing source-side protective device. This feature inhibits relay response to overcurrents occurring during initial energization or during reclosing by delaying, for one second, starting of the two-millisecond time delay.

To enable the **Inrush Restraint** feature of the relay use the following procedure:

STEP 6. If the Type ZSD Overcurrent Relay is mounted to a slide-out panel, unlatch the panel and pull it out. If the relay is mounted to the enclosure style, locate and remove the four ⅜ × ¾-inch hex-head bolts that secure the Type ZSD Overcurrent Relay to the enclosure style. Then carefully remove the relay.

STEP 7. Remove the hole plug on the top of the relay housing.

STEP 8. Place the selector switch in the **In** position.

STEP 9. Replace the hole plug.

STEP 10. Slide in the panel if the relay is mounted to a slide-out panel. Otherwise, remount the relay to the enclosure style. Re-install and tighten the four ⅜ × ¾-inch hex-head bolts.

Trip Level

Adjust the 400- to 2400-ampere TRIP LEVEL dial to the phase current above which the Type ZSD Overcurrent Relay is to respond.

The TRIP LEVEL dial reads to within ±20% of the trip-level detector setting. (For a more precise setting, operational tests are required; such tests should be performed at completion of this section. See the "Operational Testing" section on pages 16 through 18.) The trip level detector will maintain its setting with a repetitive accuracy of ± 5%.

In most instances, a trip-level setting equal to 105% of the current on the total-clearing curve of the feeder fuse at high values of time (300 seconds or above) is appropriate. E-rated power fuses are designed to melt at two times the ampere rating. Additionally, their time-current characteristic (TCC) curves are vertical or nearly so at low current levels. For E-rated power fuses, the minimum trip-level setting of the Type ZSD Overcurrent Relay should be set as follows:

- 2 × ampere rating of the fuse × 1.1 × 1.05 (for fuses rated 100E amperes or less),

  or

- 2.2 × ampere rating of the fuse × 1.1 × 1.05 (for fuses rated greater than 100E amperes).

For fuses that do not melt at two times the ampere rating, for example, C-Rated current-limiting fuses, or for fuses having TCC curves that are not vertical at low current levels, set the minimum trip level of the Type ZSD Overcurrent Relay equal to 105% the current on the total clearing curve of the fuse at 100 seconds.

Unlike E-rated power fuses or C-rated current-limiting fuses, S&C Fault Fiter® Electronic Power Fuses are designed to trip at current levels equal to their minimum pickup current settings. Fault Fiter Electronic Power Fuses are available with minimum pickup current settings significantly higher than other types of fuses. For Fault Fiter Electronic Power Fuses, the minimum trip-level setting of the Type ZSD Overcurrent Relay should be set as follows:

- 1 × minimum pickup current setting × 1.1 × 1.05 (for fuses with minimum-pickup current settings through 1500 amperes),

  or

- 2 × minimum pickup current setting × 1.1 × 1.05 (for parallel fuses with minimum pickup current settings through 2000 amperes).

For fuses rated 150E amperes and below, the 400-ampere minimum trip-level setting should be used.

When the Type ZSD Overcurrent Relay is set as just described, its response, including all relay tolerances, will be properly coordinated with the feeder fuse; the relay will pick up on high magnitude faults that the fuse is designed to clear while not responding to the lower-magnitude currents that the fuse is not supposed to clear.

NOTICE

If the electrical system is impedance grounded to limit the fault current to less than 400 amperes, a phase-to-ground fault may be well below the minimum-melting current of the feeder fuse. In this case, the Type ZSD Overcurrent Relay will only respond to phase-to-phase faults.

Elapsed Time Timer

Adjust the 1- to 35-second ELAPSED TIME timer dial for the allowable time delay for normal load current to return on all three phases (after an overcurrent is detected in excess of the value set in the "Trip Level" section on page 14). This setting should be selected so operation of the Type ZSD Overcurrent Relay coordinates with operation of the load-side and source-side protective devices. In most instances, a setting of about 10 seconds is appropriate.

The ELAPSED TIME timer dial reads to within ± 20% of the timer setting. (For more precise setting, operational tests are required; such tests should be performed at completion of this section. See the "Operational Testing" section on pages 16 through 18.) The timer will maintain its setting with a repetitive accuracy of ± 5%.

The following instructions provide the procedure for checking operation of the Type ZSD Overcurrent Relay using the test-voltage input jacks on the front of the relay. These instructions assume the S&C Metal-Enclosed Switchgear has been installed in accordance with the applicable drawings, instruction sheets, and wiring diagrams, and is in all respects ready for operation, with the medium-voltage circuits energized and carrying current and with control power available to the Type ZSD Overcurrent Relay.

NOTICE

Do not apply test voltage directly to the terminals on the rear of the Type ZSD Overcurrent Relay, or to the secondary circuits of the current sensors. Damage to these devices can occur.

To Verify Current Sensors Are Functioning

STEP 1. Verify the "A-phase" current sensor is functioning properly by inserting the probes of a digital voltmeter, having a minimum input impedance of 1 megaohm per volt, into the test-voltage input jacks labeled "Aϕ" and GROUND on the front of the relay. See Figure 1 on page 7. The current-sensor output voltage multiplied by 30 is approximately equal to the actual primary current. Thus, a 5-volt ac measurement corresponds to a current-sensor primary-circuit current of approximately 150 amperes.

STEP 2. Repeat Step 1 for the "B-phase" and "C-phase" current sensors.

STEP 3. Remove the TRIP CIRCUIT DISCONNECT slug from the front of the relay.

STEP 4. Make the test circuit connections shown in Figure 5 on page 17.

STEP 5. With the signal-voltage source ON-OFF switch in the **Off** position, connect the signal-voltage source to the "Aϕ" and GROUND test-voltage input jacks.

STEP 6. Press the PUSH TO RESET button. The TRIP INDICATOR target should appear black.

STEP 7. Set the variable transformer for zero volts. Energize the isolation transformer.

To Simulate Operation of the Blocking Circuit

STEP 8. To simulate operation of the blocking circuit, increase the signal voltage to approximately 100 volts ac. Then place the signal-voltage source ON-OFF switch in the **On** position.

The PICKUP INDICATOR lamp should light and, after the ELAPSED TIME timer setting selected in the "Elapsed Time Timer" section on page 15, the ELAPSED TIME INDICATOR lamp should also light. The TRIP INDICATOR target should remain black.

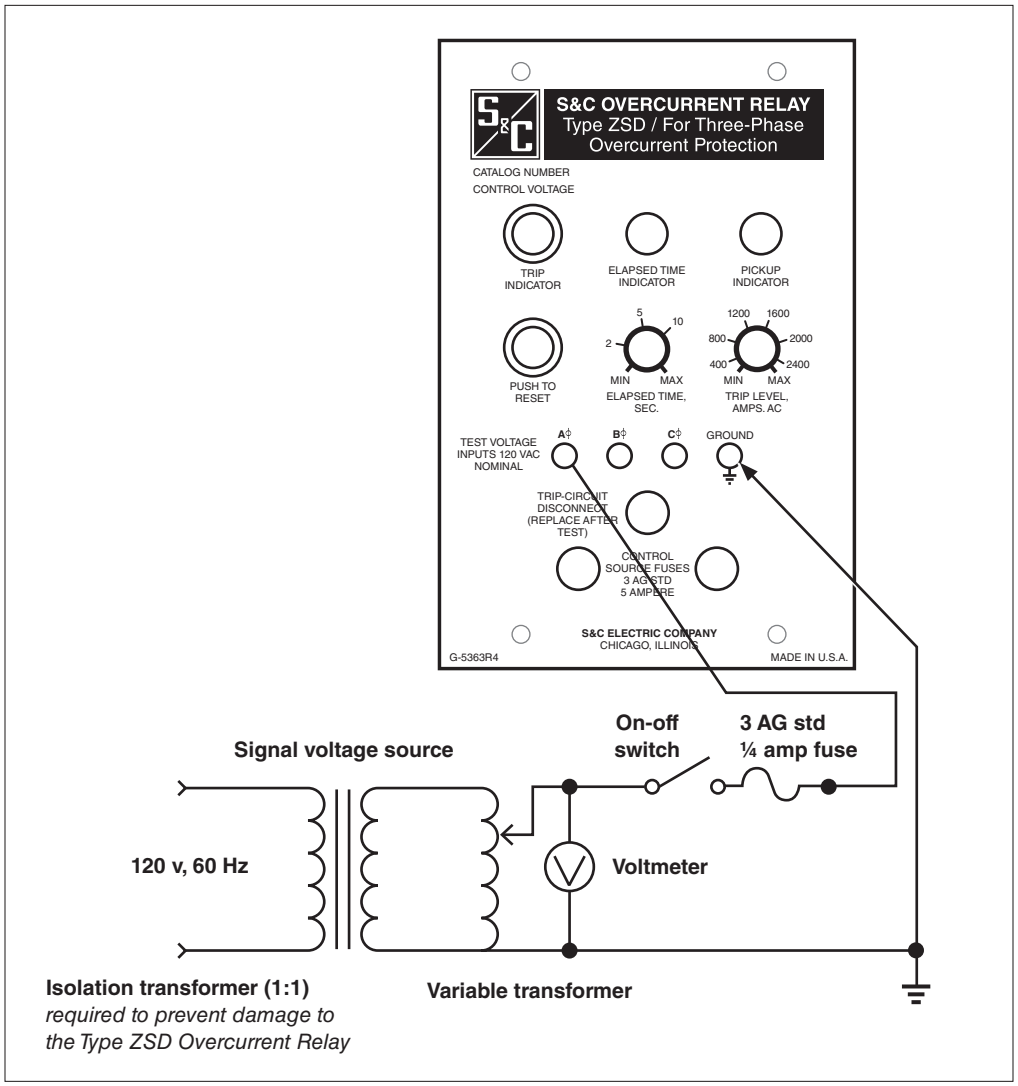

Figure 5. Test-circuit connection diagram.

To Simulate Relay Operation After Blocking Circuit Has Functioned and Current Falls Below Pickup Current

STEP 1. To simulate operation of the relay after the blocking circuit has functioned and current subsequently falls below the trip-level detector setting (or 600★ or 1200▲ amperes—whichever is lower), connect the signal voltage source to the "Aϕ" and GROUND test-voltage input jacks. Decrease the signal voltage to approximately 10 volts ac—corresponding to an overcurrent less than the blocking-circuit pickup level. The TRIP INDICATOR target should immediately appear red. Simultaneously, the output relay should energize for 0.75 second and then drop out. The PICKUP INDICATOR and ELAPSED TIME INDICATOR lamps should extinguish.

STEP 2. Repeat Step 1 with the signal voltage source connected to the "Bϕ" and GROUND test-voltage input jacks. Then repeat Step 1 with the signal voltage source connected to the "Cϕ" and GROUND test-voltage input jacks.

STEP 3. Determine, from the graph in Figure 6 on page 19, the signal voltage corresponding to the phase-current trip-level setting selected in the "Trip Level" section on page 14.

To Simulate Relay Operation in Response to Increasing Load Current

To simulate operation of the Type ZSD Overcurrent Relay in response to increasing load current, first place the signal-voltage source ON-OFF switch in the **Off** position. Jumper the "Aϕ," "Bϕ," and "Cϕ" test-voltage input jacks.

Set the variable transformer for zero volts. Then place the signal-voltage source ON-OFF switch in the **On** position. Now, slowly increase the signal voltage to the level determined in Step 3, ±20%—just until the PICKUP INDICATOR lamp lights—and immediately decrease the signal voltage just below this level. (This must be accomplished before the ELAPSED TIME INDICATOR lamp lights.) Verify that the PICKUP INDICATOR lamp extinguishes immediately. Place the signal-voltage source ON-OFF switch in the **Off** position.

★ Models with 38930R1 base catalog number.
▲ Models with 38932R1 base catalog number.

⚠ CAUTION

Do not apply a signal voltage in excess of 140 Vac, RMS.

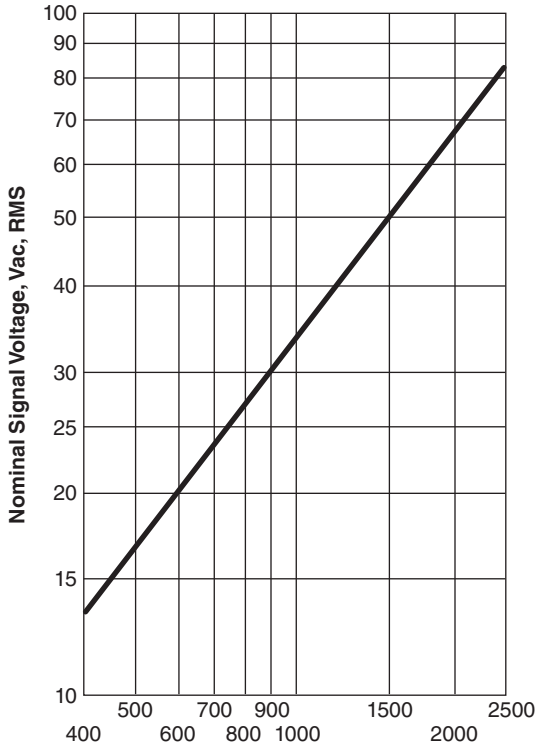

Figure 6. Signal voltage corresponding to phase-current trip-level setting.

To Simulate Relay Operation if Overcurrent Occurs During Energization or During Reclosing of Source-Side Device

To simulate operation of the Type ZSD Overcurrent Relay in response to overcurrent occurring during initial energization or during reclosing of a source-side protective device, set the variable transformer to approximately 50 volts ac. Then place the signal-voltage source ON-OFF switch in the **On** position. The PICKUP INDICATOR lamp should light after approximately one second if the **Inrush Restraint** feature—included on relays with catalog number suffix "R1"—has been enabled. Otherwise, the PICKUP INDICATOR lamp should light immediately. Place the signal-voltage source ON-OFF switch in the **Off** position. The elapsed time timer will start.

After the ELAPSED TIME timer setting selected in the "Elapsed Time Timer" section on page 15, the ELAPSED TIME INDICATOR lamp should light and the TRIP INDICATOR target should appear red. Simultaneously, the output relay should energize for 0.75 second, then drop out. The PICKUP INDICATOR and ELAPSED TIME INDICATOR lamps should extinguish.

Press the PUSH TO RESET button. The TRIP INDICATOR target should appear black. Remove the jumper between the "Aϕ," "Bϕ," and "Cϕ" test-voltage input jacks.

To Simulate Relay Operation After Fault Is Cleared by Protective Device

To simulate operation of the Type ZSD Overcurrent Relay after a fault cleared by a protective device, first do one of the following:

STEP 1. Open the associated interrupter switch, or

STEP 2. Remove the current-sensor output wires attached to Terminals 1, 2, and 3 on the back of the relay. See Figure 4 on page 12.

This step is necessary because the presence of load current can cause the elapsed time timer to reset during the simulation.

STEP 3. Connect the signal-voltage source to the "Aϕ" and GROUND test-voltage input jacks. Set the variable transformer for zero volts. Then place the signal-voltage source ON-OFF switch in the **On** position. Slowly increase the signal voltage to the level determined in Step 3 on page 18, ±20%—just until the PICKUP INDICATOR lamp lights. Then immediately place the signal-voltage source ON-OFF switch in the **Off** position, simulating operation of the load-side fuse or source-side protective device. The elapsed time timer will start.

After the ELAPSED TIME timer setting selected in the "Elapsed Time Timer" section on page 15, the ELAPSED TIME INDICATOR lamp should light and the TRIP INDICATOR target should appear red. Simultaneously, the output relay should energize for 0.75 second and then drop out. The PICKUP INDICATOR and ELAPSED TIME indicator lamps should extinguish.

Press the PUSH TO RESET button. The TRIP INDICATOR target should appear black.

STEP 4. Repeat Step 3 with the signal-voltage source connected to the "Bϕ" and GROUND test-voltage input jacks. Then repeat Step 3 with the signal-voltage source connected to the "Cϕ" and GROUND test-voltage input jacks.

STEP 5. Remove test circuit connections and replace TRIP CIRCUIT DISCONNECT slug.

STEP 6. Close the interrupter switch or reattach the current-sensor output wires to Terminals 1, 2, and 3 on the back of the Type ZSD Overcurrent Relay, as applicable.

To ensure the S&C Metal-Enclosed Switchgear is ready for normal operation, the following conditions must exist:

- All disconnect style medium-voltage fuses are closed and latched.
- All non-disconnect style medium-voltage fuses are secured in their clips.
- All appropriate medium-voltage switches are closed.
- All medium-voltage compartment doors are closed and latched.
- All Type MS-2 and Type AS-30 Switch Operators are coupled to their medium-voltage switches.
- All Type MS-10 Switch Operators are charged.
- All Type ZSD Overcurrent Relay TRIP CIRCUIT DISCONNECT and CONTROL SOURCE FUSES are installed.
- All Type ZSD Overcurrent Relay TRIP INDICATOR targets appear black and PICKUP INDICATOR and ELAPSED TIME INDICATOR lamps are not illuminated.
- All Type ZSD Overcurrent Relay PICKUP INDICATOR lamp and ELAPSED TIME INDICATOR lamp push-to-test features have been tried, to verify the presence of control power and that the lamps are operable.
- All Type ZSD Overcurrent Relay TRIP LEVEL settings are appropriately set, based on the ampere rating of their feeder fuses.

No routine maintenance is recommended for the S&C Type ZSD Overcurrent Relay other than an annual functional checkout, as described in the "Operational Testing" section on pages 16 through page 20. Check functioning of the PICKUP INDICATOR lamp and the ELAPSED TIME INDICATOR lamp by pushing on the lens. These lamps have a life expectancy of two years when operating continuously. When either lamp fails, both lamps should be replaced.

Table 1. S&C Overcurrent Relay—Type ZSD

Catalog Number	Control Circuit		
	Voltage		Current Requirement Milliamperes, Max
	Nominal	Operating Range	
38930R1-V	24 Vdc	21-32 Vdc	10
38930R1-A	48 Vdc	39-56 Vdc	240
38930R1-B	125 Vdc	100-140 Vdc	185
38930R1-D	120 Vac 60 Hz	102-132 Vac 60 Hz	100
38932R1-A	48 Vdc	39-56 Vdc	240
38932R1-B	125 Vdc	100-140 Vdc	185
38932R1-D	120 Vac 60 Hz	102-132 Vac 60 Hz	100

Operating Temperature Range

Ambient Adjacent to Device.....–40°F (-40°C) to +l60°F (+71°C)

Dielectric Strength

1-Second..... 1000 Vac, 60 Hz

Signal-Input Circuit

Trip-Level Detector

User Adjustable Range.....400 to 2400 amperes RMS
Factory Setting..... 400 amperes RMS

Blocking-Level Detector

Factory Setting:
38930R1 (all models)..... 600 amperes RMS
38932R1 (all models)..... 1200 amperes RMS

Return of Load-Current Level Detector

Factory Setting..... 3.5 amperes RMS
Current-Level Detector Accuracy● (over ambient temperature range)..... ± 5% of setting

Timing

Elapsed Time Timer

User Adjustable Range..... 1 to 35 seconds
Factory Setting..... 2 seconds
Accuracy (over ambient temperature range)..... ± 5% of setting

Output-Relay Contact Ratings

Current Carrying

Continuous ..... 10 amperes
1-Second..... 50 amperes
Interrupting ..... 10 amperes at 24 Vdc;
.....1 ampere at 48 Vdc;
..... 0.5 ampere at 125 Vdc;
.....10 amperes at 120 Vac, 60 Hz, 100% PF

● Excluding current sensor tolerance.

Test-Voltage Inputs

Maximum Input Signal ..... 140 Vac, 60 Hz
Input Voltage Range, Nominal ..... 13 to 80 Vac, 60 Hz■

Indicating Lamps

Chicago Miniature Lamp Works Catalog Number CM-382
Sylvania or General Electric Catalog Number 382
Fuse Rating ..... 3 AG Std, 5 amperes

S&C Closed-Gap Current Sensor

Catalog Number TA-1758

Accommodates Cable Diameter, Max ..... 2½ inches
Burden Resistance ..... 160 ohms
Output Voltage▲ ..... 5 Vac, 60 Hz
Dielectric Strength, 1-Second ..... 1800 Vac, 60 Hz
Coil Resistance ..... 180 ohms ±10%
Ambient Temperature Operating Range ..... –40°F (-40°C) to +l60°F (+71°C)
Accuracy ..... ± 5%

Catalog Number TA-1759

Accommodates Cable Diameter, Max ..... 3½ inches
Burden Resistance ..... 160 ohms
Output Voltage▲ ..... 5 Vac, 60 Hz
Dielectric Strength, 1-Second ..... 1800 Vac, 60 Hz
Coil Resistance ..... 180 ohms ± 10%
Ambient Temperature Operating Range ..... –40°F (-40°C) to +l60°F (+71°C)
Accuracy ..... ± 5%

■ Corresponds to trip-level detector adjustment range: 400 to 2400 amperes RMS.
▲ For line current of 150 amperes.