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Protection Module User's Guide

Description

The Model 2290-PM-200 protection module (PM) is a stand-alone module that protects certain lower-voltage source-measure units (SMUs) that are part of a testing configuration from damage by voltage sources that are greater than 220 V.

Figure 1: Model 2290-PM-200



The protection module is for use with the following lower-voltage SMUs:

- Model 2611B Single-Channel System SourceMeter® Instrument
- Model 2612B Dual-Channel System SourceMeter Instrument
- Model 2635B Single-Channel System SourceMeter Instrument
- Model 2636B Dual-Channel System SourceMeter Instrument
- Model 4200-SCS Semiconductor Characterization System SMUs:
 - Model 4200-SMU Medium Power Source-Measure Unit
 - Model 4210-SMU High Power Source-Measure Unit



The protection module is intended for use in applications where a device breakdown or other potential failure could connect the high-voltage output of the Model 2290-5 or Model 2290-10 high-voltage power supply instrument to a lower-voltage SMU.

⚠ CAUTION

The Model 2290-PM-200 does not protect the Model 2601B Single-Channel System SourceMeter Instrument or the Model 2602B Dual-Channel System SourceMeter Instrument. Do not use the protection module with these source-measure instruments.

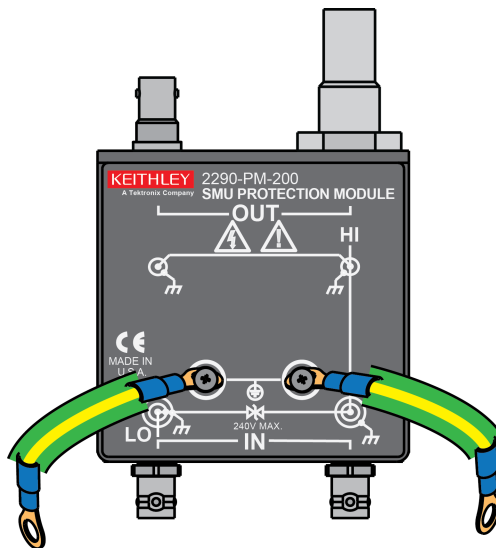
⚠ CAUTION

To prevent damage to the Model 2290-PM-200 in the case of device failure, the current from all power sources, including SourceMeter instruments and power supplies, should be limited to 100 mA.

⚠ WARNING

The Model 2290-PM-200 protection module must be connected to protective earth terminals (safety grounds) using the supplied green-yellow ground cables (Model CA-568). Connection of ground cables to protective earth terminals is necessary for safety.

Figure 2: Model 2290-PM-200 grounding



The standard triaxial IN connectors are used to connect the SMU. Maximum clamped voltage on the IN connectors is 240 V DC.

- The center conductor of the LO connector inner shield is connected to LO. The outer shield (shell) is chassis ground.
- The center conductor of the HI connector is HI and the inner shield is guard. The outer shield (shell) is chassis ground.

There are two high-voltage coaxial connectors used for connection to the device under test (DUT).

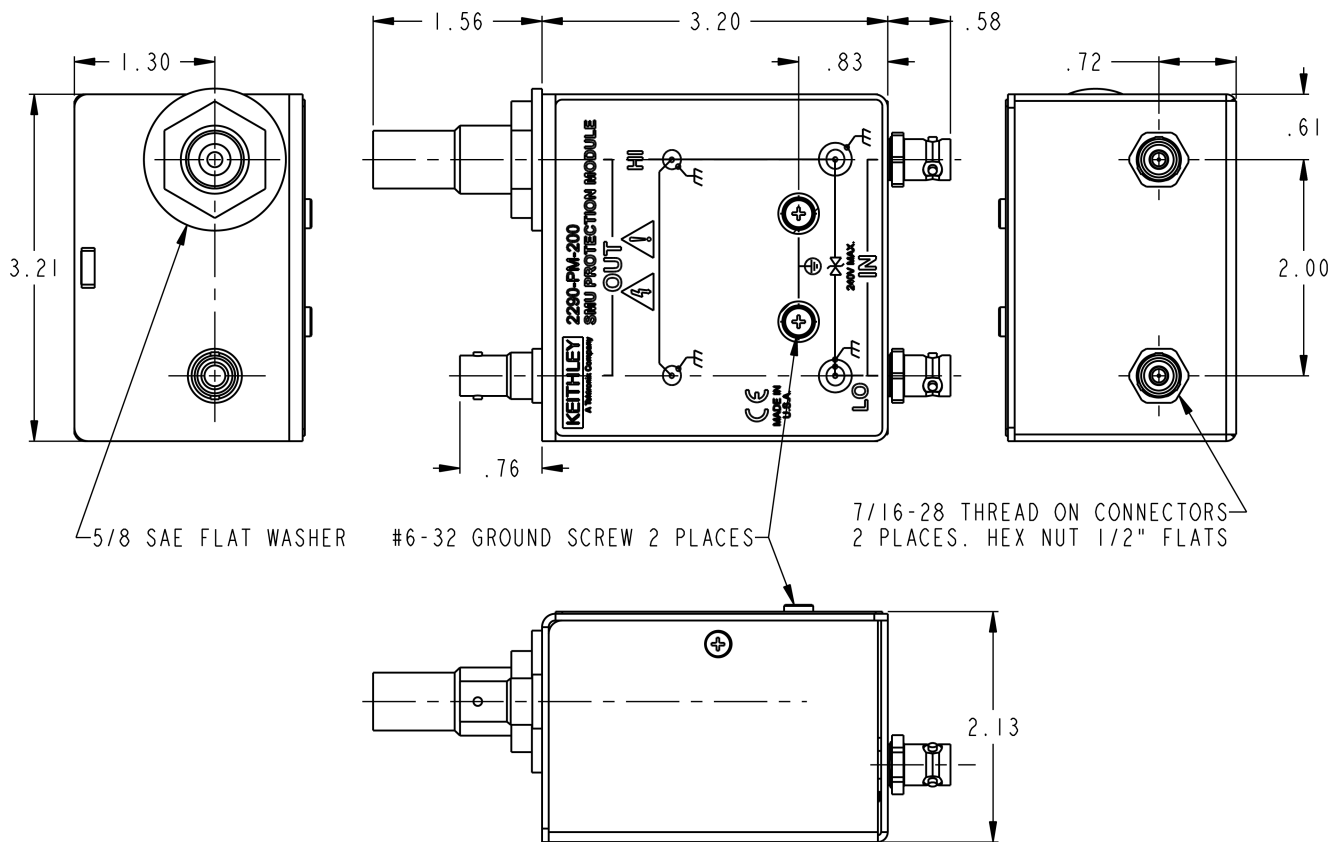
- The smaller OUT connector is intended for use in applications that include the Model 2290-5 high-voltage power supply only. This connector is rated to 5000 V.
- The larger OUT connector is intended for use in applications that include the Model 2290-10 high-voltage power supply only. This connector is rated to 10000 V.

Electrical characteristics

- Leakage: < 10 pA at 200 V typical
- DC current carrying capability: 100 mA maximum in unclamped condition
- Pulsed current carrying capability: 10 A maximum at 1% duty cycle in unclamped condition
- Maximum protection active current: You must limit current to <120 mA in clamped condition (~230 V)
- Protection voltage:
 - Minimum: 220 V DC
 - Typical: 230 V DC
 - Maximum: 240 V DC
- Series resistance: 470 Ω ± 10 percent

Mechanical dimensions

Figure 3: Model 2290-PM-200 dimensions



Connections using a Model 2611B or 2612B SMU

Required accessories:

- One Model 2600-TRIAX adapter per channel
- Two standard triaxial cables (either Model 7078-TRX or 4200-TRX) per source-measure unit (SMU) channel
- One high-voltage (HV) coaxial cable
 - Use Model 2290-5-SHV or 2290-5-MHV if you are using the 2290-5 high-voltage power supply
 - Use Model 2290-10-SHVUC or 2290-10-SHV if you are using the 2290-10 high-voltage power supply

Connection summary

Refer to the next figure to connect the Model 2611B or 2612B source-measure unit (SMU) channels to the Model 2290-PM-200.

Only 2-wire applications are supported.

NOTE

Connecting the Model 2600-TRIAX to the Model 2290-PM-200 connects the LO terminal of the Model 2611B or 2612B to protective earth (safety ground).

CAUTION

Do not convert triaxial cables to BNC cables. Using BNC cables may compromise overvoltage protection and can result in damage to the SMU. You must use triaxial cables to connect to the lower-voltage SMU.

Figure 4: Model 2290-PM-200 connections for Model 261xB using Model 2290-5 power supply

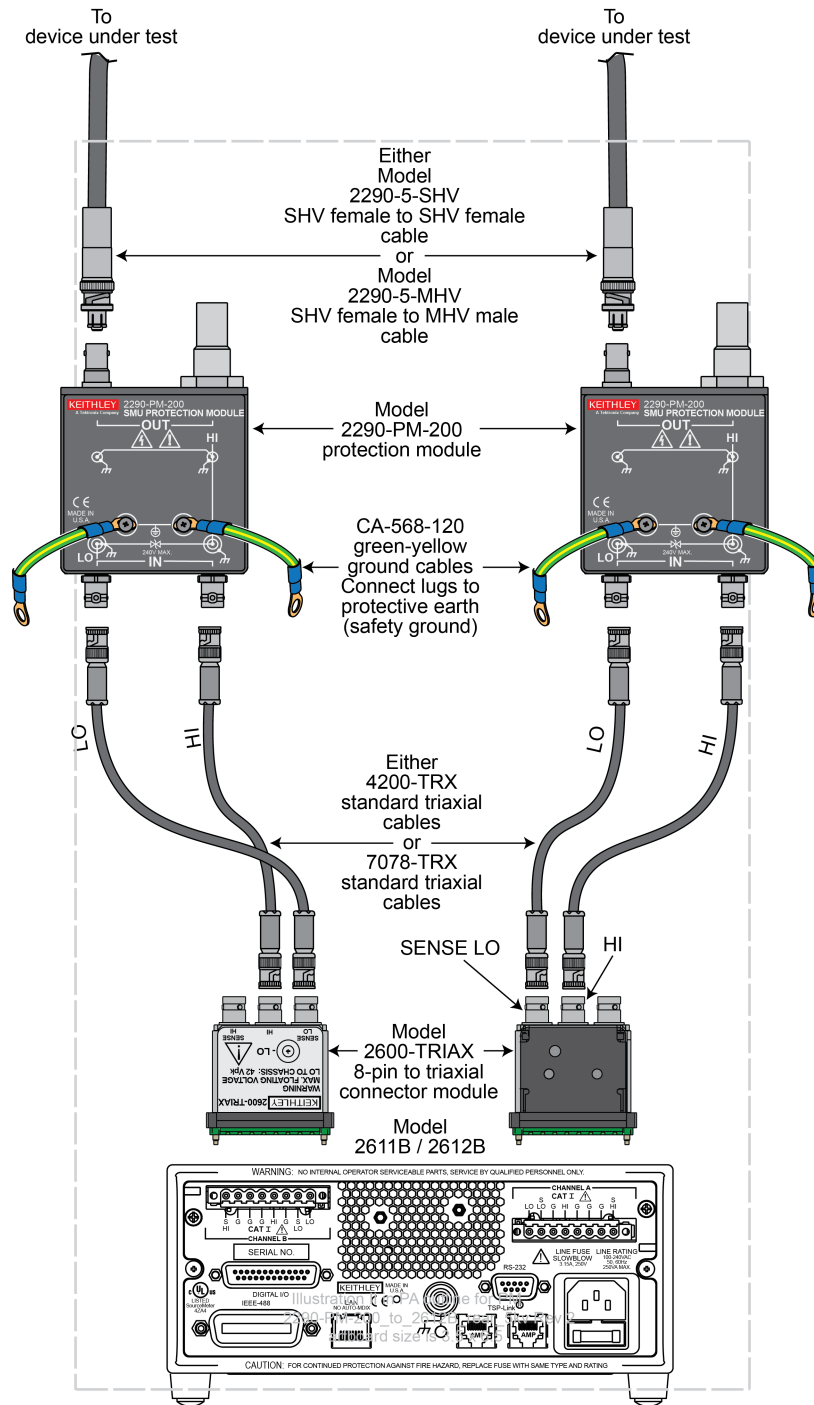
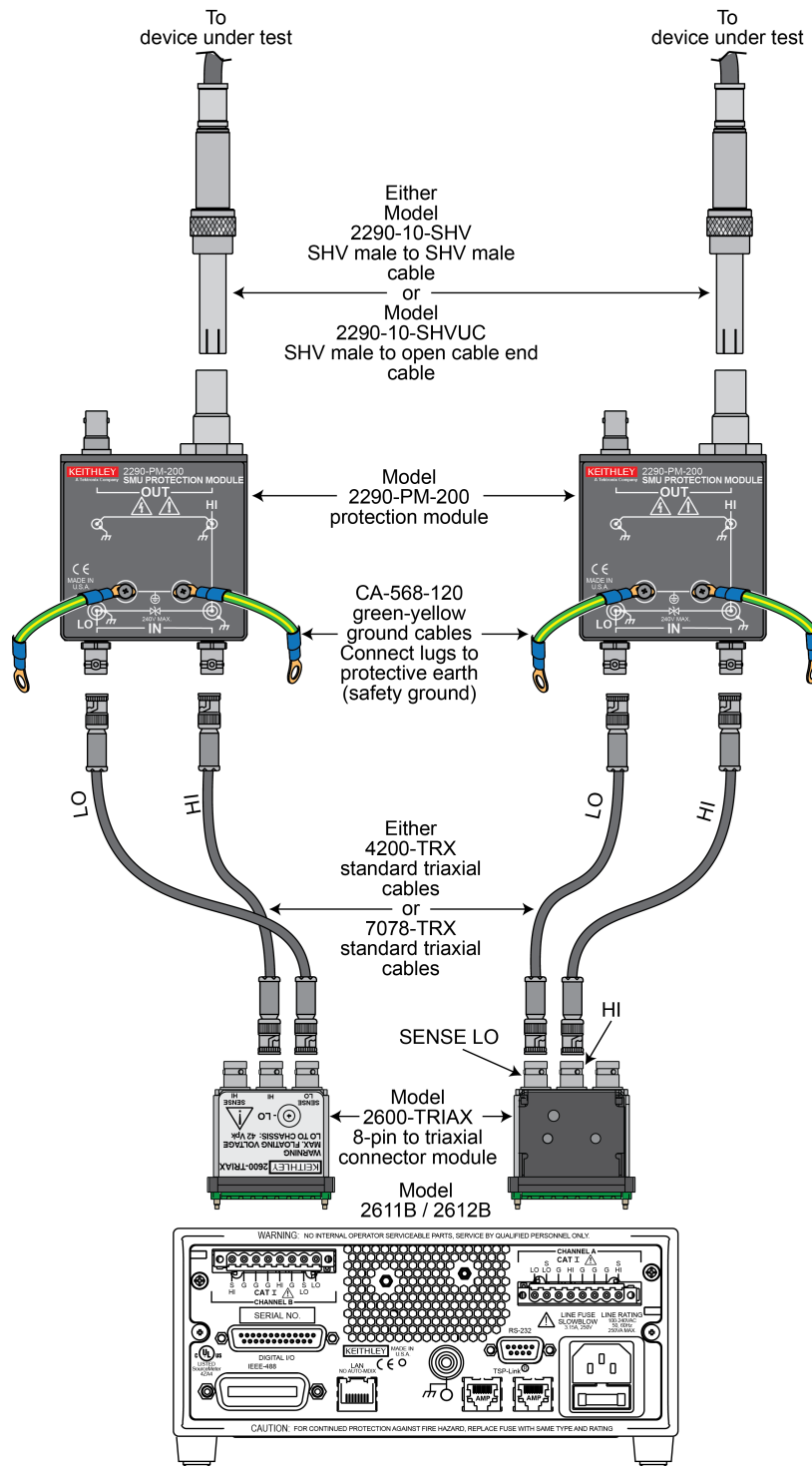


Figure 5: Model 2290-PM-200 connections for Model 261xB using Model 2290-10 power supply



Connections using a Model 2635B or 2636B SMU

Required accessories:

- Two standard triaxial cables (either Model 7078-TRX or 4200-TRX) for each source-measure unit (SMU) channel
- One high-voltage (HV) coaxial cable
 - Use Model 2290-5-SHV or 2290-5-MHV if you are using the Model 2290-5 high-voltage power supply
 - Use Model 2290-10-SHVUC or 2290-10-SHV if you are using the Model 2290-10 high-voltage power supply

Connection summary

Refer to the next figure to connect source-measure unit (SMU) channels of the Model 2635B or 2636B to the Model 2290-PM-200.

Only 2-wire applications are supported.

CAUTION

Do not convert triaxial cables to BNC cables. Using BNC cables may compromise overvoltage protection and can result in damage to the SMU. You must use triaxial cables to connect to the lower-voltage SMU.

Figure 6: Model 2290-PM-200 connections for Model 263xB using Model 2290-5 power supply

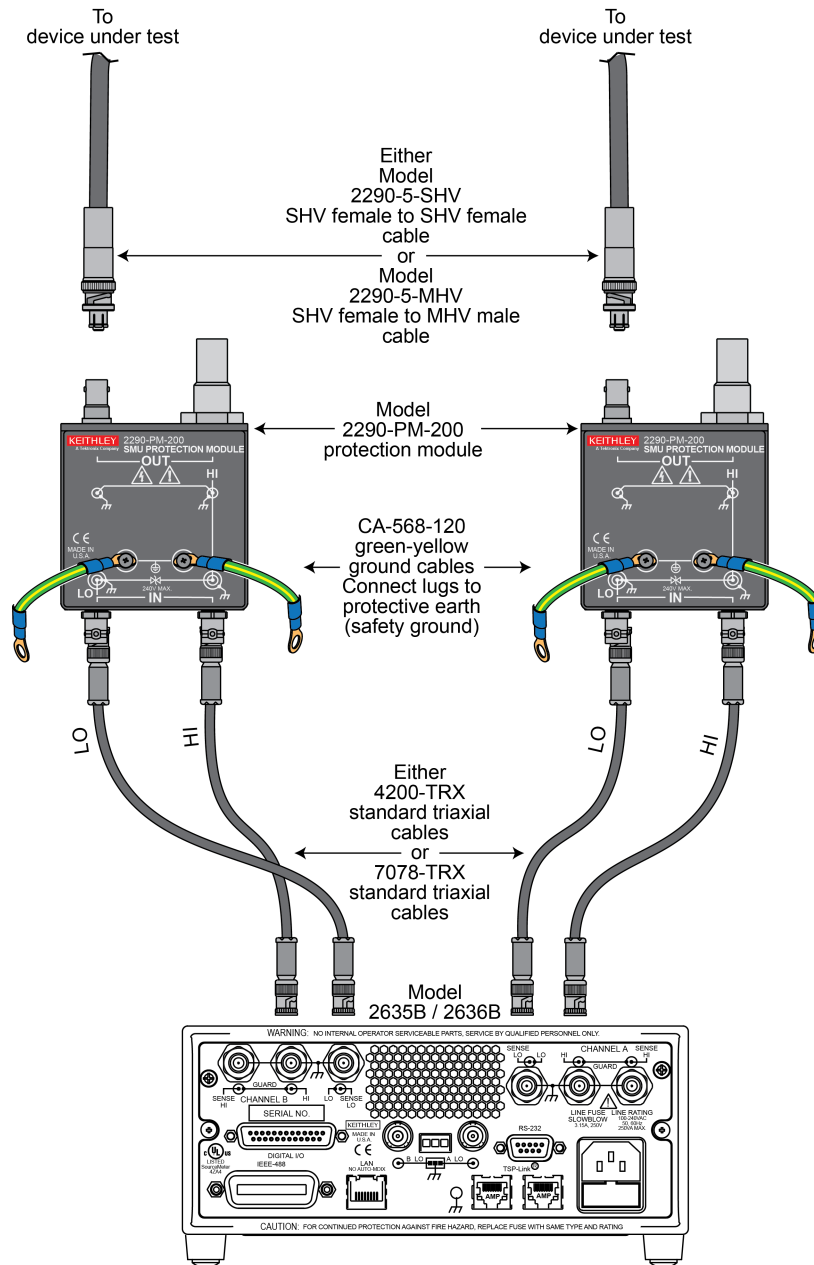
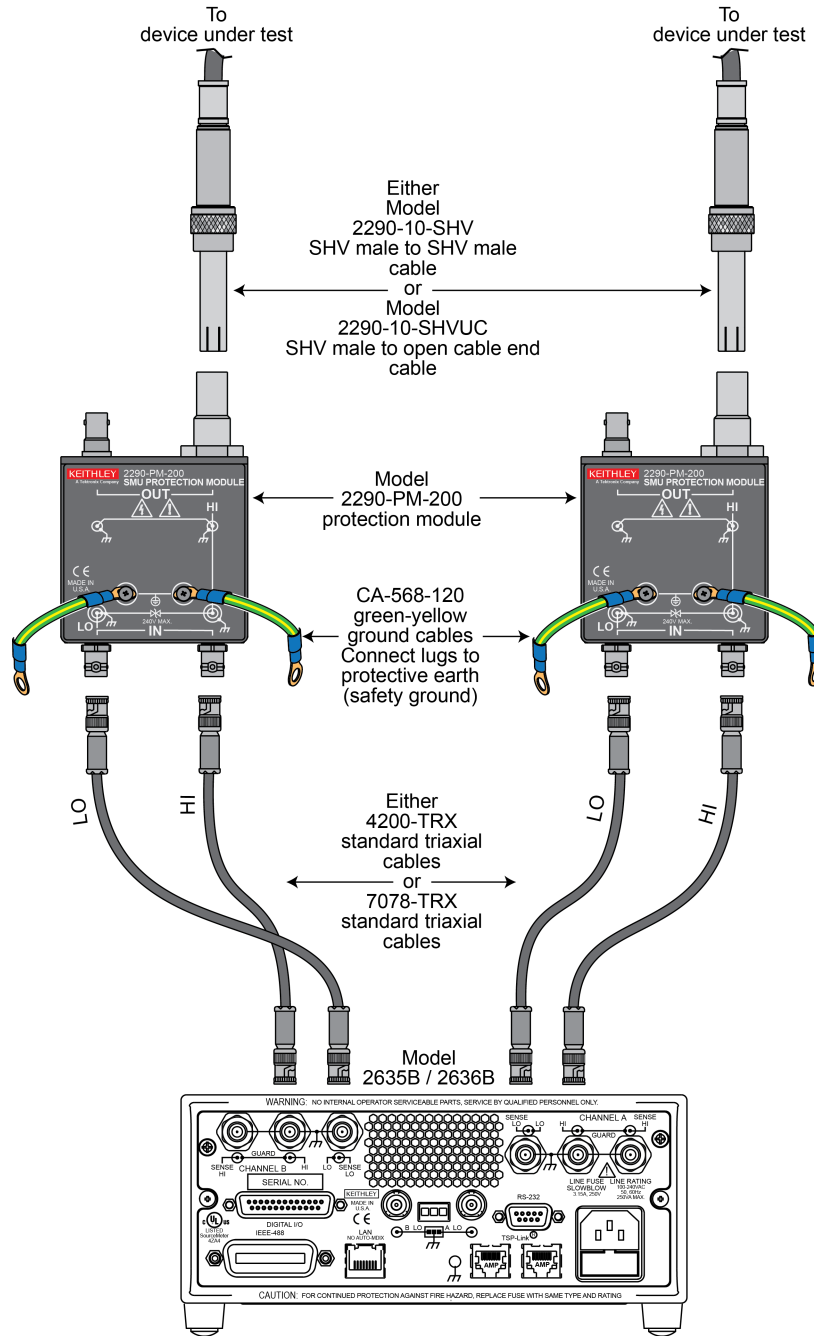


Figure 7: Model 2290-PM-200 connections for Model 263xB using Model 2290-10 power supply



Connections using a Model 4200-SCS SMU

Required accessories to connect one Model 4200-SMU or 4210-SMU (without the Model 4200-PA Remote PreAmp):

- One Model 4200-TRX cable
- One Model 4200-MTRX cables
- One high-voltage (HV) coaxial cable
 - Use Model 2290-5-SHV or 2290-5-MHV if you are using the Model 2290-5 high-voltage power supply
 - Use Model 2290-10-SHVUC or 2290-10-SHV if you are using the Model 2290-10 high-voltage power supply

Connection summary

Refer to the next figure to connect a Model 4200-SMU or 4210-SMU and the GNDU (ground unit) to the Model 2290-PM-200. Make sure to use the IN connectors of the Model 2290-PM-200 for connection to the Model 4200-SCS and use the OUT connector for connection to the device under test (DUT).

Only 2-wire applications are supported.

NOTE

When using multiple source-measure units (SMUs) that are installed in the Model 4200-SCS, each SMU needs its own protection module. To achieve adequate voltage protection, connect the GNDU Sense terminal to the LO, SL (LO and sense LO) connector of each protection module using triaxial tees (such as the Keithley Model 237-TRX-T) and additional triaxial cables (Model 4200-TRX).

Connecting the Model 4200-SMU or 4210-SMU to the Model 2290-PM-200 connects the LO terminal of the SMU to protective earth (safety ground).

Figure 8: Model 2290-PM-200 connections for Model 4200-SCS SMU using Model 2290-5 power supply

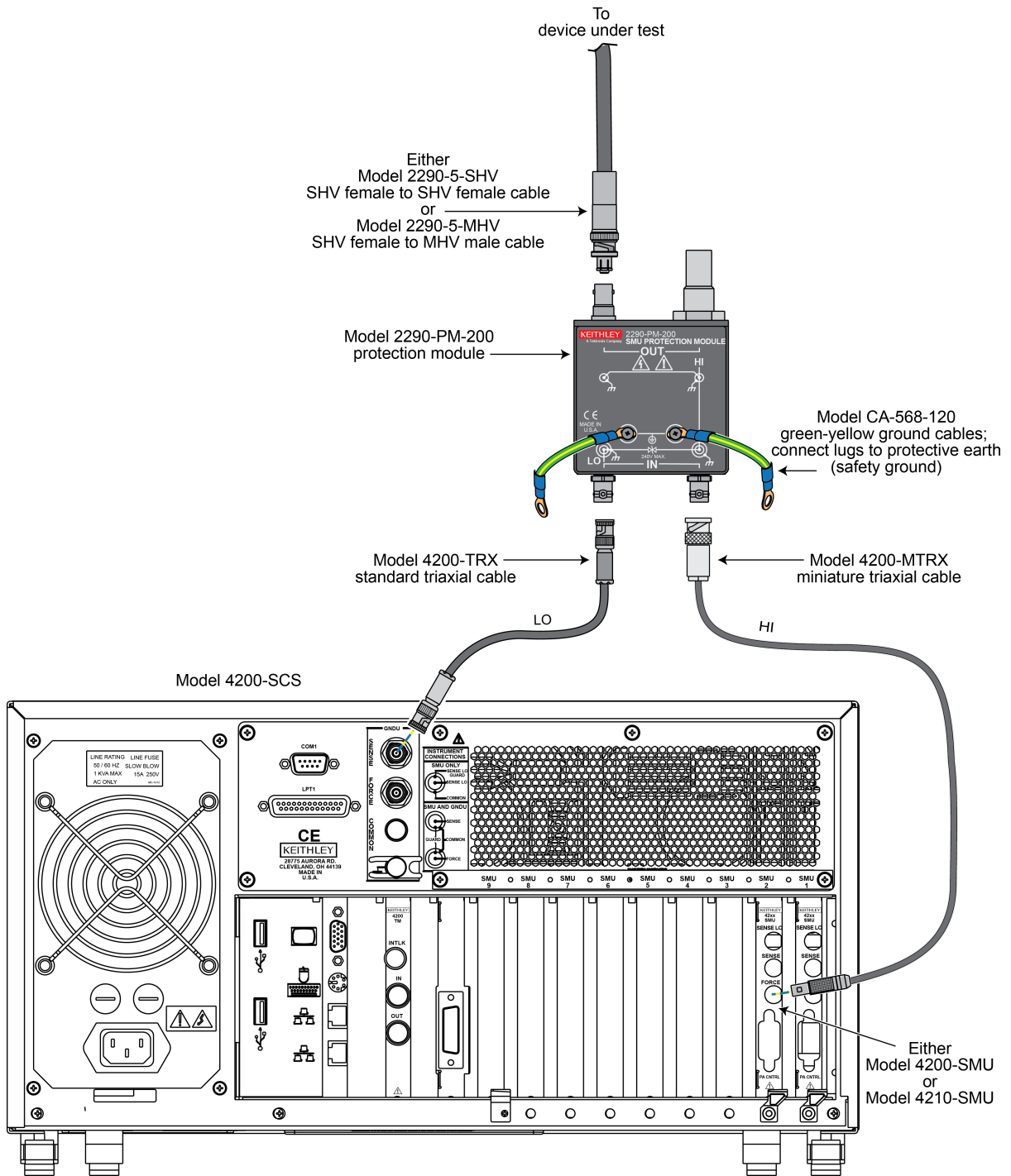
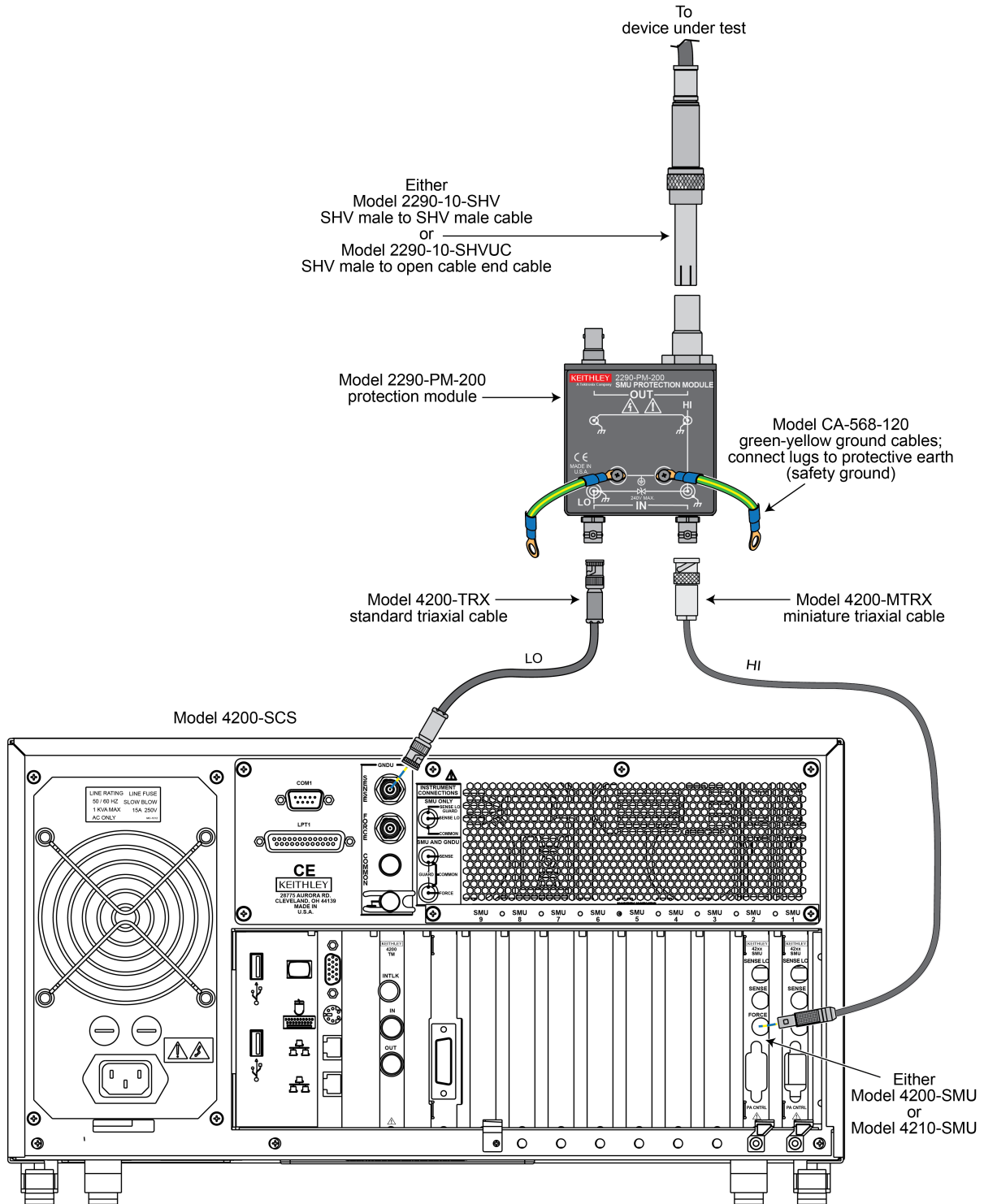


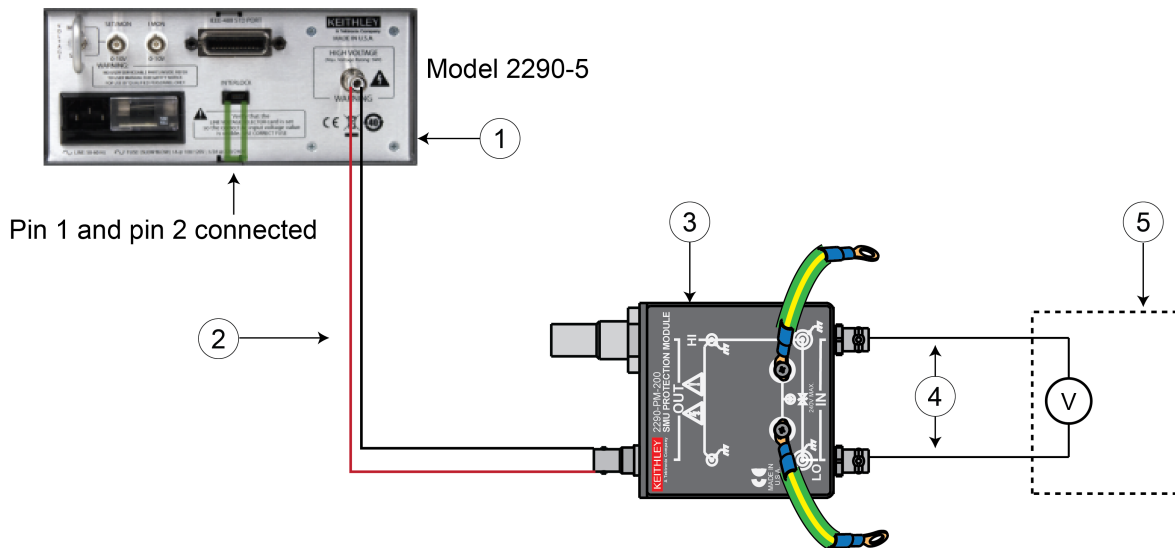
Figure 9: Model 2290-PM-200 connections for Model 4200-SCS SMU 7 using Model 2290-10 power supply



Model 2290-PM-200 verification

A Keithley SourceMeter instrument capable of sourcing 100 V at 10 mA and 1 A at >10 V and a high voltage power supply are required for verification purposes. Refer to the next figure when performing [Verify module continuity](#) (on page 13), Verify the HI to LO leakage of the Model 2290-PM-200, and [Verify module clamp voltage](#) (on page 14) steps in this section.

Figure 10: Model 2290-PM-200 Connections for verification procedures using a Model 2290-5 high-voltage power supply



Item	Description
1	Model 2290-5 or 2290-10 high-voltage power supply
2	Model 2290-5 or 2290-10 SHV high-voltage cable
3	Model 2290-PM-200 high-voltage SMU protection module
4	Triaxial cables
5	Source-measure unit (SMU)

Verify module continuity

1. Make sure that the high-voltage power supply is off.
2. Connect a high-voltage cable to the protection module OUT terminal (see the previous figure).
3. Short the HI and LO conductors on the high-voltage output cable.
4. Set the source-measure unit (SMU) to source 10 V and program the current limit to 1 A.
5. Turn on SMU output and verify that SMU is in current limit.

Verify the HI to LO leakage of the Model 2290-PM-200

1. Turn off the high-voltage power supply.
2. Remove the high-voltage cable from the protection module.
3. As shown in the previous figure, connect the protection module inputs to HI and LO terminals of a source-measure unit (SMU) using two triaxial cables.
4. Program the SMU to source 100 volts or greater.
5. Turn on SMU output and allow to settle for 10 seconds minimum.
6. Observe current measurement on the SMU.
7. Current indication should be below 10 pA module specification.

Verify module clamp voltage

1. Make sure that the high-voltage power supply is off.
2. Turn the source-measure unit (SMU) output off and disconnect the triaxial cables (see the previous figure).
3. Connect a high-voltage cable from the protection module OUT terminal to the high-voltage power supply.
4. Engage the interlock on the back of the high-voltage power supply by connecting pin 1 to pin 2.

WARNING

The high-voltage power supply is capable of sourcing hazardous live high voltages that can cause personal injury or death due to electric shock. This unit should be used only by qualified personnel who recognize the dangers of high voltages.

Make certain that the source is turned off and that high voltage is completely discharged before removing the high-voltage cable. High-voltage cables can store a charge if they are disconnected from the supply while the high voltage is on. The charge on the cable can cause injury or damage even after the cable is disconnected from the unit.

The high-voltage power supply is provided with an interlock circuit that must be engaged to allow high-voltage output. The interlock helps facilitate safe operation of the equipment in a test system. Bypassing the interlock could expose the operator to hazardous voltages that could result in personal injury or death.

5. Turn on the high-voltage power supply.
6. Set the current limit of the high-voltage power supply to 1 mA.
7. Set the high-voltage power supply for 300 V DC.
8. Turn the high-voltage output on and verify that the high-voltage power supply is in current limit.
9. Voltage should never exceed 250 V DC.

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley Instruments products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS, 42.4 V peak, or 60 VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as protective earth (safety ground) connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.


If a  screw is present, connect it to protective earth (safety ground) using the wire recommended in the user documentation.

The  symbol on an instrument means caution, risk of danger. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The  symbol on an instrument means caution, risk of electric shock. Use standard safety precautions to avoid personal contact with these voltages.

The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits — including the power transformer, test leads, and input jacks — must be purchased from Keithley Instruments. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Safety precaution revision as of January 2013.