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## Multi-measurement Prober Cable Kit

### Overview

The Keithley Model 4210-MMPC-L multi-measurement prober cable kit provides a collection of matched connection accessories. When properly installed, these accessories have the performance needed to allow current-voltage (I-V), capacitance-voltage (C-V), and pulsed I-V parametric characterization measurements to be made using a single prober cable setup. The components of this kit provide 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.

This document contains the following information about the installation and use of this cable kit:

- **Model 4200A-SCS instrument connections:** Explains how to make connections from the 4200A-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)
  - Pulsed I-V measurements using the Keithley Model 4225-PMU, and the 4225-PMU with the 4225-RPM

### Prober cable kit contents

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

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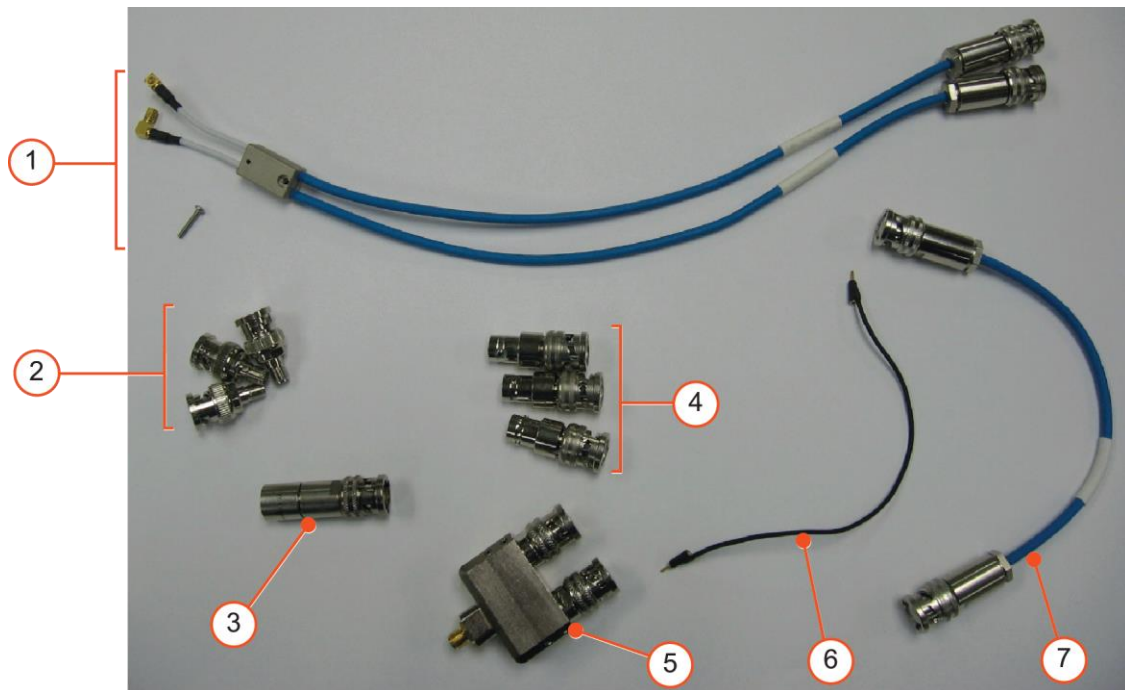
#### NOTE

Each kit supplies the components to make sense and force connections to one pin. Additional kits are required to make additional connections.

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



The items shipped may vary from the items in the picture.

Item	Description	Keithley Instruments part number	Qty
1	Prober cable assembly (with clamp); length: 37.5 cm (14.75 in.)	CA-587	1
2	BNC to 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 Length: 17.8 cm (7 in.)	CA-535-7	1
7	Triaxial to triaxial cable Length: 12.7 cm (5 in.)	CA-534-6	1
Not shown	Black M3 X 12MM stainless steel socket head cap screw	M3X12MMSSSOHCBLK	1

## Related documents

The following documents are available in the 4200A-SCS Learning Center and at [tek.com/keithley](https://tek.com/keithley):

- The *Model 4200A-SCS Prober and External Instrument Control* (document number 4200A-913-01).
- **White Paper 3023: 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 an example single multi-measurement cabling system.

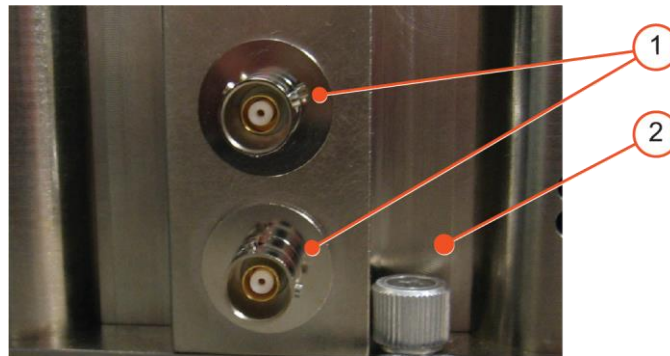
## Model 4200A-SCS instrument connections

### **⚠ WARNING**

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

Connect the 4200A-SCS instruments to the triaxial jacks on the Signatone WaveLink series top hat. Refer to the following figure for an example.

**Figure 2: Typical prober top hat triaxial connectors**



Item	Description
1	Triaxial jack
2	Top hat

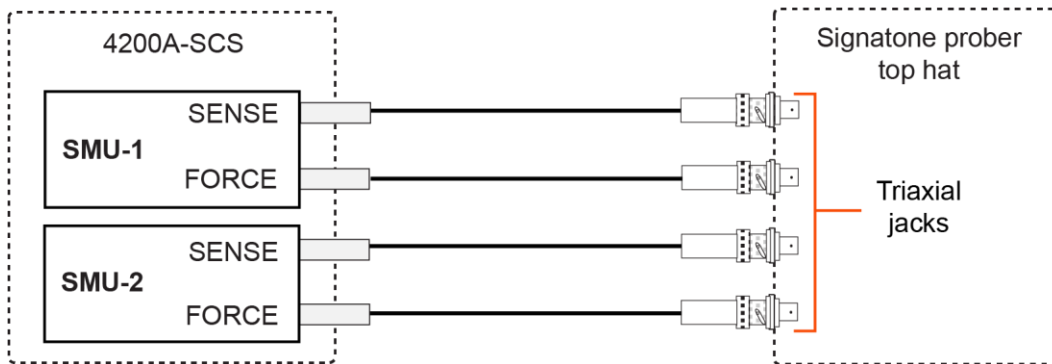
## I-V testing

For I-V testing, connect the triaxial cables of the 4200A-SCS source-measure units (SMUs) to the standard triaxial jacks on the top hat of the prober. The following figure shows the prober connections for two SMUs.

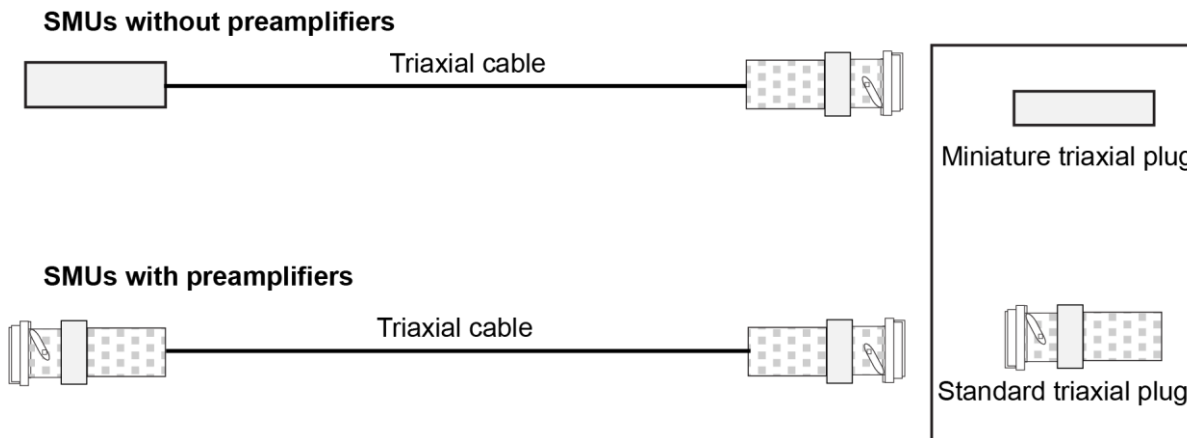
### NOTE

The 4200A-SCS to prober portion of the following figure shows SMUs that do not use preamplifiers. These SMUs use triaxial cables that are terminated with a miniature triaxial connector on one end and a standard triaxial connector on the other end. These cables are supplied with the 4200A-SCS. If your SMUs are equipped with preamplifiers, use the supplied cables that are terminated with standard triaxial connectors on both ends. The cable diagrams after the following figure show both cables.

**Figure 3: Model 4200A-SCS SMU connections to the prober top hat**



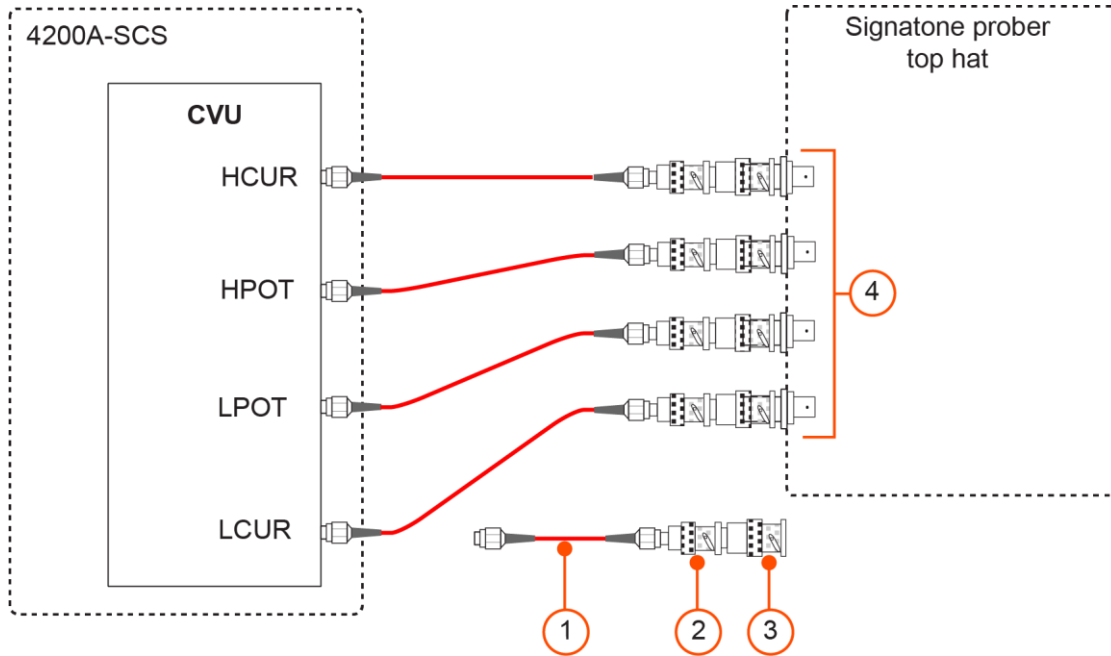
**Figure 4: SMU triaxial cable diagrams**



## C-V testing

You need two prober cable kits to connect the subminiature version A (SMA) cables of the CVU to the triaxial jacks on the top hat of the prober. The following figure shows how to make the connections. Use the torque wrench supplied with the 4200A-SCS to tighten the SMA connections to 8 in. lb.

**Figure 5: 4200A-SCS CVU prober connections**



Item	Description	Part number
1	SMA cable (plug to plug), supplied with the CVU	Not applicable
2	SMA jack to BNC plug	CS-1247
3	BNC jack to triaxial plug	CS-712
4	Triaxial jacks	Not applicable

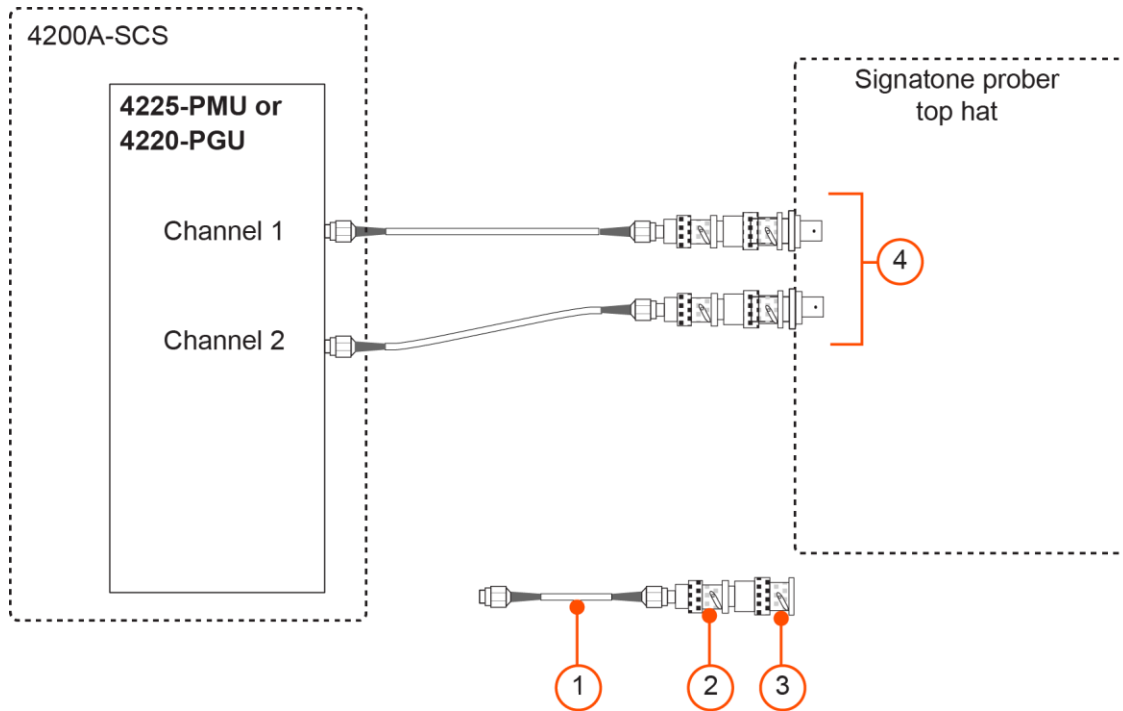
## Pulsed I-V testing

You can perform 2-pin pulsed I-V measurements using two prober cable kits and a Model 4225-PMU or 4220-PGU. The following figure shows the prober connections for a 4225-PMU or a 4220-PGU.

### NOTE

This setup requires two prober cable kits.

**Figure 6: Model 4225-PMU or 4220-PGU prober connections**



Item	Description	Part number
1	SMA cable (plug to plug), supplied with the PMU or PGU	Not applicable
2	SMA jack to BNC plug	CS-1247
3	BNC jack to triaxial plug	CS-712
4	Triaxial jacks	Not applicable

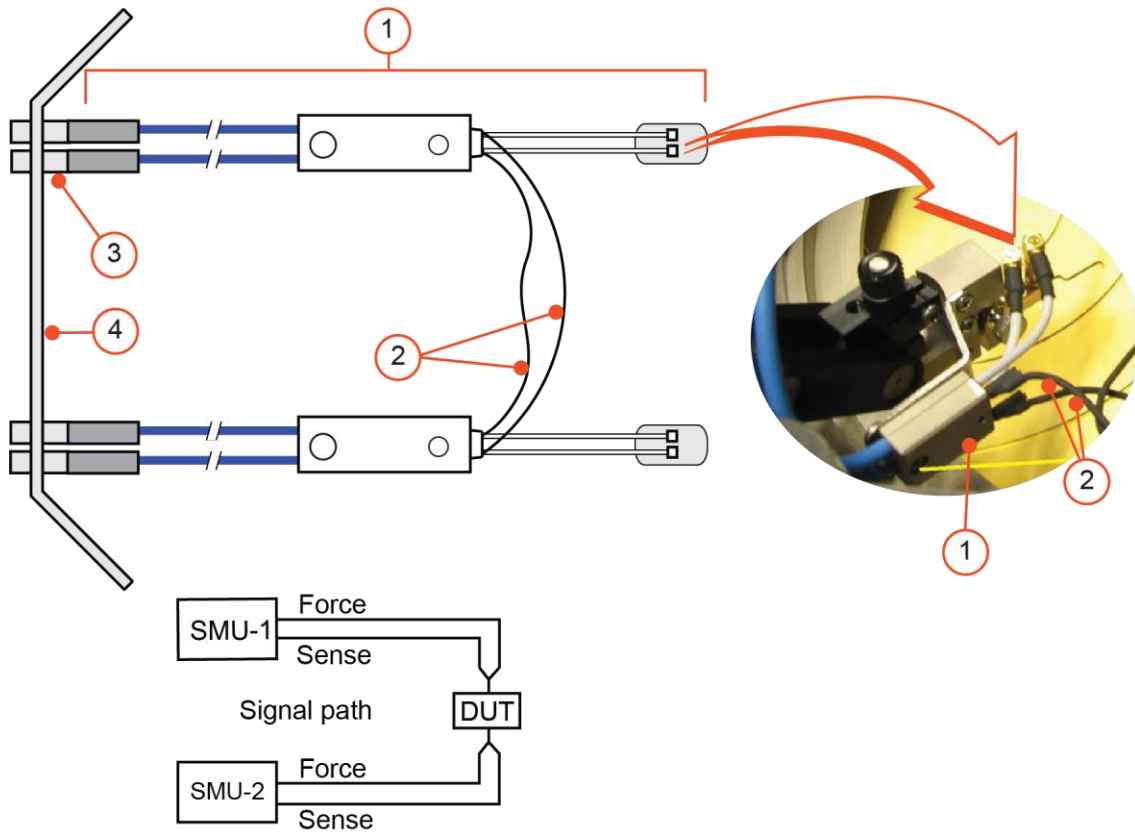
## Prober top hat to prober pin connections

The following figure shows the basic cable setup for the 2-pin I-V and 2-pin C-V testing scenarios described in this document. The 4-pin I-V and 4-pin C-V testing scenarios require minor setup changes. Pulsed I-V setup, which is more complex, is described in [Usage scenarios](#) (on page 9).

### NOTE

This setup requires two 4210-MMPC-L kits.

**Figure 7: 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	Not applicable	4	Prober top hat triaxial connectors
4	Prober top hat	Not applicable	1	

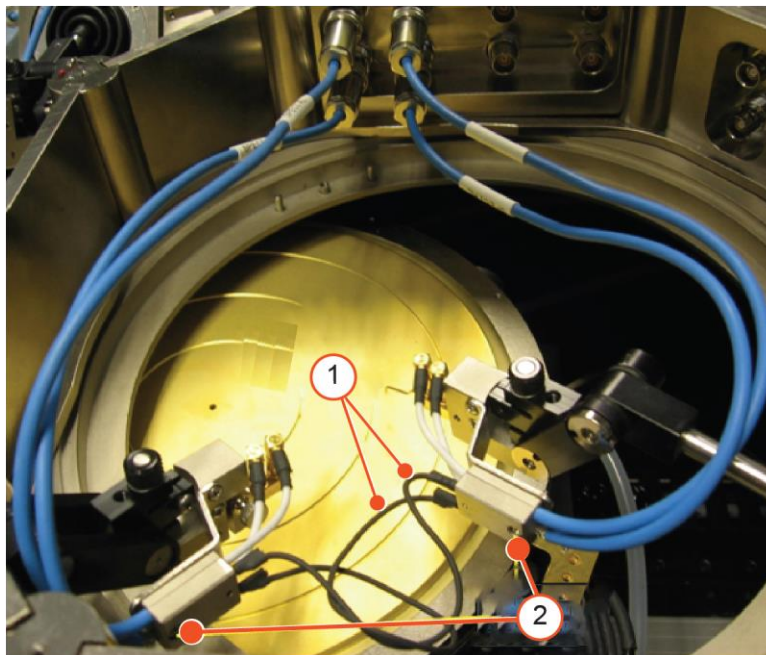
## Installation guidelines

The following figure shows the prober cable assemblies of two 4210-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. When properly installed, the clamp contacts the exposed metal portion of the blue triaxial cable.

**To 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 the mounting screw to secure the cable assembly to the micropositioner mounting bracket.

**Figure 8: Two prober cable kits installed in a Signatone WaveLink series prober**

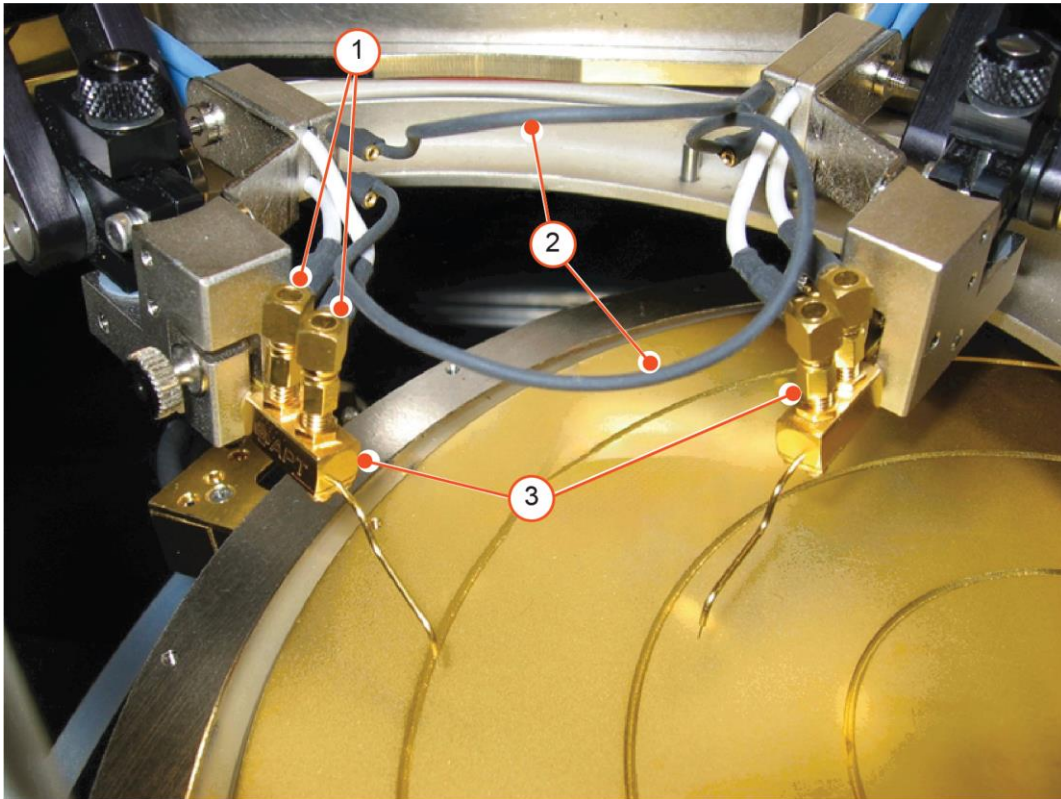


Item	Description
1	Ground jumpers
2	Mounting screws

3. Replace the micropositioner in the top hat.
4. Route the blue cables to avoid interference with the microscope and other manipulators. Consider the possible movements of the manipulators and the movements of the camera or microscope.
5. Connect each cable assembly by plugging a black ground jumper into the ends of the assembly blocks, as shown in the following figure. This jumper connects the commons of the two cable assemblies. It is good practice to install the second jumper. It improves the connection and is a good place to store the extra jumper.



Figure 9: Front view of the installed prober cable kit assemblies



Item	Description	Part number
1	Cable assemblies	Not applicable
2	Ground jumpers	CA-535-7
3	APT probe tips	Not applicable

6. Connect the cable wires of the cable assemblies (1) to the APT probe tips (3), as shown in the previous figure.
7. When routing the wires, consider the possible movements of the manipulators or the camera.
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.

## Usage scenarios

The following usage scenarios provide information on how to set up 2-pin and 4-pin I-V tests, 2-pin and 4-pin C-V tests, and pulsed I-V tests.

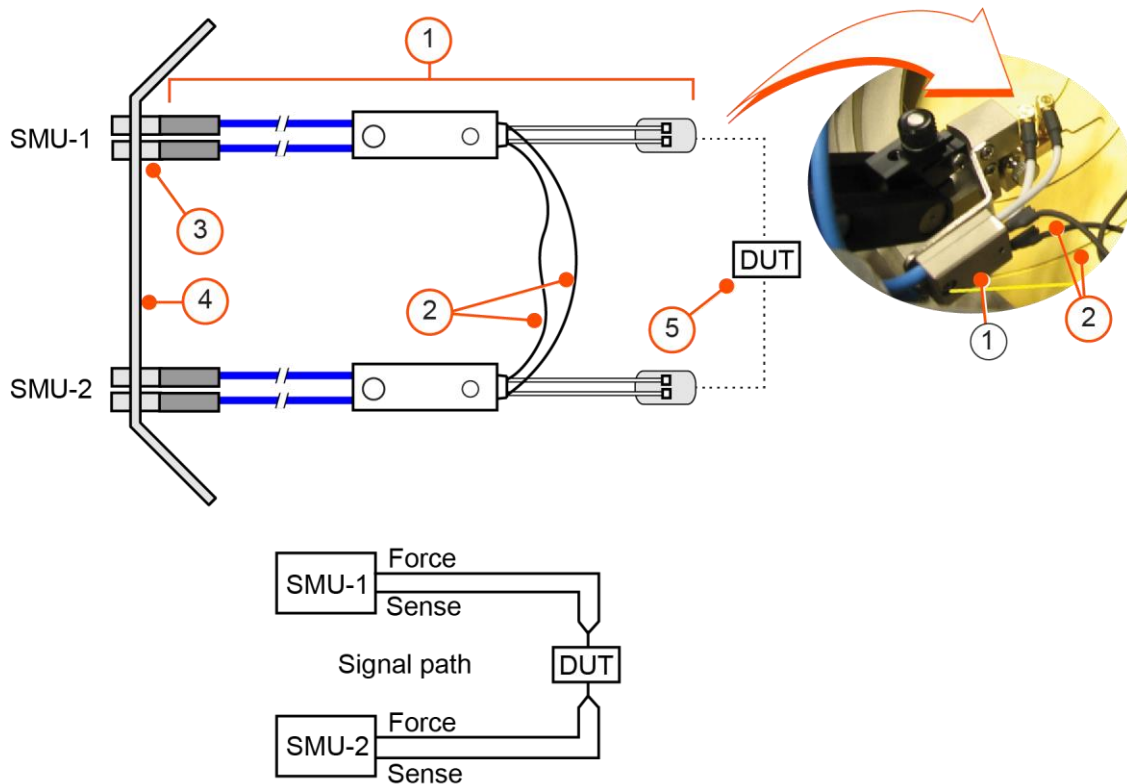
## I-V testing: 2-pin I-V setup

### NOTE

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

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

**Figure 10: Test setup for 2-pin I-V testing**



Item	Description	Part number	Qty.	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).

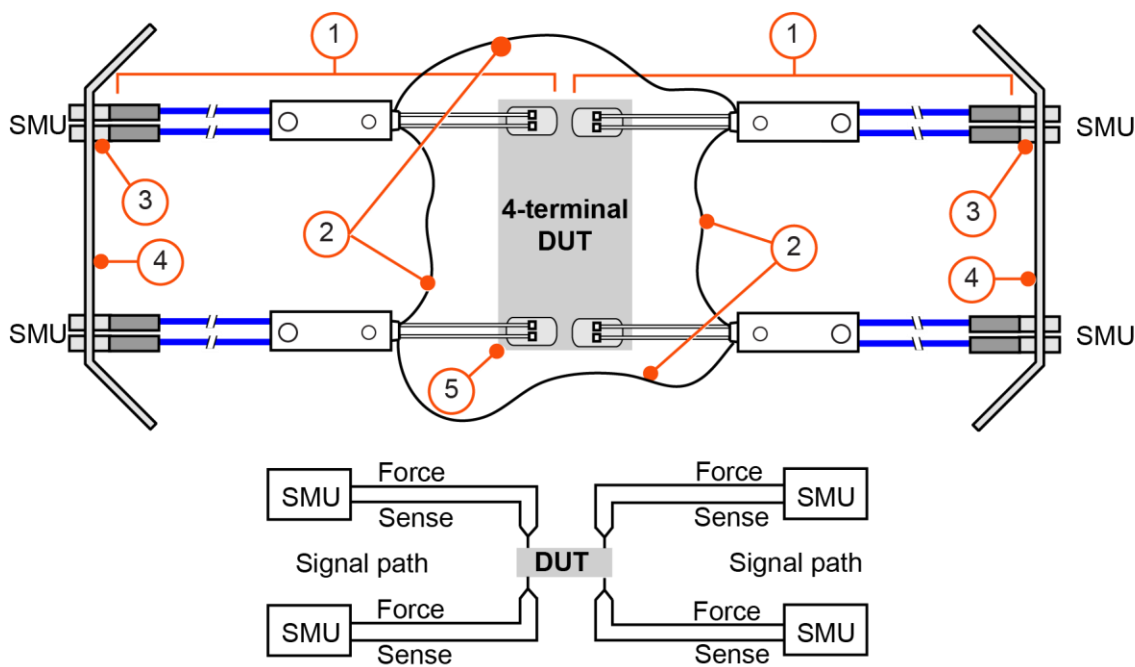
## I-V testing: 4-pin I-V setup

### NOTE

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

To perform 4-pin I-V testing, connect four 4200A-SCS SMUs to the prober top hat and then use the setup shown in the following figure as a guide to connect to the device under test (DUT). The prober top hat triaxial connectors shown in [Model 4200A-SCS instrument connections](#) (on page 3) show two typical triaxial SMU connections on the outside of the top hat. Connect the two remaining SMUs to other triaxial connectors on the top hat of the prober.

**Figure 11: Test setup for 4-pin I-V testing**



Item	Description	Part number	Qty.	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	Not applicable	8	Prober top hat triaxial connectors.
4	Prober top hat	Not applicable	1	
5	Device under test	Not applicable	1	Four terminal device under test (DUT).

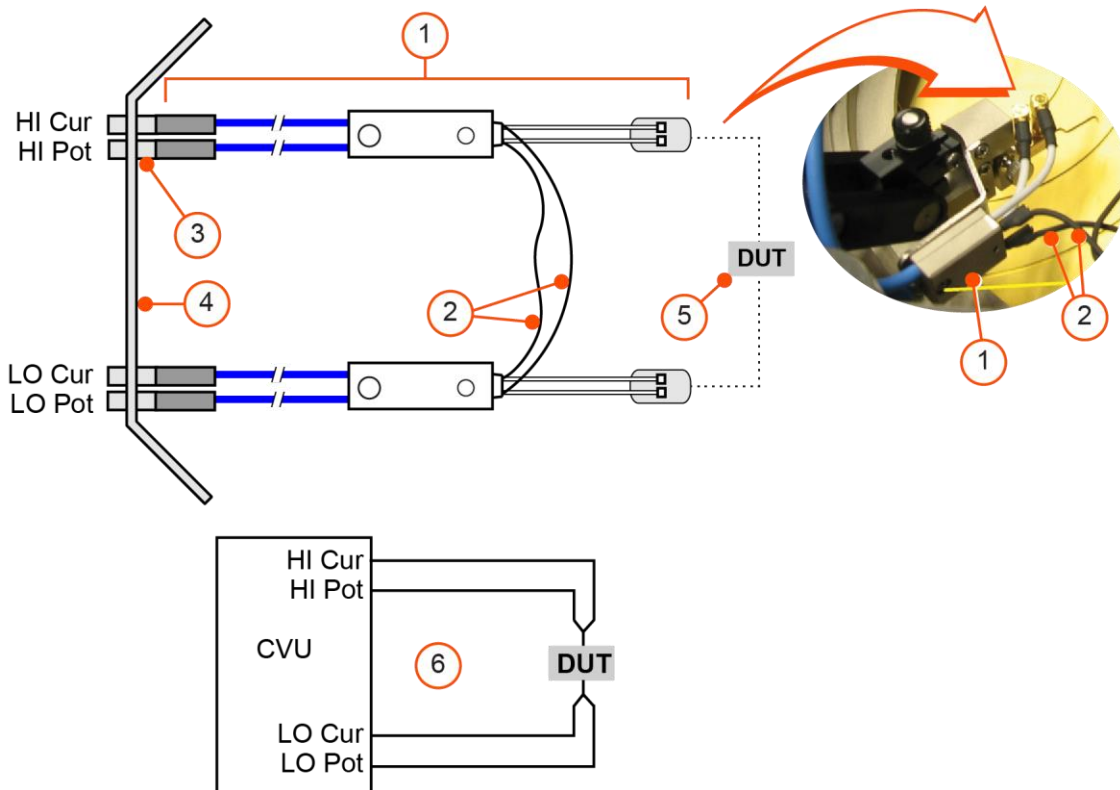
## C-V testing: 2-pin C-V setup

### NOTE

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

To perform 2-pin C-V testing, connect a Model 4210-CVU to the prober top hat. Use the setup shown in the following figure as a guide to make connections to the device under test (DUT). The following figure shows the CVU connections to the outside of the top hat.

Figure 12: Test setup for 2-pin C-V testing



Item	Description	Part number	Qty.	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	Not applicable	4	Prober top hat triaxial connectors.
4	Prober top hat	Not applicable	1	
5	Device under test	Not applicable	1	Two terminal device under test (DUT).
6	Signal path	Not applicable		

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

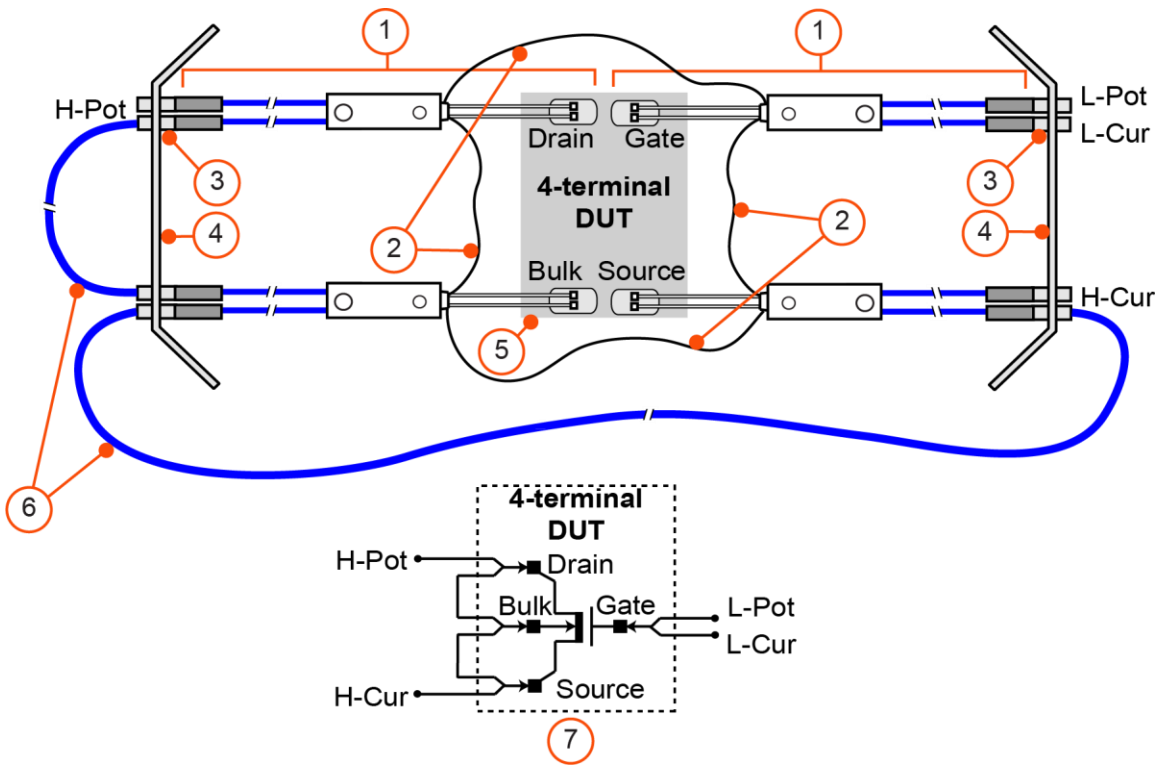
### NOTE

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

A typical test for a field effect transistor (FET) is to connect the drain, bulk, and source together and make the measurement across the gate.

To perform 4-pin C-V testing on a device, connect a CVU to the prober top hat, and then use the setup shown in the following figure as a guide to connect to the device under test (DUT).

Figure 13: 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	
7	Signal path			

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

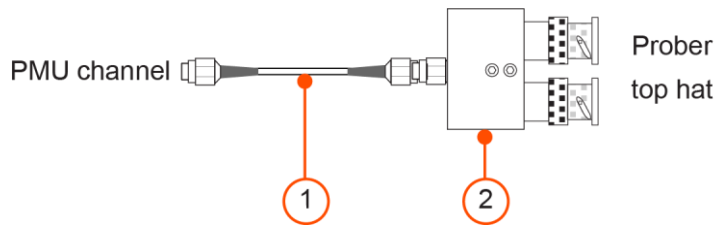
### NOTE

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

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

The following figure shows the cable and adapters needed to connect a PMU channel to the prober top hat.

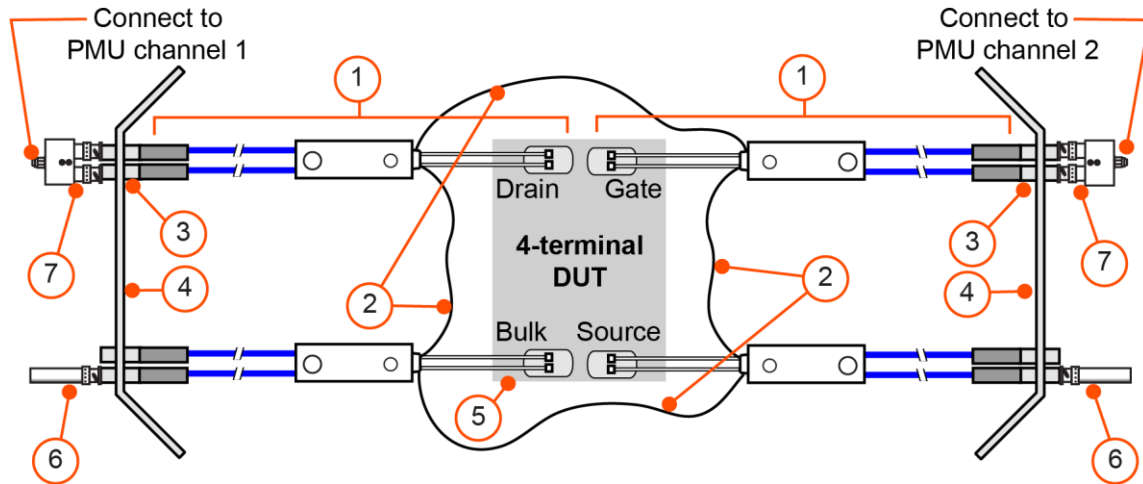
**Figure 14: Cable and adapters used to connect PMU channel to prober top hat**



Item	Description	Part number
1	SMA cable (plug to plug), 2 m, supplied with the PMU	Not applicable
2	SMA to triaxial tee	CS-1658

The following figure shows typical prober connection setup for testing a four-pin device. This example uses two pulsed I-V channels and two ground connections.

**Figure 15: Basic four-pin prober setup for PMU**



Item	Description	Part number	Qty.	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	Not applicable	8	Prober top hat triaxial connectors.
4	Prober top hat	Not applicable	1	
5	Device under test	Not applicable	1	Four terminal device under test (DUT).
6	Triaxial shorting plug	CS-1546	2	The triaxial shorting plug connects the center conductor of the triaxial cable 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 pulsed I-V measurements

### NOTE

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

The Model 4225-RPM Remote Amplifier/Switch is an optional accessory for the Model 4225-PMU. The PMU has two channels and each channel can support an RPM. 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 pulsed I-V automatically, without any manual cable reconnections. When using only two RPMs on a four-terminal device, some re-cabling is required for certain C-V test configurations.

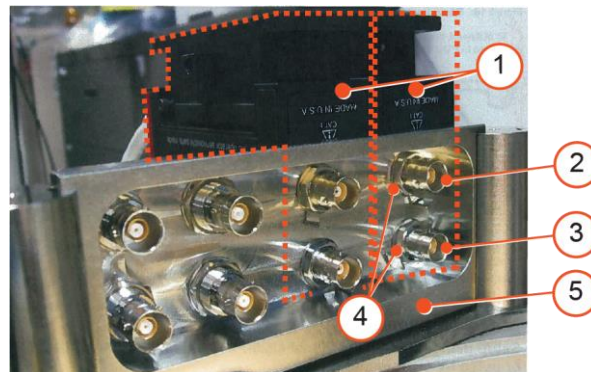
The 4225-RPM has the appropriate connector types at the input and output of the RPM enclosure to eliminate any adapters when connecting cables to the RPM. On the input side, there are two triaxial connectors for SMU Force and SMU Sense. There are two SMA connectors for CVU POT and CVU CUR. There is also an RPM control connector for the control and power of the RPM from the 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 following figure.

**To configure the prober:**

1. Place the 4225-RPM upside down.
2. Insert the 4225-RPM force and sense connectors through the holes.
3. Secure the 4225-RPM using a nut on each triaxial connector on the inside of the top hat.

The following figure shows an example of two RPMs mounted to the prober in this way.

**Figure 16: Model 4225-RPM installation**



Item	Description	Part number	Qty.	Notes
1	Remote amplifier/switch	4225-RPM	2	
2	Sense triaxial connector	Not applicable	1	Each Model 4225-RPM has one sense triaxial connector
3	Force triaxial connector	Not applicable	1	Each Model 4225-RPM has one force triaxial connector
4	Nut	Not applicable	1	
5	Top hat	Not applicable	1	

See the *Model 4200A-SCS Pulse Card (PGU and PMU) User's Manual* for Model 4225-PMU and Model 4225-RPM information and how to configure an ITM for a pulsed I-V test.

## 2-channel I-V or pulsed I-V setup

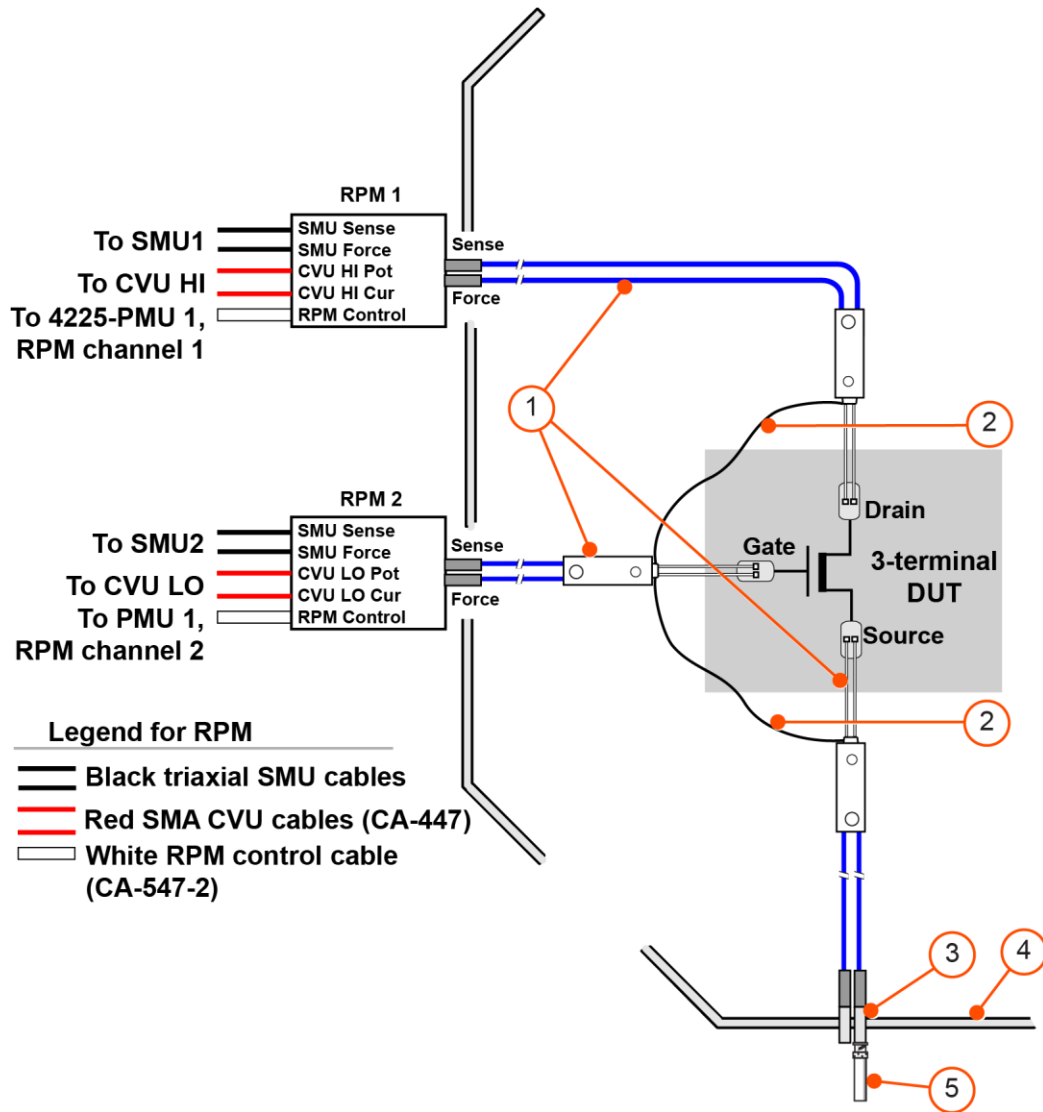
For I-V and pulsed I-V testing, typically only two source/measure channels are used. The two active signals are connected to the gate and drain. Source and bulk, if present, are connected to ground. See the following graphics for illustrated setup examples.

### NOTE

The following 3-pin setup requires three 4210-MMPC-L kits.



Figure 17: Test setup for three-pin device using two-channel I-V and pulsed I-V

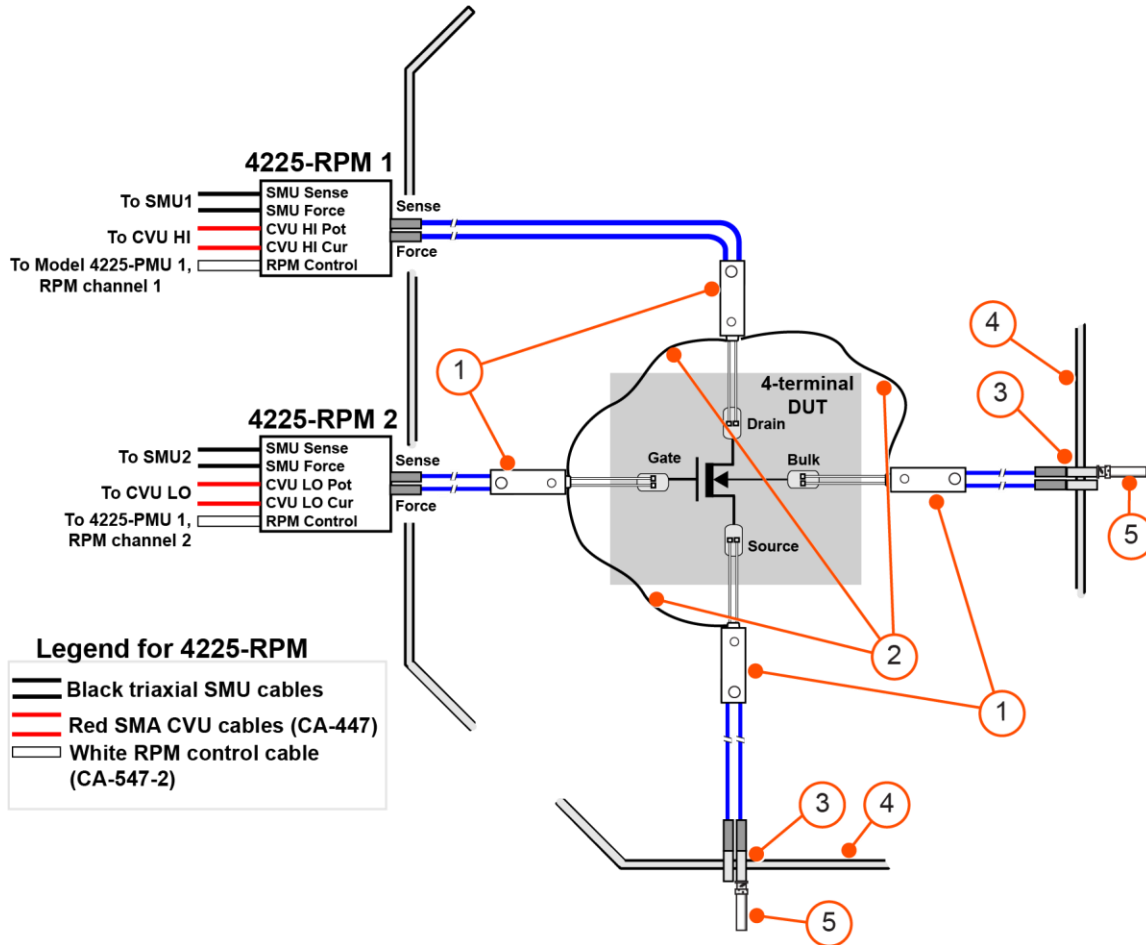


Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	3	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	Not applicable	1	Prober top hat triaxial connectors.
4	Prober top hat	Not applicable	1	
5	Triaxial shorting plug	CS-1546	1	The triaxial shorting plug connects the center conductor of the triaxial cable to its outer shield, effectively connecting the DUT LO to pulse generator low.

## NOTE

The following 4-pin setup requires four Model 4210-MMPC-L kits.

**Figure 18: Test setup for four-pin device using two-channel I-V and pulsed I-V**



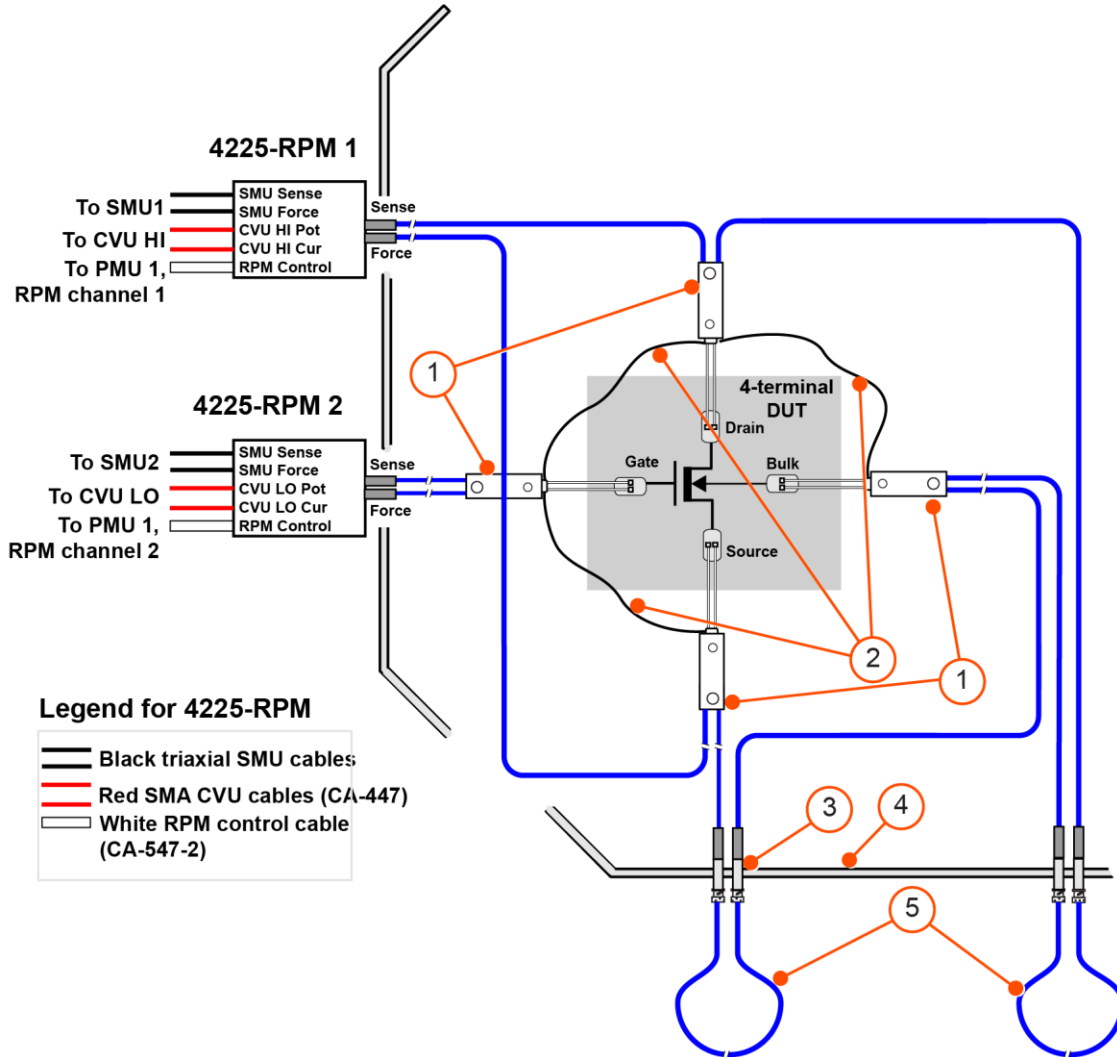
Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-587	4	
2	Ground jumper cable assembly	CA-535-7	3	The jumpers connect the commons of the four cable assemblies.
3	Triaxial connectors	N.A.	2	Prober top hat triaxial connectors.
4	Prober top hat	N.A.	1	
5	Triaxial shorting plug	CS-1546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

## 2-channel 4-terminal C-V test setup

### NOTE

The following 4-pin setup requires four 4210-MMPC-L kits.

Figure 19: 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	Not applicable	2	Prober top hat triaxial connectors.
4	Prober top hat	Not applicable	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 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 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. Maximum signal levels are defined in the specifications and operating information and shown on the instrument panels, test fixture panels, and switching cards.


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 hazard. 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 warning, 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 hazards 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.

The **CAUTION** heading with the  symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument 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. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. 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 to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water 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 June 2018.