

## Overview

The Keithley Instruments Model 4210-MMPC-L multi-measurement prober cable kit (see Figure 1) provides a collection of matched connection accessories. When properly installed, these accessories have the performance needed that allow current-voltage (I-V), capacitance-voltage (C-V), and pulse I-V parametric characterization measurements to be made using a single prober cable setup. The components of this kit provides for a Lucas Signatone WaveLink series prober and one of the following micropositioners: SP-100, SP-150, S-926, S-931, S-725, or CAP-946.

## Quick start guide topics

The guide contains information about the use of this cable kit:

- **Model 4200-SCS instrument connections:** Explains how to make connections from the Model 4200-SCS to the top hat.
- **Prober top hat to prober pin connections (basic setup):** Explains how to make connections from the prober top hat to the prober pins.
- **Usage scenarios:** Provides the following specific prober cable setups:
  - I-V testing (2-pin and 4-pin)
  - C-V testing (2-pin and 4-pin)
  - Pulse I-V measurements using the Keithley Model 4225-PMU, and the 4225-PMU with the 4225-RPM

## Related documents

The following documents (in PDF format) are located on the Model 4200-SCS Complete Reference CD:

- **4200-SCS Reference Manual:** Section 16  
The reference manual PDF can be found in the main 4200-SCS Complete Reference. Open the complete reference web page by double-clicking the Complete Reference icon in the upper-left corner of the 4200 desktop.
- **White Paper:** Labs' Demands for Greater Measurement Flexibility Require Cabling Systems Capable of Accommodating Multiple Measurement Types  
This white paper explains the different cabling requirements for I-V, C-V, and pulse I-V testing. It also describes the concept behind this easy-to-use multi-measurement cabling system.

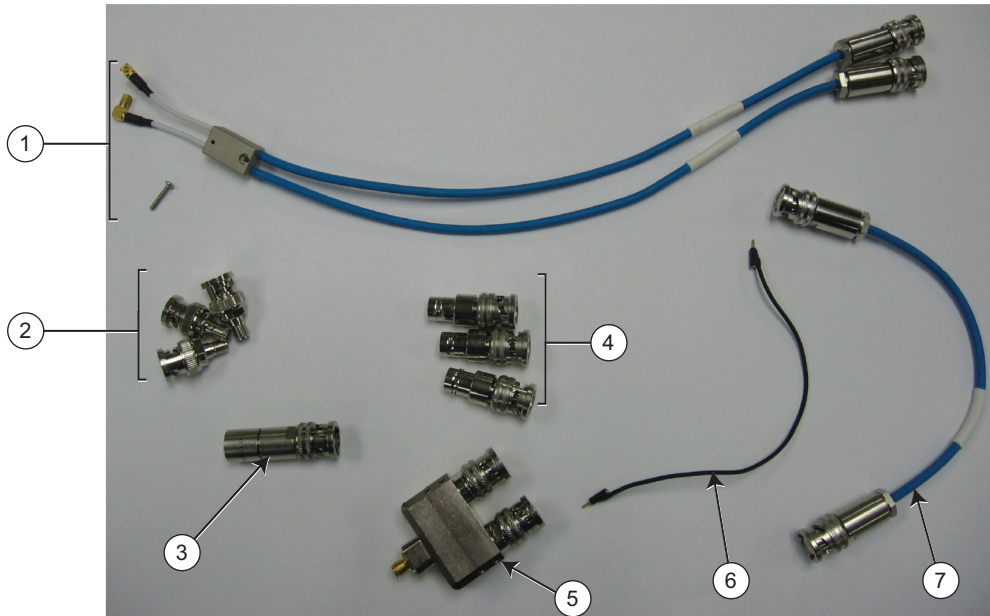
### Prober cable kit contents

Figure 1 shows the cables, adapters, and supplies that are included in the Model 4210-MMPC-L multi-measurement cable kit.

## NOTE

Each kit (Model 4200-MMPC-L) supplies the required components to make sense and force connections to one pin (additional kits are required to make additional connections).

**Figure 1: Model 4210-MMPC-L multi-measurement prober cable kit**



Item	Description	Keithley Instruments part number	Qty
1*	Prober cable assembly (with clamp)(blue) Length: 37.5 cm (14.75 in.)	CA-587	1
2	BNC-SMA adapter	CS-1247	3
3	Triaxial shorting plug	CS-1546	1
4	Triaxial to BNC adapter	CS-712	3
5	Dual triaxial to SMA adapter	CS-1658	1
6	Ground jumper cable assembly (black) Length: 17.8 cm (7 in.)	CA-535-7	1
7	Triaxial to triaxial cable (blue) Length: 12.7 cm (5 in.)	CA-534-6	1

\* Also shown black M3X12MM stainless steel socket head cap screw (Keithley Instruments part number M3X12MMSSSOHCBLK)

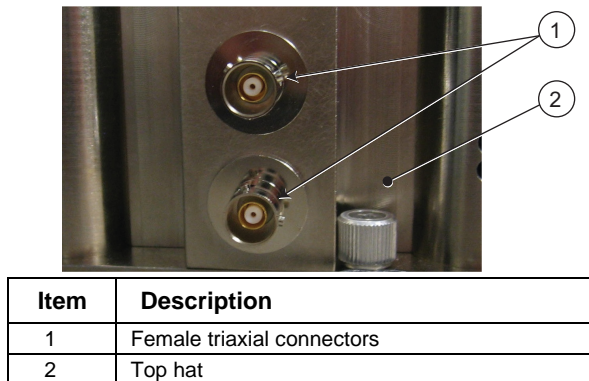
## Model 4200-SCS instrument connections

**⚠ WARNING**

*To prevent injury or death due to electric shock, remove all power from the Model 4200-SCS and shut down the Signatone probe before installing the probe cable kit.*

Connect the Model 4200-SCS instruments to the female triaxial connectors located on the Signatone WaveLink series probe's top hat (see Figure 2 for an example).

**Figure 2. Typical probe top hat triaxial connectors**



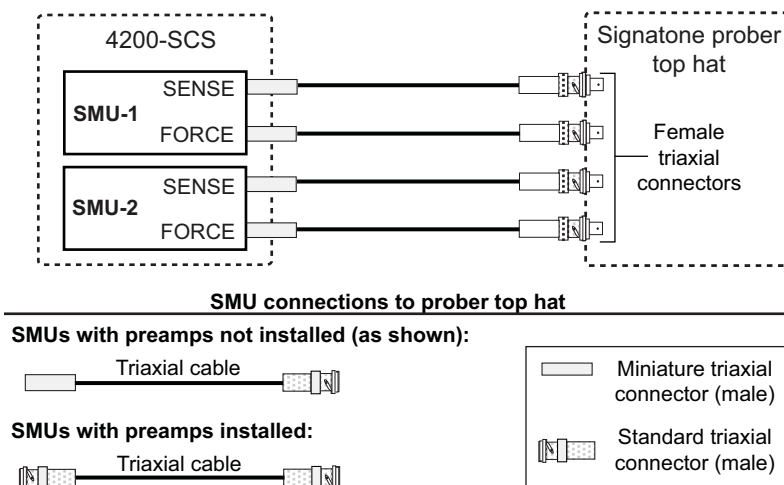
### I-V testing

For I-V testing, connect the triaxial cables of your Model 4200-SCS source-measure units (SMUs) to the standard female triaxial connectors on the probe's top hat. Figure 3 shows the probe connections for two SMUs (Model 4200-SMU or Model 4210-SMU).

**NOTE**

Figure 3 shows connections to SMUs that do not use preamps. These SMUs use the supplied triaxial cables that are terminated with a miniature triaxial connector on one end and a standard triaxial connector on the other end. If your SMUs are equipped with preamps, use the supplied cables that are terminated with standard triaxial connectors on both ends. Figure 3 shows both cables.

**Figure 3: Model 4200-SCS SMU connections to the probe**

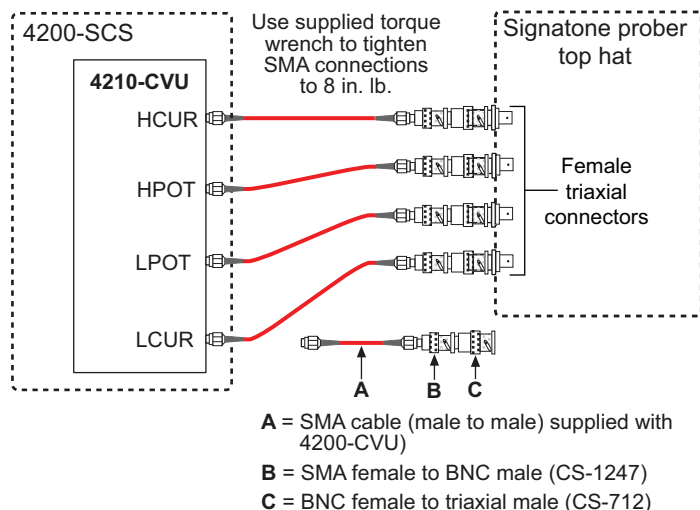


### C-V testing

Two Model 4210-MMPC-L probe cable kits include the cable adapters needed to connect the subminiature version A (SMA) cables of the Model 4210-CVU to the female triaxial connectors on the probe's top hat.

Figure 4 shows how to make the connections. Use the torque wrench (supplied with the Model 4210-CVU) to tighten the SMA connectors to the proper specification (8 in. lb.).

**Figure 4: Model 4210-CVU probe connections**



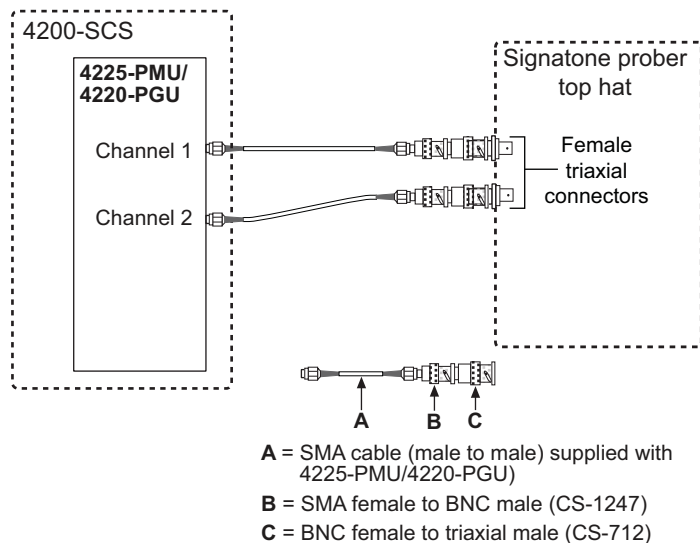
### Pulse I-V testing

Perform 2-pin pulse I-V measurements using two probe cable kits and a Model 4225-PMU (or 4220-PGU). Figure 5 shows the probe connections for a Model 4225-PMU or a Model 4220-PGU.

NOTE

Four probe cable kits are required for 2-pin pulse I-V testing.

**Figure 5. Model 4225-PMU (or 4220-PGU) probe connections**



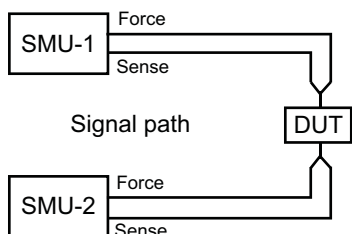
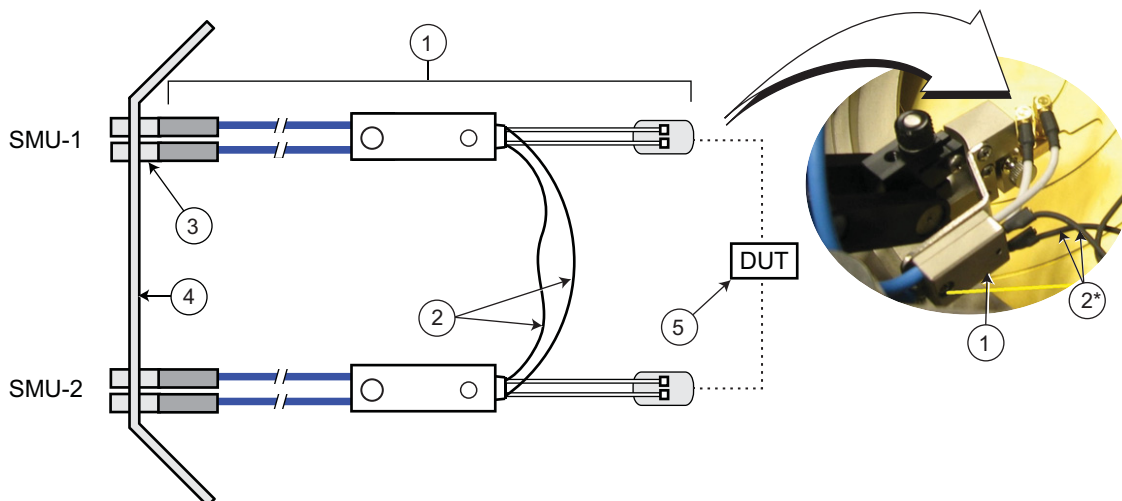
### Prober top hat to prober pin connections (basic setup)

Figure 6 shows the basic cable setup for the 2-pin I-V and 2-pin C-V testing scenarios described in this guide. The 4-pin I-V and 4-pin C-V testing scenarios require minor setup changes; pulse I-V setup, which is more complex, is described later in this quick start guide.

**NOTE**

The two-pin setup illustrated below requires two Model 4210-MMPC-L kits.

**Figure 6: Basic 2-pin prober cable setup**

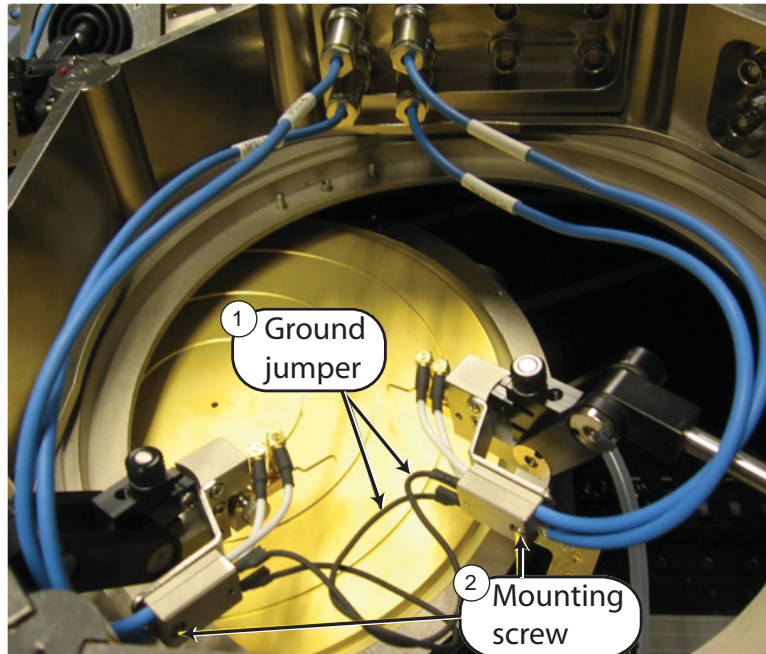


Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	2	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the two cable assemblies.
3	Triaxial connectors	N.A.	4	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Device under test	N.A.	1	Two terminal device under test (DUT)

## Installation guidelines

Figure 7 shows the prober cable assemblies of two Model 4200-MMPC-L kits installed in a Signatone WaveLink series prober. Each blue triaxial cable (CA-587) is secured to both a metal cable clamp and the manipulator mounting bracket by one mounting screw (see Figure 7 for location). When properly installed, the clamp contacts the exposed metal portion of the blue triaxial cable.

**Figure 7: Two prober cable kits installed in a Signatone WaveLink series prober**



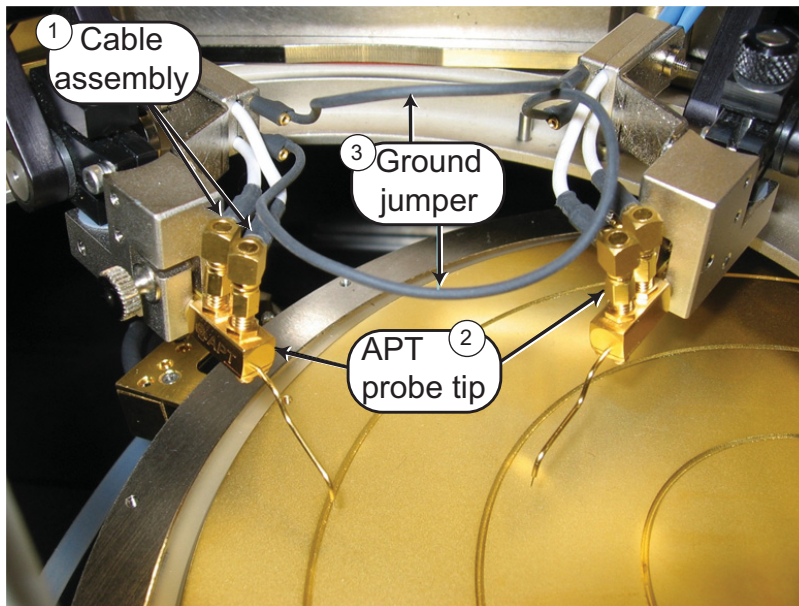
### To properly attach the cable:

1. Remove the micropositioner from the top hat.
2. While ensuring that the exposed metal portion of the blue triaxial cable contacts the metal cable clamp, firmly tighten mounting screw securing the cable assembly to the micropositioner mounting bracket.
3. Replace the micropositioner in the top hat.
4. Route the blue cables to avoid interference with the microscope and other manipulators.
5. Connect each cable assembly by plugging a black ground jumper (CA-535-7) into the ends of the assembly blocks (see Figure 7). This jumper connects the commons of the two cable assemblies. It is good practice to install the second jumper. It not only improves the connection, but it is also a good place to store the extra jumper. Figure 8 shows another view of the jumper.

## NOTE

Figure 7 shows an example of good routing for the ground jumper wires. When routing the wires, consider the possible movements of the manipulators, as well as the movements of the camera or microscope.



**Figure 8: Front view of the installed prober cable assemblies**

6. Connect the cable wires of the cable assemblies (1) to the APT probe tips (2), as shown in Figure 8.
7. When routing the wires, consider the possible movements of the manipulators or the camera. Figure 7 shows an example of good routing for the jumper and cable wires.
8. For each pin, connect the two blue triaxial cable assemblies (CA-587) to the triaxial connectors on the inside of the top hat panel (see Figure 7).

## Usage scenarios

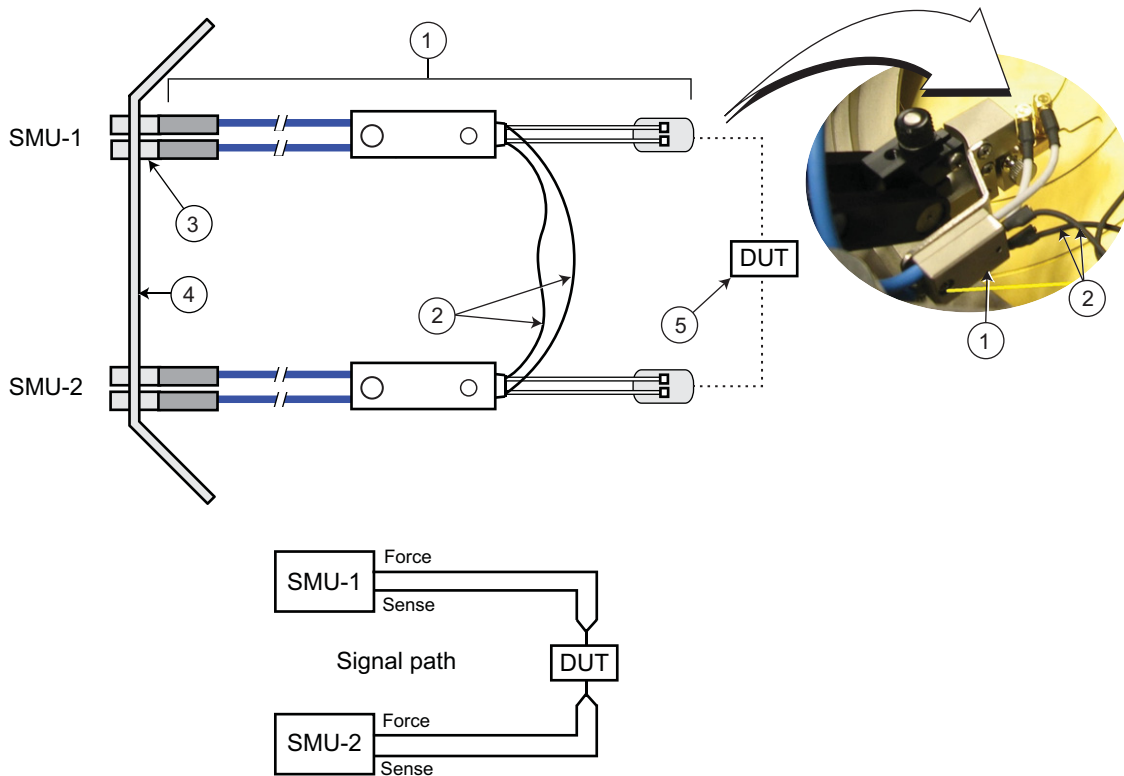
### I-V testing: 2-pin I-V setup

To perform 2-pin I-V testing, connect two Model 4200-SMUs or Model 4210-SMUs to the prober top hat and then use the setup shown in Figure 9 as a guide to connect to the device under test (DUT). Figure 2 shows two typical triaxial SMU connections to the outside of the top hat.

**NOTE**

The setup for 2-pin I-V testing requires two prober cable kits.

**Figure 9: Test setup for 2-pin I-V testing**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	2	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the two cable assemblies.
3	Triaxial connectors	N.A.	2	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Device under test	N.A.	1	Two terminal device under test (DUT)



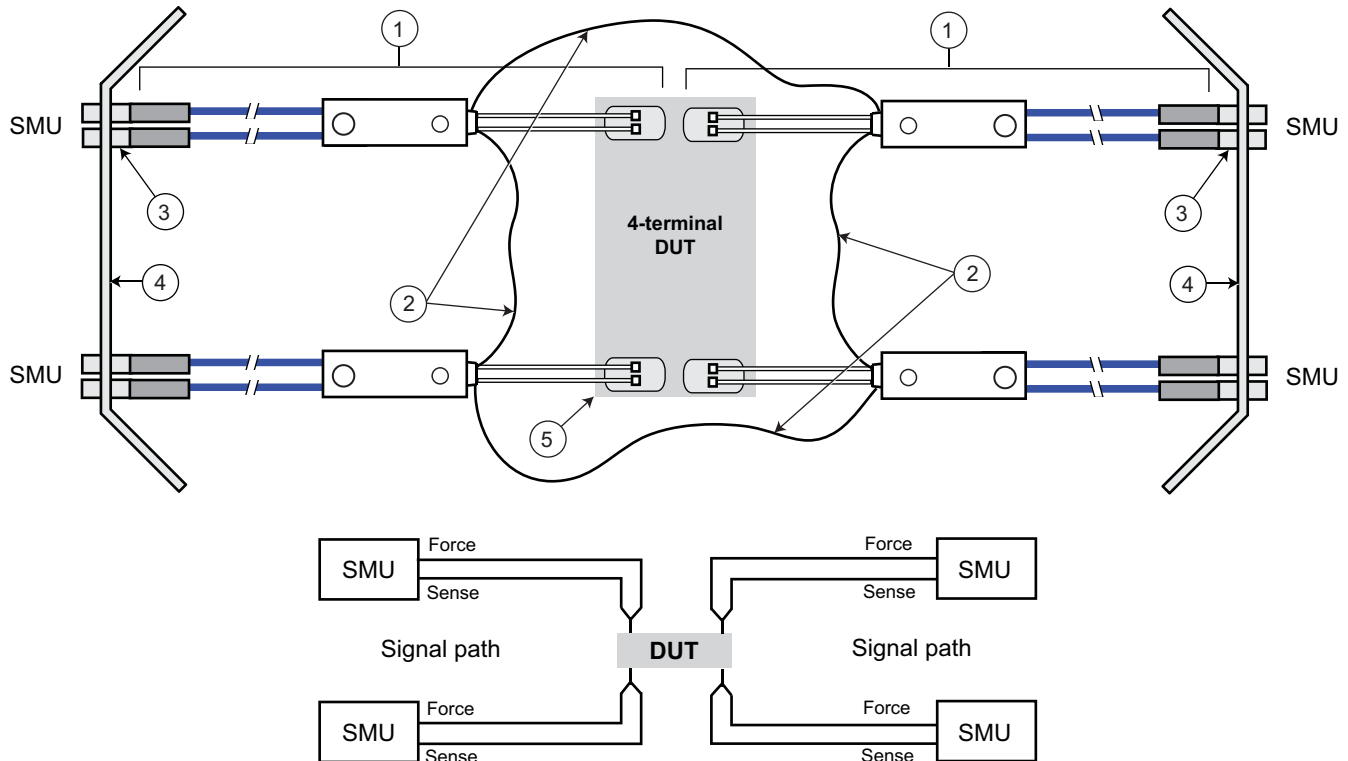
### I-V testing: 4-pin I-V setup

To perform 4-pin I-V testing, connect four Model 4200-SMUs to the prober top hat, and then use the setup shown in Figure 10 as a guide to connect to the device under test (DUT). Figure 2 shows two typical triaxial SMU connections on the outside of the top hat. Connect the two remaining SMUs to other triaxial connectors located on the prober's top hat.

**NOTE**

The setup for 4-pin I-V testing requires four prober cable kits.

**Figure 10: Test setup for 4-pin I-V testing**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	4	
2	Ground jumper cable assembly	CA-535-7	4	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	8	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Device under test	N.A.	1	Four terminal device under test (DUT)

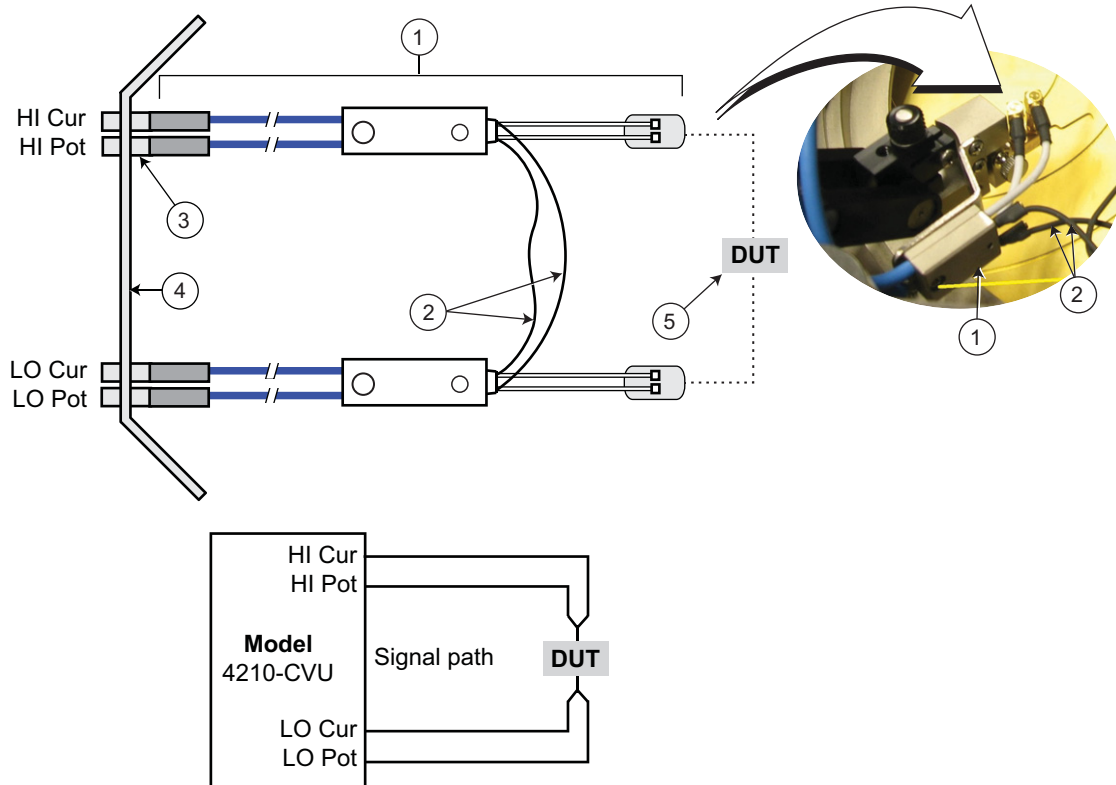
### C-V testing: 2-pin C-V setup

To perform 2-pin C-V testing, connect a Model 4210-CVU to the prober top hat and then use the setup shown in Figure 11 as a guide to connect to the device under test (DUT). Figure 2 shows the CVU connections to the outside of the top hat.

NOTE

The setup for 2-pin C-V testing requires two prober cable kits.

**Figure 11: Test setup for 2-pin C-V testing**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	2	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the two cable assemblies.
3	Triaxial connectors	N.A.	4	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Device under test	N.A.	1	Four terminal device under test (DUT)

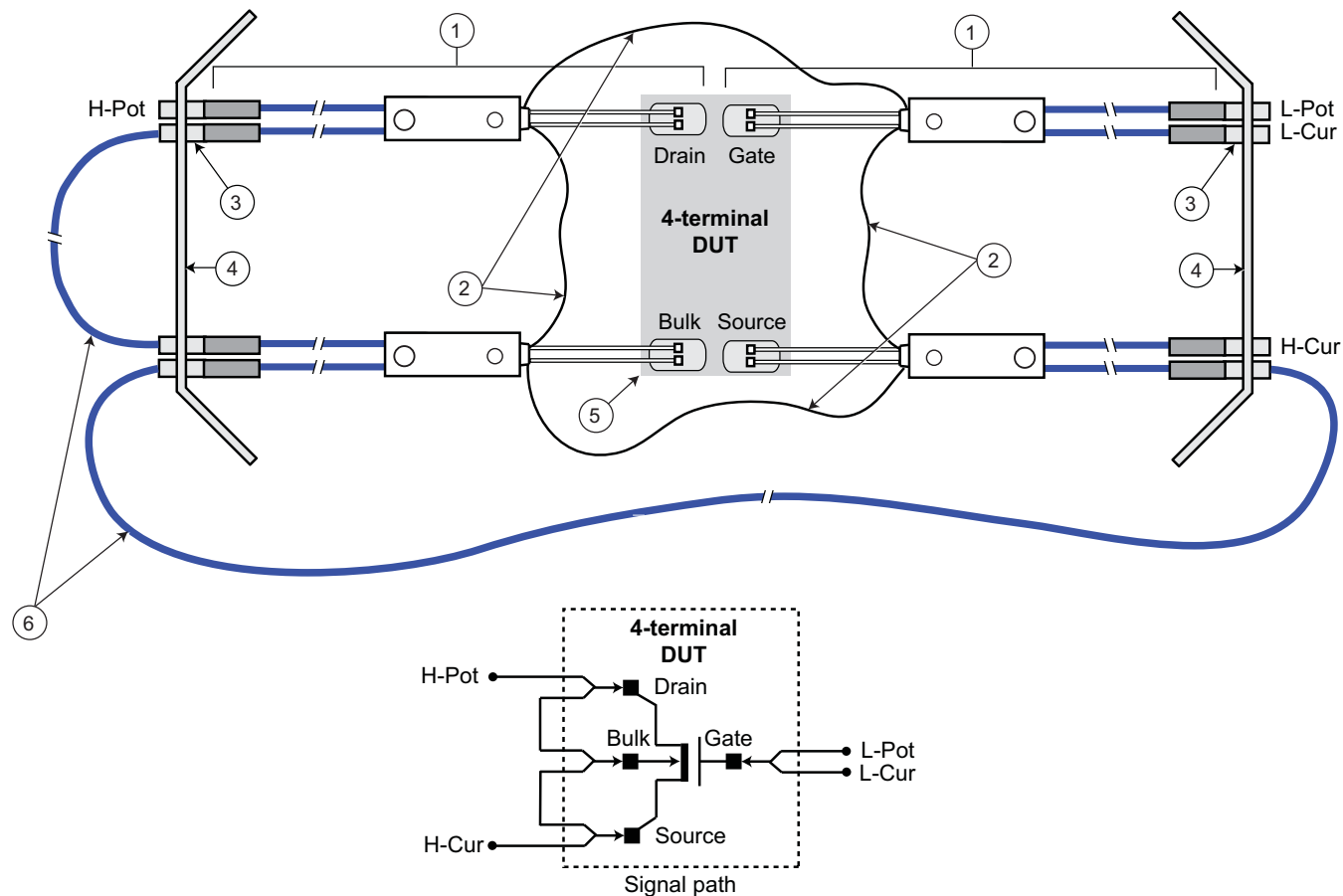
### C-V testing: 4-pin C-V setup

A typical test performed on a field effect transistor (FET) connects the drain, bulk, and source together and then performs the measurement across the gate. To perform 4-pin C-V testing on a device, connect a Model 4200-CVU to the prober top hat, and then use the setup shown in Figure 12 as a guide to connect to the device under test (DUT).

**NOTE**

The setup for 4-pin C-V testing requires four prober cable kits.

**Figure 12: Test setup for 4-pin C-V testing**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	4	
2	Ground jumper cable assembly	CA-535-7	4	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	8	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Device under test	N.A.	1	Four terminal device under test (DUT)
6	Triaxial cable	CS-534-6	2	

### Setup using the Keithley Model 4225-PMU for pulse I-V measurements

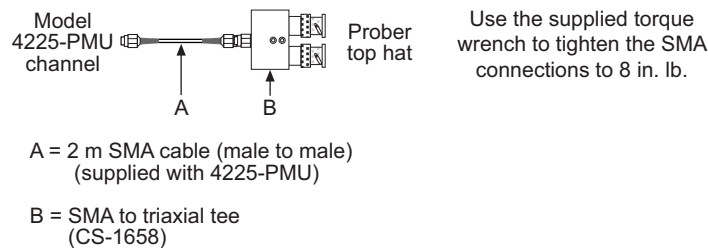
The Model 4225-PMU is an Ultra Fast I-V Module that is an instrument card for the Model 4200-SCS. The PMU has two channels of voltage pulse source with integrated simultaneous voltage and current measurement.

NOTE

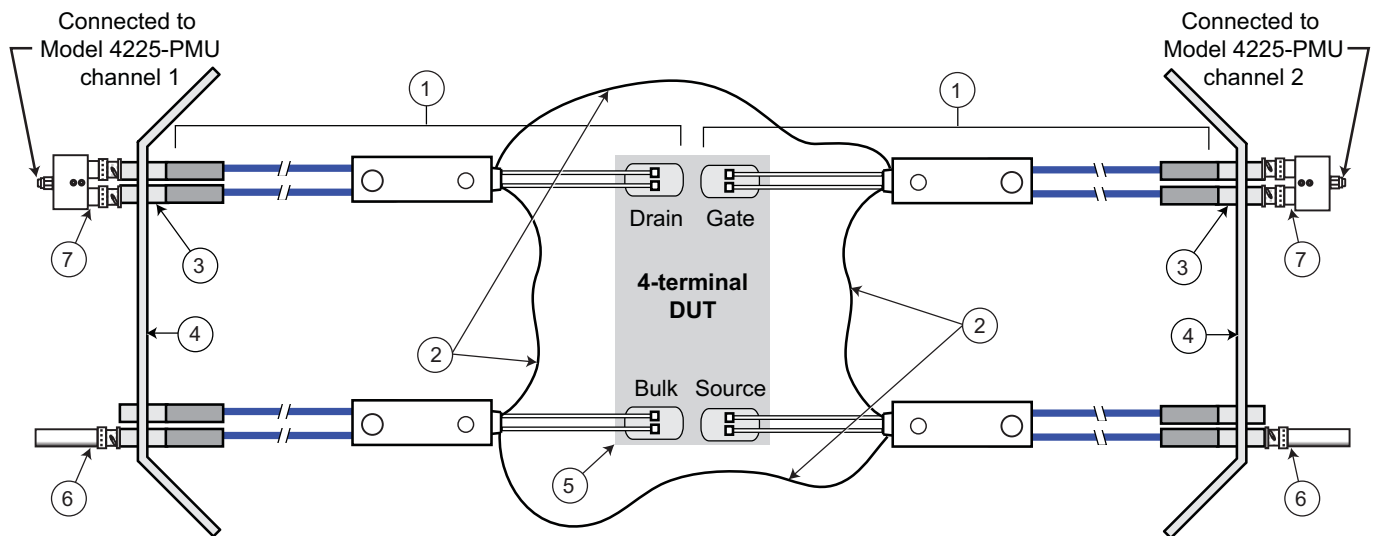
The setup for four-pin pulse I-V testing requires four prober cable kits.

Figure 13 shows the cable and adapters needed to connect a PMU channel to the prober top hat and Figure 14 shows a typical prober connection setup for testing a four-pin device using 2 pulse I-V channels and 2 ground connections.

**Figure 13: Cable and adapters used to connect PMU channel to prober top hat**



**Figure 14: Basic four-pin prober setup for one 4225-PMU card**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	4	
2*	Ground jumper cable assembly	CA-535-7	4	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	8	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Device under test	N.A.	1	Four terminal device under test (DUT)
6	Triaxial shorting plug	CS-1546	2	The triaxial shorting plug connects the triaxial cable's center conductor to its outer shield, effectively connecting the DUT LO to the pulse generator low.
7	SMA to triaxial connector tee	CS-1658	2	

## Setup using the Keithley Model 4225-RPM for I-V, C-V, or pulse I-V measurements

### NOTE

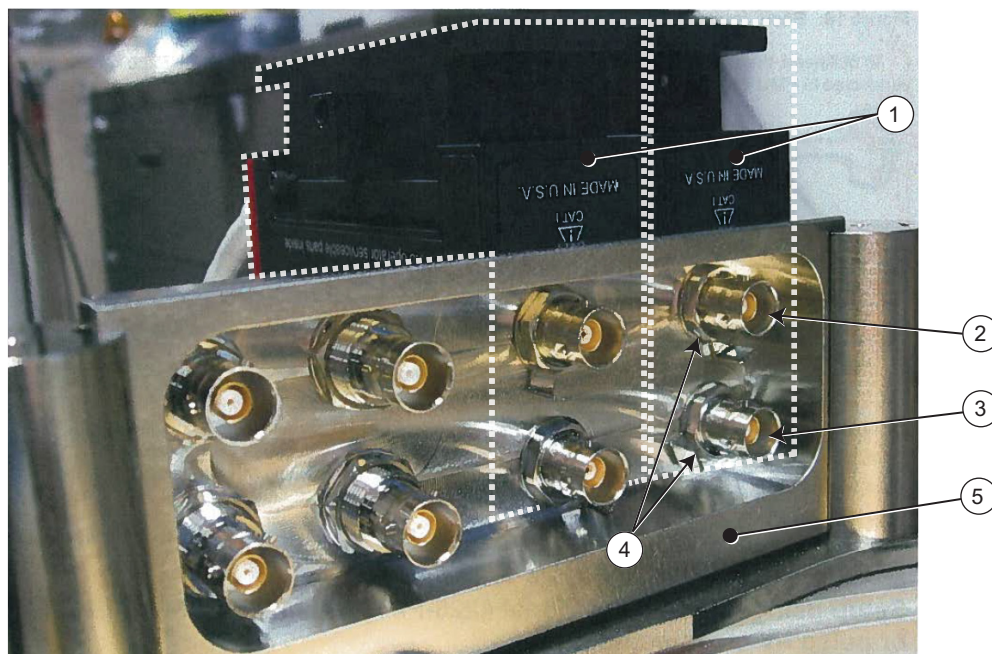
The setup for three-pin pulse I-V testing requires three prober cable kits. The setups for four-pin testing require four prober cable kits.

The Model 4225-RPM is a Remote Amplifier/Switch that is an optional item to the Model 4225-PMU. The PMU has two channels, so each PMU instrument card supports two (2) RPMs. The MMPC cables simplify the connection and re-connection between the instruments and the device-under-test. The combination of the MMPC cables with the RPM permits testing I-V, C-V, or pulse I-V automatically, without any manual cable re-connections. When using only two RPMs on a four-terminal device, some re-cabling is required for certain C-V test configurations.

The Model 4225-RPM has the appropriate connector types at the input and output of the RPM enclosure to eliminate any adapters when connecting cables to the RPM. On the input side, there are two triaxial connectors for SMU Force and SMU Sense. There are two SMA connectors for CVU POT and CVU CUR. There is also an RPM control connector for the control and power of the RPM from the Model 4225-PMU. The output of the RPM is a pair of triaxial cables (Force and Sense), which connect directly to the MMPC cables as shown in the figures below.

The best way to configure the prober is to use the place the Model 4225-RPM upside down, insert the RPM force and sense connectors through the holes, and secure the RPM using a nut on each triaxial connector on the inside of the top-hat. Figure 15 shows an example of two RPMs mounted to the prober in this way.

**Figure 15: Model 4225-RPM installation**



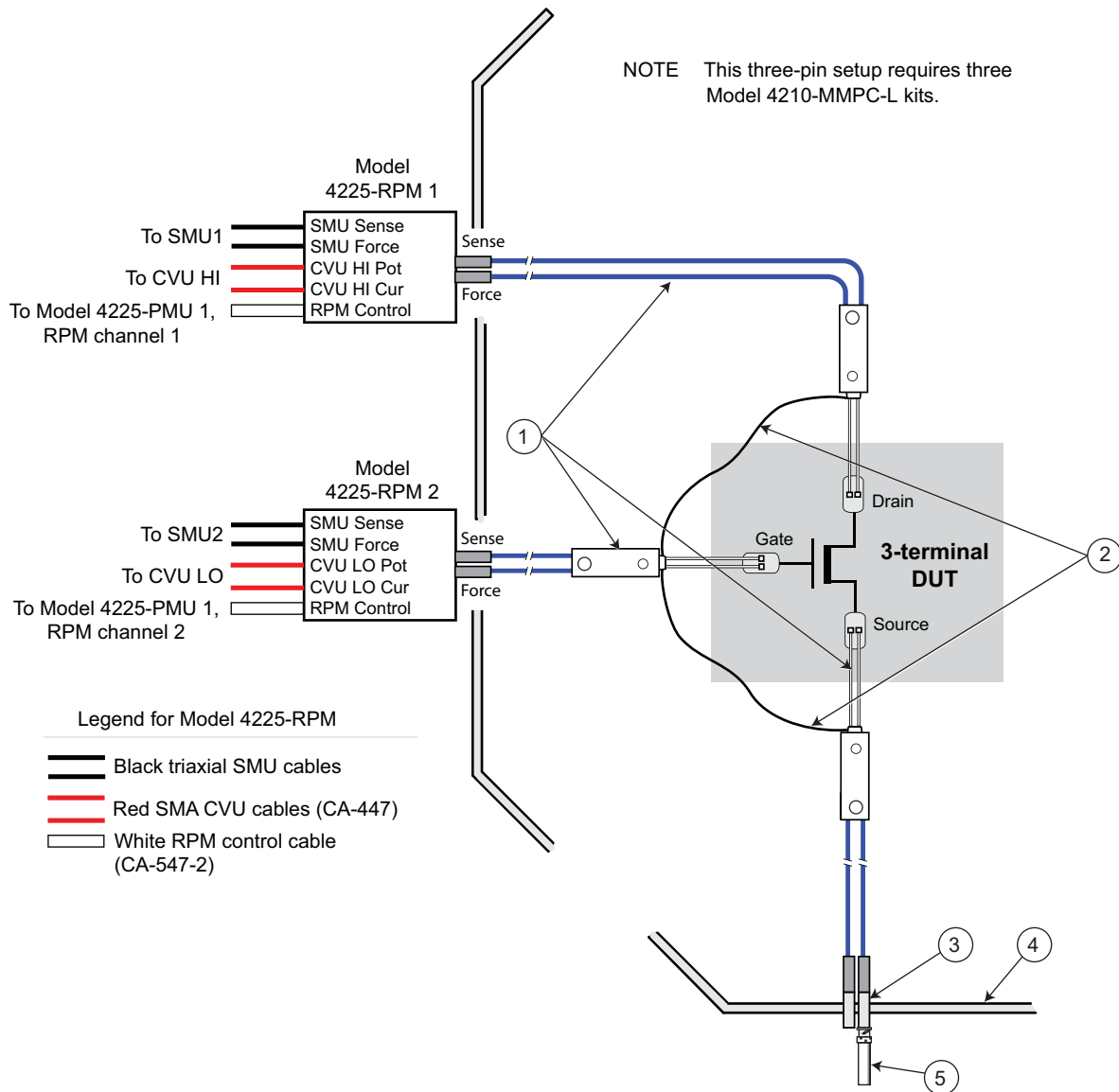
Item	Description	Part number	Quantity	Notes
1	Remote amplifier/switch	Model 4225-RPM	2	
2	Sense triaxial connector	NA	1	Each Model 4225-RPM has one sense triaxial connector
3	Force triaxial connector	N.A.	1	Each Model 4225-RPM has one force triaxial connector
4	Nut	N.A.	1	
5	Top hat	N.A.	1	

See Section 16 of the 4200 Reference Manual for Model 4225-PMU and Model 4225-RPM information and how to configure an ITM for a pulse IV test.

## Two Channel I-V or Pulse I-V Setup

For most I-V and pulse I-V testing, typically only two source/measure channels are used. The two active signals are connected to the gate and drain; source (and bulk, if present) is connected to ground (see Figure 16 and Figure 17). For the C-V test setup shown in Figure 19, all four source/measure channels are used.

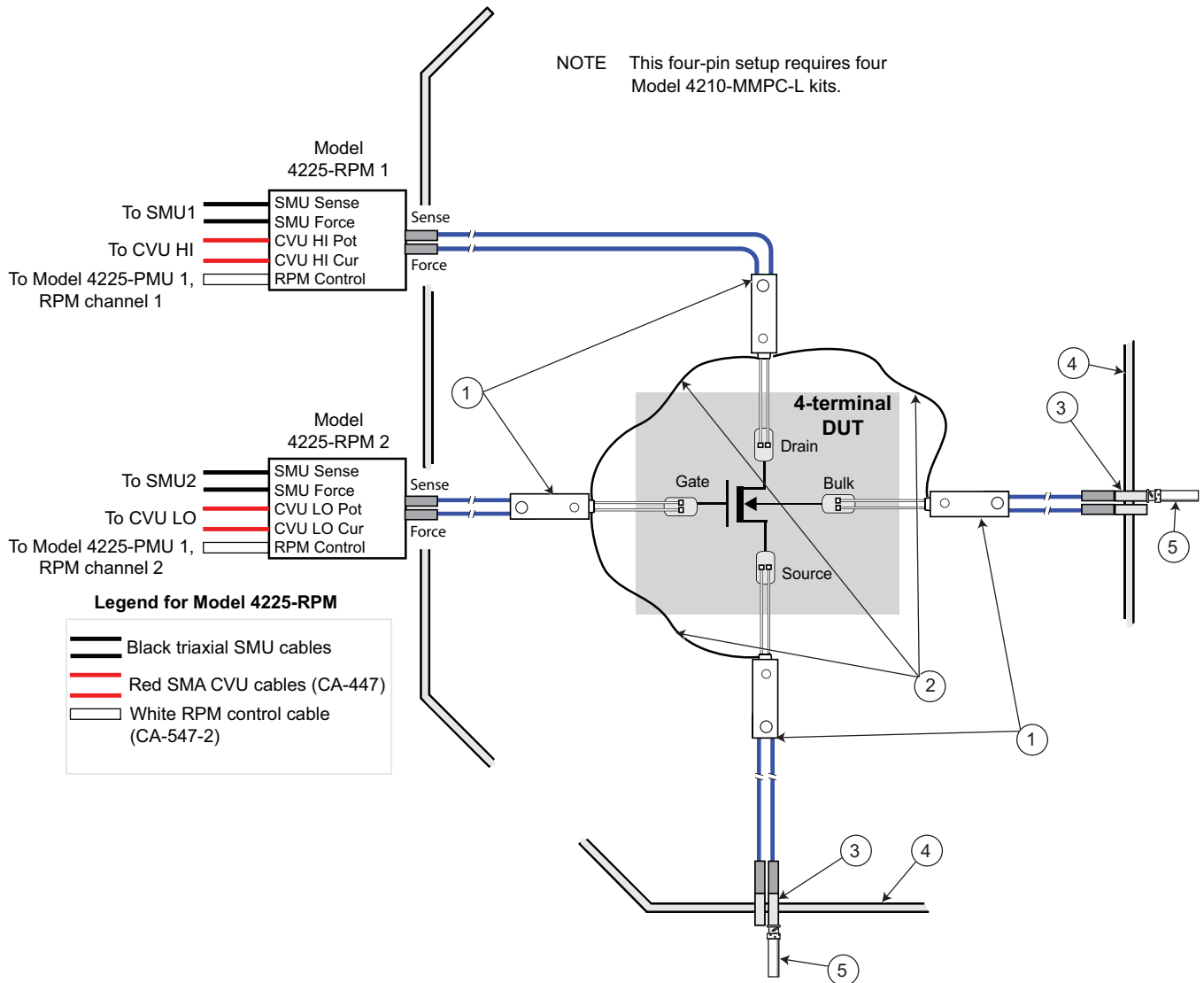
**Figure 16: Test setup for three-pin device using two-channel I-V and pulse I-V**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	3	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	1	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Triaxial shorting plug	CS-1546	1	The triaxial shorting plug connects the triaxial cable's center conductor to its outer shield, effectively connecting the DUT LO to the pulse generator low.

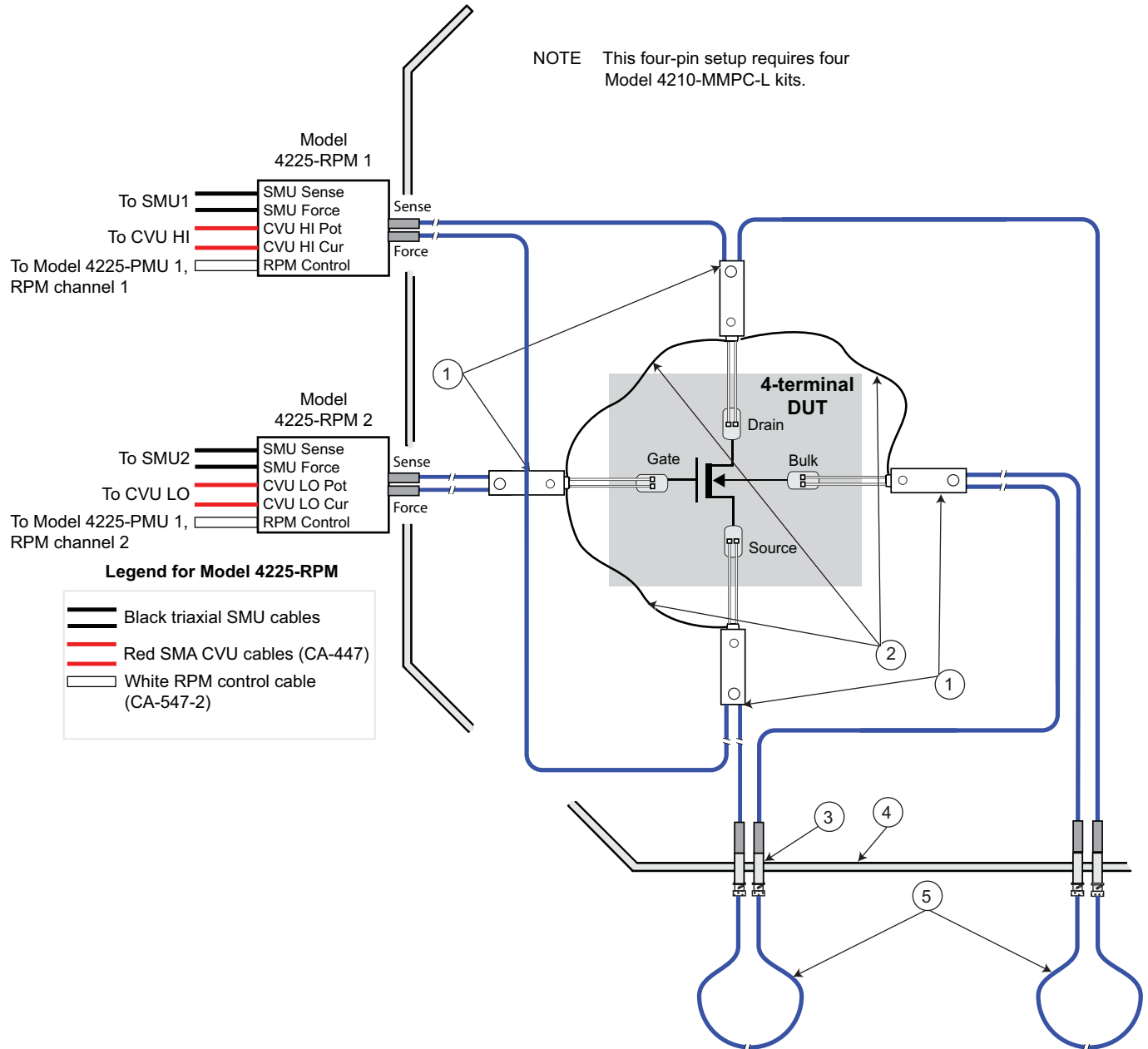


**Figure 17: Test setup for four-pin device using two-channel I-V and pulse I-V**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	4	
2	Ground jumper cable assembly	CA-535-7	3	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	2	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Triaxial shorting plug	CS-1546	2	The triaxial shorting plug connects the triaxial cable's center conductor to its outer shield, effectively connecting the DUT LO to the pulse generator low.

**Figure 18: Test setup for four-terminal C-V testing**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	4	
2	Ground jumper cable assembly	CA-535-7	3	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	2	Prober top hat triaxial connectors
4	Prober top hat	N.A.	1	
5	Triaxial cable	CS-534-6	2	Provides CVU HI to Drain, Bulk, and Source terminals.

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 rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II connections require protection for high transient overvoltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

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.


The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of 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 should 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.