

Setting Phase and Ground Overcurrent Levels

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Introduction

Qualified Persons

WARNING

The equipment covered by this publication must be installed, operated, and maintained by qualified persons who are knowledgeable in the installation, operation, and maintenance of overhead electric power distribution equipment along with the associated hazards. A qualified person is one who is trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from non-live 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 the special precautionary techniques, personal protective equipment, insulating 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

Thoroughly and carefully read this instruction sheet before programming, operating, or maintaining your S&C 5800 Series Switch Control. Familiarize yourself with the safety information on page 3. The latest version of this instruction sheet is available online in PDF format at www.sandc.com. Select: Support/Product Literature Library.

Retain this Instruction Sheet

This instruction sheet is a permanent part of your S&C 5800 Series Switch Control. Designate a location where you can easily retrieve and refer to this publication.

Warranty

The standard warranty contained in S&C's standard conditions of sale, as set forth in Price Sheet 150, applies to the 5800 Series Automatic Switch Control, except that the first paragraph of said warranty is replaced by the following:

(1) General: Seller warrants to immediate purchaser or end user for a period of 10 years from the date of shipment that the equipment delivered will be of the kind and quality specified in the contract description and will be free of defects of workmanship and material. Should any failure to conform to this warranty appear under proper and normal use within ten years after the date of shipment the seller agrees, upon prompt notification thereof and confirmation that the equipment has been stored, installed, operated, inspected, and maintained in accordance with recommendations of the seller and standard industry practice, to correct the nonconformity either by repairing any damaged or defective parts of the equipment or (at seller's option) by shipment of necessary replacement parts. The seller's warranty does not apply to any equipment that has been disassembled, repaired, or altered by anyone other than the seller. This limited warranty is granted only to the immediate purchaser or, if the equipment is purchased by a third party for installation in third-party equipment, the end user of the equipment. The seller's duty to perform under any warranty may be delayed, at the seller's sole option, until the seller has been paid in full for all goods purchased by the immediate purchaser. No such delay shall extend the warranty period.

Replacement parts provided by seller or repairs performed by seller under the warranty for the original equipment will be covered by the above special warranty provision for its duration. Replacement parts purchased separately will be covered by the above special warranty provision.

Warranty of the S&C 5800 Series Automatic Switch Control is contingent upon the installation, configuration, and use of the control or software in accordance with S&C's applicable instruction sheets. This warranty does not apply to major components not of S&C manufacture, such as batteries, and communication devices. However, S&C will assign to immediate purchaser or end user all manufacturer's warranties that apply to such major components.

**Understanding
Safety-Alert Messages**

There are several types of safety-alert messages which may appear throughout this instruction sheet as well as on labels attached to the 5800 Series Automatic Switch Control. Familiarize yourself with these types of messages and the importance of the various signal words, as explained below.

⚠ DANGER

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

WARNING

“WARNING” identifies hazards or unsafe practices which *can* result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

“CAUTION” identifies hazards or unsafe practices which *can* result in minor personal injury or product or property damage 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 you do not understand any portion of this instruction sheet and need assistance, contact your nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C’s website www.sandc.com. Or call S&C Headquarters at (773) 338-1000; in Canada, call S&C Electric Canada Ltd. at (416) 249-9171.

NOTICE

Read this instruction sheet thoroughly and carefully before installing or operating your S&C 5800 Series Automatic Switch Control.



**Replacement Instructions
and Labels**

If you need additional copies of this instruction sheet, contact your 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 your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

Phase fault current is measured by a high speed detecting circuit that has a full scale of approximately 4000 amps RMS and is sampled every 6.25 ms. The control phase fault detection characteristics are controlled by two setpoints: the *Phase Fault Detection Current Level* and the *Phase Fault Duration Time Threshold*. All three phase currents are monitored and compared with these setpoints. Once an overcurrent condition is registered, the switch control starts the *Phase Fault Duration Time Threshold* timer. If the overcurrent condition is present for the duration of the timer, the switch control records a *Phase Overcurrent Fault*.

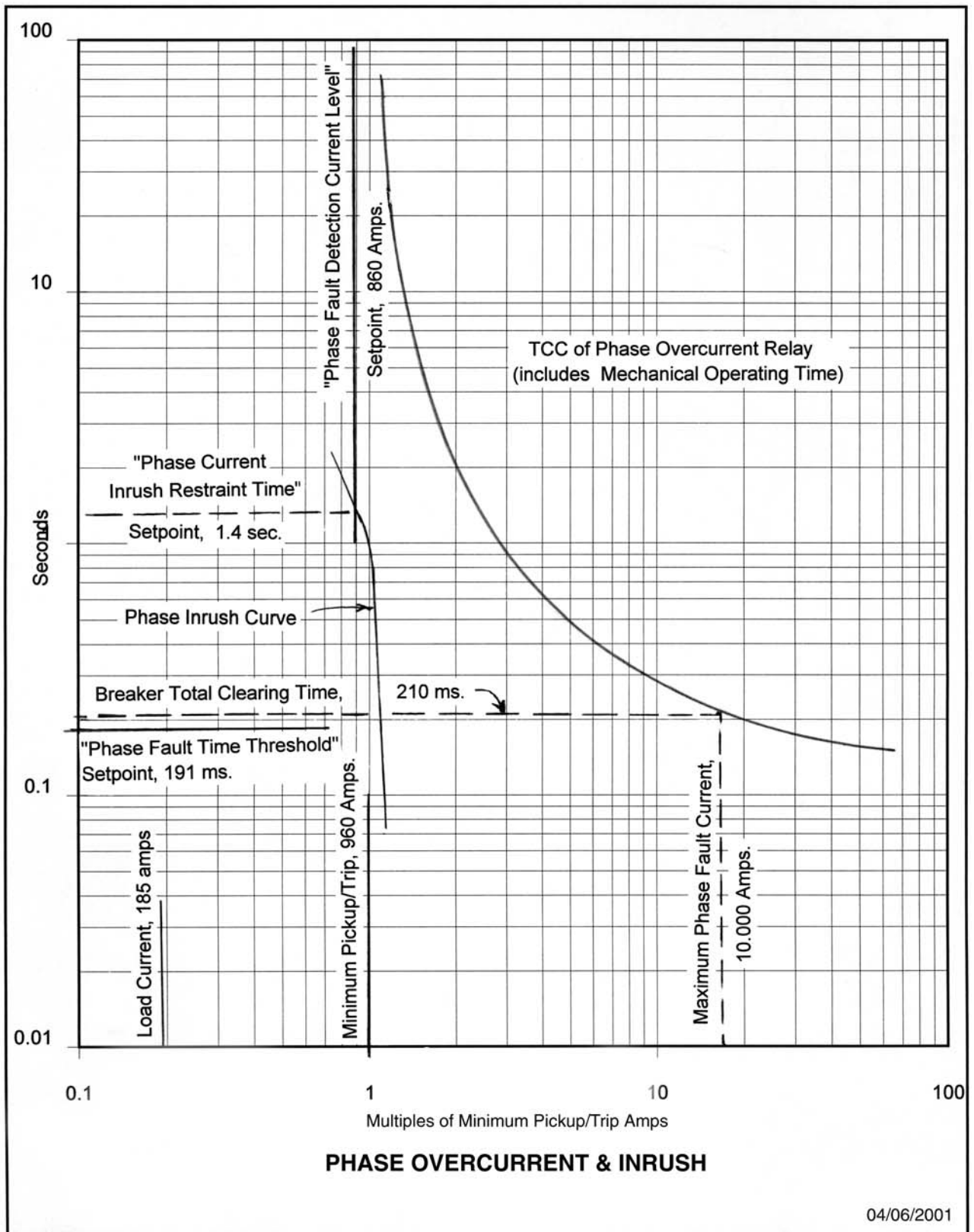
To determine the proper setting, we need to look at the source-side device phase Time Current Characteristic (TCC) curves for a range of fault duty, up to the maximum available phase fault current at the sectionalizing switch. In general, set the Phase Fault Detection Current Level setpoint slightly lower than the source-side device's minimum pickup/trip, and the Phase Fault Duration Time Threshold slightly faster than the fastest time the source-side device will trip. See Coordination Sheet #1 for an example.

Setup Procedure

- A. Set the *Phase Fault Detection Current Level* to a value about 90% of the minimum pickup/trip of the source-side device.
- B. Set the *Phase Fault Duration Time Threshold* to a value equal to or less than the breaker total clearing time minus 19 ms. The 19 ms is the approximate time required for the control to confirm a fault.

Note: When you set the *Phase Current Inrush Restraint Multiplier* setpoint to *Time Block*, you must coordinate the *Phase Fault Duration Time Threshold* and *Phase Current Inrush Restraint Time* setpoints to insure that the switch control has enough time after the time block to detect a phase fault.

COORDINATION SHEET #1



Ground fault current is measured separately by a true RMS detecting circuit as the analog residual of the three individually sensed phase currents. The detecting circuit (which has a full scale of approximately 800 amps) is slower than the phase detecting circuit. The circuit continuously integrates the analog signal over several cycles and samples every 50 ms. Because the circuit is continuously integrating the current signal, the switch control can detect faults of a shorter duration than the sampling rate. The net response of the circuit is similar to the Time Current Characteristic (TCC) curves of a protective relay. (See the ground fault current curves in the *Setup Instructions*.) For example, the curves show that with a *Ground Fault Detection Current Level* setting of 150 amps, the switch control would detect a 500 amp fault in 42 ms. It would detect a 600 amp fault in about 30 ms.

The switch control's ground fault detection characteristics are controlled by two setpoints: the *Ground Fault Detection Current Level* and the *Ground Fault Duration Time Threshold*. To determine the proper setting, we need to look at the source-side device's ground TCC curves for a range of fault duty, up to the maximum available ground fault current at the sectionalizing switch. The switch control must be able to detect the fault prior to the source-side device tripping. See Coordination Sheet #2 for an example.

Setup Procedure

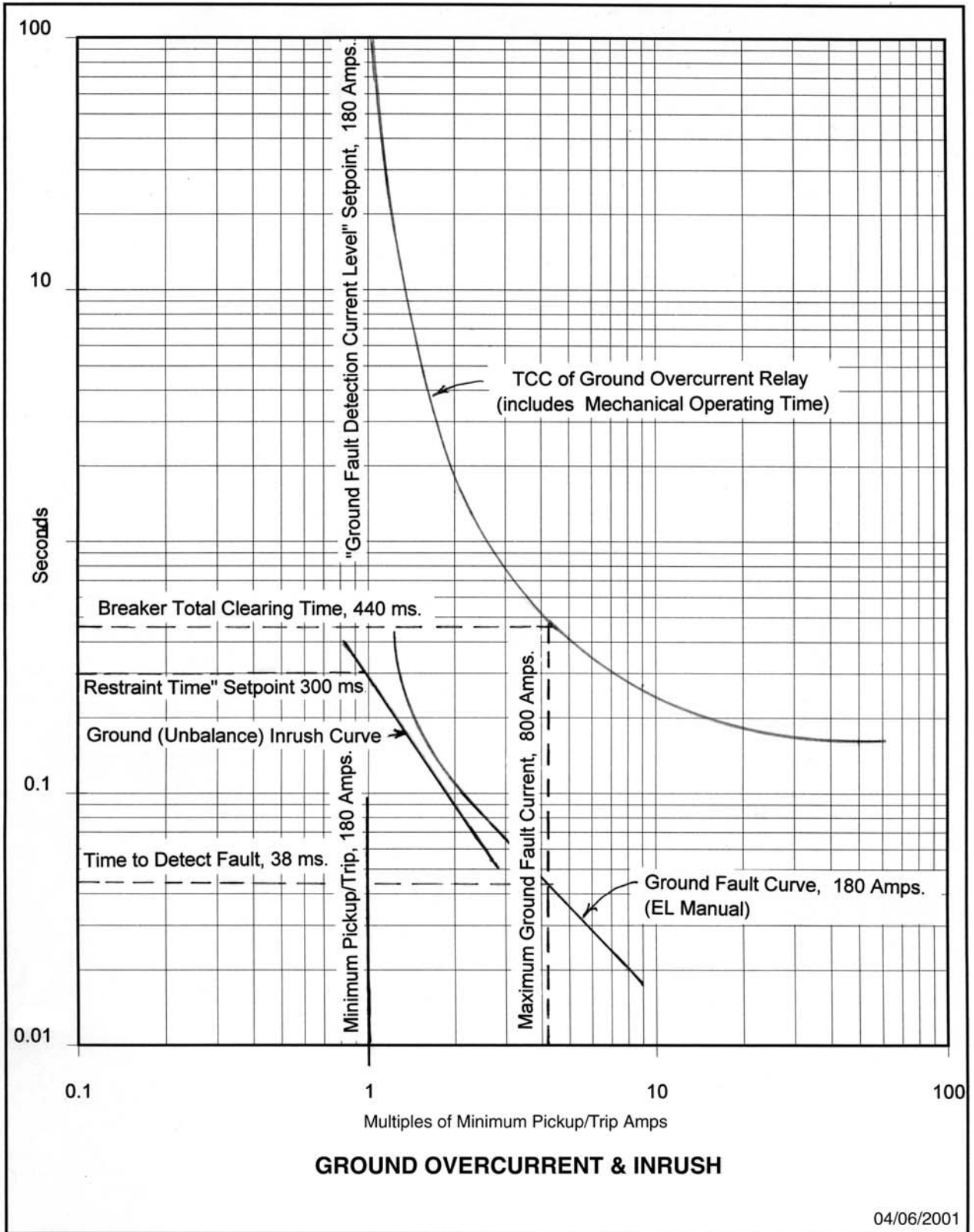
- A. *Ground Fault Detection Current Level* – Set the setpoint to a value equal to or slightly less than the source-side device ground minimum pickup/trip value. Then compare the source-side device TCC curve (including breaker mechanical operating time) with the switch control's *Ground Fault Current* curve for the selected value. The control should detect fault currents at all current levels up to the maximum available ground fault current at the sectionalizing switch prior to the source-side device tripping. If the control's curve does not coordinate over the full range of fault current, lower the *Ground Fault Detection Current Level* setpoint and try again.

For locations where the load current exceeds the *Ground Fault Detection Current Level* setpoint and the circuitry is 4-wire grounded wye – Source-side line-to-ground faults on a 4-wire grounded wye distribution system can reduce load current on faulted phase(s) and result in an imbalance up to the magnitude of the phase load current. If the unbalanced current exceeds the *Ground Fault Detection Current Level* for a period equal to the *Ground Fault Duration Time Threshold*, the switch control records a ground fault. If the event is followed by a loss of voltage, the control will count. During stand-alone sectionalizing, the control may go to a full count and trip. For IntelliTEAM systems, registering a false fault may prematurely shut down the reconfiguration and service restoration process. In both cases, customers will experience unnecessary outages. You can prevent this by setting the *Ground Fault Detection Current Level* setpoint to a value greater than the load current. A disadvantage is that the switch control will ignore any low level ground faults below the setpoint. However, in most cases the fault current levels are high enough to be detected by the high speed phase fault detection system. This is especially true with underground construction because the faults are usually low impedance, high current and persistent.

- B. *Ground Fault Duration Time Threshold* – Set the setpoint to a value equal to or less than the breaker total clearing time minus the time required to detect a ground fault. See the ground fault current curves in the *Setup Instructions* for the time required to detect a ground fault.

Note: When you set the *Ground Current Inrush Restraint Multiplier* setpoint to *Time Block*, you must coordinate the *Ground Fault Duration Time Threshold* and *Ground Current Inrush Restraint Time* setpoints to insure that the switch control has enough time after the time block to detect a real ground fault.

COORDINATION SHEET #2



Inrush and Load Pickup Restraint

Inrush and load pickup currents occur when voltage is restored to a distribution circuit with connected load:

- *Magnetizing inrush* – The magnetizing inrush current has a short duration, and its magnitude depends primarily on connected transformer capacity, residual magnetism in the transformers, and system impedance.
- *Hot load pickup* – The hot load pickup current occurs when the source breaker trips and recloses. Its magnitude depends on the type of connected load. For example, motor controllers may disconnect motors due to a momentary power interruption.
- *Cold load pickup* – The cold load pickup current occurs from connected load after an extended outage. The magnitude depends on the type and amount of connected load and the duration of the outage. For example, thermostatically controlled loads (such as refrigeration, air conditioning, and heating) will increase due to a loss in diversity.

Generally Accepted Values

- Inrush (for a single distribution transformer):
 - 25x full load kVA for 0.01 second
 - 2x full load kVA for 0.1 second
- Hot load pickup:
 - 12x to 15x full load for 0.1 second
- Cold load pickup:
 - 6x full load for 1 second
 - 3x full load for 10 seconds
 - 2x full load for 100 to 300 seconds

The 5800 Series Automatic Switch Control invokes inrush restraint after an outage whenever 3-phase voltage is restored. The software has two types of inrush/load pickup restraint. When the *Inrush Restraint Multiplier* setpoint is set to *Time Block*, the switch control ignores all overcurrent conditions during the restraint time. When it is set to a value (2x, 4x, 8x, or 16x), the corresponding *Phase* or *Ground Fault Detection Current* level is temporarily raised by the multiplier value.

Setup Procedure

Evaluate the magnitude and type of load beyond the switch control, and estimate the magnitude and duration of the inrush/load pickup current.

Phase

Phase Current Inrush Restraint Time – Set this setpoint to a value long enough to allow the inrush/load pickup current to drop below the *Phase Fault Detection Current Level* setpoint before the timer expires.

Phase Current Inrush Restraint Multiplier – Set this setpoint to *Time Block* or to a multiplier value.

- *Time Block* – All phase currents are ignored until the restraint timer expires. If an overcurrent condition is present at the end of the *Time Block*, the switch control starts the *Phase Fault Duration Time Threshold* timer.

Note: When you set the *Phase Current Inrush Restraint Multiplier* setpoint to *Time Block*, you must coordinate the *Phase Fault Duration Time Threshold* and *Phase Current Inrush Restraint Time* setpoints to insure that the switch control has enough time after the time block to detect a phase fault.

- *Multiplier value* – The phase fault detection current level is temporarily raised by the selected multiplier value (2x, 4x, 8x, or 16x). If the switch control detects currents whose magnitudes are greater than the elevated level, it starts the *Phase Fault Duration Time Threshold* timer immediately. If the currents remain above fault levels and the timer expires, the switch control records a fault.

Where Possible, set the multiplier to raise the phase fault current detection level above the inrush/load pickup levels, but below End of Line (EOL) minimum-phase fault currents.

Ground

Ground Current Inrush Restraint Time – Estimate the maximum imbalance inrush/load pickup current and its duration at the switch control. Set this setpoint to a value long enough to allow the inrush/load pickup current to drop below the *Ground Fault Detection Current Level* setpoint before the timer expires.

Ground Current Inrush Restraint Multiplier – Set this setpoint to *Time Block* or to a multiplier value.

- *Time Block* – All ground (unbalanced) currents are ignored until the restraint timer expires. If an overcurrent condition is present at the end of the *Time Block*, the switch control starts the *Ground Fault Duration Time Threshold* timer.

Note: When you set the *Ground Current Inrush Restraint Multiplier* setpoint to *Time Block*, you must coordinate the *Ground Fault Duration Time Threshold* and *Ground Current Inrush Restraint Time* setpoints to insure that the switch control has enough time after the time block to detect a ground fault.

- *Multiplier value* – The ground fault detection current level is temporarily raised by the selected multiplier value (2x, 4x, 8x, or 16x). If the switch control detects currents whose magnitudes are greater than the elevated level, it starts the *Ground Fault Duration Time Threshold* timer immediately. If the currents remain above fault levels and the timer expires, the switch control records a fault.

Where possible, set the multiplier to raise the ground fault current detection level above the inrush/load pickup levels, but below End of Line (EOL) minimum ground fault currents.

Site Information for Each Switch Location

For more information about fault detection, see the *Setup Instructions* and *Operating Instructions*. The following information should be obtained for each switch control location:

- Phase and ground Time Current Characteristic (TCC) curves for the source-side protective device
- Phase and ground source-side breaker minimum pickup/trip (amps)
- Source-side breaker total interrupting time
- Maximum available phase and ground fault current at each sectionalizing switch
- Minimum end-of-line fault current at each sectionalizing switch location
- Normal load current

