

## Overview

The Keithley Instruments Model 4210-MMPC-W 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. This kit has been assembled for use with a Wentworth prober.

This prober cable kit requires the Keithley Instruments Articulated Arm (Wentworth Part Number 2026-96509). Contact your Wentworth representative to obtain the necessary manipulator arm and instructions.

## 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 bulkhead.
- **Prober bulkhead to prober pin connections (basic setup):** Explains how to make connections from the prober bulkhead 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 with the Model 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.

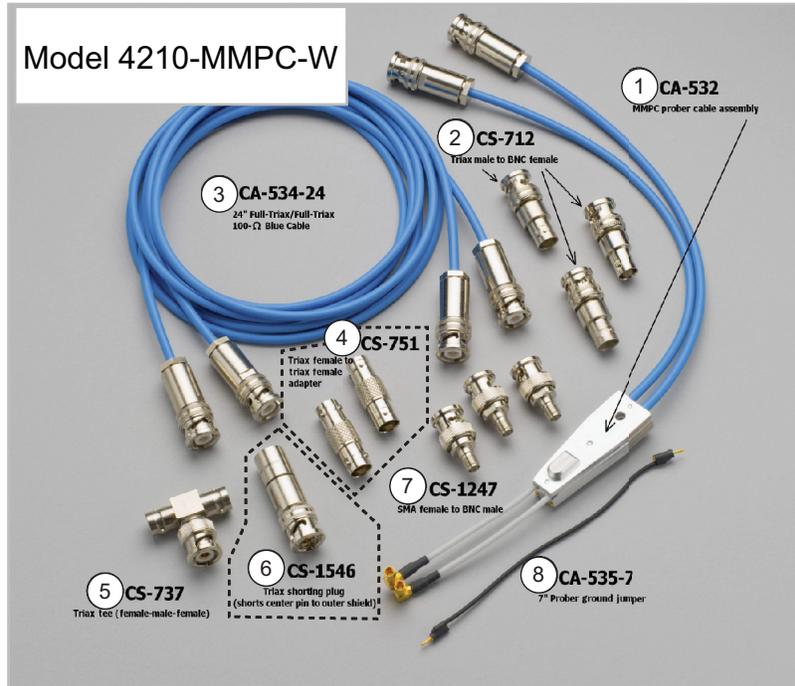
### Prober cable kit contents

Figure 1 shows the cables, adapters, and supplies that are included in the Model 4210-MMPC-W multi-measurement cable kit. This kit also includes the following screw (not shown): M3X12MMSSSOHCBLK

NOTE

Each kit (Model 4210-MMPC-W) 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-W multi-measurement prober cable kit**



Item	Description	Keithley Part number	Qty
1*	Prober cable assembly with clamp (blue) Length: 37.5 cm (14.75 in.)	CA-532	1
2	Triaxial to BNC Adapter	CS-712	3
3	Triaxial to triaxial cable (blue) Length: 61.0 cm (24 in.)	CA-534-24	2
4	Triaxial female to triaxial female, high voltage adapter	CS-751	2
5	Triaxial male to triaxial female, tee	CS-737	1
6	Triaxial shorting plug	CS-1546	1
7	BNC-SMA adapter	CS-1247	3
8	Ground jumper cable assembly (black) Length: 17.8 cm (7 in.)	CA-535-7	1
* Not shown black M3X12MM stainless steel socket head cap screw (Keithley Instruments part number M3X12MMSSSOHCBLK)			

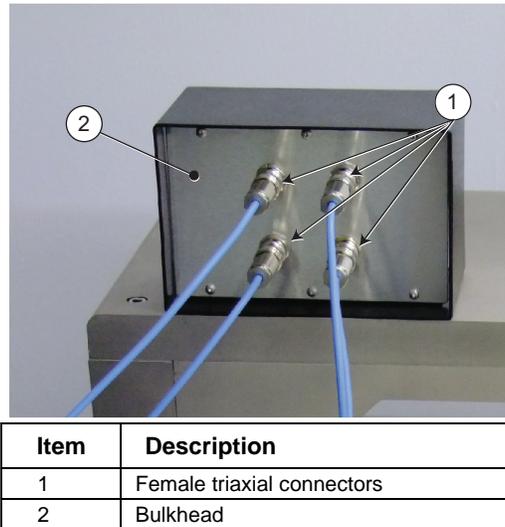
## Model 4200-SCS instrument connections

**⚠ WARNING**

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

Connect the Model 4200-SCS instruments to the female triaxial connectors located on the prober bulkhead (see Figure 2 for an example).

**Figure 2. Typical prober bulkhead triaxial connectors**



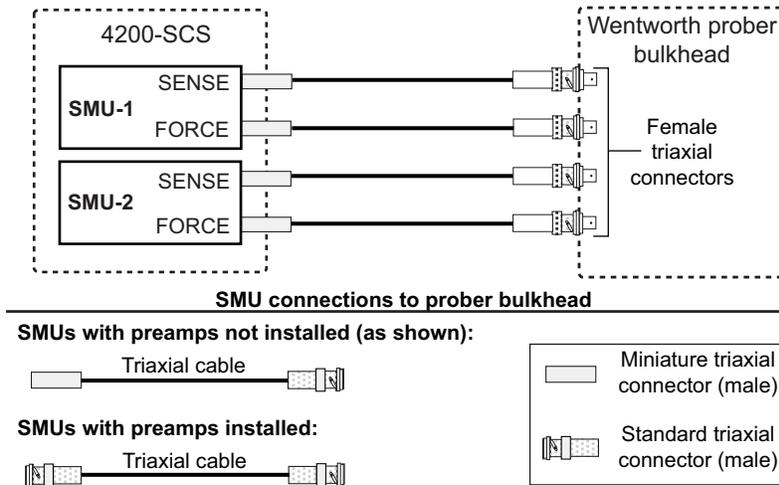
### I-V testing

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 bulkhead. Figure 3 shows the prober 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 prober**

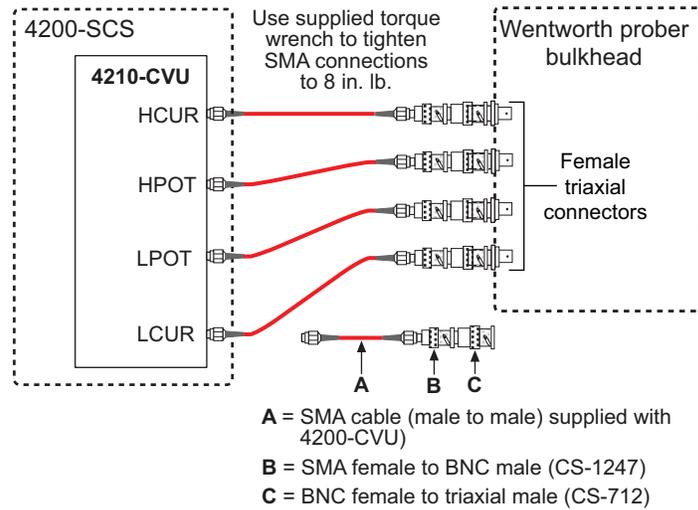


**C-V testing**

Two prober 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 prober's bulkhead.

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 prober connections**



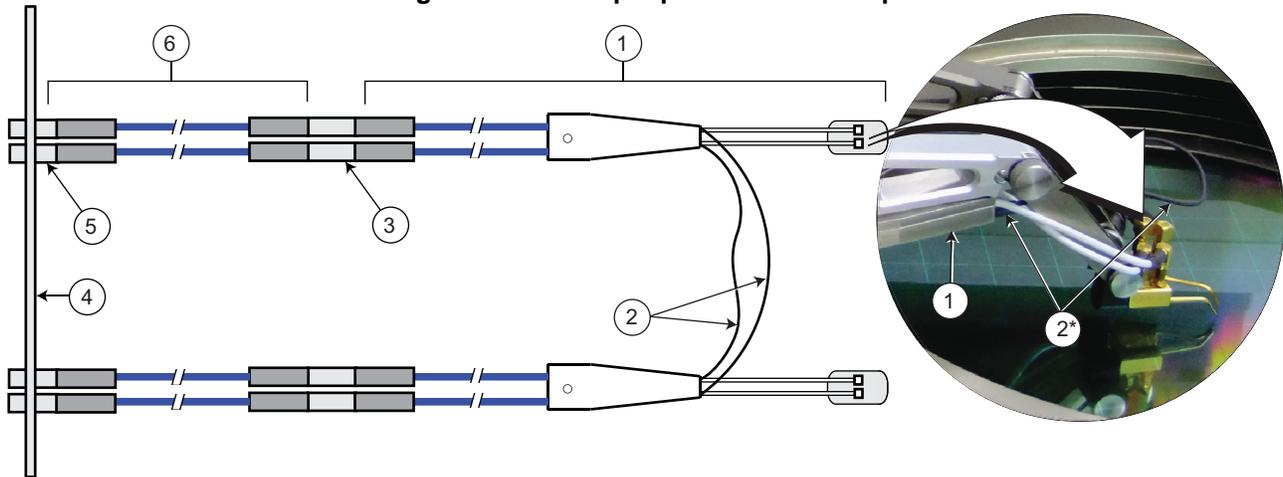
### Prober bulkhead to prober pin connections (basic setup)

Figure 5 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-W kits.

**Figure 5: Basic 2-pin prober cable setup**

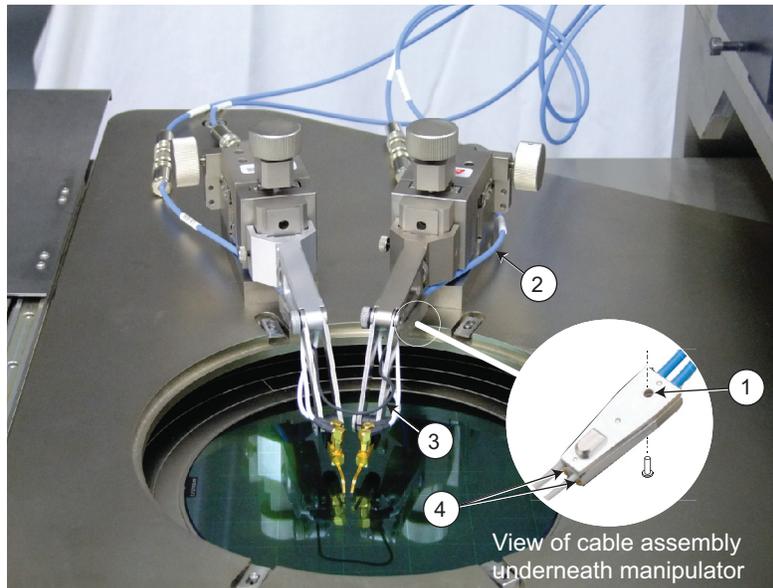


Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-532	2	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the two cable assemblies.
3	Triaxial female to triaxial female, high voltage adapter	CS-751	4	
4	Prober bulkhead (for triaxial connectors)	N.A.	1	
5	Triaxial connectors	N.A.	4	Prober bulkhead triaxial connectors
6	Triaxial to triaxial cable	CA-534-24	4	

## Installation guidelines

Figure 6 shows the prober cable assemblies of two Model 4210-MMPC-W kits installed in a Wentworth prober. Each blue triaxial cable (CA-587) is secured to the manipulator mounting bracket by one mounting screw (see item 1, Figure 6 for location).

**Figure 6: Two prober cable kits installed in a Wentworth prober**

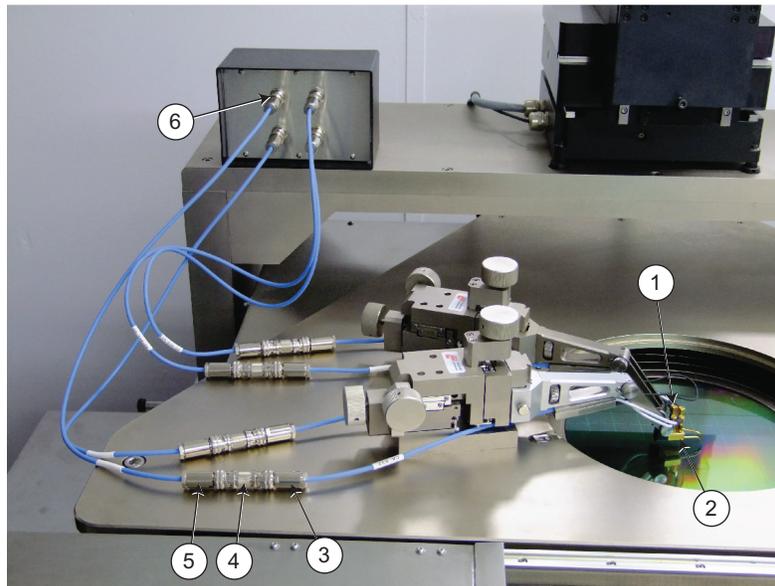


### Guidelines:

- Secure each prober cable assembly to a manipulator using a single mounting screw (1, Figure 6 shows the location of the mounting screw). Firmly tighten the cable assemblies to the manipulators.
- As shown in Figure 6, route the blue cables (2) along the sides of the manipulators.
- Connect a black jumper (3) from one cable assembly to the other. This jumper connects the commons of the two cable assemblies together. The jumper plugs into the ends of the assembly blocks (4). It is good practice to install the second jumper. It improves the connection and is a good place to store the extra jumper (second jumper not shown in Figure 6).

## NOTE

Figure 6 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 7: Side view of the installed prober cable assemblies****To properly attach the cable:**

1. Connect the cable wires of the cable assemblies (1) to the APT probe tips (2), as shown in Figure 7.
2. When routing the wires, consider the possible movements of the manipulators and the microscope. Figure 6 shows an example of good routing for the jumper and cable wires.
3. For each pin, connect the triaxial cable assemblies (3) to the supplied female adapters (4).
4. Connect the triaxial cable assemblies (5) to the triaxial connectors on the bulkhead panel (6).

## Usage scenarios

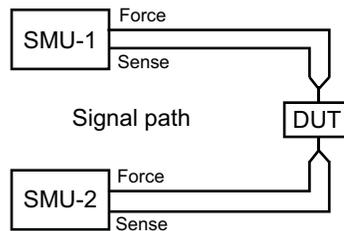
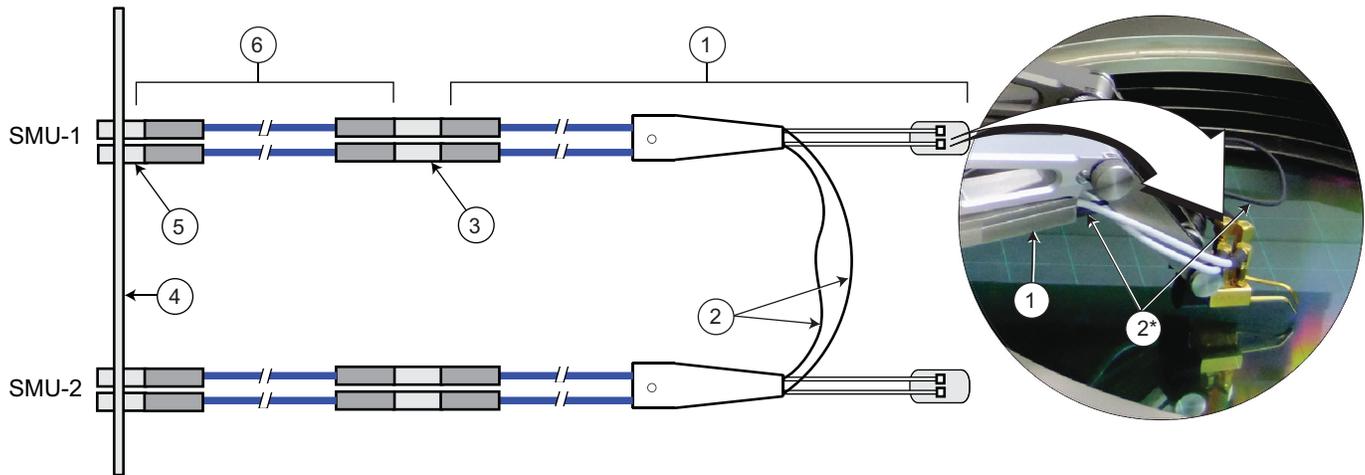
### I-V testing: 2-pin I-V setup

To perform 2-pin I-V testing, connect two Model 4200-SMUs or Model 4210-SMUs to the prober bulkhead and then use the setup shown in Figure 8 as a guide to connect to the device under test (DUT). Figure 2 shows typical triaxial SMU connections to the outside of the bulkhead.

## NOTE

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

**Figure 8: Test setup for 2-pin I-V testing**



Item	Description	Part number	Quantity	Notes
1	Prober cable assembly	CA-532	2	
2	Ground jumper cable assembly	CA-535-7	2	The jumpers connect the commons of the two cable assemblies.
3	Triaxial female to triaxial female, high voltage adapter	CS-751	4	
4	Prober bulkhead (for triaxial connectors)	N.A.	1	
5	Triaxial connectors	N.A.	4	Prober bulkhead triaxial connectors
6	Triaxial to triaxial cable	CA-534-24	4	

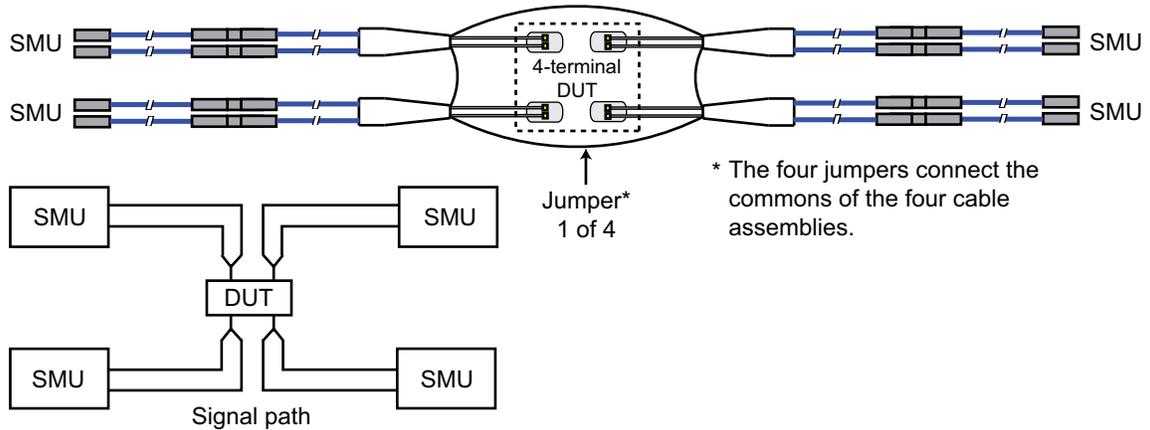
**I-V testing: 4-pin I-V setup**

With four Model 4200-SMUs connected to the prober bulkhead, use the setup shown in Figure 9 to perform 4-pin I-V testing. Figure 3 shows two SMUs connected to one of the bulkhead connection panels. Connect two additional SMUs to the other bulkhead connection panel.

**NOTE**

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

**Figure 9: Test setup for 4-pin I-V testing**



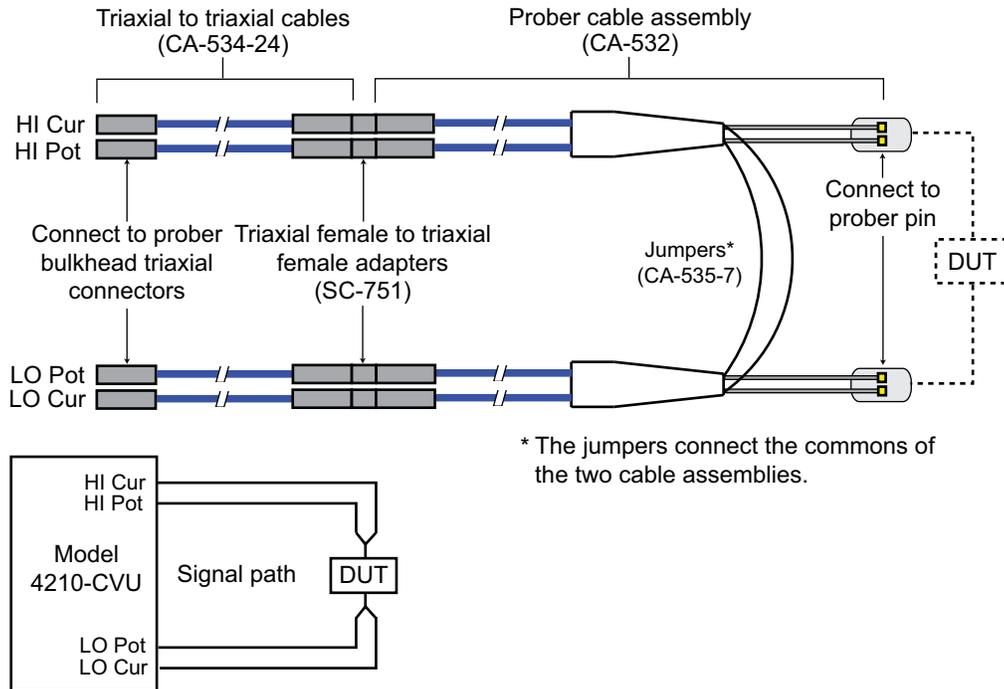
**C-V testing: 2-pin C-V setup**

**NOTE**

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

With a Model 4210-CVU connected to the prober bulkhead, use the fundamental setup shown in Figure 10 to perform 2-pin C-V testing. Figure 4 shows the CVU connections to the outside of the bulkhead.

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



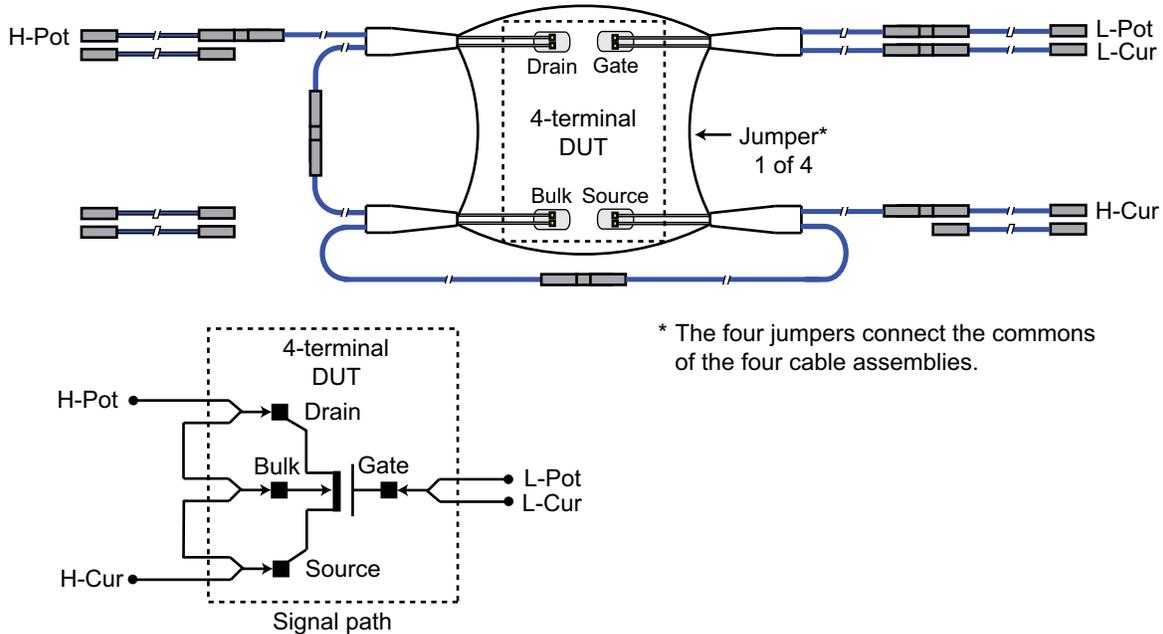
### C-V testing: 4-pin C-V setup

**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 perform the measurement across the gate. With a Model 4210-CVU connected to the prober bulkhead, use the setup shown in Figure 11 to perform 4-pin C-V testing.

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



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

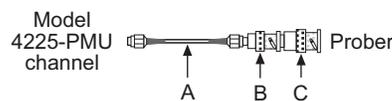
**NOTE**

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

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.

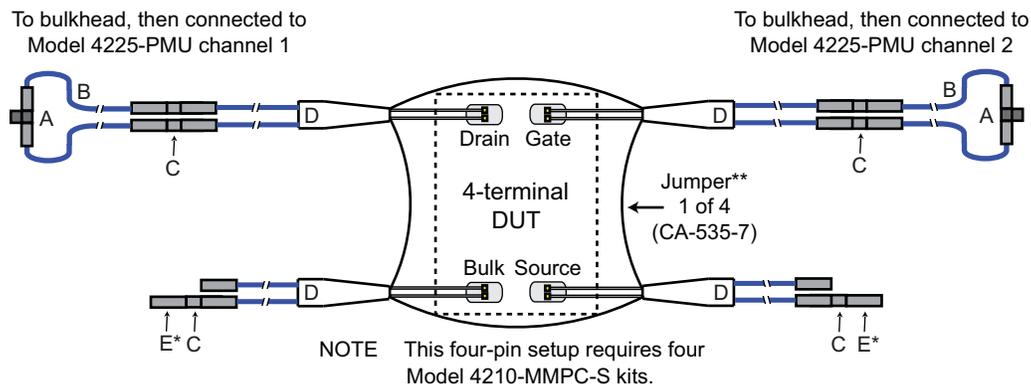
Figure 12 shows the cable and adapters needed to connect a PMU channel to the prober bulkhead, and Figure 13 shows a typical prober connection setup for testing a four-pin device.

**Figure 12: Cable and adapters used to connect PMU channel to prober bulkhead**



- A = 2 m SMA cable (male to male)  
(supplied with Model 4225-PMU)
- B = SMA female to BNC male  
(CS-1247)
- C = BNC female to triax male  
(CS-712)

Use the supplied torque wrench to tighten the SMA connections to 8 in. lb.

**Figure 13: Basic four-pin prober setup for PMU**

A = Triaxial tee (CS-737)  
 B = 24" triaxial to triaxial 100 W cable (CA-534-24)  
 C = Triaxial female to triax female adapter (CS-751)  
 D = MMPC prober cable assembly (CA-532)  
 E = Triaxial shorting plug\* (CS-1546)

\* The triaxial shorting plug (H) connects the center conductor of the triaxial cable to the outer shield. This connects DUT LO to pulse generator low.

\*\* The four jumpers connect the commons of the four cable assemblies.

## 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.

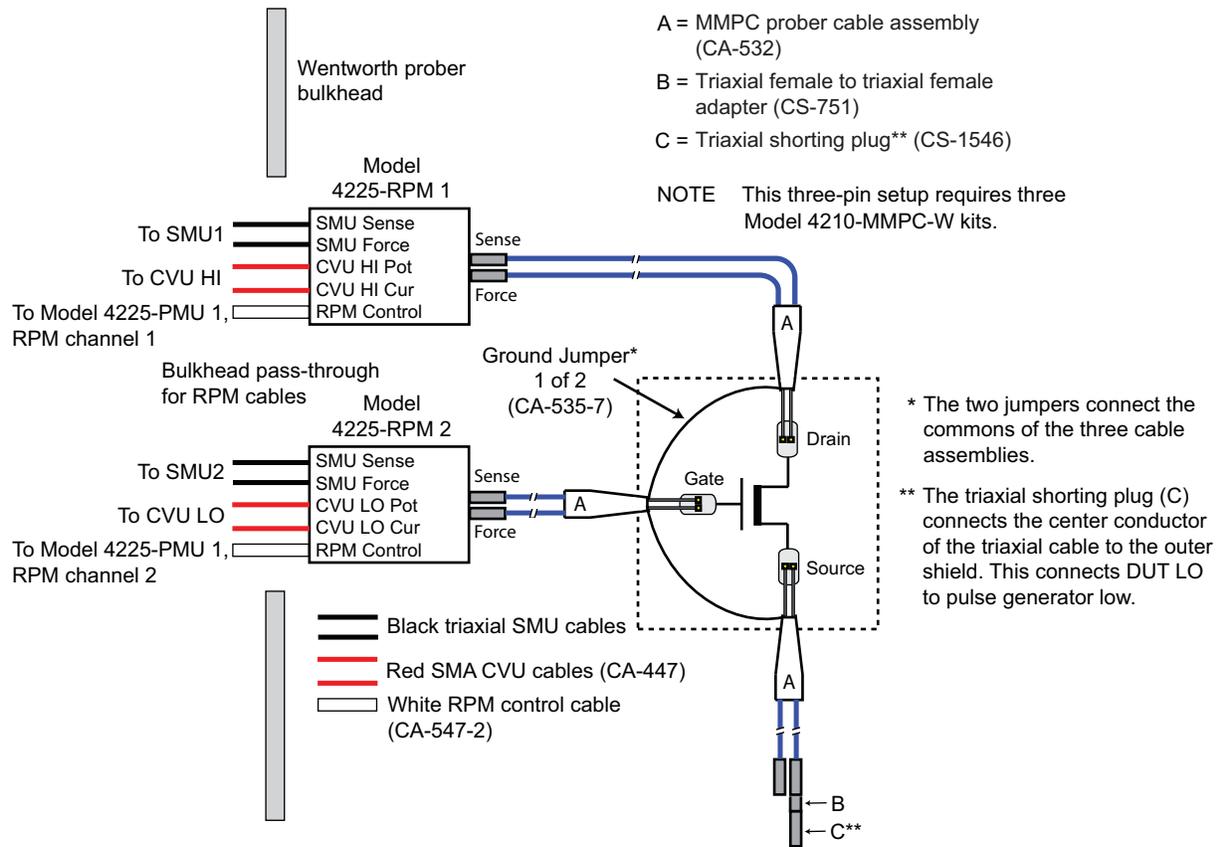
The Model 4225-RPM has the appropriate connector types at the input and output of the RPM enclosure to eliminate any adapters when connecting cables to the RPM. On the input side, there are two triaxial connectors for SMU Force and SMU Sense. There are two SMA connectors for CVU POT and CVU CUR. There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

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.

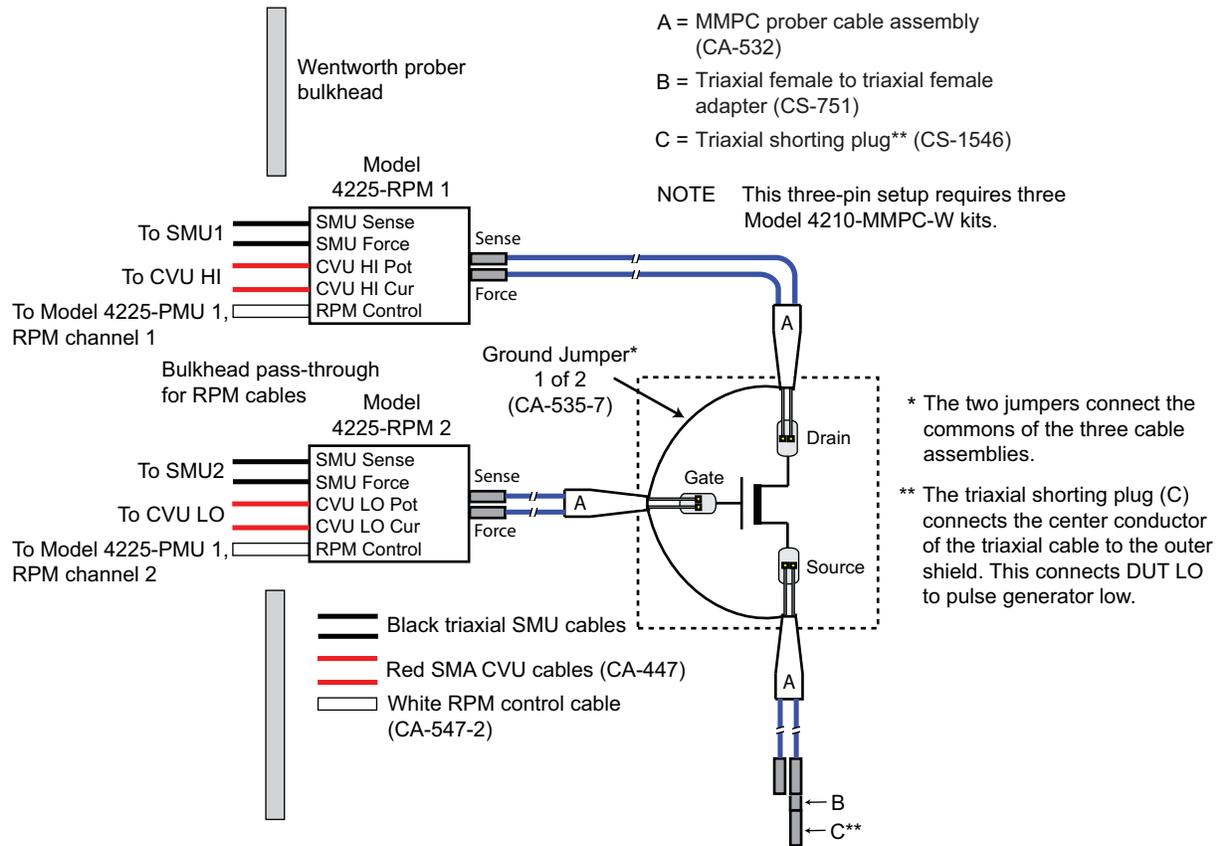
## 2 Channel I-V or Pulse I-V Setup

For most I-V and pulse I-V testing, only two source/measure channels are typically used. The two active signals are connected to the gate and drain, and the source (and bulk, if present) is connected to ground (see Figure 14 and Figure 15). For the C-V test setup shown in Figure 16, all four source/measure channels are used.

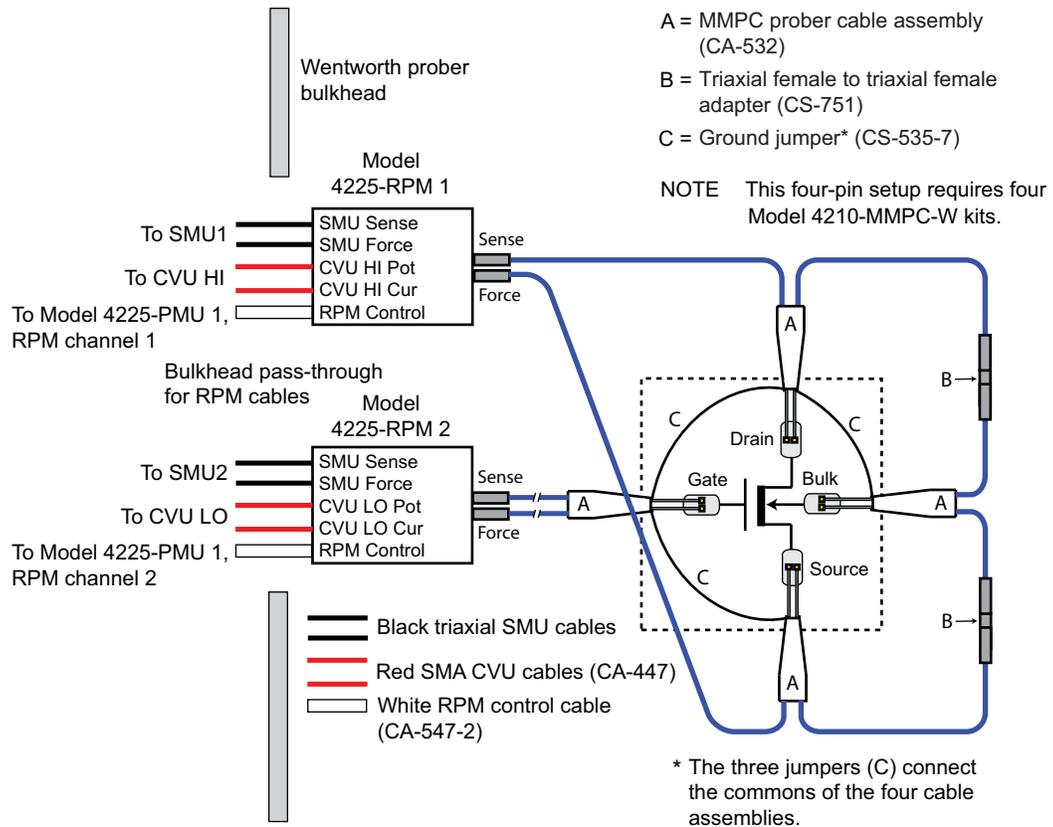
**Figure 14: Test setup for three-pin device using two-channel I-V and Pulse I-V**



**Figure 15: Test setup for four-pin device using two-channel I-V and Pulse I-V**



**Figure 16: Test setup for four-terminal C-V testing**



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.