M9614A and M9615A PXIe 5-ch Precision Source / Measure Unit
500 kSa/s, 100 pA/10 pA, 30 V, 500 mA

Introduction

The Keysight M9614A and M9615A is a PXIe five-channel precision source / measure units (SMUs). These SMUs supports accurate measurements up to 30 V / 500 mA with resolution down to 6 µV / 10 pA. The M9614A and M9615A are suitable for applications that requires high channel density, such as semiconductor reliability testing and integrated circuit (IC) tests.

This table shows an overview of the M9614A and M9615A, the product options and its associated accessories. This guide provides a step-by-step instruction to help you configure to meet the desired test requirements.

Model Number	
M9614A	PXIe 5-channel SMU, 500 kSa/s, 100 pA, 30 V, 500 mA
M9615A	PXIe 5-channel precision SMU, 500 kSa/s, 10 pA, 30 V, 500 mA
Accessories	
PX0106A	Dsub25-to-5 SMB adapter for M9614/15
PX0107A	Low noise filter adapter for M9614/15
PX0108A-001/002	BNC-to-SMB cable, 1.5 m/3 m
N1254A-106	Triaxial(m) to BNC(f) adaptor
PX0101A-001/002	BNC-to-ferrule terminal cable, 1.5 m/ 3 m
Options	
1A7	Calibration + uncertainties + guardbanding (not accredited)
A6J	ANSI Z540-1-1994 calibration
UK6	Commercial calibration certificate with test data

Configure Your Keysight M9614A/M9615A 5-channel Precision SMU

Step 1. Define the required number of M9614A/M9615A modules

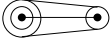You need to define the required number of modules based on your application requirements.

Product Number	Required Slots	Number of Channels	Max. Voltage	Max. Current	Min. Voltage Resolution	Min. Current Resolution	Max. Sampling Rate
M9614A	1	5	30 V	500 mA	6 µV	100 pA	500 kSa/s
M9615A						10 pA	

The following items comes as standard with each M9614A/M9615A PXIe precision SMU module:

	Qty.	Additional information
Quick startup poster	1ea	Printed reference for quick startup (English)
Certificate of calibration (without test data)	1ea	Certificate of calibration (without actual test data). If you need the test data, please specify option UK6.
Short bar	1ea	Short bar to connect low terminals to chassis common; orderable part number is M9601-87001 (includes 5 qty.)
Connector-terminal block 2.5 mm 5-terminal	1ea	Connector-terminal block to connect external trigger terminals and interlock terminal; orderable part number is M9615-87001 (includes 5 qty.)

Step 2. Select optional accessories

The following accessories are available for connection between M9614A and M9615A to your DUT.

Product number	Description	Additional Information
PX0106A	Dsub25-to-5 SMB adapter	Standard adapter for Two-wire, non-guarded connection
PX0107A	Low noise filter adapter	For low voltage source noise requirement
PX0108A-001	BNC-to-SMB cable, 1.5 m	Cable between PX0106A or PX0107A adapter to your BNC interface
PX0108A-002	BNC-to-SMB cable, 3.0 m	
N1254A-106	Triaxial(m) to BNC(f) adaptor	Convert Triaxial to BNC
PX0101A-001	BNC to ferrule terminal cable, 1.5 m	Convert trigger or interlock terminals to BNC
PX0101A-002	BNC to ferrule terminal cable, 3 m	

M9614A/15A front panel

As shown in Figure 1, the M9614A/M9615A has D-sub 25 pin connector. It provides High force (HF), Low force (LF), High sense (HS), Low sense (LS) and Guard (G) terminals for 5 channels. Each channel supports both two-wire and four-wire measurement, and low current measurement with a guard.
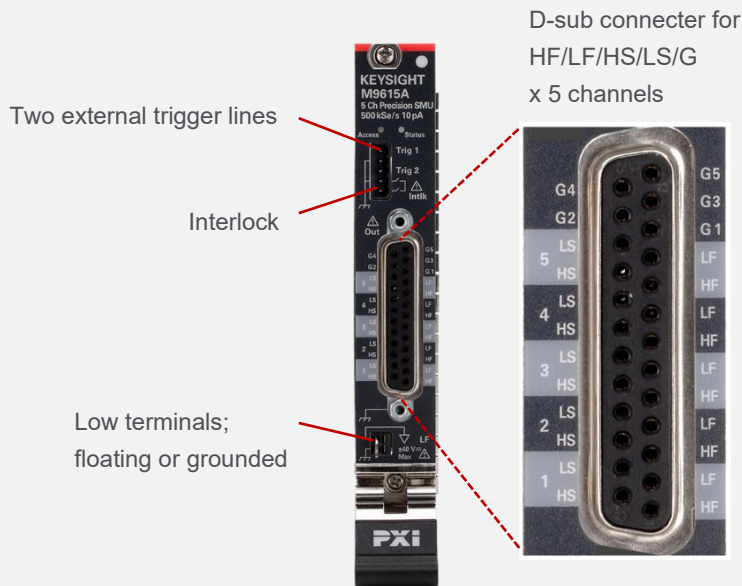

Two external trigger lines

Interlock

Low terminals;
floating or grounded

D-sub connecter for
HF/LF/HS/LS/G
x 5 channels

Figure 1. Front panel

Step 2-1. Select cable and accessories for connection between M9614A/15A and your DUT

You will need to select an appropriate accessory according to the connection type. There are basically four types of the connection configurations. The essential cables and accessories are as follows. Please refer the Appendix for the details of the two-wire connections or the four-wire connections, and the guarding connection.

Two-wire or Four-wire Wire	Guard	Connection between M9614A/15A and your DUT Cable	
		D-sub Adapter	Cable
Two-wire	No guard	PX0106A Dsub25-to-5 SMB adapter	PX0108A-001/002 BNC-to-SMB cable, 1.5 m/ 3 m
	Guard		
Four-wire	No guard	Need customer cables	
	Guard		

Two-wire, no guard connection

Figure 2 shows the two-wire and no guard connection configuration. For this configuration, select 1 x PX0106A Dsub25-to-5 SMB adapter 5 x PX0108A BNC-to-SMB cable per module. The PX0106A is recommended unless lower voltage source noise is required. If your DUT has triaxial interface, add a suitable number of N1254A-106 Triaxial(m) to BNC(f) adaptor.
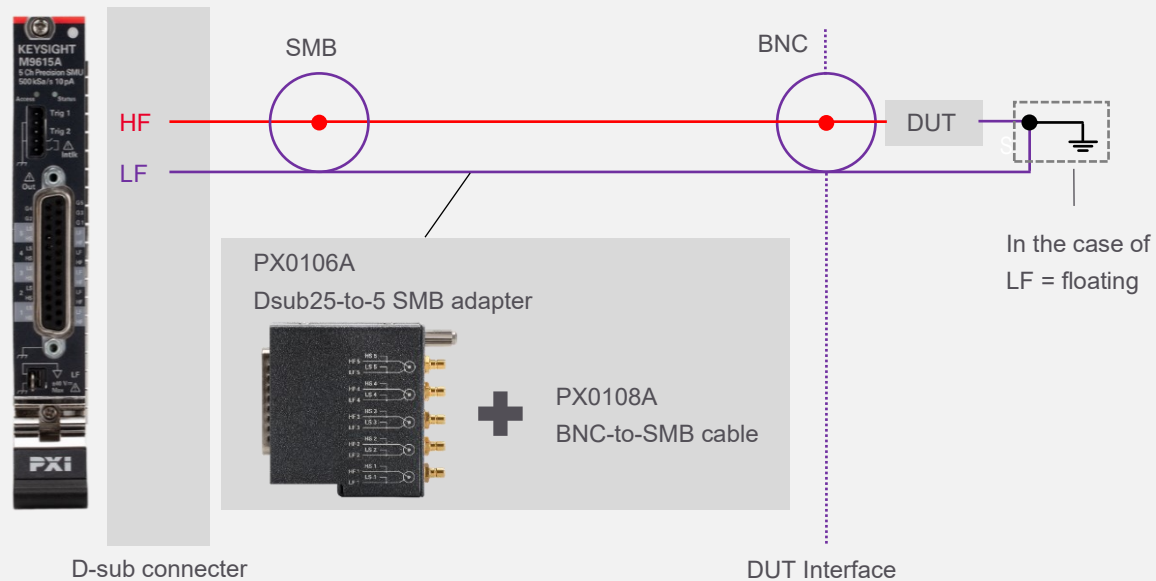

Figure 2. Two-wire, non-guarded connection configuration

If you need low noise voltage source

Figure 3 shows the two-wire and no guard connection configuration with the PX0107A low noise filter adapter. The PX0107A reduces the voltage source noise of the M9614A/M9615A to 25 µVrms in the frequency range of 10 Hz – 20 MHz, while still allowing it to source up to 30 V and 150 mA. It enables the M9614A/M9615A to evaluate noise sensitive devices and circuits such as quantum computing and many types of analog and RF ICs.

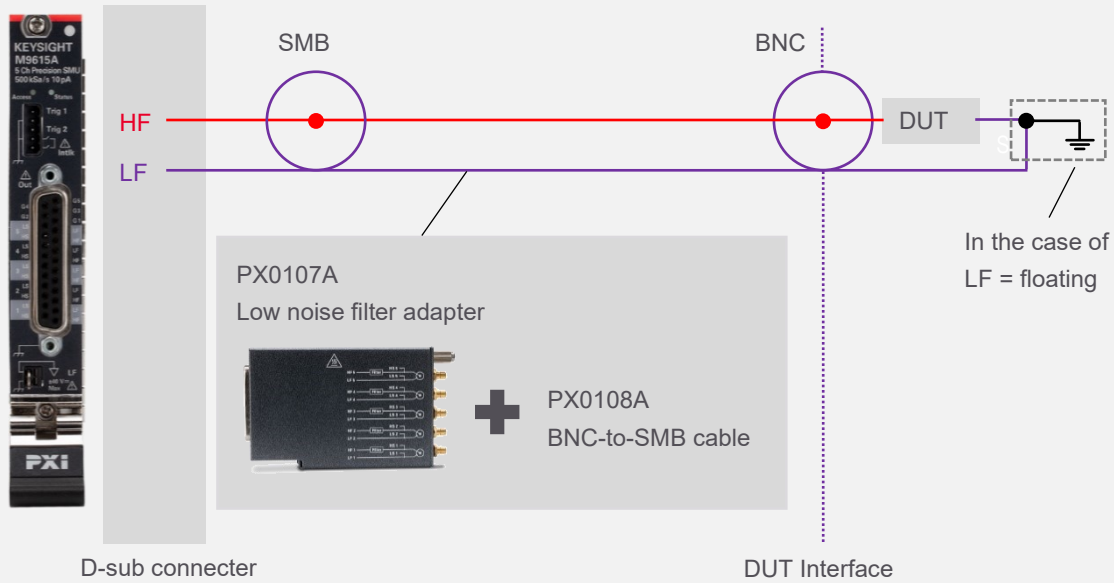| Two-wire or Four-wire Wire	Guard	Connection between M9614A/15A and your DUT Cable	
		D-sub Adapter	Cable
Two-wire	No guard	PX0107A Low noise filter adapter	PX0108A-001/002 BNC-to-SMB cable, 1.5 m/ 3 m

Figure 3. Low noise voltage source configuration with PX0107A

Any connections other than two-wire, no guard

For other connections, you need to develop custom cables to fit your measurement needs. Please refer the Appendix for the tips of making custom cables.

Step 2-2. Select the cable if you utilized an interlock circuit

The M9614A/M9615A has an interlock safety feature to protect against exposure to voltages above a user-specified value. You can engage the safety lock using interlock pins on the connector located at the front panel. Normally, these pins are routed to a shielding box or test fixture that must be closed to complete the interlock circuit.

You can install an interlock circuit as shown in Figure 4. If your shielding box has a BNC connector for the interlock circuit, you can use the PX0101A-001 or 002 BNC to ferrule terminal cable with a connector-terminal block to connect the M9614A/M9615A's interlock pins to it. For more detail information, please refer to the Keysight M9614A/M9615A Startup Guide.
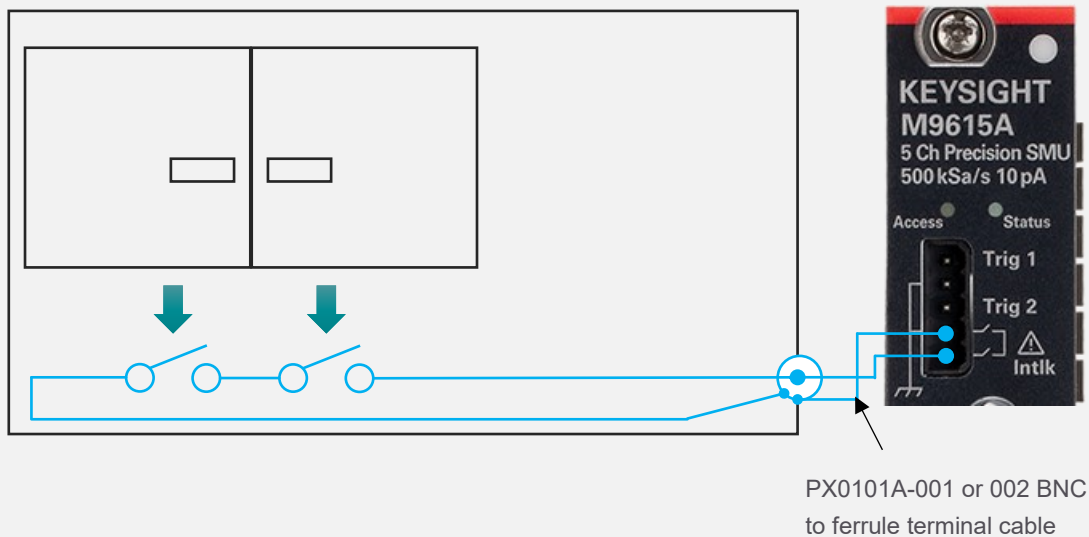

PX0101A-001 or 002 BNC
to ferrule terminal cable

Figure 4. An example of interlock circuit installation

Step 2-3. Select the cables if you use an external trigger

There are trigger lines in the PXIe chassis available to synchronize the M9614A/M9615A with the other PXIe modules. In addition, there are two external trigger lines are available if you need to synchronize it with an external instrument. You can use the PX0101A-001 or 002 BNC to ferrule terminal cable with a connector-terminal block to connect the M9614A/M9615A's external trigger lines to the external instrument.

Step 3. Select software license type (Optional)

The PX0109A Quick I/V Measurement Software for PXIe Precision SMU is recommended for easy and quick I/V measurement. Because it supports various license type, select the appropriate one for your purpose. Please visit: www.keysight.com/find/px0109a in detail.

Product	License Type	License term (36 months Subscription) License & support
PX0109A	Node-locked (fixed)	R-X45-001-Y
	Transportable	R-X45-004-Y
	USB Portable[1]	R-X45-005-Y
	Floating (single site)	R-X45-002-Y
	Floating (single region)	R-X45-006-Y
	Node-locked (fixed)	R-X45-001-Y

1. USB portable license requires a certified USB dongle (available for additional purchase. Keysight part number PX0100-D10)

Step 4. Select a calibration plan

Step 4-1. Select a relevant calibration services plan (optional)

Factory calibration and certification of calibration comes as standard. The optional ISO 17025 (not accredited), ANSI Z540, and commercial calibration certificate with test data are available as follows:

Description	Product Number	Additional Information
Calibration + uncertainties + guardbanding (not accredited)	M9614A-1A7/ M9615A-1A7	Calibration certificate with measurement results available only at time of purchase
ANSI Z540-1-1994 calibration	M9614A-A6J/ M9615A-A6J	Calibration certificate with measurement results available only at time of purchase
Commercial calibration certificate with test data	M9614A-UK6/ M9615A-UK6	Calibration certificate with measurement results available only at time of purchase

Step 4-2. Select recalibration service plans (optional)

The following options are available. If you need other options — for example, the standard compliant calibration option — please contact your local Keysight office for availability.

Description	Product Number
Calibration plan — return to Keysight — 3 years	R-50C-011-3
Calibration plan — return to Keysight — 5 years	R-50C-011-5

Related Literature

Publication Title	Publication number
M9614A and M9615A PXIe Precision 5-Channel Source/Measure Unit, Data Sheet	3120-1310EN
M9614A and M9615A PXIe Precision 5-Channel Source/Measure Unit, Product Fact Sheet	3120-1338EN
PX0109A Quick I/V Measurement Software for PXIe Precision SMU, Technical Overview	3121-1317EN
Keysight PXI and AXIe Products and Solutions, Catalog	5992-0600EN
Keysight PXI & AXIe Instruments, Software, Reference Solutions, and Services	5990-6379EN

Appendix. Tips for Connection between M9614A/15A and your DUT

Two-wire connection or four-wire connection

If you are measuring very small resistances or applying very large current, you should use the four-wire measurement method (also known as the Kelvin method). This technique uses both force and sense terminals. Performing the measurement through the sense terminals (in which no current is flowing) eliminates the undesirable effects of cable resistance.
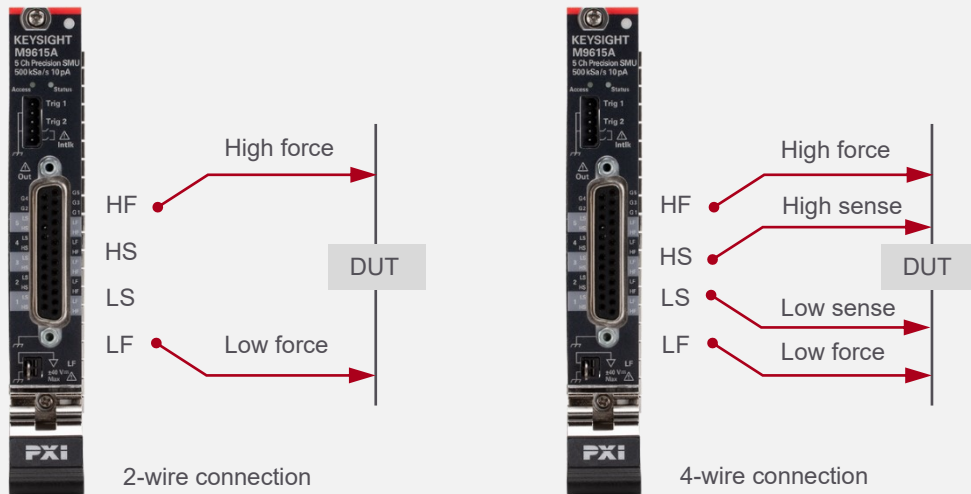

Figure 5. Two-wire connection and four-wire connection configuration

Guarding connections

Low current measurements (< 1 nA) requires a guarding to prevent leakage through the measurement cable. Figure 6 illustrates a simplified overview of the guarding technique. Guarded measurements require the use of triaxial cables. A follower (x1) buffer amplifier maintains the same potential between the guard conductor and the center conductor. Since there is no voltage difference, there is no current from the center conductor to the guard.

Note: In this example, the device interface also has a guarded shield to prevent leakage at the device interface.
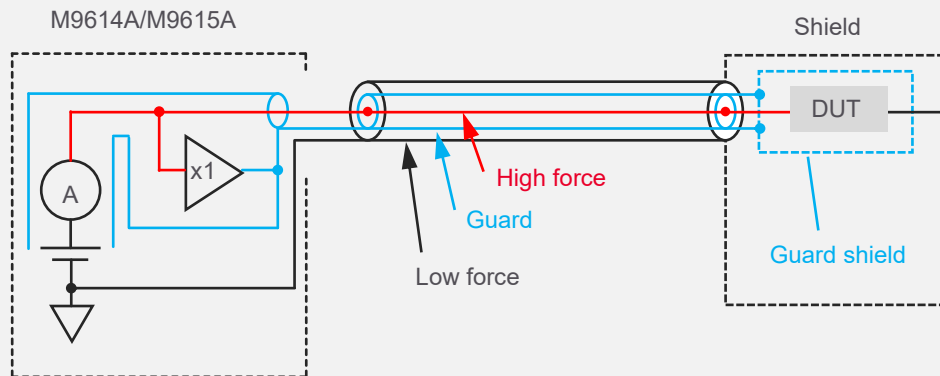
Figure 6. Guarding technique

Tips for making custom cables

The following three types of connections requires the custom cable for connections:

- Four-wire, guarded connection
- Four-wire, non-guarded connection
- Two-wire, guarded connection

The PX0106A Dsub25-to-5 SMB adapter and the PX0108A BNC-to-SMB cable is available for two-wire, non-guarded connection. For other connections, you need to develop custom cables to fit your measurement needs.

These are common tips for all connections:

- Although LF is shared by all channels, it is recommended to use each HF terminal with the LF terminal of the same channel.
- The simpler two-wire configuration uses only the force terminals. In two-wire mode, the sense terminals remain open.
- Never connect the guard shield to any output, including the frame/chassis ground or any other guard terminal.

Figure 7 to 9 are tips for each connection.

Four-wire, guarded connection

- Shield HF and HS by G to reduce the leakage current between the instrument and a DUT.
- Shield G by LF, because G can be over 42 V when LF is floating
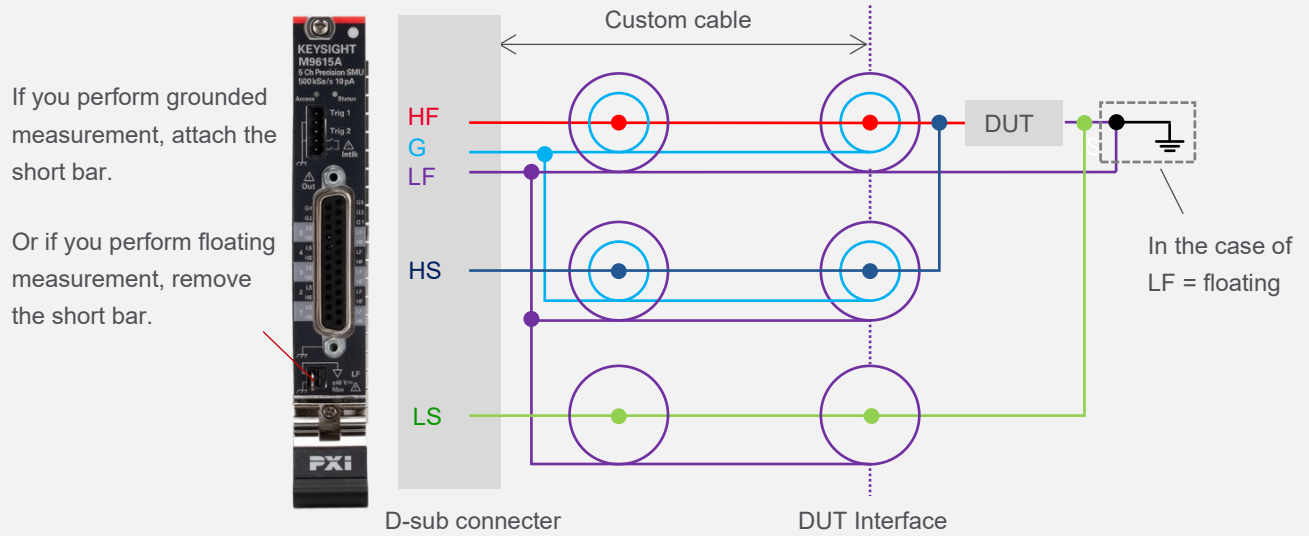- Shield LS by LF to avoid the external noise influence.

Figure 7. Four-wire, guarded connection configuration

Four-wire, non-guarded connection

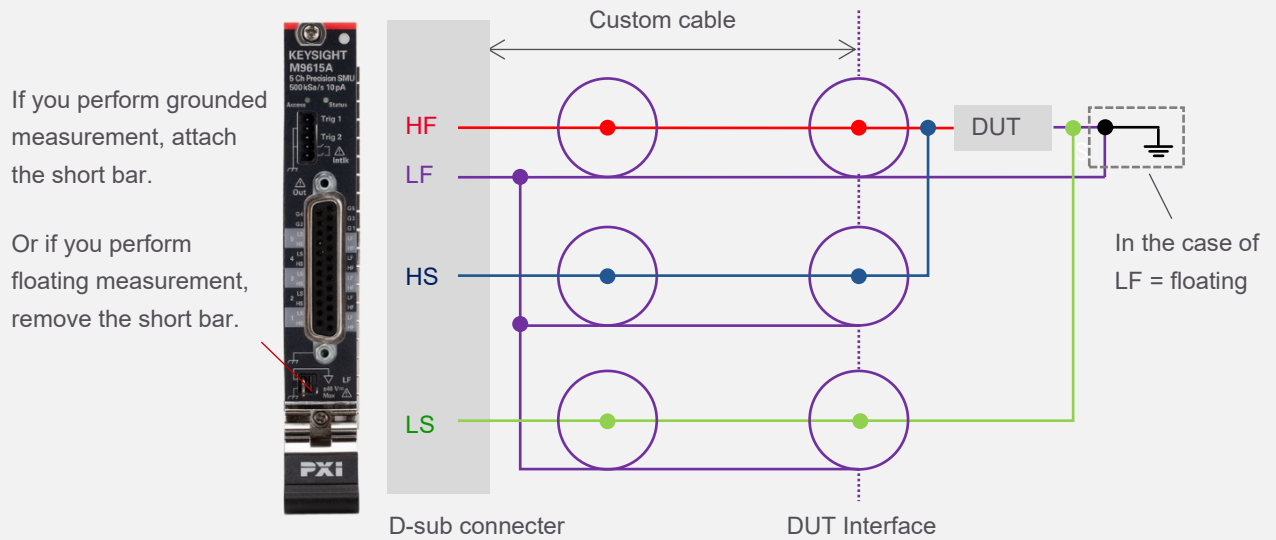- Shield HF, HS, LS by LF to avoid any external noise influence.

Figure 8. Four-wire, non-guarded connection configuration

Two-wire, guarded connection

- The simpler two-wire configuration uses only the force terminals. Retain the sense terminals open.
- Shield HF by G to minimize the leakage current and stray capacitance from the cables.
- Shield G by LF, because G can be over 42 V when LF is floating.
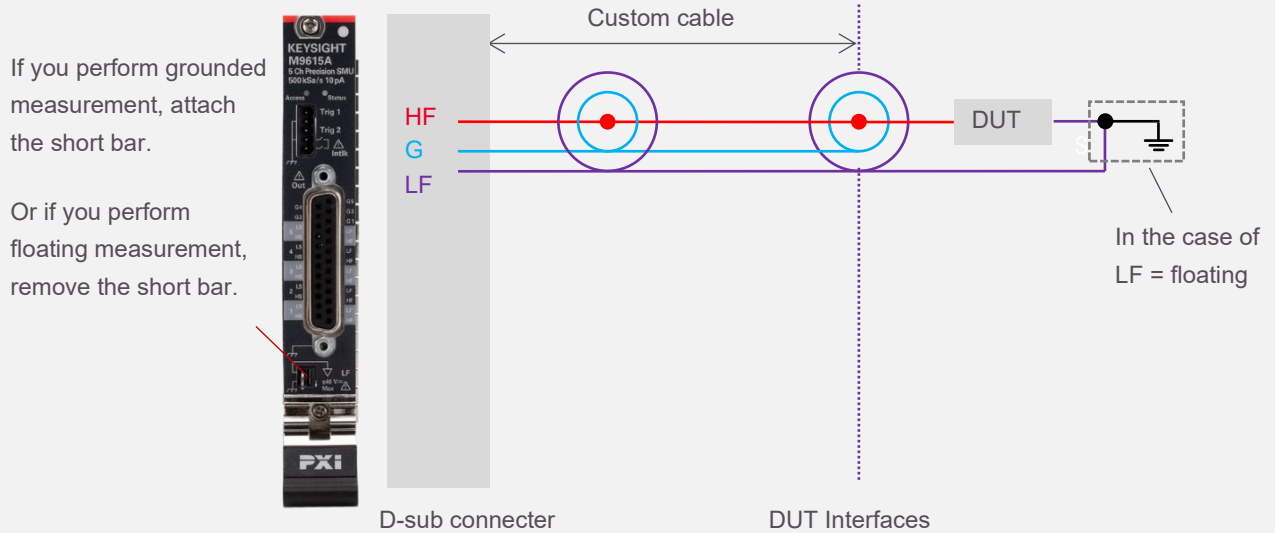

Figure 9. Two-wire, guarded connection configuration

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