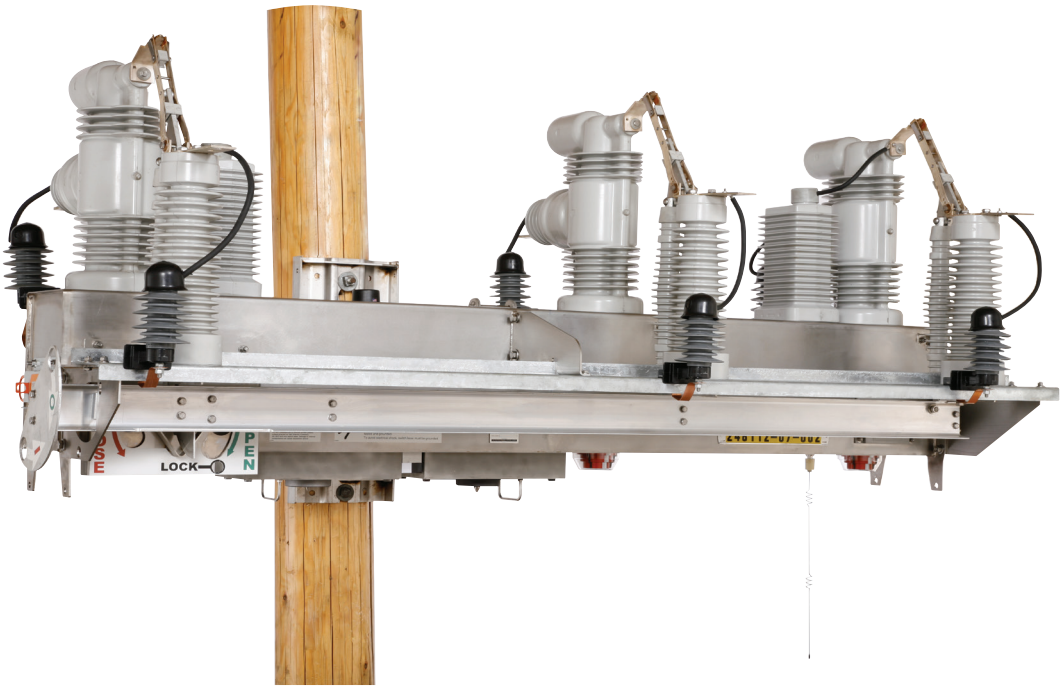
Primary Injection Test Procedure

Table of Contents



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 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 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 IntelliRupter PulseCloser Fault Interrupter. Familiarize yourself with the Safety Information and Safety Precautions on pages 3 through 5. The latest version of this instruction sheet is available online in PDF format at **sandc.com/Support/Product-Literature.asp**

Retain this Instruction Sheet

This instruction sheet is a permanent part of your S&C IntelliRupter® fault interrupter. Designate a location where you can easily retrieve and refer to this publication.

Proper Application

⚠ CAUTION

The equipment in this publication must be selected for a specific application. The application must be within the ratings furnished for the selected equipment.

Special Warranty Provisions

The standard warranty contained in S&C's standard conditions of sale, as set forth in Price Sheet 150, applies to the IntelliRupter fault interrupter and its associated options except for the control group (the protection and control module and communication module) and S&C SpeedNet™ Radio, as applicable. For these devices 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.

Replacement control groups and S&C SpeedNet Radios 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 control groups and S&C SpeedNet Radios purchased separately will be covered by the above special warranty provision.

This warranty does not apply to major components not of S&C manufacture, such as batteries, and communication devices, as well as hardware, software, resolution of protocol related matters, and notification of upgrades or fixes for those devices. However, S&C will assign to immediate purchaser or end user all manufacturers' warranties that apply to such major components.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels attached to the IntelliRupter PulseCloser Fault Interrupter. Familiarize yourself with these types of messages and the importance of these various 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 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 **sandc.com,** or call S&C Headquarters at (773) 338-1000; in Canada, call S&C Electric Canada Ltd. at (416) 249-9171.

⚠ DANGER

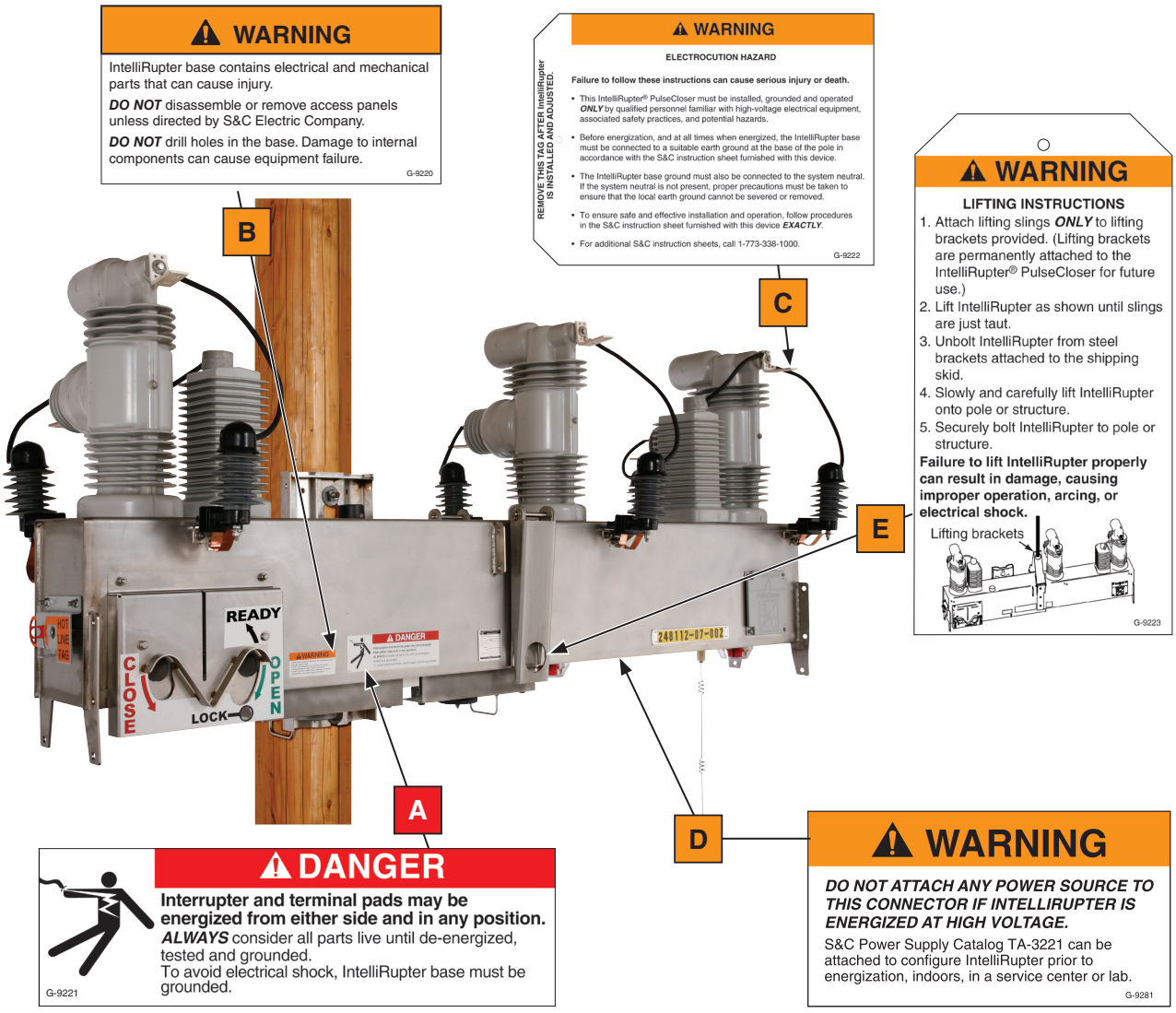
Read this instruction sheet thoroughly and carefully before installing or operating your S&C IntelliRupter PulseCloser Fault Interrupter.

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.

Location of Safety Labels



Reorder Information for Safety Labels			
Location	**Safety Alert Message**	**Description**	**Part Number**
A	DANGER	Interrupter and terminal pads may be energized from either side . . .	G-9221★
B	WARNING	IntelliRupter base contains electrical and mechanical parts that . . .	G-9220
C	WARNING	Electrocution Hazard—Failure to follow these instructions can . . .	G-9222▲
D	WARNING	Do not attach any power source to this connector if IntelliRupter . . .	G-9281
E	WARNING	Lifting Instructions—1. Attach lift slings only to lifting brackets . . .	G-9223▲

★ Label is placed on front and back of IntelliRupter fault interrupter base.
▲ Tag which is removed and discarded after IntelliRupter fault interrupter is installed and adjusted.

⚠ DANGER

IntelliRupter PulseCloser Fault Interrupters 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 an IntelliRupter fault interrupter must be restricted only to qualified persons. See "Qualified Persons" 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.** IntelliRupter fault interrupters contain fast-moving parts that can severely injure fingers. Do not remove or disassemble operating mechanisms or remove access panels on the IntelliRupter fault interrupter base unless directed by S&C Electric Company.
6. **ENERGIZED COMPONENTS.** Always consider all parts live until de-energized, tested, and grounded. The Integrated Power Module (IPM) contains components that can retain a voltage charge for many days after the IntelliRupter fault interrupter has been de-energized and can derive a static charge when in close proximity to a high-voltage source. 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 IntelliRupter fault interrupter base 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 an IntelliRupter fault interrupter, 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 that the local earth ground, or building ground, cannot be severed or removed.
8. **VACUUM INTERRUPTER POSITION.** Always confirm the open/close position of each interrupter by visually observing its indicator.

   Interrupters, terminal pads, and disconnect blades on disconnect style models may be energized from either side of the IntelliRupter fault interrupter.

   Interrupters, terminal pads, and disconnect blades on disconnect style models may be energized with the interrupters in any position.
9. **MAINTAINING PROPER CLEARANCE.** Always maintain proper clearance from energized components.

An IntelliRupter PulseCloser Fault Interrupter primary injection test is used to verify configured settings, time current characteristics, and test sequences. These instructions do not cover voltage and current-source setup, because there are many ways to provide test current and voltage for a primary injection test. These instructions describe the minimum requirements for configuring and testing an IntelliRupter fault interrupter with a primary injection test.

Minimum voltage required for IntelliRupter fault interrupter primary injection testing is a 480-volt 3-phase source. Higher voltage can be used, but 480 volts is the minimum that will allow PulseClosing® Technology to function correctly. The voltage supply does not need to provide fault current and does not need to be synchronized with the fault current. The voltage supply provides a voltage angle reference for an IntelliRupter fault interrupter point-on-wave closing. The fault current can be generated by any source that also can be connected to the voltage source.

Recloser mode testing or testing without PulseClosing Technology can be performed to verify trip setting and test-sequence timing with hard close operations. This form of testing can be accomplished by connecting a voltage source to one pole and a current source to another pole when the sources cannot be connected together. When high voltage and high current sources are available but cannot be connected together, this approach allows testing without a settings change. Recloser-mode testing can be performed on IntelliRupter fault interrupters operating with firmware versions 3.1.13 and above without a voltage by changing the **Voltage Detection** setting to zero. See the setting options in the voltage settings section on page 8.

The current source must provide sufficient current to meet the primary injection test goals. Because IntelliRupter fault interrupters use very accurate Rogowski coils for current sensing, they can react to current as low as 5 amperes. Therefore, you can use low-level test current to verify IntelliRupter fault interrupter functionality and timing, and to confirm the proper sequence and timing of a **Testing After Initial Trip** setup.

To achieve a successful fault test with pulse testing, fault currents have to be a minimum of 480 amperes and a minimum of 150 amperes above the minimum trip setting. For example, 480 amperes would be required for an IntelliRupter fault interrupter with a minimum trip setting of 330 amperes or below. The current source must also be capable of providing an inductive current, and purely resistive current is not adequate.

The test sequence uses a varied scale for fault detection, designed to increase the probability of continuing the sequence at the beginning of the test sequence, and increase the probability of closing at the end of the test sequence. To accomplish this, a pulse evaluation equal to or greater than 80% of the minimum trip on the first test will be designated a fault resulting in the IntelliRupter fault interrupter remaining open and continuing the test sequence.

On the last test of the sequence, a pulse evaluation equal to or less than 150% of the minimum trip will result in the IntelliRupter fault interrupter closing. Intermediate tests steps will vary between these values, based on the number of tests chosen, unless the Manual Override of Automatic Setting is set to **Yes**. With the *Manual Override of Automatic Setting* set to *Yes*, fault detection is based on the **PulseClosing Fault Current Threshold** setting.

The integral power module cannot provide power with voltage sources below 11.4 kV for the 15-kV model, below 20.4 kV for the 27-kV model, and below 28.3 kV for the 38-kV model. However, there will be leakage current through the IPM ranging from 2 milliamperes at 277 volts line-to-ground to approximately 35 milliamperes at nominal system line-to-ground voltage. When the available source voltage does not provide sufficient power to operate with the integral power module, one of the External Power Supply options (see S&C Specification Bulletin 766-31), the TA-3221 power supply, or a communication module with a fully charged battery will be required to power the IntelliRupter fault interrupter.

Use only the S&C Power Supply, catalog number TA-3221, to power the protection and control module and communication module for pre-installation upload and download of configuration settings, radio programming, and battery charging, as applicable. For an IntelliRupter fault interrupter equipped with one of the External Power Supply options, see S&C Specification Bulletin 766-31.

Power can also be provide by applying the appropriate voltage to the External Power Supply input. See S&C Instruction Sheet 766-510 for more information about the External Power Supply connections. After installing the control module and communication module, attach the power supply output cable to the connector on the bottom of the IntelliRupter fault interrupter base, near the center OPEN/CLOSE indicator, and energize the power source connected to the External Power Supply input. When testing has been completed, remove both modules before transporting the IntelliRupter fault interrupter to the installation site.

⚠ DANGER

ENERGIZED COMPONENTS. Always consider all parts live until de-energized, tested, and grounded. The integral power module contains components that can retain a voltage charge for many days after the IntelliRupter fault interrupter has been de-energized and can derive a static charge when in close proximity to a high-voltage source. Voltage levels between the base of the IntelliRupter fault interrupter and the terminal connection of the integral power module can be as high as the peak line-to-ground voltage last applied to the IntelliRupter fault interrupter. Units that have been energized and de-energized should be considered live until tested and grounded.

NOTICE

S&C Power Supply catalog number TA-3221 is intended for indoor use only in your service center or lab.

⚠ CAUTION

Remove the protection and control module and communication module from the base before transporting the IntelliRupter fault interrupter to the installation site. If modules are not removed, module connectors may be damaged and the communication-module battery (if supplied) may be discharged.

Voltage Settings

The nominal 60-Hz impedance of the integral power module is approximately 135 k ohms for a 15-kV and 423-k ohms for a 27-kV integral power module. The voltage source must be capable of providing the leakage current that results from these impedances. If the voltage source provides a voltage below the minimum rated voltage of the integral power module, 11.4 kV for the 15-kV model and below 20.4 kV for the 27-kV model, or if a voltage source is not going to be used for recloser mode testing, a few settings will need to be configured before primary injection testing can begin. Open the IntelliLink® Setup Software and navigate to the *Setup > General > Site-Related* screen. See Figure 1.

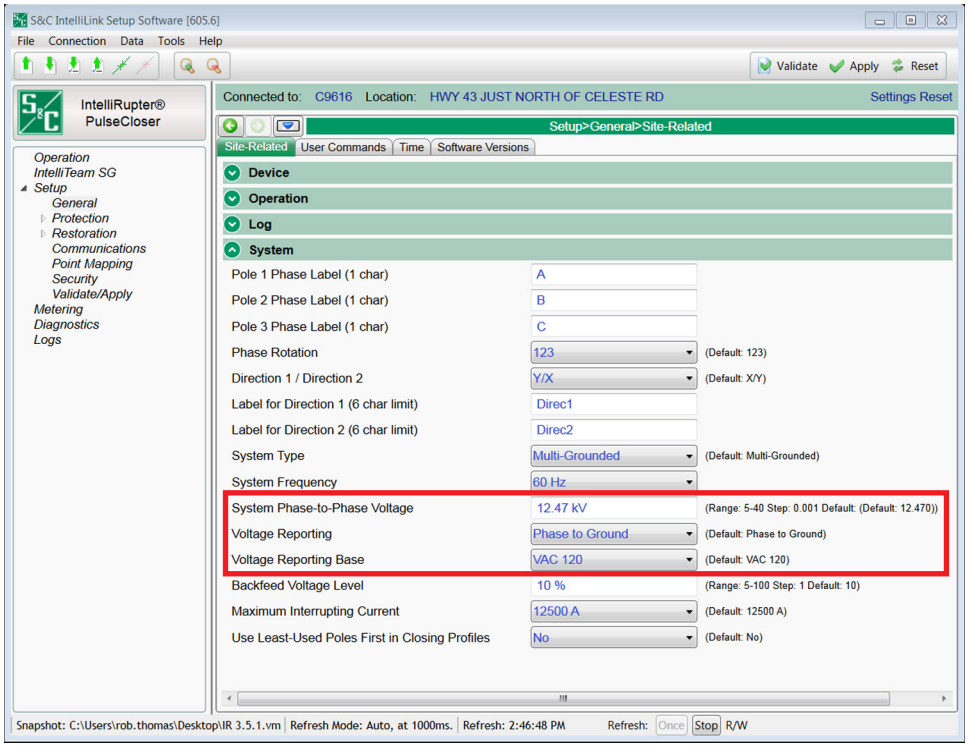


Figure 1. General > Site-Related setup screen.

System Phase-to-Phase Voltage

Set the System Phase-to-Phase voltage to **4.00 kV**.

Voltage Reporting

Set the Voltage Reporting to **Phase To Ground**.

Voltage Reporting Base

Set the Voltage Reporting Base to **120 Vac**.

Site Related Voltage Settings

For voltage sources operating above 2,890 V line-to-ground, set the System Phase-to-Phase voltage as is appropriate for the voltage to be applied. For voltage sources operating between 2890 V and 277 V ac line-to-ground, set the System Phase-to-Phase voltage to 4.00 kV. The Voltage Reporting and Voltage Reporting Base may be adjusted if desired.

When testing without a voltage source for IntelliRupter fault interrupters with firmware version 3.1.13 and above, no changes to this section are necessary.

Voltage Indication Settings

The **Source Voltage Indication** elements must be configured for the active General Profile to be tested. Use the Full Setup method to access all the necessary element configurations. The **Source Voltage Indication** elements are located on the *Setup* > *Protection* > *General Profiles* > *General Profile 1* > *Voltage Trip* screen. See Figure 2.

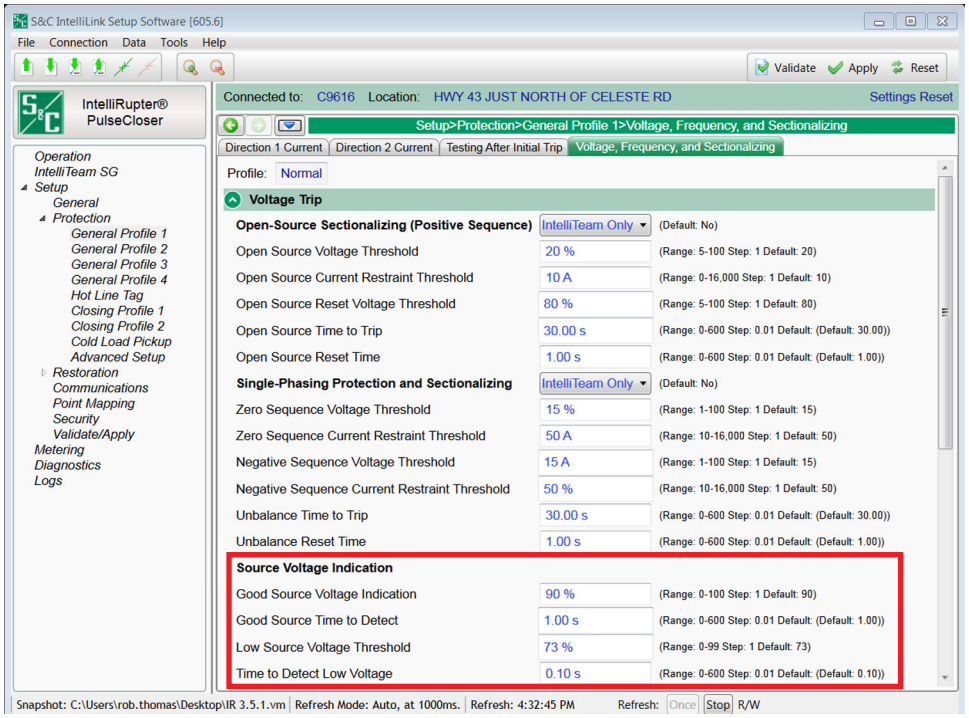


Figure 2. General Profile—Voltage Trip screen.

For voltage sources operating above 2,890 V line-to-ground, set the **Good Source Voltage Indication**, **Good Source Time to Detect**, **Low Source Voltage Threshold**, and **Time to Detect Low Voltage** to the default values or as is appropriate for your operating practices.

For voltage sources operating between 2890 V and 277 V ac line-to-ground use the following settings:

Voltage Indication = 5%

Good Source Time to Detect = 0.10 s

Low Source Voltage Threshold = 5%

Time to Detect Low Voltage = 0.10 s

When testing without a voltage source for IntelliRupter fault interrupters with firmware version 3.1.13 and above, use the following settings:

Voltage Indication = 0%

Good Source Time to Detect = 0.10 s

Low Source Voltage Threshold = 0%

Time to Detect Low Voltage = 0.10 s

After all settings changes have been completed, click the **Validate/Apply** menu option on the left side of the screen. When the page has refreshed, click the **Apply** button and confirm that **Command Status** shows: *Completed Successfully.*

TCC for Test Sequence

When the IntelliRupter fault interrupter is operating on firmware versions below version 3.1.13, is configured to the **Test After the Initial Trip** setting and for using PulseClosing Technology, and PulseClosing Technology is not available, the TCC configured for the initial trip will be the TCC used when the IntelliRupter fault interrupter closes during a test sequence. This will be the observed behavior when testing is performed and the voltage and current sources are not connected to the same pole. Configuring *TCCs for Test Sequence* will have no affect on outcome with firmware versions older than 3.1.13.

Although it is not necessary to configure TCCs for the test sequence, if the *TCCs for Test Sequence* have been configured for IntelliRupter fault interrupters operating with firmware version 3.1.13 and above, the configured TCCs will be used when the IntelliRupter fault interrupter is configured for PulseClosing Technology and PulseClosing Technology is not available. This will be the observed behavior when testing is performed and the voltage and current sources are not connected to the same pole and when testing is performed without a voltage source.

Voltage Supply

The voltage supply for IntelliRupter fault interrupter primary injection testing must be at least a 480-V 3-phase source, 277-V line-to-ground. Higher voltage can be used, but 480 V is the minimum required for PulseClosing Technology to function reliably. The voltage supply does not need to provide fault current. It provides the IntelliRupter fault interrupter a voltage-angle reference for point-on-wave closing.

Attach the voltage source to all three terminals on one side of the IntelliRupter fault interrupter and then navigate to the *Metering* screen. With the IntelliRupter fault interrupter configured to report voltage *Phase-to-Ground on a 120 V Scale* (default), when using a 480-V 3-phase source, the voltage measurements should show a minimum of 11.4 V.

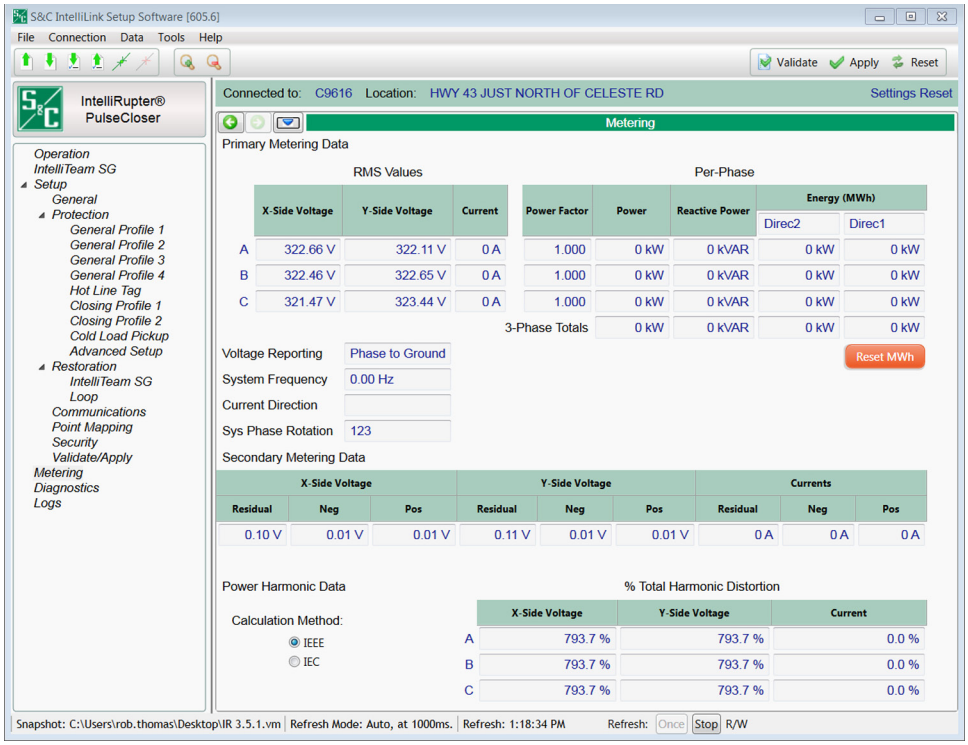


Figure 3. Metering screen.

Depending on the phase rotation of the applied 480V source, the IntelliRupter fault interrupter may be measuring voltage as either *Positive-* or *Negative-Sequence*. In order for Primary Injection Testing to work correctly, the IntelliRupter fault interrupter must measure positive-sequence voltage. If the IntelliRupter fault interrupter is measuring negative-sequence voltage, navigate to the *Setup* > *Validate/ Apply* screen and click the **Apply** button. This forces the IntelliRupter fault interrupter to recalculate the Phase Rotation.

When the IntelliRupter fault interrupter is reading *Positive-Sequence* voltage, it will perform a PulseClosing action when a close is requested, if the active closing profile is configured for PulseClosing Technology. This functionality can be tested on the **Operation** screen. The IntelliRupter fault interrupter is now ready for primary injection testing.

Applying the Fault

The user can select the method used for fault injection. The selected method depends on the settings to be tested and the desired fault-current level. The only requirement is that the voltage source must be able to coexist with the chosen current injection method. There are no requirements for load current or pre-fault current.