

Keysight M9614A/M9615A PXIe 5-Channel Precision Source/Measure Unit

Notices

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This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. To review the Declaration of Conformity, go to www.keysight.com/go/conformity.

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Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the product. In addition, it violates safety standards of design, manufacture, and intended use of the product. Keysight Technologies assumes no liability for customer's failure to comply with these requirements.

- Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.
- This product is INDOOR USE product.
- This product complies with POLLUTION DEGREE 2 defined in IEC 61010-1.

- If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

- System installation, safety and performance are the responsibility of the assembler of the system.

WARNING

The persons who plan, supervise, consign, and implement the installation, start-up, maintenance, and delivery of this product are required to carefully read documents related to the equipment and take and implement safety measures to prevent accidents. Also, safety and performance of the system in which the equipment is installed are the responsibility of the assembler responsible for the system construction.

WARNING

Equipment built in the system may be heavy. So there is the possibility of physical disability in the person by moving the equipment to a high place or moving it from a high place. To prevent accidents, take appropriate safety work means.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as above WARNING, shall be complied. Procedures throughout in this manual prevent you from potentially hazard. Their instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

This is Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

DO NOT REMOVE COVERS

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

IN CASE OF DAMAGE

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel. Return the instrument to a Keysight Technologies sales or service office for services and repair to ensure that safety features are maintained.

USE ONLY THE SPECIFIC ACCESSORIES

Specific accessories satisfy the requirements for specific characteristics for using the instrument. Use the specific accessories, cables, adapters, and so on for safety reasons.

Safety Symbols

The general definitions of safety symbols used on equipment or in manuals are listed below.



Direct current.



Alternating current.



Earth ground terminal.



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Grounded terminal which indicates the earth potential.



On supply.



Off supply.



Standby supply. The equipment will be marked with this symbol is not completely disconnected from AC mains when power switch is in the standby position.



In position of a bi-stable push switch.



Out position of a bi-stable push switch.



Hazardous voltage and potential for electrical shock. Do not touch terminals that have this symbol when the equipment is on.



Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.



Low temperature or freezing conditions. Avoid contact. Surfaces are cold and may cause personal injury if touched.



Heavy object. Lifting can cause back injury. Use mechanical lifting device to move.



Caution, refer to accompanying documentation. The equipment will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Read operator's manual. To indicate that the operator's manual or card should be read before continuing the operation.



Affixed to product containing static sensitive devices--use anti-static handling procedures to prevent electrostatic discharge damage to component.

CAT I



IEC Measurement Category I

The CE mark shows that the product complies with all applicable European Directives.



The CSA mark is a registered trademark of the Canadian Standards Association.



The RCM mark is a registered trademark of the Australian Communications Authority. This signifies compliance with the Australian EMC Framework Regulations under the terms of the Radio communications Act.

ICES/NMB-001

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

CAN ICES/NMB-001(A)

This ISM device complies with Canadian ICES-001 Class A.

Cet appareil ISM est conforme à la norme NMB-001 classe A du Canada.

ISM GROUP 1 CLASS A

This is the symbol for an Industrial, Scientific and Medical, Group 1 Class A product. (CISPR 11)



The UKCA mark shows that the product complies with all applicable UK regulations.



Korea's safety and EMC mark



China RoHS - Environmentally Green Product Label



China RoHS - Product with Toxic Substance 40 yr EPUP



The Chinese mark for paper-based packaging materials; Paperboard and Corrugated Fiberboard

CFB



Plastic Material Coding Identification

CAUTION

A CAUTION denotes a hazard. It calls attention to an operating procedure or practice, that, if not correctly performed or adhered to could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING denotes a hazard. It calls attention to an operating procedure or practice, that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.



Waste Electrical and Electronic Equipment (WEEE)

The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation.

Please refer to <http://keysight.com/go/take-back> to understand your Trade in options with Keysight in addition to product takeback instructions.

South Korean EMC Declaration

Information to the user:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

(*) This EMC statement applies to the equipment only for use in business environment.

사용자안내문

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

(*) 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

Cleaning Precautions

To prevent electrical shock, disconnect the Keysight Technologies instrument from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally. To clean the connectors, use alcohol in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

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Introduction

The Keysight M9614A/M9615A 5-Channel Precision Source/Measure Unit (SMU) delivers high channel density per a single slot module, wide output range, and easy installation and configuration via the Keysight Connection Expert and a soft front panel (SFP).

- 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

Keysight also supplies software drivers that allow you to support the modules in many popular PXI chassis and programming environments. You can control the M9614A/M9615A using IVI drivers. LabVIEW driver is also available.

Related Documentation

This Startup Guide, and the documentation listed below, can be found on the Keysight web site. Visit www.keysight.com/find/m9614a or www.keysight.com/find/m9615a to get the latest documents, specifications, and software. For further information on the functions, refer to the User's Guide.

- User's Guide
- Soft Front Panel User's Guide
- IVI.NET Driver Reference
- IVI-C Driver Reference
- LabVIEW Driver Help
- Data sheet
- Configuration guide

Step 1: Unpack and Inspect the Module

CAUTION

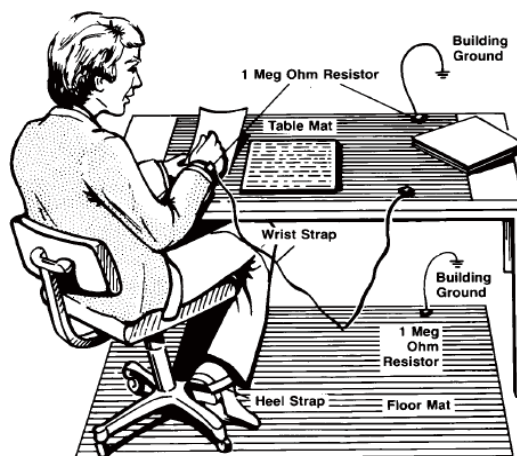
Keysight's PXIe chassis and instrument modules are shipped in materials which prevent static electricity damage. The modules should only be removed from the packaging in an anti-static area ensuring that correct anti-static precautions are taken. Store all modules in anti-static envelopes when not in use.

Electrostatic Discharge (ESD) Precautions

Electrostatic discharge (ESD) can damage or destroy electronic components. Use a static-safe work station to perform all work on electronic assemblies. This figure shows a static-safe work station using two types of ESD protection.

- Conductive table mat and wrist strap combination
- Conductive floor mat and heel strap combination

Both types, when used together, provide a significant level of ESD protection. Of the two, only the table mat and wrist strap combination provides adequate ESD protection when used alone. To ensure user safety, the static-safe accessories must provide at least 1 M Ω of isolation from ground.



WARNING

DO NOT use these techniques for a static-safe work station when working on circuitry with a voltage potential greater than 500 V.

Before Unpacking

Keysight M9614A/M9615A module is designed to meet IEC/EN61010-1 and must only be installed in the PXIe chassis which is certified by a Nationally Recognized Testing Laboratory. The PXIe chassis must already be installed on a static-safe workbench so that you can install the module soon after unpacking.

Refer to the PXIe chassis manual for chassis installation and details.

Inspect for Damage

After unpacking a module, carefully inspect it for any shipping damage. Report any damage to the shipping agent immediately, as such damage is not covered by the warranty (see warranty information at the beginning of this document).

CAUTION

To avoid damage when handling a module, do not touch any exposed components or connector pins.

NOTE

Visit www.keysight.com/find/tips for information on preventing damage to your Keysight equipment.

Return the Module for Service

Should it become necessary to return a module for repair or service, follow the steps below.

1. Review the warranty information shipped with your product.
2. Contact Keysight to obtain a Return Material Authorization (RMA) and return address. For assistance in finding Keysight contact information, visit www.keysight.com/find/assist.
3. Write the following information on a tag and attach it to the malfunctioning equipment.
 - Name and address of owner. A Post Office box is not acceptable as a return address.
 - Product model number (for example, M9615A)
 - Product serial number (for example, MYXXXXXXXX). The serial number label is located on the side of the module.
 - Description of failure or service required
4. Carefully pack the module in its original ESD bag and packing carton. If the original carton is not available, use bubble wrap or packing peanuts and place the instrument in a sealed container and mark the container "FRAGILE."
5. On the shipping label, write ATTENTION REPAIR DEPARTMENT and the RMA number.

NOTE

If any correspondence is required, refer to the product by serial number and model number.

Step 2: Verify Shipment Contents

The following items are included in this shipment.

Table 1-1

Shipment Contents

Model number	Description	Quantity
M9614A or M9615A	PXIe 5-Channel Precision Source/Measure Unit	1
NA	Quick Startup Poster	1
NA	Certification of calibration (without test data)	1
NA	Short bar	1
NA	Connector-terminal block 2.5 mm 5-terminal	1

Consumable supplies of the M9614A/M9615A are shown in below.

Table 1-2

Consumable Supplies

Part number	Description	Quantity
M9601-87001	Short bar	5
M9615-87001	Connector-terminal block 2.5 mm 5-terminal	5

Step 3: Install the Software

NOTE

Install the software prior to installing the PXle modules in the chassis so that Keysight IO Libraries Connection Expert finds them.

Requirements

The followings are required for installing the M9614A/M9615A software.

- Controller (desktop PC, laptop PC, rackmount PC, or PXle embedded computer) installed with Keysight IO Libraries Suite
- Keysight PXle chassis which has already been set up

For setting up the controller and the PXle chassis, refer to the PXle chassis documentation.

NOTE

Minimum 1.5 GB free space is required on the controller for installing the M9614A/M9615A software.

Installation Process

Visit www.keysight.com/find/m9614a or www.keysight.com/find/m9615a to get the latest version of the M9614A/M9615A software.

1. Copy the M9614A/M9615A software installer into the controller.
2. Launch the M9614A/M9615A software installer.
3. Follow the installer prompts to install the M9614A/9615A software.
4. Reboot the controller when prompted by the software installer.

If a firmware update is available, you can perform the firmware update by using the M960x PXle Source Measure Unit Soft Front Panel (the M960x SFP) after the module installation. See [“To Update the Firmware” on page 16](#).

Step 4: Install the Module

NOTE

Current capacity of the PXle chassis may restrict the module configuration. For more information, refer to the User's Guide, the M9614A/M9615A data sheet, and the PXle chassis documentation.

NOTE

The M9614A/M9615A module must be installed in the PXle chassis certified by a Nationally Recognized Testing Laboratory.

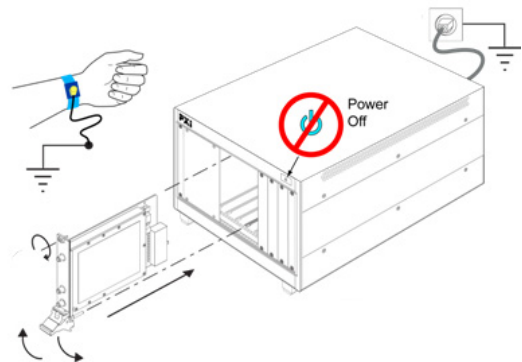
CAUTION

PXle hardware does not support “hot-swap” (changing modules while power is applied to the chassis) capabilities. Before installing or removing a module to/from the chassis, power down the chassis to prevent damage to the module.

Place the chassis on a static-safe work station (see “[Electrostatic Discharge \(ESD\) Precautions](#)” on page 8). And position it so that there is ample space between the chassis fan intake and exhaust vents. Blockage by walls or obstructions affects the air flow needed for cooling. Use slot blockers and filler panels in empty slots to ensure proper operating temperatures.

For more information about precautions and cooling, refer to the PXle chassis documentation.

Generic module installation is shown below. It may not reflect your module's actual size and chassis placement. Install the leftmost module first and continue installing modules from left to right according to the image below.



Step 4: Install the Module

NOTE

Before the module installation, make sure that the controller is turned off.

Procedure

1. Make sure that the power cord is plugged into a grounded outlet to establish earth ground and to prevent ESD.
2. Make sure that the chassis power switch is off.
3. If the chassis has multiple fan speed settings, ensure that the fans are set to automatic. Do not set the fan speed to low or turn them off.
4. Remove the filler panel that covers the slot in which you want to install the module.
5. Remove thread protectors from the top and bottom mounting screws of the module.
6. Hold the module by the injector/ejector handle, and slide it into the slot.
 - Install the module into the slot of the chassis by placing the module card edges into the front module guides (top and bottom).
 - Slide the module to the rear of the chassis and assure that the injector/ejector handle is pushed down in the unlatched (downward) position.
 - Slide the module completely into the chassis. When you begin to feel resistance, push up on the injector/ejector handle to fully seat the module into the chassis.
7. Latch the module by pulling up on the injector/ejector handle and secure the front panel to the chassis using the module front-panel mounting screws.
8. Tighten the screws on the module front panel. Performance may suffer if the screws are not securely tightened.
9. Install all chassis covers, filler panels, and air scoops after installing the module. Also see CAUTION below.

For more information on the module installation, refer to the PXIe chassis documentation.

CAUTION

Ensure that filler panels are installed in all empty slots. Missing filler panels will impact cooling of the chassis and may cause RFI (radio frequency interference) with other devices.

Step 5: Verify Operation of the Module

CAUTION

If you are using a remote controller (rackmount, desktop, or laptop PC), and you have installed the interface cable, you must power up the chassis before you power up the controller. When you power down your system, shut down the controller before you power down the chassis.

NOTE

Line frequency (power line frequency) must be set properly according to the AC power at your site. This setting is non-volatile and not changed by power-on or reset. The default is 50 Hz.

You must specify the line frequency by programming, if necessary. For more information, refer to the User's Guide.

To Check Communication

Perform the following procedure to check the communication between the module and the controller.

1. Make sure that the chassis and the controller are turned off.
2. If you are using a remote controller, connect a PXIe cable between the chassis and the controller.
3. Power up the chassis. Verify that the chassis fans are operating and free of obstructions that may restrict airflow.
4. Power up the controller.
5. Check that the controller automatically recognizes the module in the device manager; e.g. via **Start menu > Windows System Tools > Control Panel > Device Manager**. The module should be visible in the device tree.

The controller might request a reboot. Reboot the controller, if requested.

6. Check if the module is also visible in the Keysight Connection Expert; e.g. via **Start menu > Keysight Connection Expert**.

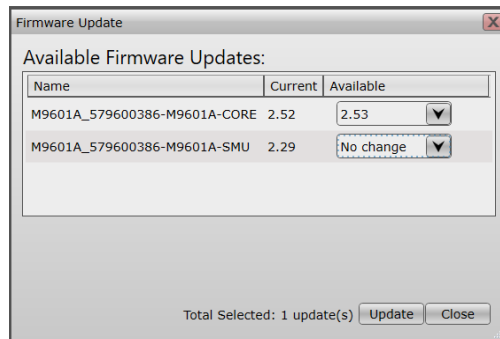
If something went wrong and the module is not shown in the PXIe section, it may be necessary to reboot the controller once more.

Step 5: Verify Operation of the Module

To Update the Firmware

If a firmware update is available, perform the following procedure to update the firmware of the M9614A/M9615A modules.

1. Click **Start menu > Keysight M960x Source Measure Unit > M960x SFP**. The Connect to Instrument dialog box will open.
2. In the list on the window, highlight the M9614A/M9615A modules to connect, and click **Connect** to launch the Keysight M960x PXIe Source Measure Unit Soft Front Panel (the M960x SFP).
3. Confirm that the Access indicator on the M9614A/M9615A front panel turns green. Refer to [Figure 1-1](#) and [Table 1-3](#) for LED status.
4. Select **Firmware Update...** from the Utilities menu. The Firmware Update dialog box will open.



5. Select the latest version of the firmware, if it is available.
If the selection menu displays “No change”, there are no firmware updates.
6. Click **Update** at the bottom of the Firmware Update dialog box to start the firmware update.
When the firmware is updated successfully, the message appears in the Firmware Update dialog box.
7. Close the M960x SFP.
8. Restart your system; Power down the controller, then the chassis, and power up the chassis, then the controller.

To Perform Self Test

You can perform the self test using the M960x PXIe Source Measure Unit Soft Front Panel (the M960x SFP).

NOTE

Before performing the self test, turn the instrument output off and disconnect cables from the measurement terminals.

1. Click **Start menu > Keysight M960x Source Measure Unit > M960x SFP**. The Connect to Instrument dialog box will open.
2. In the list on the window, highlight the M9614A/M9615A modules to connect, and click **Connect** to launch the M960x SFP.
3. Confirm that the Access indicator on the M9614A/M9615A front panel turns green. Refer to [Figure 1-1](#) and [Table 1-3](#) for LED status.
4. Select **Self Test...** from the Utilities menu. The Self Test dialog box will open.
5. Click **Run Self Test** at the bottom of the Self Test dialog box to start the self test. When the self test is completed, the results will be displayed in the Self Test dialog box.

NOTE

If the module fails the self test, it will be defective. See [“Return the Module for Service” on page 10](#) to return the modules to Keysight.

CAUTION

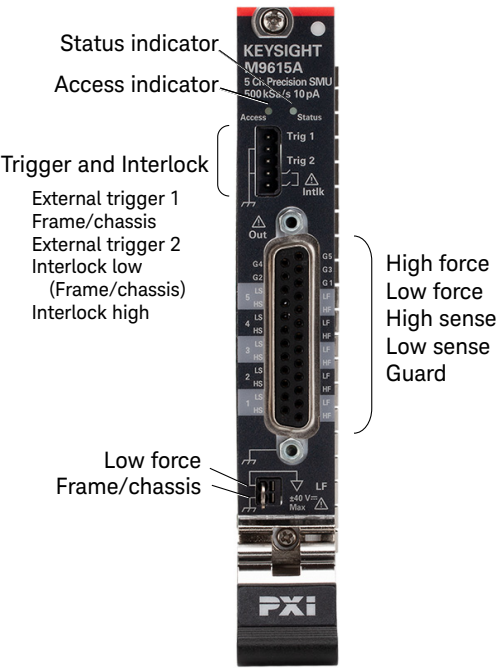
Use the module within the rating. If you input a signal above the rating, the module will be damaged.

Front Panel Features

This section describes the connectors and the indicators on the M9614A/M9615A front panel.

- “LED Indicators”
- “Measurement Terminals”
- “Trigger and Interlock Terminals”

Figure 1-1 M9614A/M9615A Front Panel



LED Indicators

The M9614A/M9615A module has two LED indicators, Access and Status. These indicators show the status of the module. See [Table 1-3](#) for the meanings. If the emergency shutdown occurs, both indicators turn red.

Table 1-3

LED Status

LED	LED state	Status
Access	Solid Green	The module is turned on, the initialization is completed, and the operation is ready.
	Flashing Green	The “Identify PXIe module” feature is on.
	Solid Red	Emergency shutdown occurs.
	Off	The control session is closed.
Status	Solid Green	Output is enabled.
	Solid Red	Emergency shutdown occurs.
	Off	Output is disabled.

Measurement Terminals

The M9614A/M9615A has the following measurement terminals. You can make 2-wire connection using the High force and Low force terminals or 4-wire connection (Kelvin connection) using the High force, Low force, High sense and Low sense terminals. The Kelvin connection is effective in high current measurement.

WARNING

Use a three-conductor AC power cord to connect the cabinet (if used) and the instrument to an electrical ground (safety ground).

Utilisez un cordon d'alimentation CA à trois connecteurs pour connecter la cabine (si utilisée) et l'instrument à la mise électrique à la terre (sol de sécurité).



HF, LF, HS, LS

High force (HF), Low force (LF), High sense (HS), and Low sense (LS) terminals (D-sub connector)

These terminals are used to connect a device under test (DUT). If you make the 2-wire connection, use only the HF and LF terminals, and open the HS and LS terminals. The HS and LS terminals are used to make the 4-wire connection (Kelvin connection).

The D-sub connector has 25 positions and consists of five-channel interfaces as shown in the following figure and table. Each channel has five terminals: HF, LF, HS, LS, and Guard. Although LF is shared by all channels, it is recommended to use each HF terminal with the LF terminal of the same channel.

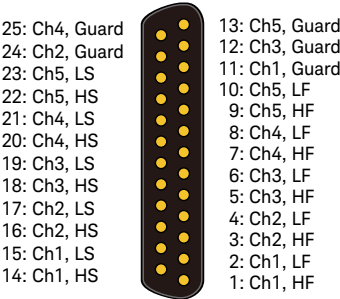


Table 1-4 Pin Assignment of the D-sub Connector

No.	Name	Description
1	Ch1, HF	High force for channel 1
2	Ch1, LF	Low force for channel 1
3	Ch2, HF	High force for channel 2
4	Ch2, LF	Low force for channel 2
5	Ch3, HF	High force for channel 3
6	Ch3, LF	Low force for channel 3
7	Ch4, HF	High force for channel 4
8	Ch4, LF	Low force for channel 4
9	Ch5, HF	High force for channel 5
10	Ch5, LF	Low force for channel 5

No.	Name	Description
11	Ch1, Guard	Guard for channel 1
12	Ch3, Guard	Guard for channel 3
13	Ch5, Guard	Guard for channel 5
14	Ch1, HS	High sense for channel 1
15	Ch1, LS	Low sense for channel 1
16	Ch2, HS	High sense for channel 2
17	Ch2, LS	Low sense for channel 2
18	Ch3, HS	High sense for channel 3
19	Ch3, LS	Low sense for channel 3
20	Ch4, HS	High sense for channel 4
21	Ch4, LS	Low sense for channel 4
22	Ch5, HS	High sense for channel 5
23	Ch5, LS	Low sense for channel 5
24	Ch2, Guard	Guard for channel 2
25	Ch4, Guard	Guard for channel 4

The maximum voltage which appears in HF, HS, and Guard is expressed by the equation: $\pm 30.5 \text{ V} + V_{\text{floating}}$. Where V_{floating} is the voltage between Low force and the frame/chassis ground. V_{floating} is 0 V in the grounded measurement, and the maximum voltage of V_{floating} is $\pm 40 \text{ V}$ in the floating measurement.

CAUTION

Never connect the Guard terminal to any output, including the frame/chassis ground or any other guard terminal. Doing so will damage the M9614A/M9615A.

Front Panel Features



LF and frame/chassis

Low force terminal and frame/chassis terminal

These terminals are connected together by the short bar when the M9614A/M9615A is shipped from the factory. The short bar must be connected to perform the grounded measurement.

If you want to perform the floating measurement, or if you want to connect another instrument's ground to the Low force, remove the short bar, and leave the terminals open. Then use the Low force terminals on the D-sub connector to connect the other instruments.

CAUTION

For the floating measurement, do not apply voltage over ± 40 V to the Low force terminal. $V_{floating}$, the voltage between Low force and the frame/chassis ground, is limited to ± 40 V. Failure to heed this caution may result in damage to the M9614A/M9615A.

CAUTION

Do not apply current or voltage to the frame/chassis terminal. Doing so will damage the M9614A/M9615A.

Trigger and Interlock Terminals

The M9614A/M9615A has the following terminals for the trigger source or output and the interlock circuit status detection.

The M9614A/M9615A has a 5-pin terminal block on the front panel. The pin assignment of the terminal block is shown in [Figure 1-1](#). You can connect these terminals using a connector-terminal block furnished with the M9614A/M9615A and ferrule terminal cables such as Keysight PX0101A-001 or PX0101A-002 BNC to ferrule terminal cable.

Trig 1 and Trig 2 External trigger 1 and 2 terminals

These terminals are used to make synchronization with other modules or instruments. You can specify the direction (input/output), the polarity (positive/negative), and the pulse width of the trigger signal. The output trigger is push-pull, and the trigger level is 0 V to 3.3 V at high impedance. The input trigger should be the TTL level.



Intlk Interlock terminals

These terminals are used to connect an interlock circuit which is installed in your test fixture or shielding box. The interlock circuit can be created by using two mechanical switches and wire as shown in [Figure 1-6](#). If the interlock terminals are opened or the interlock circuit is opened, the output voltage is limited to ± 42 V or less as you specified.

The interlock circuit is not necessary for the M9614A/M9615A because the maximum output voltage is ± 30 V, but can be used to limit the output voltage to the specified value. If you set the limit to 0 V, the interlock function will be the same as inhibit control.

For more details, see [“Installing Interlock Circuit” on page 31](#).

CAUTION

Do not connect the interlock terminals to anything other than the interlock circuit. Applying current or voltage to the terminals may damage the M9614A/M9615A.

Connecting a DUT

This section describes how to connect a device under test (DUT) to the M9614A/M9615A, and includes the following descriptions.

- “2-Wire Connection or 4-Wire Connection”
- “Floating”
- “Guarding”
- “Using the Low Noise Filter Adapter”

WARNING



To avoid touching the end of the extension cable or the terminal area with the DUT, cover over the conductors with insulator. Also it is important to protect the terminal area by using the grounded shield cover and such.

To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after the measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use gloves and any tool. Also have enough time for discharge and radiation.

Afin d'éviter de toucher l'extrémité du câble d'allongement ou l'aire de la borne avec l'appareil mis sous tension (MST), couvrez les conducteurs avec l'isolant. En outre, il est important de protéger la zone de la borne en utilisant le couvercle d'écran à la mise à terre, ou tout autre élément.

Afin d'éviter toute décharge électrique et dommage MST, ne branchez ou déconnectez pas la sortie MST alors que la source de sortie est appliquée.

Lorsque vous touchez le MST après la mesure, élaborer une contre-mesure de la charge résiduelle et du chauffage afin d'éviter tout choc électrique et toute brûlure. Utilisez des gants et des outils. Prévoyez également du temps pour la décharge et la radiation.

NOTE

Set the instrument output off when changing the connections. If not, the DUT may be damaged.

NOTE**Using the interlock circuit**

The M9614A/M9615A provides an interlock function. If the interlock terminals are open, the M9614A/M9615A *cannot* apply a high voltage over the limit. The limit is programmable within ± 42 V.

The interlock circuit is not necessary for the M9614A/M9615A because the maximum output voltage is ± 30 V, but can be used to limit the output voltage to the specified value.

For more details, see [“Installing Interlock Circuit” on page 31](#).

NOTE

Generally, environmental conditions, such as electromagnetic environment, have a negative impact on the performance of the instrument. Use coaxial cables and shielding technique to minimize the impact.

2-Wire Connection or 4-Wire Connection

When connecting a device under test (DUT), you can choose the connection type either the 2-wire connection or the 4-wire connection.

If you want to simplify the connection, use the 2-wire connection by connecting the force terminals only, while the sense terminals remain open.

To make the 4-wire connection, well known as Kelvin connection, use both force and sense terminals. Connecting the force and sense lines together at the terminal of the DUT minimizes the measurement error by the residual resistance of the test leads or cables. This connection is effective for low resistance measurements and high current measurements.

The M9614A/M9615A module has five-channel interfaces, and each channel has five terminals: HF, LF, HS, LS, and Guard. Although LF is shared by all channels, it is recommended to use each HF with the LF of the same channel.

Connecting a DUT

Figure 1-2 Simplified SMU Circuit Diagram

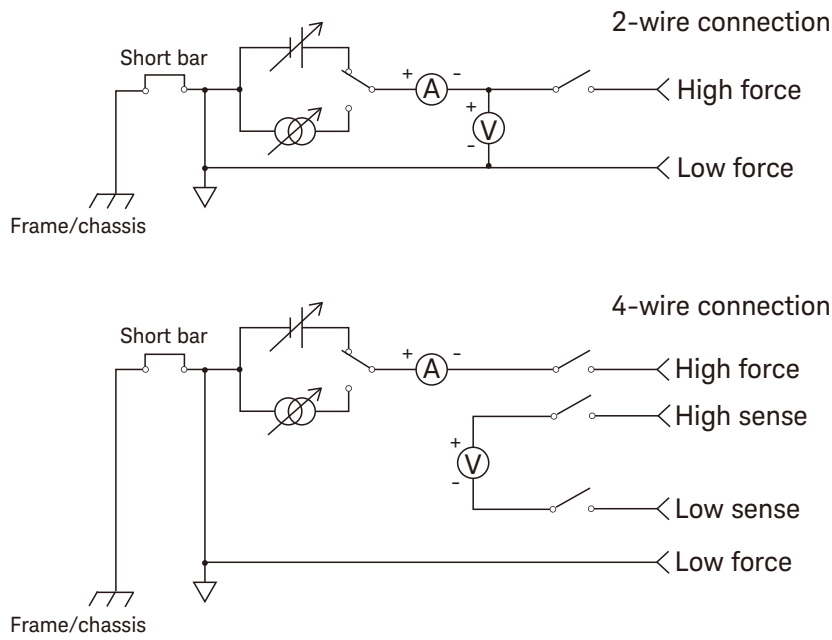
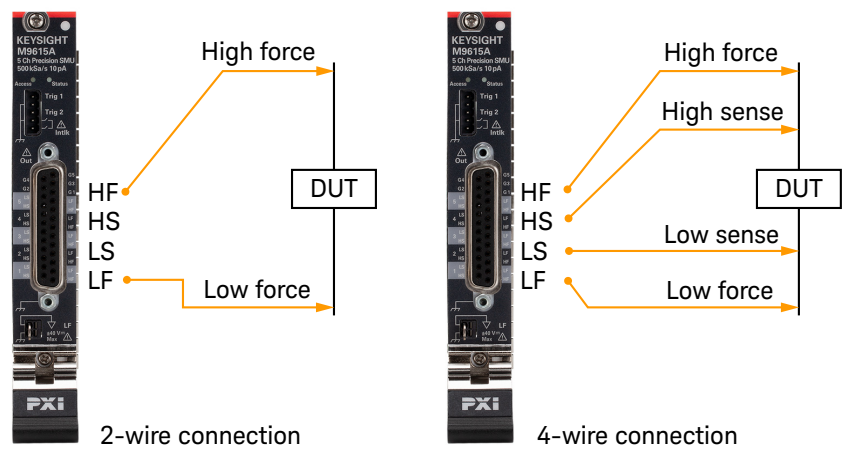


Figure 1-3 2-Wire Connection and 4-Wire Connection



Floating

When the M9614A/M9615A is shipped from the factory, the Low force terminal is connected to the frame/chassis terminal by the short bar. The short bar must be connected to perform the grounded measurement.

If you want to perform the floating measurement or if you want to connect another instrument's ground to the Low force, remove the short bar, and leave the terminals open. Then use the Low force terminals on the D-sub connector to connect the other instrument.

CAUTION

For the floating measurement, do not apply voltage over ± 40 V to the Low force terminal. Doing so will damage the M9614A/M9615A.

CAUTION

Do not apply current or voltage to the frame/chassis terminal. Doing so will damage the M9614A/M9615A.

WARNING

To prevent electrical shock, do not touch any of measurement circuit at any time while a floating measurement is in progress. Also use accessories that comply with IEC 61010-031. All terminals and the extended conductors must be isolated by using insulation caps, sleeves, etc.

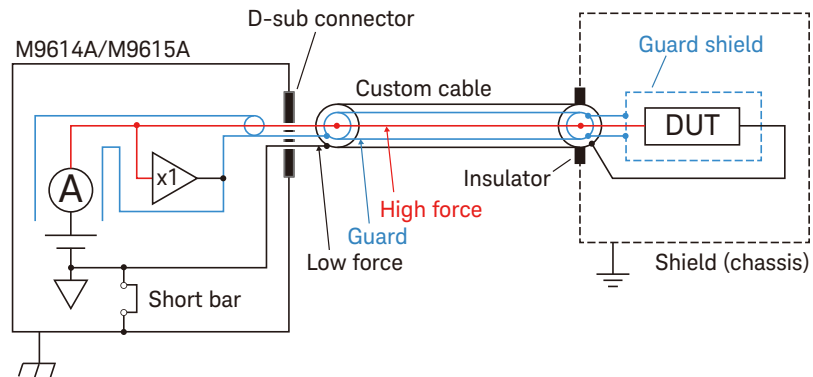
Afin d'éviter toute décharge électrique, ne touchez aucune mesure de circuit à tout moment lorsque la mesure de flotte est en cours. Utiliser également des accessoires qui sont conformes à la norme IEC 61010-031. Toutes les bornes et les conducteurs prolongés doivent être isolés en utilisant des bouchons d'isolation, des manchons, etc.

Guarding

Guarding reduces the leakage current between the instrument and a DUT. This is important when you perform low current measurements.

The overview of the guard technique for the grounded measurement is shown in [Figure 1-4](#). The guard shield is necessary to prevent the leakage current in the measurement environment including extension cables, test fixtures, shielding boxes. It is important to use a triaxial cable such as Keysight PX0102A-001 Low noise triaxial cable (1.5 m). The buffer amplifier keeps the potential of the Guard at the same potential as the High force, so that the current does not flow between the core and the inner shield. Therefore ideally, the current measured by the instrument is the same as the current at the DUT terminal because there is no leakage current. For several connection examples such as the floating measurement, refer to the configuration guide.

Figure 1-4 Guard Technique for Grounded Measurement



NOTE

If the Low force terminal connects to the outer shield of the triaxial cable in the grounded measurement, the outer shield must be electrically isolated from the shield of your test fixture or shielding box. Do not connect the outer shield to anything other than the low terminal of DUT.

CAUTION

Never connect the guard shield to any output, including the frame/chassis ground or any other guard terminal. Doing so will damage the M9614A/M9615A.

Using the Low Noise Filter Adapter

The following external filter is available for the M9614A/M9615A to apply low-noise and clean output signal.

- Keysight PX0107A Low Noise Filter Adapter for M9614/15

The adapter is attached to the D-sub connector on the front panel of the M9614A/M9615A and has five SMB connectors for outputs as shown below.

Figure 1-5

Low Noise Filter Adapter



To use the low noise filter adapter, you can enable the settings by using the M960x PXIe Source Measure Unit Soft Front Panel as the following procedures.

1. Press the settings button on the instrument panel to open the Settings dialog box.
2. Select the Options tab.
3. Select **On** from the Low Noise Filter options.

Then the low noise filter is enabled and LF indicators appear on the panels of all five channels.

The low noise filter setting is initialized and set to off by turning on the M9614A/M9615A or the reset command. When using the low noise filter adapter, the setting must be enabled after the module is powered off and then turned on, or after the module is reset.

WARNING

The body of the low noise filter adapter is electrically at the same potential as the Low force. For the floating measurement, see **"Floating"** on page 27 to prevent electrical shock.

Connecting a DUT

NOTE

When using the low noise filter adapter, the output current should be limited to ± 150 mA. If you set an output current value outside the range and press the output switch on the soft front panel to supply current with the low noise filter enabled, an error message appears.

CAUTION

Before making the output on with PX0107A Low Noise Filter Adapter, ensure that the low noise filter setting is enabled. Failure to heed this caution may result in damage to the M9614A/M9615A.

Installing Interlock Circuit

To use the interlock function, the M9614A/M9615A interlock terminals must be connected to the interlock circuit installed in the measurement environment such as the shielding box. The interlock circuit is a simple electric circuit as shown in [Figure 1-6](#). The circuit electrically opens when the access door is opened, and closes when the door is closed.

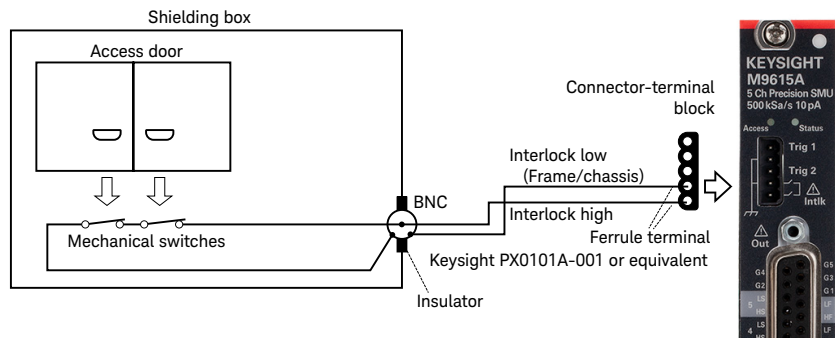
The M9614A/M9615A module cannot apply high voltage over the limit when the interlock terminals are open. The limit value, or Interlock threshold voltage level, is programmable within ± 42 V. The interlock circuit is not necessary for the M9614A/M9615A because the maximum output voltage is ± 30 V, but can be used to limit the output voltage to the specified value. If you set the threshold level to 0 V, the interlock function will be same as inhibit control.

You can specify the threshold level by using the M960x PXIe Source Measure Unit Soft Front Panel. Select **M960x Settings...** from the Utilities menu, and type the value into the box.

For information on setting the threshold level by programming, refer to the driver references.

Figure 1-6

Interlock Circuit



Installing Interlock Circuit

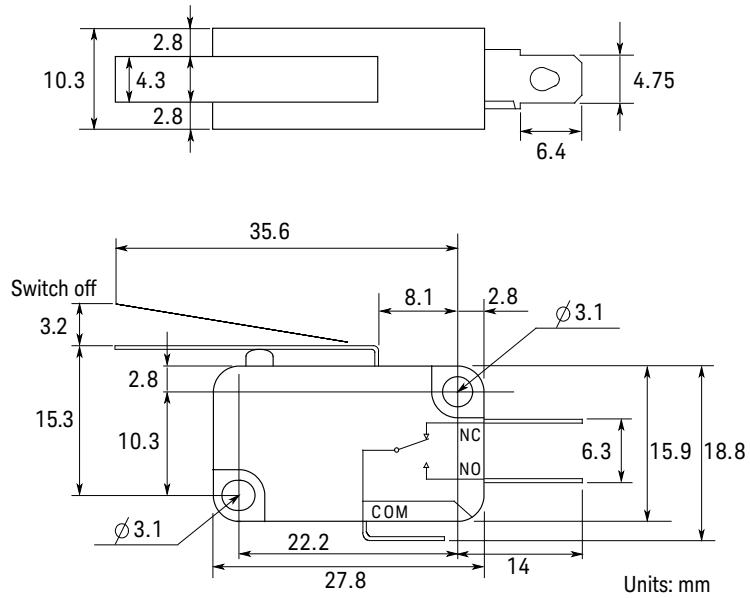
- Requirements**
- Mechanical switch (Keysight N1254A-402 or equivalent), 2 ea.
 - Connector-terminal block 2.5 mm 5-terminal, 1 ea.
 - BNC to ferrule terminal cable (Keysight PX0101A-001 (1.5 m), PX0101A-002 (3.0 m), or equivalent), 1 ea.
 - BNC connector (jack to soldering terminals), 1 ea.
 - Connection wires

- Procedure**
1. Mount two mechanical switches onto your shielding box, so that the switches close when the access door is closed, and open when the access door is opened. See [Figure 1-7](#) for the switch dimensions.
 2. Mount a BNC connector onto your shielding box. Be sure that the outer shield of the BNC connector is electrically isolated from the shielding box.
 3. Use a wire, and connect the two switches in series between the soldering terminals of the BNC connector as shown in [Figure 1-6](#).
 4. Connect the connector-terminal block to the M9614A/M9615A.
 5. Connect the BNC to ferrule terminal cable to the interlock terminals of the M9614A/M9615A.
 6. Connect the BNC to ferrule terminal cable to the BNC connector on the shielding box.

You can also connect the mechanical switches directly to the connector-terminal block by connection wires and ferrule terminals.

Figure 1-7

Dimension of the Interlock Switch (Keysight N1254A-402)



Maintenance

This section describes the maintenance tasks of the M9614A/M9615A.

- “Cleaning”
- “Self Test”
- “Self Calibration”
- “Calibration”

Cleaning

To prevent electrical shock, disconnect the chassis from the mains before cleaning.

Use a dry soft cloth or a soft cloth slightly dampened with water or a mild soap and water solution to clean the external surfaces of the chassis, modules, and accessories. Do not use detergents or chemical solvents.

Do not attempt to clean the inside.

To clean the connectors, use alcohol in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

WARNING**SHOCK HAZARD**

To avoid any risk of electric shock, unplug the PXIe chassis before cleaning.

RISQUE D'ÉLECTROCUTION

Pour éviter tout risque de choc électrique, débranchez le châssis PXIe avant le nettoyage.

CAUTION

Do not use too much liquid in cleaning the PXIe chassis. Water can enter the PXIe chassis panels and damage sensitive electronic components. Make sure that the PXIe chassis is completely dry before reconnecting the power cord.

Self Test

Keysight M9614A/M9615A provides the self test function to check the operation. It is recommended to perform the self test for the following condition or purpose.

- If emergency shutdown occurs.

In this condition, both the Access and Status indicators turn red. The shutdown condition will be solved after passing the self test.

- If you feel that the instrument may be defective.
- For preventive maintenance.

NOTE

Before performing the self test, turn the instrument output off and disconnect cables from the measurement terminals.

To perform self test

See [“To Perform Self Test” on page 17](#).

Self Calibration

Keysight M9614A/M9615A provides the self calibration function to maintain the measurement performance. If the environmental temperature changes ± 5 °C or more, perform the self calibration. This is effective in the accurate measurements by minimizing the effect of thermal drift.

For measurements with the specified accuracy, the self calibration should be performed within the last 24 hours and after 40 minutes of warm-up. Refer to the M9614A/M9615A data sheet for more details of the specification conditions.

NOTE

The warm-up starts when the module initialization successfully finishes for the first time after the PXIe chassis is powered on. The initialization runs when you connect the module using the Soft Front Panel or open a session to control the module.

NOTE

Before performing the self calibration, turn the instrument output off and disconnect cables from the measurement terminals.

Maintenance

To perform self calibration

1. Click **Start menu > Keysight M960x Source Measure Unit > M960x SFP**. The Connect to Instrument dialog box will open.
2. From the list on the window, highlight the M9614A/M9615A modules to connect and click **Connect** to launch the Keysight M960x Source Measure Unit Soft Front Panel.
3. Confirm that the Access indicator on the M9614A/M9615A front panel turns green. Refer to [Figure 1-1](#) and [Table 1-3](#) for LED status.
4. Select **Self Calibration...** from the Utilities menu on the soft front panel to open the Self calibration dialog box.
5. Click **Run Self Cal...**

Calibration

Calibration and adjustments must be performed periodically so that the instrument can meet its specifications and keep good condition. It is recommended to perform the calibration once a year at least. For the calibration and adjustments, contact Keysight Technologies. Trained service personnel will perform the calibration and adjustments.

Function Overview

This section introduces major functions of the M9614A/M9615A. For more information, refer to the User's Guide, the IVI driver references, and Soft Front Panel User's Guide.

- “Limit (Compliance)”
- “Operation Mode”
- “Output Filter and External Filter”
- “Pulse Output”
- “Sweep Output”
- “List Sweep”
- “Ranging Mode”
- “Seamless Current Measurement Ranging”
- “Trigger System”
- “Measurement Time”
- “Automatic Output On/Off”
- “Output Off Mode”
- “Interlock”
- “Protection from Emergency”

Limit (Compliance)

Limit or compliance is the output limiter for preventing damage to a device under test (DUT) due to overcurrent or overvoltage. The voltage Limit is for current source, and the current Limit is for voltage source.

Operation Mode

The M9614A/M9615A module provides two operation modes for source output. The following modes can be selected depending on DUT or application.

Standard	Default
-----------------	---------

PowerSupply Power supply mode
This mode enables applying voltage with the faster slew rate.

Output Filter and External Filter

The M9614A/M9615A module has a built-in output filter to obtain clean output signal without spikes or overshoots. However, using a filter may increase the settling time. You can enable or disable this function and also specify the filter time constant.

The M9614A/M9615A can also be equipped with an external filter, Keysight PX0107A Low Noise Filter Adapter for M9614/15. To use this filter, see [“Using the Low Noise Filter Adapter” on page 29](#).

Pulse Output

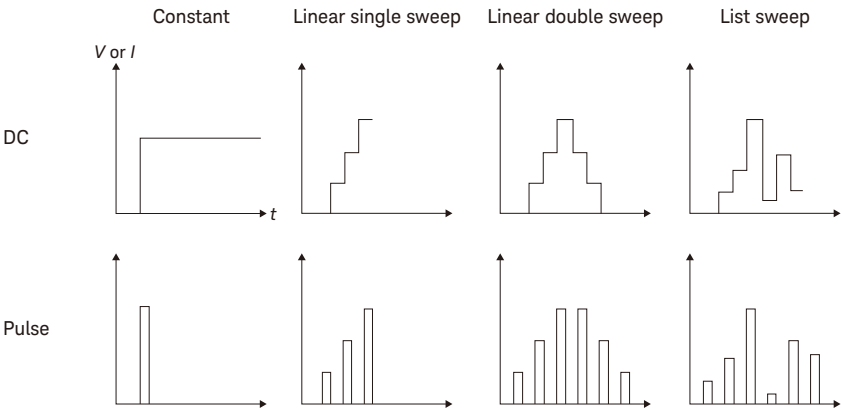
The M9614A/M9615A module has the function to apply a pulsed voltage or current as shown in [Figure 1-8](#). You can control the pulse output and measurement timing by setting trigger parameters.

Sweep Output

The M9614A/M9615A module has the function to apply a sweep voltage or current in several shapes as shown in [Figure 1-8](#) and performs the measurement for each sweep step. You can control the sweep output and measurement timing by setting trigger parameters.

Figure 1-8

Variety of Sweep Outputs



List Sweep

The M9614A/M9615A module also has the function to apply an arbitrary waveform output by specifying a list of output values and measure voltage or current at each output step. The source output and the measurement are performed at the specified interval. The minimum interval is 4 μ s.

Ranging Mode

Output Range (Source Range)

The following ranging modes are available for performing source output.

FIXED	Fixed range The specified range is used. This mode is available for all source output.
AUTO	Auto range The range is automatically selected to provide the best resolution of the source output value. It is possible to specify the minimum range in the auto range operation. This mode is available for source output except linear sweep output.
BEST	Best range The minimum range covering the whole sweep output is automatically selected. This mode is available for linear sweep output.

The following table summarizes which ranging mode can be used in each case.

Table 1-5

Ranging Mode for Output

	FIXED	AUTO	BEST
Output except sweep	✓	✓	
Linear sweep output	✓		✓
List sweep output	✓	✓	

Measurement Range (Sense Range)

When the Limit value is specified, the measurement range is set to the minimum range that includes the Limit value.

FIXED

Fixed range

The range is specified. If the range is smaller than the measurement range defined by the Limit value, the specified range is used as the measurement range during the measurement.

SEAMLESS

Seamless current measurement ranging

See [“Seamless Current Measurement Ranging” on page 40](#).

Seamless Current Measurement Ranging

This function allows you to measure current with the best resolution over multiple ranges without changing the range.

In this function, current measurement is performed at multiple ranges simultaneously, and then the value with the best resolution is automatically selected. The multiple ranges involved in the measurement are defined by the current Limit and the specified minimum range.

Trigger System

Trigger system can be used to control the timing of the source output and the measurement. The M9614A/M9615A supports the ARM-TRIGger model in *1999 SCPI Command Reference*. This trigger model is independently applied to two device actions: Transient (source output) and Acquire (measurement). These two device actions can start simultaneously or separately.

PXI Trigger and External Trigger

The M9614A/M9615A has two trigger terminals on the front panel, External trigger 1 and 2, as described in [“Trigger and Interlock Terminals” on page 23](#). In addition to the external trigger terminals, eight trigger lines on the PXIe chassis backplane are available.

The external triggers and the trigger lines on the PXIe chassis backplane can be used as trigger sources or outputs of the trigger system to synchronize the M9614A/M9615A with other modules or instruments.

Trigger Source

The following trigger source settings are available.

- AUTO (AINT)
Triggers at the specified interval
The timing is controlled by the software. Depending on the controller, the interval may be larger than the specified value.
- TIMER
Triggers at the specified interval
The timing is controlled by the hardware.
- EXT1 or EXT2
Triggers synchronizing with a signal from an external trigger
- PXI0, PXI1, PXI2, PXI3, PXI4, PXI5, PXI6, or PXI7
Triggers synchronizing with a signal from the PXIe chassis backplane

Trigger Output

The M9614A/M9615A provides the trigger output at the specified timing. Trigger output terminal can be selected from the external trigger terminals on the front panel (EXT1 and EXT2) and the trigger lines on the PXIe chassis backplane (PXI0, PXI1, ..., PXI7).

Measurement Time

The measurement time depends on the aperture time, measurement range, and other measurement conditions. It can be expressed by the following equation.

$$\text{Measurement time} = \text{Aperture time} + \text{Overhead time}$$

Aperture time is the time required to acquire the measurement data. For accurate and reliable measurement, the aperture should be increased. This value can be specified.

Overhead time includes other factors such as range change or data compensation. This value depends on the measurement conditions and cannot be specified.

Automatic Output On/Off

The M9614A/M9615A module has output on/off settings when the trigger system changes the status. You can enable or disable these settings independently.

Auto Output On The source output is automatically turned on just before the trigger system is initiated by programming.

When the trigger system is initiated on the Soft Front Panel, this setting is ignored.

Auto Output Off The source output is automatically turned off when all trigger systems change the status from busy to idle.

Output Off Mode

The output off mode is the condition immediately after the source output is turned off. The mode should be specified by programming before enabling the source output. The following settings are available for the output off mode.

High impedance	Output switch: off
	Voltage source setup is not changed.
	Current source setup is not changed.
Normal	Output switch: off
	Source function: voltage source
	Output voltage: 0 V
	Current Limit: 100 μ A at the 100 μ A range
Zero	Source function: voltage source
	Output voltage: 0 V
	Current Limit: 100 μ A at the 100 μ A range

NOTE

The output off mode is ignored if an emergency condition such as interlock open and over voltage is detected. Then the output voltage is immediately set to 0 V, and the output switch is set to off.

Interlock



The interlock function is designed to prevent electrical shock when you touches the measurement terminals and also to prevent DUT damages caused by undesirable high voltage.

The M9614A/M9615A module cannot apply high voltage over the interlock threshold voltage level when the interlock terminals are open. The interlock threshold voltage level is programmable within ± 42 V, and the default value is ± 42 V. Set the threshold voltage to the voltage you think still safe. If the threshold voltage level is set to 0 V, the interlock function is same as inhibit control.

For details on installing the interlock circuit, see [“Installing Interlock Circuit” on page 31](#).

The interlock function works as follows.

- When the interlock terminals are open, the maximum output is limited to the threshold voltage level.
- When the interlock terminals are shorted, the module can apply the maximum output voltage of the channel.
- If the interlock terminals are opened in a high voltage condition over the threshold voltage level, the output voltage is immediately set to 0 V, and the output switch is set to off.

Protection from Emergency

The protection from emergency is effective in preventing damages to the module due to high temperature, over voltage, over current, or other conditions. The M9614A/M9615A provides two types of protection. One is an emergency shutdown and the other is an immediate output-off.

When the over temperature or the system error such as power supply failure or internal communication failure is detected, the emergency shutdown occurs. The module is powered off and two LED indicators turn red.

When the emergency including the over voltage, over current, and interlock open is detected, the output is automatically turned off; the output voltage is immediately set to 0 V, the output switch is set to off, and the “Status” LED indicator turns off. If the emergency condition continues for a certain period of time after the immediate output-off, the emergency shutdown occurs.

If the emergency shutdown occurs, perform the self test. See [“Self Test” on page 35](#).

This information is subject to change without notice.
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