Keysight M8194A 120 GSa/s Arbitrary Waveform Generator

Getting Started Guide

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TECHNOLOGIES

Notices

Manual Part Number

Edition

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Safety Notices

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like 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 notice denotes a hazard. It calls attention to an operating procedure, practice, or the like 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.

Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements. Product manuals are provided with your instrument on CD-ROM and/or in printed form. Printed manuals are an option for many products. Manuals may also be available on the Web. Go to www.keysight.com and type in your product number in the Search field at the top of the page. Safe operation and the general safety precautions for the M9502A and M9505A AXIe chassis, must be followed. See: http://www.keysight.com/find/M9505A.

WARNING	**To ensure mandatory safety requirements are being met, the module must be installed in a chassis which has been certified and marked by a Nationally Recognized Testing Lab (such as CSA, UL, TUV, ETL etc.) in which all the means of protection are properly implemented.** **NOTE: CE marking alone is not adequate.**

NOTE	This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have selected the contents of the shipment for completeness and verified the instrument both mechanically and electrically. The Performance Tests give procedures for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Keysight Technologies Sales/Service Office.

WARNING To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

General

This product is a Safety Class 3 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

ESD Sensitive Device	All front-panel connectors of the M8194A are sensitive to Electrostatic discharge (ESD). There are also several exposed components on the PCAs, on both sides of M8194A, which can be touched accidentally while handling the unit and can risk damage to the instrument, due to ESD. It is recommend to operate the instrument in an electrostatic safe environment. There is a risk of instrument malfunction when touching a connector or side components. Please follow this instruction: Before touching the unit, discharge yourself by touching the properly grounded mainframe.
Environment Conditions	This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate within a temperature range of 0 °C – 40 °C (32 °F – 105 °F) at a maximum relative humidity of 80% and at altitudes of up to 2000 meters.
	This module can be stored or shipped at temperatures between -40 °C and +70 °C. Protect the module from temperature extremes that may cause condensation within it.
Before Applying Power	Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.
Line Power Requirements	The Keysight M8194A operates when installed in an Keysight AXIe mainframe.
Do Not Operate in an Explosive Atmosphere	Do not operate the instrument in the presence of flammable gases or fumes.
Do Not Remove the Instrument Cover	Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel.
	Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.
Ground the Instrument	To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Instrument Markings

The Table 1 lists the definitions of markings that may be on or with the product.

Table 1   Instrument Markings

Marking	Description
⚠	The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction in the documentation.
⏚	Frame or chassis ground terminal. Typically connects to the equipment's metal frame.
KC	South Korean Certification (KC) mark; includes the marking's identifier code which follows this format: R-R-Kst-ZZZZZZZZZZZZZZ
⚠	Indicates that anti-static precautions should be taken.
⟳40	China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.
RCM	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
CSA US	The CSA mark is a registered trademark of the CSA International.

Marking	Description
$C \in$	The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). This product complies with all relevant directives.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.
ccr.keysight@keysight.com	The Keysight email address is required by EU directives applicable to our product.

Compliance and Environmental Information

Table 2   Compliance and Environmental Information

Safety Symbol	Description
	This product complies with WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product. Do not dispose in domestic household waste.
	To return unwanted products, contact your local Keysight office, or see http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

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Keysight M8194A 120 GSa/s Arbitrary Waveform Generator

Getting Started Guide

1 Introduction

This chapter provides an overview of M8194A Arbitrary Waveform Generator.

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M8194A Overview

The Keysight M8194A is a 120 GSa/s AWG (Arbitrary Waveform Generator) with highest combination of speed, bandwidth and channel density. The M8194A is ideally suited to address following key applications:

- Coherent optical – a single M8194A module can generate 2 independent I/Q baseband signals (dual polarization = 4 channels) at 64 Gbaud and beyond.
- Multi-level / Multi-channel digital signals – generate NRZ, PAM4, PAM8, DMT, etc. signals at up to 56 Gbaud. Embed/De-embed channels, add Jitter, ISI, noise and other distortions.
- Physics, chemistry, and electronics research – generate any mathematically defined arbitrary waveforms, ultra-short yet precise pulses and extremely wideband chirps.
- Wideband RF/µW – generate extremely wideband RF signals with an instantaneous bandwidth of DC to 32 GHz for aerospace, defense and communication applications.

Key Features

The M8194A 120 GSa/s Arbitrary Waveform Generator has the following key features:

- Sample rate up to 120 GSa/s (on each channel)
- 1, 2 or 4 differential channels on a 1-slot AXIe module enable optimized channel density
- Vertical resolution: 8 bits
- Arbitrary signal generation with frequency content up to 50 GHz
- 8-bit vertical resolution
- 512 kSamples per channel (enables PRBS 2^{15}-1)

Supporting Operating System

The Keysight M8194A supports the following operating systems:

- Windows 10 (32 bit or 64 bit)
- Windows 8.1 (32 bit or 64 bit)
- Windows 8 (32 bit or 64 bit)
- Windows 7 (32 bit or 64 bit)

Options

The following options are available for the current release of M8194A:

Table 3   M8194A feature options

Product Number	Description	Available as SW upgrade?	Comments
M8194A-001	Arbitrary waveform generator module 1 channel, 120 GSa/s	N/A (minimum configuration)	Must order either: 001, 002, or 004
M8194A-002	Arbitrary waveform generator module 2 channels, 120 GSa/s	Yes	Must order either: 001, 002, or 004
M8194A-004	Arbitrary waveform generator module 4 channels, 120 GSa/s	Yes	Must order either: 001, 002, or 004
M8194A-BU2	Bundle consisting of one M9502A 2-slot AXIe chassis with USB option		
M8194A-BU3	Bundle consisting of one M9502A 2-slot AXIe chassis with USB option and one M9537A AXIe embedded PC controller		

Option -001, Option -002, and Option -004

With this option the number of channels is selected. The M8194A is available in a one channel (-001), two channel (-002) or 4 channel (-004) version. A software upgrade from one to two channels is possible by installing option U02. A software upgrade from two to four channels is possible by installing option U04. In order to upgrade from one to four channels, first option –U02 and next –U04 must be installed.

Upgrade Options

For the M8194A, the following upgrade options are available.

Table 4   M8194A upgrade options

Option	Description
M8194AU-U02	Upgrade from 1 channel to 2 channels
M8194AU-U04	Upgrade from 2 channels to 4 channels

Installing Licenses

After you purchase a license and you acquire the corresponding license file, you need to install the license on M8194A.

You can install the new license in the following ways:

1   In the **Keysight License Manager**, click the **Tools** button, and then select **Install License File...**. An **Install License File(s)** window appears. In this window, browse to the location where you saved the license file. Select the license file, and then click the **Open** button.

2   To manually install a license by entering the appropriate license file information, click the **Tools** button, click **Install License from Text...**. The **Install License from Text** dialog box appears. Type in the license data exactly as you received from Keysight. Click the **Install** button to install the license.

Once the licenses are installed, you can use the **Keysight License Manager** to view all licenses for the local system as depicted in the following figure.

Options U02 and U04 are upgradeable using the KLM (Keysight License Manager); see Table 4 on page -14.

Observe following steps while installing licenses:

1   Close the firmware of the M8194A.

2   Install the licenses using KLM.

3   Start the firmware of the M8194A. The firmware finds the new licenses in KLM and installs them in the M8194A.

In case of an upgrade from one channel (-001) to four channels (-004), the following steps must be observed:

1   Close the firmware of the M8194A.

2   Install license –U02 using KLM.

3   Start the firmware of the M8194A. The firmware finds the new license –U02 in KLM and installs it in the M8194A.

4   Close the firmware of the M8194A.

5   Install license –U04 using KLM.

6   Start the firmware of the M8194A. The firmware finds the new license –U04 in KLM and installs it in the M8194A.

Front Panel

illustrates the front panel of the M8194A instrument.

Figure 1   M8194A front panel

The M8194A front panel include the following input/output ports:

Data Outputs

- The M8194A is always delivered with four physically available differential Data Outputs of the Digital to Analog Converter (DAC). The analog DAC outputs are labeled with Data Out Channel 1, Data Out Channel 2; Data Out Channel 3, Data Out Channel 4. Depending on the channel option (-001 or -002 or -004) that has been installed, the M8194A one, two, or four differential analog outputs of the Digital to Analog Converters (DAC) are enabled for data generation.

  Option -001: The differential output Data Out Channel 1 is enabled for analog data generation. Also, one or two digital markers can be generated at Data Out Channel 3 and Data Out Channel 4.

  Option -002: The selected Instrument Mode (see Instrument Modes on page 17) determines, which channels are enabled for analog data and marker generation.

- In '**Dual Channel**' mode the differential outputs Data Out Channel 1 and Data Out Channel 2 are enabled for analog data generation. Data Out Channel 3 and Data Out Channel 4 are disabled.
- In '**Dual Channel with Marker**' mode the differential outputs Data Out Channel 1 and Data Out Channel 2 are enabled for analog data generation. One or two digital markers can be generated at Data Out Channel 3 and Data Out Channel 4.

- **Option -004**: The differential output Data Out Channel 1, Data Out Channel 2, Data Out Channel 3 and Data Out Channel 4 are enabled for analog data generation.

NOTE	The Data Outputs can be used differentially or single-ended. In case the output is used single-ended, the unused output must be terminated with 50 Ohm to GND to achieve optimum signal quality.

- **Sync In A 1 2 3 4** - This port is reserved for the future use.
- **Sync Out A 1 2 3 4** - This port is reserved for the future use.
- **Sync In B** - This port is reserved for the future use.
- **Sync Out B** - This port is reserved for the future use.

Data Out LEDs

Table 5   Data out LEDs

State/Color	Meaning	Description
Off	Output disabled	Represents the state 'Disable'. Selectable from Soft Front Panel or SCPI. The output amplifier is not powered. After Power-On the LED is off. After successful initialization of the M8194A, the LED turns to its default state which is OFF.
ON, Green	Output enabled	Represents the state 'Enable'. Selectable from Soft Front Panel or SCPI: ▪ Output amplitude is equal to the adjusted amplitude. ▪ Offset is equal to the adjusted amplitude. ▪ External Termination voltage is equal the adjusted termination voltage.
On, Red	Protection circuit active	Error condition such as: ▪ The externally applied termination voltage significantly differs from the adjusted termination voltage. ▪ External termination resistor significantly differs from 50 Ohm. User interaction is required to remove the externally applied error condition. After removal, the user must actively enable the output again.

Status LEDs

Following LEDs are available at the front panel to indicate the status of the M8194A module:

- The green '**Access**' LED:
    - It indicates that the controlling PC exchanges data with the AWG module.
- The red '**Fail**' LED has following functionality:
    - It is 'ON' for about 30 seconds after powering the AXIe chassis.
    - After about 30 seconds the LED is switched 'OFF'. If an external PC is used to control the AXIe chassis, this PC can be powered after this LED has switched OFF.
    - During normal operation of the module this LED is 'OFF'. In case of an error condition such as e.g. a self-test error, the LED is switch 'ON'.

Instrument Modes

Following are the available instrument modes which are associated with the instrument options:

- Option –001 allows the selection of the instrument mode 'Single Channel' or 'Single Channel with Marker'.

    The waveform is always sent at channel 1. The digital markers are always sent at channel 3 and 4.

- Option -002 allows the selection of the Instrument Mode 'Single Channel', 'Single Channel with Marker', 'Dual Channel with Marker' or 'Dual Channel'.

    In Instrument mode 'Dual Channel', no digital markers are available.

    Each channel can be enabled and disabled independently from other channels.

- Option -004 allows the selection of the Instrument Mode 'Single channel', 'Single Channel with Marker', 'Dual Channel with Marker', 'Dual Channel', or 'Four Channel'.

    In Instrument mode 'Four Channel', no digital markers are available.

    Each Channel can be enabled and disabled independently from other channels.

Related Documents

To access documentation related to the Keysight M8194A digitizer, use one of the following methods:

- **CD** – Browse the product CD for M8194A documentation.
- **Start** > **All Programs** > **Keysight M8194** > **Keysight M8194 Documentation** – Provides links to all product documentation.
- **Start** > **All Programs** > **Keysight M8194** > **Keysight M8194 Examples** – Provides example waveform files.
- Go to the product web site (www.keysight.com/find/M8194A) and browse the manuals under **Document Library** tab.

Additional Documents

Additional documentation can be found at:

- http://www.keysight.com/find/M9502A for 2-slot chassis related documentation.
- http://www.keysight.com/find/M9505A for 5-slot chassis related documentation.
- http://www.keysight.com/find/M9514A for 14-slot chassis related documentation.
- http://www.keysight.com/find/M9537A for embedded AXIe controller related documentation

2 M8194A Software Installation

This chapter explains the steps required to install M8194A software package.

Prerequisites

The following are the prerequisites for installing Keysight M8194A software:

1   Windows Operating System

    The supported Window operating systems are:

    · Windows 10 (32 bit or 64 bit)
    · Windows 8.1 (32 bit or 64 bit)
    · Windows 8 (32 bit or 64 bit)
    · Windows 7 (32 bit or 64 bit)

2   Keysight IO Libraries Suite

    Ensure that you have **Keysight IO Libraries Suite** version 18.0 or higher installed on your system. The **Keysight IO Libraries Suite** can be found on the CD that is part of shipment content or at
    http://www.keysight.com/find/iosuite

| NOTE | Even if a non-Keysight I/O library is already installed on your PC, it is still necessary to install the Keysight I/O library. The Keysight I/O library will install as "secondary" I/O library in this case. |

Installation Steps

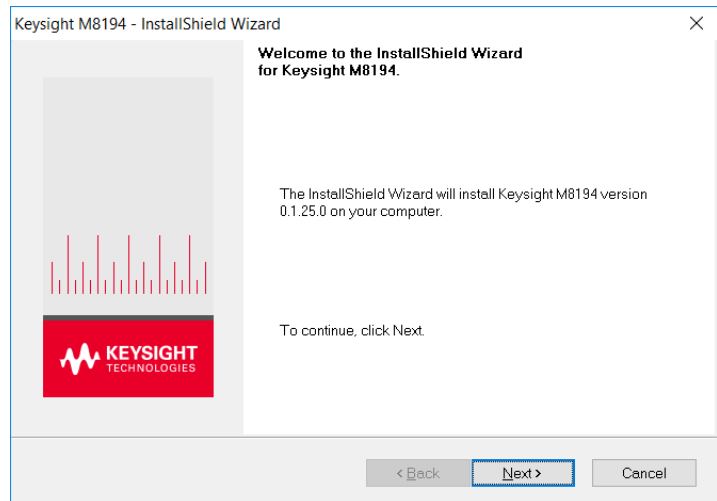Follow the given steps to install Keysight M8194A software on your system:

1   Double-click the executable (*M8194A_Setup.exe*). This executable file is available either on CD or Web.
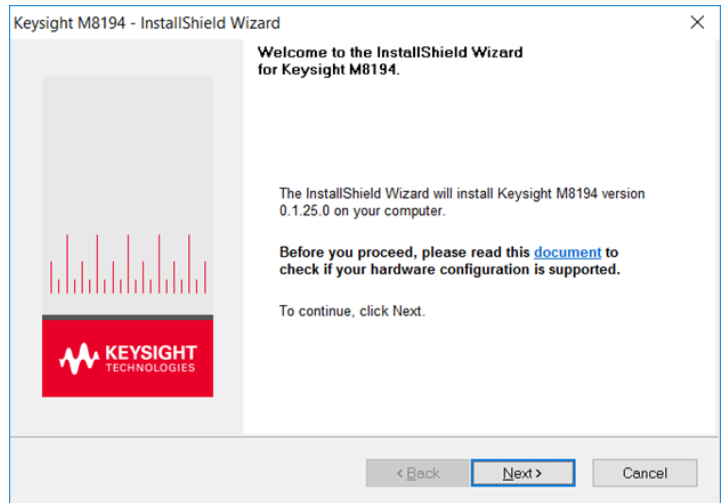
2   The Keysight **M8194A Setup** will prepare the **InstallShield Wizard** for the installation process.

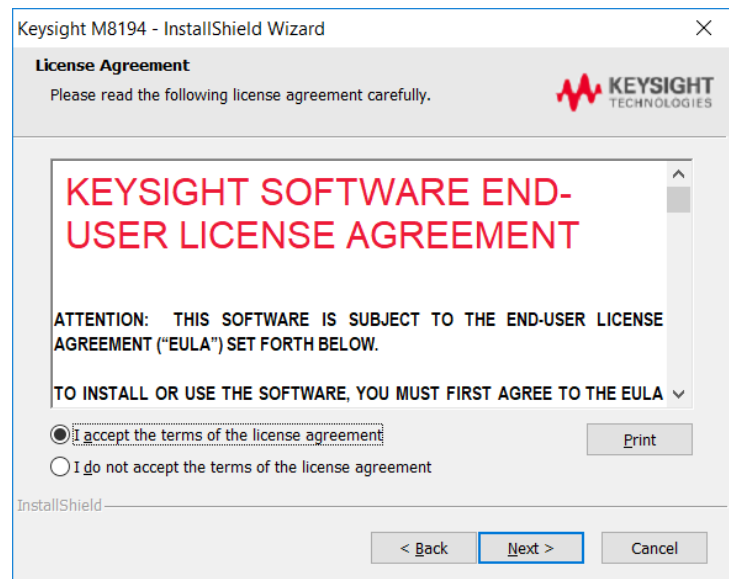3   Follow the on-screen instructions to begin the installation process. Click **Next**.

4   We recommend you to read the document to check if your hardware configuration is supported. Click **Next** to proceed to the license
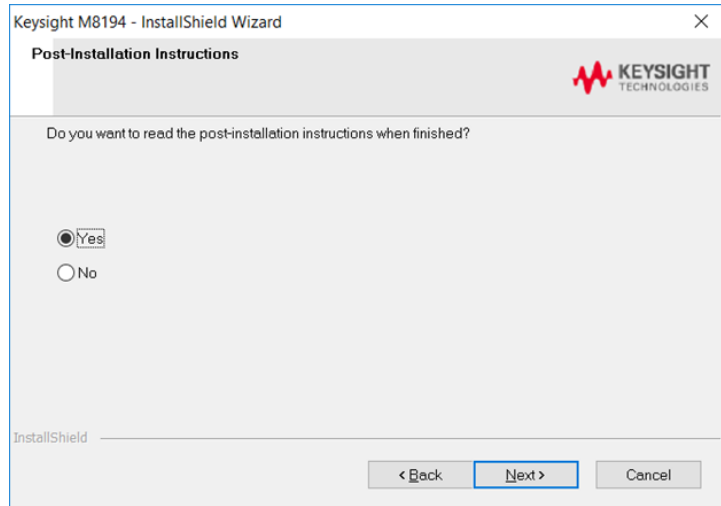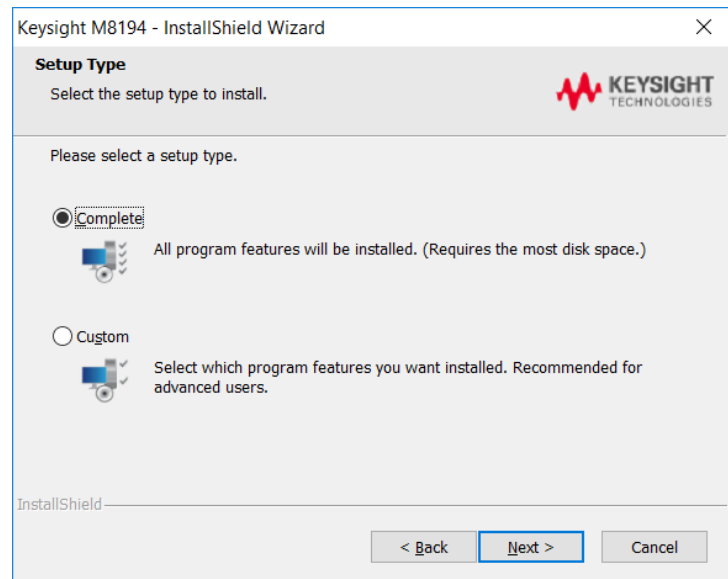
agreements.

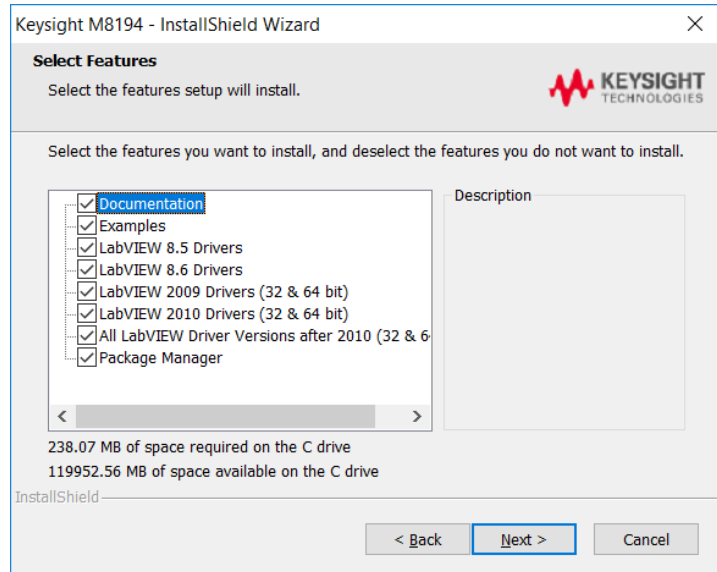5   Accept the terms of Keysight software end-user license agreement and click **Next**.

6   Select **Yes** if you want to read the post-installation instructions when finished. Click **Next** to select setup type.
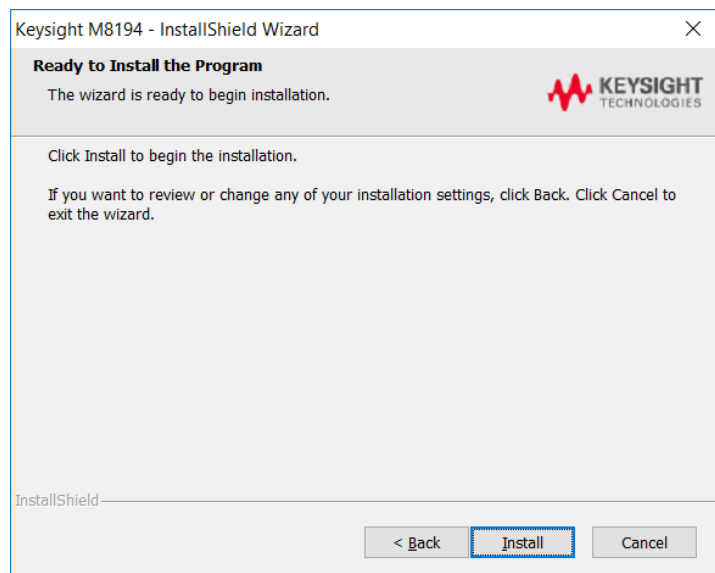

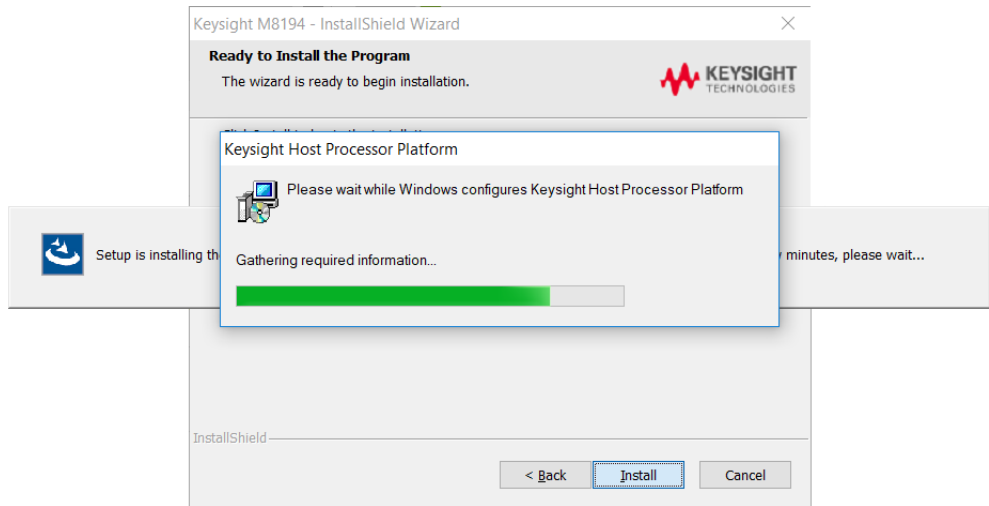7   Select a setup type either **Complete** or **Custom**. Click **Next**.

8   If you select **Custom** and click **Next**, you can specify which optional features will be installed.
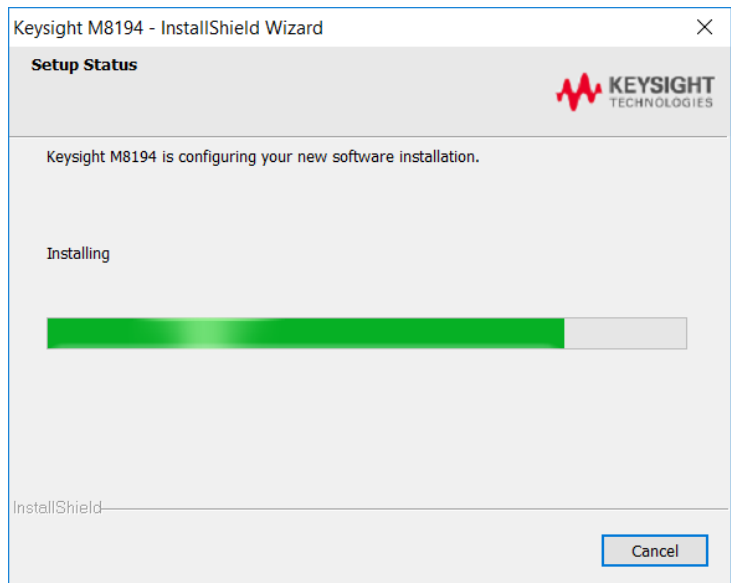

9   Click **Install** to begin installation.

10 The **Setup Wizard** will now install M8194A beginning with Keysight Common Components Libraries, Host Processor Platform and USB driver installation.

11 The Keysight M8194A will configure the new software installation.

12 The following screen will appear once the Keysight M8194A software is successfully installed on your system.
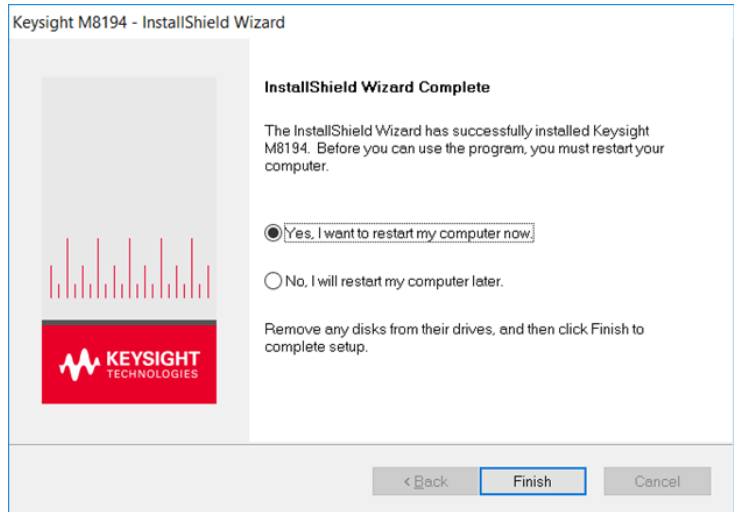
13 Click **Finish** to restart your system. Do not connect the AXIe chassis to your system using the PCIe or USB cable during this reboot.

This completes the Keysight M8194A software installation.

Post Installation Steps

Follow the post installation steps as shown below:

NOTE If M8194A is already powered up and connected to PC using the PCIe, just reboot the PC and start with step 5. No such reboot step is required in case of USB connection.

1 Shut down PC and instrument.
2 Connect the instrument to the PC using the PCIe cable.
3 Switch on the instrument. Wait until the 'Access' LED of the M8194A has switched from red to green.
4 Switch on the PC.
5 The PC should automatically recognize the instrument.

   Check this in the device manager; e.g. via **Start** > **Control Panel** > **Device Manager**, or right-click **Computer** > **Manage** > **Device Manager**:

   · In case of PCIe: The instrument should be visible in the device tree as **Keysight Technologies Modular Devices** > **M8194A**
   · In case of USB: The instrument should be visible in the device tree as **Keysight Modular Platform (AMP/AXIe)** > **Keysight Technologies USB AMP/AXIe Chassis**

NOTE In case of PCIe, post installation steps must be followed strictly in the same order as mentioned for successful connection of the PC with M8194A. However, in case of USB no such restriction is applicable i.e. the PC can be powered before the M8194 is turned ON.

NOTE Your PC might request a reboot. Reboot your PC, if requested.

6 (For PCIe only) Check if the M8194 is also visible in the **Connection Expert**. The connection expert can be opened by clicking its icon in the system tray. If something went wrong and the instrument is not showing in the PXI section, it may be necessary to reboot the PC once more.

How to use M8194A Instrument

In order to use the instrument:

1   If you use a PCIe link to control the M8194A, the AXIe chassis must be switched on before you start the PC.

2   Start the M8194A Soft Front Panel (**Start** > **All Programs** > **Keysight M8121** > **Keysight M8194A Soft Front Panel**). The user interface will display the VISA resource strings for different kinds of connection.

3   Using the appropriate VISA resource string you can control the instrument with your own application using the SCPI interface.

You must start the M8194A Soft Front Panel in order to send SCPI commands to the instrument.

NOTE   The M8194A IVI Drivers start the M8194A Soft Front Panel automatically.

3 M8194A Maintenance

This chapter explains the steps required to install M8194A software package.

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Service and Repair

This system should be serviced only by authorized personnel.

WARNING Using controls or adjustments or performing procedures other than those specified in the documentation supplied with your equipment can result in hazardous radiation exposure.

ESD Protection

CAUTION All the connectors are very sensitive to electrostatic discharge (ESD). There are also several exposed components on the PCAs, on both sides of M8194A, which can be touched accidentally while handling the unit and can risk damage to the instrument, due to ESD. When you connect a device or cable that is not fully discharged to these connectors, you risk damage to the instrument and expensive instrument repairs.

CAUTION Electrostatic discharge (ESD) can damage the circuits of the M8194A. Avoid applying static discharges to the front-panel connectors. Avoid touching the front-panel connectors without first touching the frame of the instrument. Be sure the instrument and all connected devices (DUT, etc.) are properly earth-grounded (to a common ground) to prevent buildup of static charge and electrical over-stress.

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. The following list and figure shows an example of a static-safe work station using two types of ESD protection. Purchase acceptable ESD accessories from your local supplier.

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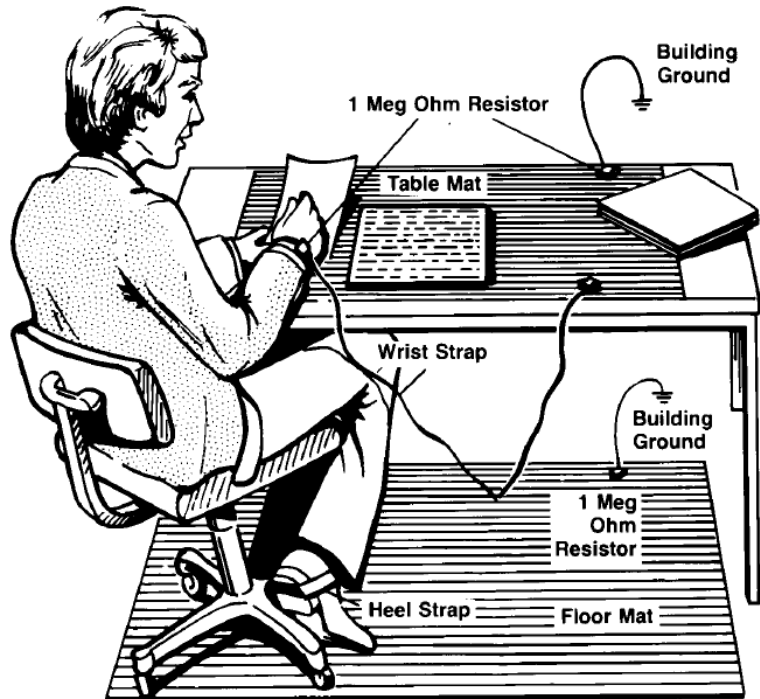- Conductive floor-mat and heel-strap combination.

Figure 2   ESD protection

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 MW of isolation from ground.

WARNING   These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.

Power and Ventilation Requirements

For power and ventilation requirements, refer to:

- http://www.keysight.com/find/M9514A for 14-slot chassis related documentation.
- http://www.keysight.com/find/M9505A for 5-slot chassis related documentation.
- http://www.keysight.com/find/M9502A for 2-slot chassis related documentation.

Thermal Protection

Overheating Detection

The instrument monitors its internal temperature. If the temperature exceeds approximately 80°C the power supply is switched off. The instrument will not turn on automatically if the temperature is decreasing again.

Fan Failure

If a fan is broken or prevented from operating by a blockage the temperature will increase. When the temperature exceeds approximately 80°C the overheating detection switches off the instrument for safety reasons. For reliability it is recommended to send instruments with broken or defective fans immediately to Keysight Service for repair.

Battery

The M8194A module does not have a battery.

Operating Environment

For details on operating environment for M8194A module, refer to the section Operating Environment on page 33.

4 Characteristics

Performance Specification

The performance specification can be found in the Data Sheet of the
M8194A at: http://www.keysight.com/find/M8194A.

Operating Environment

Storage Temperature	−40 °C to +70 °C
Operating Temperature	0 °C to 40 °C
Operating Humidity	5% to 80% relative humidity, non-condensing
Operating Altitude	Up to 2000 m
Installation	Category II
Pollution	Degree 2

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WARNING The instrument is not designed for outdoor use. Do not expose the instrument to rain or other excessive moisture. Protect the instrument from humidity and temperature changes, which could cause condensation within the instrument.

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

General

Power consumption	50 W (nom)
Safety designed to	IEC61010-1, UL61010, CSA22.2 61010.1 tested
EMC tested to	IEC61326-1
Warm-up time	30 min
Calibration interval	2 years recommended
Cooling Requirements	When operating the M8194A choose a location that provides at least 80 mm of clearance at rear, and at least 30 mm of clearance at each side for the AXIe chassis.

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