M8100 Series Arbitrary Waveform Generators

M8008A Clock Generator

M8198A Arbitrary Waveform Generator

M8157A Remote Head for M8198A AWG

M8199A Arbitrary Waveform Generator

M8158A Remote Head for M8199A AWG

M8199B Arbitrary Waveform Generator

KEYSIGHT

GETTING STARTED GUIDE

Notices

Trademarks

PCI Express® and PCIe® are registered trademarks of PCI-SIG.

Manual Part Number

M8100-91B20

Edition

Edition 6.0, March 2026

Printed in Germany

Keysight Technologies Deutschland GmbH
Herrenberger Strasse 130,
71034 Böblingen, Germany

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

U.S. Government Rights

The Software is “commercial computer software,” as defined by Federal Acquisition Regulation (“FAR”) 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement

(“DFARS”) 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at http://www.keysight.com/find/sweula. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT WILL CONTROL.

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.

Keysight Cybersecurity

Product and Solution Cybersecurity

Keysight is dedicated to ensuring the cybersecurity of its products and solutions. For detailed information, visit Product and Solution Cybersecurity.

Report a Product Cybersecurity Issue

If you encounter a cybersecurity issue with a Keysight product, report it immediately at: Product Cybersecurity Issue Reporting.

Responsible Disclosure Program

Keysight encourages responsible disclosure of security vulnerabilities. For more details, visit Responsible Disclosure Program.

Product Software Updates

Keysight releases periodic software updates to fix known defects, incorporate product enhancements, and address cybersecurity vulnerabilities, if any. Ensure that your product software is always up to date. To search for software updates for your product, visit the Keysight Technical Support page at: https://www.keysight.com/find/M8100.

User Documentation

User documentation includes comprehensive information on features that may impact the secure deployment, use, and decommissioning of our products. This includes details on exposed network ports, the use of cryptography and authentication, and firmware security settings, if necessary.

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.

General

This product is a Safety Class 1 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.

All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1.

Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters.

Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

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.

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.

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.

Safety Symbols

Table 1 Safety Symbols

Symbol	Description
	Indicates warning or caution. If you see this symbol on a product, you must refer to the manuals for specific Warning or Caution information to avoid personal injury or damage to the product.
	The UKCA (UK Conformity Assessed) marking is a new UK product marking that is used for goods being placed on the market in Great Britain (England, Wales and Scotland). It covers most goods which previously required the CE marking.
	This symbol on all primary and secondary packaging indicates compliance to China standard GB 18455-2001.
	Indicates that antistatic precautions should be taken.
	CSA is the Canadian certification mark to demonstrate compliance with the Safety requirements.
	CE compliance marking to the EU Safety and EMC Directives. ISM GRP-1A classification according to the international EMC standard. ICES/NMB-001 compliance marking to the Canadian EMC standard.
	The RCM mark is a registered trademark of the Australian Communications Media Authority (ACMA).
	KC is the Korean certification mark to demonstrate that the equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.
	Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.

Compliance and Environmental Information

Table 2 Compliance and Environmental Information

Safety Symbol	Description
	The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by DIRECTIVE 2012/19/EU and other National legislation. See http://about.keysight.com/en/companyinfo/environment/takeback.shtml to understand your Trade in options with Keysight in addition to product takeback instructions.

About This Guide

This guide provides high-level information for an initial setup of the M8100 Series Arbitrary Waveform Generators. This guide focuses on setting up “bundled” systems such as the M8100A-BU5 and M8100A-BU6.

The M8100A-BU5 system has one or more modules from the M8100 series and pre-configured system consisting of one M9505A 5-slot AXIe Chassis with USB option.

The M8100A-BU6 system has one or more modules from the M8100 series and pre-configured system (pre installed M9537A with M8070B and M8199A module driver) consisting of one M9505A 5-slot AXIe chassis with USB option and one M9537A AXIe Embedded PC Controller.

If you ordered a system that requires on-site installation of individual M8100 series modules or the M9537A AXIe Embedded Host Computer into the M9505A AXIe Chassis, refer to the *M8000 Series of BER Test Solutions Installation Guide* for detailed module-level installation instructions.

For information on remote programming of one or more AWG modules in the M8100 series, refer to the *M8100 Series Programming Guide*.

Contents

1 Introduction

This chapter introduces you to Keysight's M8100 Series of Arbitrary Waveform Generators. It also introduces you to the concept of using a host computer to communicate with the M8100 series of modules.

Introduction to M8100 Series AWG Modules

The M8100 series of AWG modules are recognized by the model number and name located on their front panel.

Each of the supported modules has some standard hardware and software features that are available with a standard license for that module. Some upgraded features/components of a module are licensed and are only available when you purchase and install a license for that option.

The M8100 series of AWGs support the following modules.

- M8008A Clock Generators
- M8198A Arbitrary Waveform Generators
- M8157A Arbitrary Waveform Generator Remote Head
- M8199A Arbitrary Waveform Generators
- M8158A Arbitrary Waveform Generator Remote Head
- M8199B Arbitrary Waveform Generators

Details on the features and hardware components of each of the above mentioned modules are further described in this chapter.

M9505A AXIe Chassis

The M9505A AXIe chassis is a modular instrument chassis that supports complex and high density testing. The chassis provides five slots for installing multiple AXIe based instrument modules such as the M8100 series AWG modules and so on. Besides providing a frame for the installation of these instrument modules, the M9505A AXIe chassis also provides power, a cooling system, a PCIe Gen2 local data bus, a Gigabit LAN interconnect, and a USB and PCIe connection for external host computer connectivity.

NOTE The USB connection is recommended when using a laptop or desktop PC as an external controller. The PCIe connection is recommended for use with a desktop PC as an external controller only.

NOTE PCIe connectivity between the M9505A AXIe Chassis and an external desktop PC controller is recommended when full channel plus large waveforms need to be downloaded.

Figure 1 M9505A 5-slot chassis

Refer to the *Keysight M9505A AXIe Chassis Startup Guide* to get detailed information about the AXIe chassis.

AXIe Embedded System Module (USB ESM)

The bottom slot of the AXIe chassis is reserved for the Embedded System Module (ESM) which is factory installed. The ESM has a USB 2.0 interface as well as a PCIe x8, Gen1 and Gen2 compliant interface to connect an external host computer to the chassis.

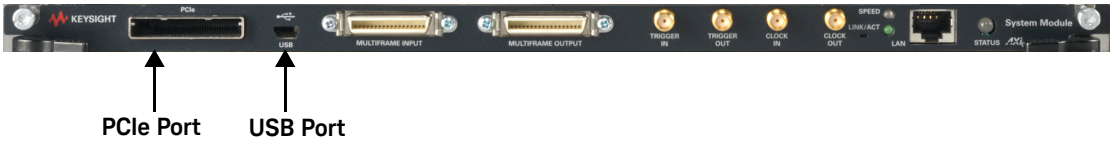


Figure 2 AXIe Embedded System Module

The ESM:

- runs the chassis embedded operating system which manages all internal tasks and communications.
- tracks inserted modules and manages power requirements.
- monitors chassis temperature and controls variable-speed chassis fans.
- monitors module sensors and reports component failures to a system log.
- acts as a Gigabit Ethernet switch; forwards frames along the backplane.
- connects an external host computer to the chassis.
- synchronizes timing across all modules through the Keysight Trigger Bus, using an internal or external clock source.

LAN connector on AXIe ESM is not used. Only use LAN connection on the host computer.
Either the PCIe (desktop only) or USB (desktop or laptop) port can be used in this ESM but not both simultaneously. When you use the PCIe port, the USB port is automatically disabled until the PCIe port is no longer in use.

M9537A AXIe Embedded Controller Module

The M9537A AXIe Embedded Controller is a one slot module that you can install in the M9505A AXIe chassis like any other instrument module. This module acts as a host computer when installed in the M9505A AXIe chassis. It is always installed in slot 1 of the M9505A AXIe chassis.

The following figure displays this module.

Figure 3 M9537A AXIe Embedded Controller Module

Host Computer

A host computer is used to:

- host all the software components of the instrument modules needed to control, configure, and use the modules.
- communicate with the ESM of the M9505A AXIe chassis to allow you to monitor and control the chassis.

A host computer can be:

- the M9537A AXIe Embedded Controller module.
- a laptop with a USB port.
- a desktop PC with a USB port or x8 or wider PCIe slot for the cabled PCIe adapter card.

Refer to the Computer Hardware and Software Requirements on page 44 for external host computer minimum requirements.

M8008A Clock Generator

Keysight's M8008A clock generator is designed as sample clock source for:

- M8198A 128 GSa/s Arbitrary Waveform Generators
- M8199A 128/256 GSa/s Arbitrary Waveform Generators
- M8199B 256 GSa/s Arbitrary Waveform Generators

It can also be used as a standalone low-jitter clock source for other applications. It has four outputs that provides an output frequency of 32 GHz to 64 GHz. It has two system trigger inputs that allow system control from external hardware. It also allows synchronous trigger distribution over local bus on the AXIe chassis backplane to adjacent AWG modules.

The M8008A is an instrument module that can be installed into the M9505A 5-slot AXIe chassis. It comes as a 1-slot AXIe module, which allows the M8008A plus either one M8198A AWG modules or up to two M8199A / M8199B modules to be plugged into a single 5-slot AXIe chassis.

The M8008A Clock Generator module provides the following key features:

- 32 - 64 GHz continuous frequency range
- Output amplitude up to +10 dBm
- Very low intrinsic jitter and wideband phase noise
- Four clock outputs can drive up to:
  - one M8198A AWG module (=2 channels)
  - four M8199A AWG modules (=16 channels)
  - four M8199B AWG modules (=8 channels)

M8008A Module Components

Figure 4 displays the front panel of the M8008A module:

Figure 4 M8008A module front panel

As displayed in the image above, the M8008A module has the following components.

Table 3 Front Panel LEDs

Front Panel LED	Active when...	Color
Fail	power-up fault condition	red
Access	power-up ready state	green

Table 4 Insertion/Extraction and Retaining

Component	Description
Retaining screws	The screws on both ends of the module are used to retain the module tightly inside the M9505A AXIe Chassis slot once you have fully placed it inside the chassis. To remove the module, you first need to loosen these screws ensuring that these screws disengage completely.
Module Insertion/Extraction Handles	The handles on both sides of the module to insert or eject the module from the slot of the M9505A AXIe Chassis.

M8008A Front Panel Connectors

CAUTION The inputs of the M8008A module are sensitive to static electricity. Therefore, take necessary anti-static precautions, such as wearing a grounded wrist strap, to minimize the possibility of electrostatic damage.

Table 5 M8008A Front Panel Connectors

Connector	Description
Sync In	Reserved for future use
Sync Out A, B, C, D	This output is used to synchronize two or more M8199A / M8199B modules to a common system clock. It is also required for the M8198A module. It is connected to the Sync In of the M8198A / M8199A / M8199B module.
Sample Clk Out 1 and Sample Clk Out 2	Sample clock outputs, connected to “Sample Clk In” on up to four M8199A modules. Each pair of sample clock outputs can be turned on and off independently. Sample clock outputs, connected to “Sample Clk In” on the M8198A module. Refer to Table 8 for cabling instructions.
Sys Trig In A/B	Reserved for future use.
Ref Clk In	This input allows locking the clock frequency to an external 10 or 100 MHz reference clock.
Ref Clk Out	The reference clock output is used to provide a 10 MHz or 100 MHz reference clock to the DUT or other test equipment.
Ref Clk Out 16G	The reference clock output is used to provide an 8 GHz ... 16 GHz reference clock to the DUT or other test equipment. It can be used as a precision time-based reference signal for DCA sampling oscilloscopes.

M8198A Arbitrary Waveform Generator

Keysight's M8198A 128 GSa/s Arbitrary Waveform Generators are high-performance signal source with large memory and sequencing capabilities for generation of arbitrary signals, to aid engineers in quick development and design of complex electronic and computing systems.

The key benefits of using the M8198A Arbitrary Waveform Generator are:

- Up to two channels per module at 128 GSa/s with an analog bandwidth of 58 GHz
- Integrated, ready-to-use instrument, requires M8008A clock module
- Operates with well-known software, like MATLAB, Keysight IQTools and SCPI programming interface based on M8070B
- Offers up to 8 GSa sample memory per channel

M8198A Applications

- Coherent Optical Applications - The M8198A is the ideal solution to test various optical systems from discrete components like optical power amplifiers to more complex dual polarization systems such as optical modulators or optical receivers. Even for tests of signal processor ASICs or algorithm, the M8198A is an excellent signal source to provide stressed signals to these devices.
- Multi-Level/Multi-Channel Digital Signals - The M8198A is the right tool that provides the flexibility for advanced research on improved and more advanced modulation formats to boost transmission rates to the next level. The flexibility of the waveform generation with highest speeds, combined with excellent intrinsic jitter performance makes the M8198A a truly unique and versatile instrument.
- Wideband RF Signal Generation in Wireless and Aerospace/Defense applications - With sample rates of 128 GSa/s, the M8198A has enough oversampling gain to generate extremely broad bandwidth, yet high fidelity RF signals.
- Physics, Chemistry and General-Purpose Electronics Research - The M8198A AWG allows you to generate any arbitrary waveform that can be mathematically described. For example, a signal calculated in MATLAB can be downloaded directly into the M8198A. This includes ultra-short, yet precise pulses down to ~7 ps pulse width or extremely short, wideband RF pulses and chirps which are needed to investigate in chemical reactions, elementary particle excitation and quantum effects.

The M8198A is an instrument module that can be installed into the M9505A 5-slot AXIe Chassis. This module occupies three slots of the 5-slot chassis. It must be installed in the slot immediately above the M8008A Clock Generator module. The M8008A module must be installed in slot 1; therefore, the M8198A module must be installed in slots 2 to 4 of the AXIe chassis.

If the M9537A AXIe Embedded Controller is also being used, the Controller module must be installed in slot 1, followed by the M8008A module in slot 2 and M8198A module in slots 3 to 5, respectively.

Figure 5 shows a typical configuration of an M8198A AWG module with the M8008A Clock Generator module.

Figure 5 M8198A AWG and M8008A Clock Generator configuration

M8198A Module Components

Figure 6 displays the front panel of the M8198A module:

Figure 6 M8198A module front panel

As displayed in the image above, the M8198A module has the following components.

Table 6 Front Panel LEDs

Front Panel LED	Active when...	Color
Fail	power-up fault condition	red
Access	power-up ready state	green

Table 7 Insertion/Extraction and Retaining

Component	Description
Retaining screws	The screws on both ends of the module are used to retain the module tightly inside the M9505A AXIe Chassis slot once you have fully placed it inside the chassis. To remove the module, you first need to loosen these screws ensuring that these screws disengage completely.
Module Insertion/Extraction Handles	The handles on both sides of the module to insert or eject the module from the slot of the M9505A AXIe Chassis.

M8198A Front Panel Connectors

CAUTION

This device is ESD-sensitive when operated. The electrostatic discharge to any part of the module or chassis may cause timing alignment issues of the channels, which can be mitigated by toggling the sample rate. Therefore, take necessary anti-static precautions, such as wearing a grounded wrist strap, to minimize the possibility of electrostatic damage.

Table 8 M8198A Front Panel Connectors

Connector	Description
Channel 1 Data Out and $\overline{\text{Data Out}}$	Differential AWG data outputs (1.85 mm female connectors) for Channel 1.
Channel 2 Data Out and $\overline{\text{Data Out}}$	Differential AWG data outputs (1.85 mm female connectors) for Channel 2.
CH 1 Clk In	Channel 1 sample clock input, connect to Sample Clock Out 1 of the M8008A clock module. Note: Do not connect to Sample Clock Out 2 of the M8008A.
CH 2 Clk In	Channel 2 sample clock input, connect to Sample Clock Out 1 of the M8008A clock module. Note: Do not connect to Sample Clock Out 2 of the M8008A.
Sync In	Used for Channel synchronization. The Sync Out of the M8008A module is connected to the Sync In of the M8198A.
Sample Marker Out 1/2 and Sample Marker Out 1/2	Differential Sample Marker Output.
Event In A/B	Reserved for future use.
Event Out A/B	Reserved for future use.
LB In / Out	Local Bus connection to next chassis.
Remote Head 1/ 2	Remote Head Control.

The M8198A AWG is controlled by the M8070B software system version 10.5 and above, which includes a free version of a MATLAB-based utility named ‘IQTools’. IQTools provides a large number of utilities to generate waveforms along with an option to download user-defined waveforms. The IQTools utility also supports “in-system calibration” to measure and compensate the frequency and phase response of the AWG and any external circuitry. It can compensate skew between all channels.

M8157A Remote Head for M8198A Arbitrary Waveform Generator

The M8157A remote head is an external amplifier that is used in combination with the M8198A Arbitrary Waveform Generator. It helps in minimizing signal degradations caused by lossy channels.

The following figure shows the M8157A remote head:

Figure 7 M8157A remote head

The M8157A remote head provides 1.85 mm connectors which is used to accommodate close connection to the device under test. The M8157A remote head supports the complete sample rate range of the M8198A (100 GSa/s to 128 GSa/s).

The three cables on the back side of the remote heads are used to connect with the M8198A AWG module and are not removable.

Please refer "*M8100 Series Tips for Preventing Damage*" document for mounting remote head cables.

M8157A Remote Head Components

The following figure displays the front panel of the M8157A remote head with its various components.

Figure 8 M8157A remote head components

As displayed in Figure 8 on page -26, the M8157A remote head has the following components.

Table 9 Front Panel LED

Front Panel LED	Active when...	Color
Ready	remote head is operational	green
Data Out, $\overline{\text{Data Out}}$	On when data output is active	green

Table 10 M8157A Front Panel Connector

Connector	Description
Data Out and $\overline{\text{Data Out}}$	Connected to DUT

The back panel of M8157A remote head has cables which connects with M8198A. The blue cables connect to the M8198A Data Out ports while the grey cable connects to the M8198A Remote Head port.

Ensure that the chassis is NOT powered up or connected to a power source while making connections to M8157A.

Also, make sure NOT to remove the M8157A connections when it is powered on. However, if you wish to remove the M8157A connections, ensure that the instrument is powered off.

M8199A Arbitrary Waveform Generator

Keysight's M8199A 128/256 GSa/s Arbitrary Waveform Generator delivers twice the sampling rate, coupled with 50 percent more analog bandwidth and increased ENOB compared to legacy AWG products. This combination of industry-leading specifications enables research engineers to quickly and accurately develop advanced components for terabit transmission systems.

The M8199A is a powerful arbitrary waveform generator, which enables signal generation of up to 140 GBd with outstanding signal quality in a 2-slot AXIe module. Whether testing the discrete components of optical coherent systems or path-finding for terabit transmission in the next-generation data center, the M8199A is ideal for addressing the need for high sample rates and high analog bandwidth.

The key benefits of using the M8199A Arbitrary Waveform Generator are:

- Four channels at 128 GSa/s or 2 channels 256 GSa/s with up to 70 GHz nominal analog bandwidth
- Provides research engineers a high-performance signal source for arbitrary signals, enabling development of designs up to 140 GBd.
- Delivers twice the sampling rate of any AWG, coupled with at least 50 percent higher analog bandwidth. As a result, research engineers can quickly develop advanced components for terabit transmission systems
- Integrated, ready-to-use instrument
- Operates with well-known software, like MATLAB or Keysight IQTools and SCPI programming interface based on M8070B
- High flexibility with upgrade options from 2 channels at 128 GSa/s to 4 channels at 256 GSa/s

M8199A Applications

- Coherent Optical Applications - The M8199A is the ideal solution to test various optical systems from discrete components like optical power amplifiers to more complex dual polarization systems such as optical modulators or optical receivers. Even for tests of signal processor ASICs or algorithm, the M8199A is an excellent signal source to provide stressed signals to these devices.
- Multi-Level/Multi-Channel Digital Signals - The M8199A is the right tool that provides the flexibility for advanced research on improved and more advanced modulation formats to boost transmission rates to the next level. Interleaving can boost the sample rate to 256 GSa/s,

enabling symbol rates beyond 128 GBd.

- Wideband RF Signal Generation in Wireless and Aerospace/Defense applications - Latest developments in radar and wireless technologies require signals with modulation bandwidths beyond 10 GHz, in some cases up to 30 GHz, with good signal quality. Generating those signals on an IF rather than I/Q is another important capability to support these applications.
- Physics, Chemistry and General-Purpose Electronics Research - The M8199A AWG allows you to generate any arbitrary waveform that can be mathematically described. For example, a signal calculated in MATLAB can be downloaded directly into the M8199A.
- This includes ultra-short, yet precise pulses down to 5 ps pulse width or extremely short, wideband RF pulses and chirps which are needed to investigate in chemical reactions, elementary particle excitation and quantum effects.

The M8199A is an instrument module that can be installed into the M9505A 5-slot AXIe Chassis. This module occupies two slots of the 5-slot chassis. It must be installed in the slot immediately above the M8008A Clock Generator module. The M8008A module must be installed in slot 1; therefore, the M8199A module must be installed in slots 2 and 3 of the AXIe chassis.

If the M9537A AXIe Embedded Controller is also being used, the Controller module must be installed in slot 1, followed by the M8008A module in slot 2 and M8199A module in slots 3 and 4, respectively.

Figure 9 shows a typical configuration of M8199A and M8158A.

Figure 9 M8199A and M8158A configuration

M8199A Module Components

Figure 10 displays the front panel of the M8199A module:

Figure 10 M8199A module front panel

As displayed in the image above, the M8199A module has the following components.

Table 11 Front Panel LEDs

Front Panel LED	Active when...	Color
Fail	power-up fault condition	red
Access	power-up ready state	green

Table 12 Insertion/Extraction and Retaining

Component	Description
Retaining screws	The screws on both ends of the module are used to retain the module tightly inside the M9505A AXIe Chassis slot once you have fully placed it inside the chassis. To remove the module, you first need to loosen these screws ensuring that these screws disengage completely.
Module Insertion/Extraction Handles	The handles on both sides of the module to insert or eject the module from the slot of the M9505A AXIe Chassis.

M8199A Front Panel Connectors

CAUTION

This device is ESD-sensitive when operated. The electrostatic discharge to any part of the module or chassis may cause timing alignment issues of the channels, which can be mitigated by toggling the sample rate. Therefore, take necessary anti-static precautions, such as wearing a grounded wrist strap, to minimize the possibility of electrostatic damage.

Table 13 M8199A Front Panel Connectors

Connector	Description
Remote Head 1, 2	Remote Head Control. This output provides power and control signals for the remote head amplifier
Data Out and $\overline{\text{Data Out}}$	Data outputs 1.85 mm
Sync In/Out A,B	The Sync In/OUT usage depends on whether the M8199A is connected to the M8008A clock module or whether it is driven by an external clock source. The Sync Out connector is reserved for future use. **M8199A connected to M8008A clock source:** The Sync Out A/B is not used. The Sync In is used to synchronize multiple modules to a common system clock. It is connected to one of the Sync Out outputs of the M8008A module.
Clk In	AWG clock input (half-rate). Connect to clock output of M8008A clock generator module.
Sample Marker Out and $\overline{\text{Sample Marker Out}}$	Differential Marker output to mark individual data samples. Max output bandwidth 16 GHz.
Sync Marker Out A/B	Marker output to generate subrate clocks for example. Max output bandwidth 2 GHz.

The M8199A AWG is controlled by the M8070B software system version 7.5 and above, which includes a free version of a MATLAB-based utility named 'IQTools'. IQTools provides a large number of utilities to generate waveforms along with an option to download user-defined waveforms. The IQtools utility also supports "in-system calibration" to measure and compensate the frequency and phase response of the AWG and any external circuitry. It can compensate skew between all channels. When using the ILV-option, IQTools additionally provides an automated skew calibration to optimize system performance.

M8158A Remote Head for M8199A Arbitrary Waveform Generator

The M8158A arbitrary waveform generator remote head is an external amplifier box that is optional and can be used in conjunction with the M8199A-ILV Passive Combiner. It helps in minimizing signal degradations caused by lossy channels. There are three cables which are fixed on the back side of M8158A. These cables need to be connected to M8199A Remote Head and the Data Out ports of M8199A-ILV Passive Combiner.

M8158A Remote Head Components

The following figure displays the front panel of the M8158A remote head with its various components.

Figure 11 M8158A remote head

As displayed in Figure 11, the M8158A remote head has the following components.

Table 14 Front Panel LED

Front Panel LED	Active when...	Color
Ready	remote head is operational	green

Table 15 M8158A Front Panel Connector

Connector	Description
Data Out and /Data Out	Connected to DUT

The back panel of M8058A remote head has cables which connects with M8199A. The blue cables connect to the Data Out ports of M8199A-ILV Passive Combiner while the grey cable connects to the M8199A Remote Head port. The length of these cables are 760 mm.

Ensure that the chassis is NOT powered up or connected to a power source while making connections to M8158A.

Also, make sure NOT to remove the M8158A connections when it is powered on. However, if you wish to remove the M8158A connections, ensure that the instrument is powered off.

M8199B Arbitrary Waveform Generator

Keysight's M8199B 256 GSa/s Arbitrary Waveform Generator (AWG) is a high-performance signal source for arbitrary signals, with the highest sample rate and the widest bandwidth in its class. The M8199B enables generation of high-quality signals of up to 160 GBd in a 2-slot AXIe module.

For applications beyond 128 GBd, the M8199B AWG is the ideal solution where it provides high-speed and precise testing of various optical systems, and it provides stress signals to test next generator digital signal processor ASICs and new algorithm concepts. The flexibility of the waveform generator with high speeds, combined with excellent intrinsic jitter performances makes the M8199B a truly unique and versatile instrument for Intensity-Modulation/Direct-Detect (IM/DD) optical applications.

The M8199B AWG also allows you to generate any arbitrary waveform that can be mathematically described and can be used for physics, chemistry, and general-purpose electronics research.

The key benefits of using the M8199B Arbitrary Waveform Generator are:

- Provides up to eight synchronized channels at 256 GSa/s with a nominal 3dB-bandwidth of 75 GHz including sinc-rolloff
- enables development of designs of higher-order QAM (such as 64 QAM) at 160 GBd and above
- enables 400+ Gb/s per lane in IM/DD or 1.6+ Tb/s per carrier in coherent optical communications
- Integrated, ready-to-use instrument, works with M8008A clock module
- Operates with well-known software, including MATLAB, Keysight IQtools, and SCPI programming interfaced based on M8070B
- Built-in frequency and phase response calibration for clean output signals

The M8199B is an instrument module that can be installed into the M9505A 5-slot AXIe Chassis. This module occupies two slots of the 5-slot chassis. It must be installed in the slot immediately above the M8008A Clock Generator module. The M8008A module must be installed in slot 1; therefore, the M8199B module must be installed in slots 2 and 3 of the AXIe chassis.

If the M9537A AXIe Embedded Controller is also being used, the Controller module must be installed in slot 1, followed by the M8008A module in slot 2 and M8199B module in slots 3 and 4, respectively.

Figure 12 shows a typical configuration of two M8199B modules with the M8008A Clock Generator module.

Figure 12 M8199B AWG and M8008A Clock Generator configuration

M8199B Module Components

Figure 13 displays the front panel of the M8199B module:

Figure 13 M8199B module front panel

As displayed in the image above, the M8199B module has the following components.

Table 16 Front Panel LEDs

Front Panel LED	Active when...	Color
Fail	power-up fault condition	red
Access	power-up ready state	green

Table 17 Insertion/Extraction and Retaining

Component	Description
Retaining screws	The screws on both ends of the module are used to retain the module tightly inside the M9505A AXIe Chassis slot once you have fully placed it inside the chassis. To remove the module, you first need to loosen these screws ensuring that these screws disengage completely.
Module Insertion/Extraction Handles	The handles on both sides of the module to insert or eject the module from the slot of the M9505A AXIe Chassis.

M8199B Front Panel Connectors

CAUTION

This device is ESD-sensitive when operated. The electrostatic discharge to any part of the module or chassis may cause timing alignment issues of the channels, which can be mitigated by toggling the sample rate. Therefore, take necessary anti-static precautions, such as wearing a grounded wrist strap, to minimize the possibility of electrostatic damage.

Table 18 M8199B Front Panel Connectors

Connector	Description
Data Out and $\overline{\text{Data Out}}$	Data outputs 1.0 mm
Sync In	The Sync In is used to synchronize multiple modules to a common system clock. It is connected to one of the Sync Out outputs of the M8008A module.
Clk In	AWG clock input (quarter-rate). Connect to clock output of M8008A clock generator module.
Sample Marker Out and $\overline{\text{Sample Marker Out}}$	Differential Marker output to mark individual data samples. Max. output frequency of 16 GHz.
Sync Marker Out A/B	Marker output to generate subrate clocks for example. Max output bandwidth 2 GHz.

The M8199B AWG is controlled by the M8070B software system version 9.5 and above.

IQTools - Waveform Generation Tool

IQTools is a collection of MATLAB example applications for creating I/Q, IF/RF, serial data, multi-tone, radar pulse, and many other types of waveforms on the Keysight arbitrary waveform generators (AWG) as well as several Keysight Signal Generators.

The example applications are created to demonstrate the waveform generation capabilities of these instruments, along with the value of using these instruments together with MATLAB software.

For more details and to download the IQTools, visit the following URL: www.keysight.com/find/IQTools

2 Basic Setup for M8100

KEYSIGHT TECHNOLOGIES

Step 1 - Unpacking the shipment

The M8100A-BU5 or M8100A-BU6 is shipped with the modules pre-installed in the M9505A AXIe Chassis.

Unpack and verify the shipment contents to check if you have received all the items that you ordered. The shipment contents can vary depending on the options that you ordered. Therefore, the shipping list delivered with the shipment should supersede this list.

Table 19 Typical contents of an M8100-series instrument shipment

Item	Description
M8100A-BU5 or M8100A-BU6	The M8100 that you ordered. M8100A-BU5 is the AXIe Chassis without Embedded PC and M8100A-BU6 is AXIe Chassis with Embedded PC.
Accessories	The accessories will vary depending on the module from the M8100-series and the options that you ordered while purchasing the module. Accessories include standard items that are shipped with the M8100 as well as optional items that you ordered separately. (Check the M8100 product data sheet for the latest list of default and optional accessories. Latest version can be downloaded from www.keysight.com/find/M8100).
Start Here	Document which provides instructions to be followed before operating the M8100 Series Arbitrary Waveform Generators.
Tips for Preventing Damage Guide	Document which provides tips for preventing damage to M8100 Series Arbitrary Waveform Generators.
Getting Started Guide	This document, *M8100 Series Arbitrary Waveform Generators Getting Started Guide.* (Check the Keysight website: www.keysight.com/find/M8100 for the latest guide.)

Carefully inspect all items in the shipment for any damage.

Return the Damaged/Defective Item to Keysight for Repair/Replacement

If anything is missing, defective, or damaged,

1 Review the warranty information shipped with your product or check the warranty information on Keysight website.
   - To check the warranty information on your module, go to www.keysight.com/find/warranty and specify the module's model number (for example, M8199A) in the Product Number field, and specify the serial number from the top of the module in the Serial Number field.
2 Contact the nearest Keysight Sales Office. If you need assistance finding Keysight contact information, go to www.keysight.com/find/assist (worldwide contact information for repair and service).

Step 2 - Setting up the M8100 series of modules

This step does not have to be performed while verifying the basic setup for power up and connectivity. However, you must decide whether to use a benchtop or rack mount for one or more AWG modules in the M8100 series after this basic verification. To procedures on how to set up the AWG modules in an AXIe chassis, refer to the *M8000 Series Installation Guide*.

Step 3 - Setting up the External Host Computer (not required for M8100A-BU6)

NOTE **Perform this step if you are using a laptop or desktop computer as the host computer.**

The host computer communicates with the ESM and instrument modules in the chassis and hosts all the software components needed to use the instrument modules.

Computer Hardware and Software Requirements

The following are the hardware and software requirements that should be met on the host computer before the installation of software components on this computer:

Hardware requirements

- Pentium® processor 1 GHz or equivalent
- 16 GB available RAM
- USB 2.0 (Mini-B) recommended
- PCIe 2.0/8x (only for highest data throughput and desktop PC)
- VGA resolution 1024 x 768
- 1.5 GB or more free hard disc space

Software requirements

- Windows 10 (64-bit) operating system
- Keysight I/O libraries version 17.1 or higher

NOTE The M8070B software is required to control the M8100 series instruments.

To connect via USB

If you are planning to use USB connectivity between the M9505A AXIe Chassis and host computer, use a laptop or desktop computer with USB 2.0 or 3.0 support as the host computer.

Figure 14 USB port on the font panel of the AXIe ESM

To connect via PCIe

In case of PCIe connectivity, the host computer can be a desktop PC with an available x8 or wider PCIe slot.

Review the Keysight recommended list of host computers at http://literature.cdn.keysight.com/litweb/pdf/5990-7632EN.pdf that are compatible with the Keysight M9505A AXIe Chassis.

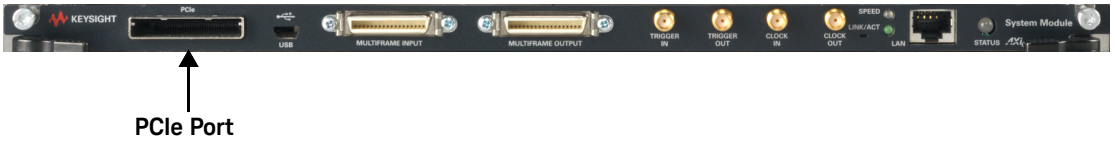


Figure 15 PCIe port on the front panel of the AXIe ESM

Step 4 - Connecting the M9505A AXIe Chassis to a Power Supply

You can use an external power supply, typically AC power mains.

1 The instrument module uses the power supplied by the M9505A AXIe Chassis in which it is installed. The M9505A AXIe Chassis power cord comes with the chassis shipment. Insert the power cord into the inlet at the rear of the chassis.

2 Connect the cord to an appropriate AC power main.

3 Push the circuit breaker to the right, which is the ON position.

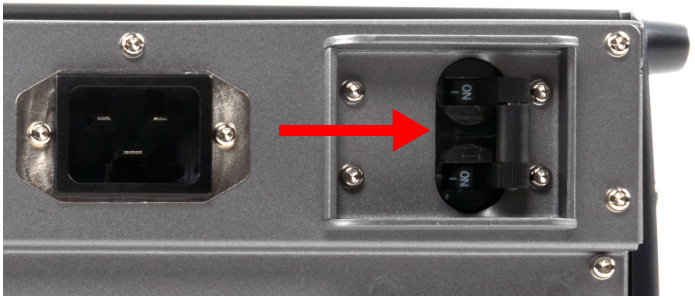


Figure 16 Chassis circuit breaker

Step 5 - Connecting the M8100 series AWG modules

Connecting to the M8198A AWG

Connecting M8008A Clock Generator to M8198A AWG Module

NOTE The unused output should be disabled on the M8070B software or terminated with 50 ohms on the module hardware.

Following are the possible ways to connect a M8008A clock source to the M8198A AWG module(s):

Case 1 Connecting M8008A clock module to a single channel of the M8198A AWG module

In this case, an M8008A clock module, one M8198A AWG modules an M9505A AXIe chassis and the following cables are required:

- 3.5 mm, 50 cm M8199A-811 customer orderable sync cable (M8199-61620)
- 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624)

Make the connections as described below:

1 Connect the M8008A Clock Generator Sync Out port with the M8198A AWG Sync In port using the sync cable (blue cable).

2 Connect the M8008A Clock Generator Sample Clock Out port with the M8198A AWG Clock In port for a Channel using clock cable (red cable).

Figure 18 shows how to connect M8008A clock generator module to a single channel of the M8198A AWG modules:

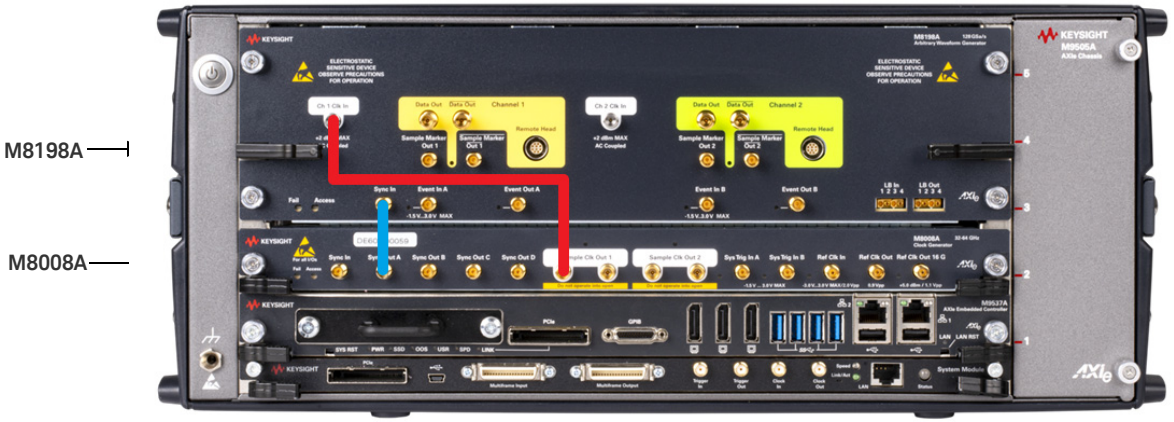


Figure 17 Connecting M8008A clock generator to a single channel of M8198A AWG

Case 2 Connecting M8008A clock module to two channels on M8198A AWG modules

In this case, an M8008A clock module, one M8198A AWG modules an M9505A AXIe chassis and the following cables are required:

- 3.5 mm, 50 cm M8199A-811 customer orderable sync cable (M8199-61620)
- 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624)

Make the connections as described below:

1 Connect the M8008A Clock Generator Sync Out port with the M8198A AWG Sync In port using the sync cable (blue cable).

2 Connect the M8008A Clock Generator Sample Clock Out ports with both the M8198A AWG Clock In ports for each Channel using clock cable (red cable).

Figure 18 shows how to connect M8008A clock generator module to the two channels of the M8198A AWG modules:

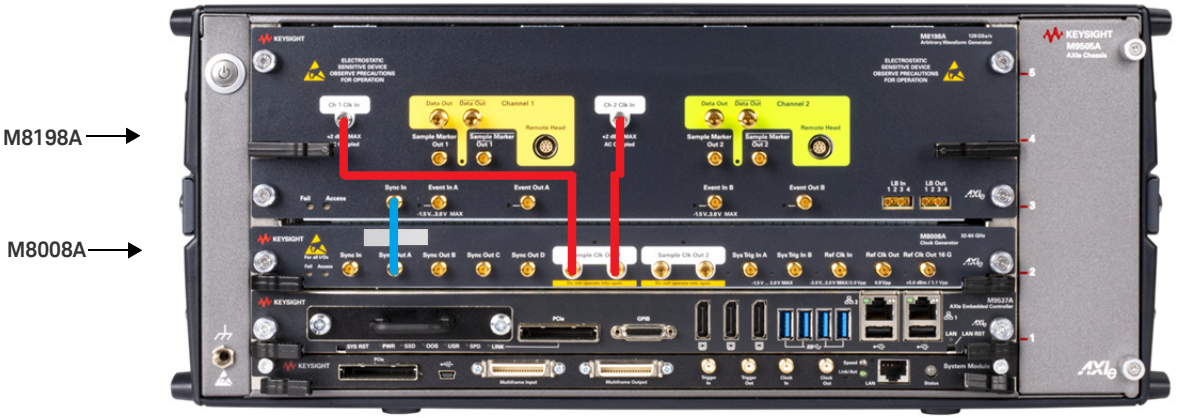


Figure 18 Connecting M8008A clock generator to two channels of M8198A AWG

NOTE

Enable the Ref Clk Out port in the primary chassis using the web interface. For details, refer to *Keysight M9505A AXIe Chassis Startup Guide*.

Connecting to the M8199A AWG

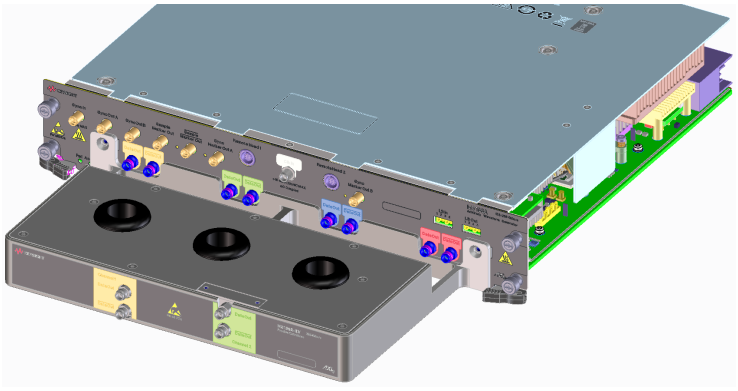
Connecting M8199A-ILV to M8199A

Follow the given steps to connect M8199A-ILV assembly to M8199A instrument:

1 Remove M8199A instrument from the AXIe Chassis.

2 Place M8199A instrument and M8199A-ILV on a flat surface (for example on a desk).

3 Move M8199A-ILV to the front panel of the M8199A instrument as in the following figure.



4 Fix it with 2x screw 0515-2741 and a long screw driver Torx T20 or with screw driver 8710-2904.

5 Screw torque will be each screw 1.7 Nm.

6 Place the 8x connectors of the M8199A-ILV on the plugs available on the M8199A front panel.

7 Screw the nut of the connector by hand until you are sure that the nut runs in the thread.

8 Use the torque wrench (8710-1765) to fix the nut with the right torque (0.9 Nm) at all 8 connectors of the M8199A-ILV. The required torque for 1.85 mm connectors is 0.9 Nm (8lb-inch).

9 Mount the M8199A instrument together with M8199A-ILV back to the AXIe Chassis.

Connecting M8008A Clock Generator to M8199A AWG Module

NOTE The unused output should be disabled on the M8070B software or terminated with 50 Ohms on the module hardware.

Following are the possible ways to connect a M8008A clock source to the M8199A AWG module(s):

Case 1 Connecting M8008A clock module to M8199A AWG module

In this case, make the connections as described below:

1 Connect the 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624) from Sample Clk Out of M8008A to Clk In of M8199A.

2 Connect the 3.5 mm, 50 cm M8199A-811 sync cable (M8199-61620) from Sync Out of M8008A to Sync In of M8199A.

Figure 19 shows how to connect the M8008A clock generator module to the M8199A AWG module:

Figure 19 Connecting M8008A clock generator to M8199A AWG module

Case 2 Connecting PSG to an M8199A module

Keysight M8257D, Opt. 567, 1EU, UNY (referred to as PSG) is an alternative to the M8008A clock module that can be used as a clock source. In this case, connect the 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624) from the PSG Output to Clk In of M8199A.

The output power needs to be set at the PSG for various sample clock frequencies. The output power level should start at 7dBm at 50 GHz and should be increased linearly to 11 dBm at 60 GHz. This means, as we increase the frequency from 50 GHz to 60 GHz, there is a linear increase in the output power from 7 dBm to 11 dBm. Above 60 GHz, a power level of 11 dBm should be used.

The following table shows the required output power level at different frequencies:

Frequency (GHz)	Amplitude (dBm)
50	7
51	7.4
52	7.8
53	8.2
54	8.6
55	9
56	9.4
57	9.8
58	10.2
59	10.6
60	11
61	11
62	11
63	11
64	11

Case 3 Connecting M8008A clock module to two M8199A AWG modules

In this case, a M8008A clock module, two M8199A AWG modules, a M9505A AXIe chassis and the following cables are required:

- 3.5 mm, 50 cm M8199A-811 customer orderable sync cable (M8199-61620)
- 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624)

Make the connections as described below:

1 Connect the M8008A Clock Generator Sync Out port with both the M8199A AWG Sync In ports using the sync cable (blue cable).

2 Connect the M8008A Clock Generator Sample Clock Out port with both the M8199A AWG Clock In ports using clock cable (red cable).

Figure 20 shows how to connect M8008A clock generator module to the two M8199A AWG modules:

Figure 20 Connecting M8008A clock generator to two M8199A AWG modules

Case 4 Connecting M8008A clock module to four M8199A AWG modules

In this case, a M8008A clock module, four M8199A AWG modules, two M9505A AXIe chassis and the following cables are required:

- 3.5 mm, 50 cm M8199A-811 customer orderable sync cable (M8199-61620)
- 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624)

Make the connections as described below:

1 Connect the M8008A Clock Generator Sync Out port with all the four M8199A AWG Sync In ports using sync cable (blue cable).

2 Connect the M8008A Clock Generator Sample Clock Out port with all the four M8199A AWG Clock In ports using clock cable (red cable).

Figure 21 shows how to connect M8008A clock generator module to the four M8199A AWG modules:

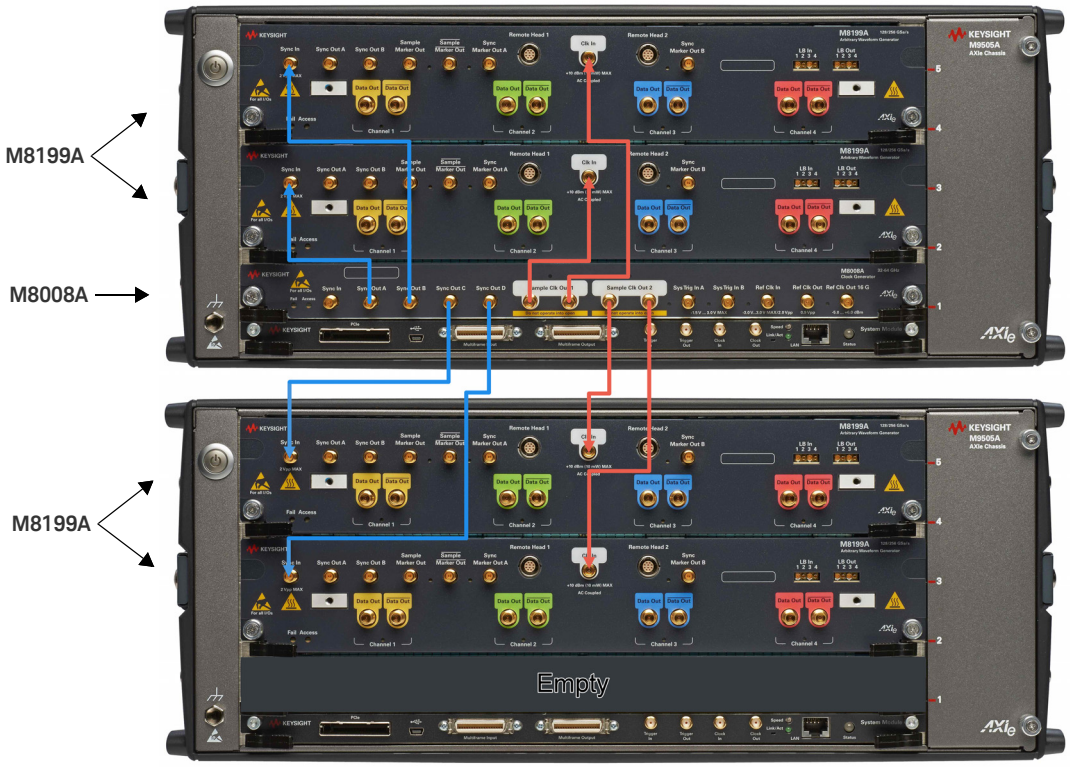


Figure 21 Connecting M8008A clock generator to four M8199A AWG modules

NOTE

Enable the Ref Clk Out port in the primary chassis using the web interface. For details, refer to *Keysight M9505A AXIe Chassis Startup Guide*.

Connecting to the M8199B AWG

Connecting M8008A Clock Generator to M8199B AWG Module

NOTE The unused output should be disabled on the M8070B software or terminated with 50 Ohms on the module hardware.

Following are the possible ways to connect a M8008A clock source to one or more M8199B AWG modules:

Case 1 Connecting M8008A clock module to one M8199B AWG module

In this case, make the connections as described below:

1 Connect the 1.85 mm, 45 cm M8199A-810 replacement channel clock blue cable (M8199-61624) from Sample Clk Out of M8008A to Clk In of M8199B.

2 Connect the 3.5 mm, 50 cm M8199A-811 sync cable (M8199-61620) from Sync Out of M8008A to Sync In of M8199B.

Figure 22 shows how to connect the M8008A clock generator module to an M8199B AWG module:

Figure 22 Connecting M8008A clock generator to one M8199B AWG module

NOTE

If you connect more than one M8199B module, you must perform an additional user calibration using the IQtools user interface to ensure that the skew between modules is stable and corrected. For more information, refer to the *IQTools User Guide*.

Case 2 Connecting M8008A clock module to two M8199B AWG modules

In this case, an M8008A clock module, two M8199B AWG modules, an M9505A AXIe chassis and the following cables are required:

- 3.5 mm, 50 cm M8199A-811 customer orderable sync cable (M8199-61620)
- 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624)

Make the connections as described below:

1 Connect the M8008A Clock Generator Sync Out port with both the M8199B AWG Sync In ports using the sync cable (blue cable).

2 Connect the M8008A Clock Generator Sample Clock Out port with both the M8199B AWG Clock In ports using clock cable (red cable).

Figure 23 shows how to connect M8008A clock generator module to the two M8199B AWG modules:

Figure 23 Connecting M8008A clock generator to two M8199B AWG modules

Case 3 Connecting M8008A clock module to four M8199B AWG modules

In this case, a M8008A clock module, four M8199B AWG modules, two M9505A AXIe chassis and the following cables are required:

- 3.5 mm, 50 cm M8199A-811 customer orderable sync cable (M8199-61620)
- 1.85 mm, 45 cm M8199A-810 replacement channel clock cable (M8199-61624)

Make the connections as described below:

1 Connect the M8008A Clock Generator Sync Out port with all the four M8199B AWG Sync In ports using sync cable (blue cable).

2 Connect the M8008A Clock Generator Sample Clock Out port with all the four M8199B AWG Clock In ports using clock cable (red cable).

Figure 24 shows how to connect M8008A clock generator module to the four M8199B AWG modules:

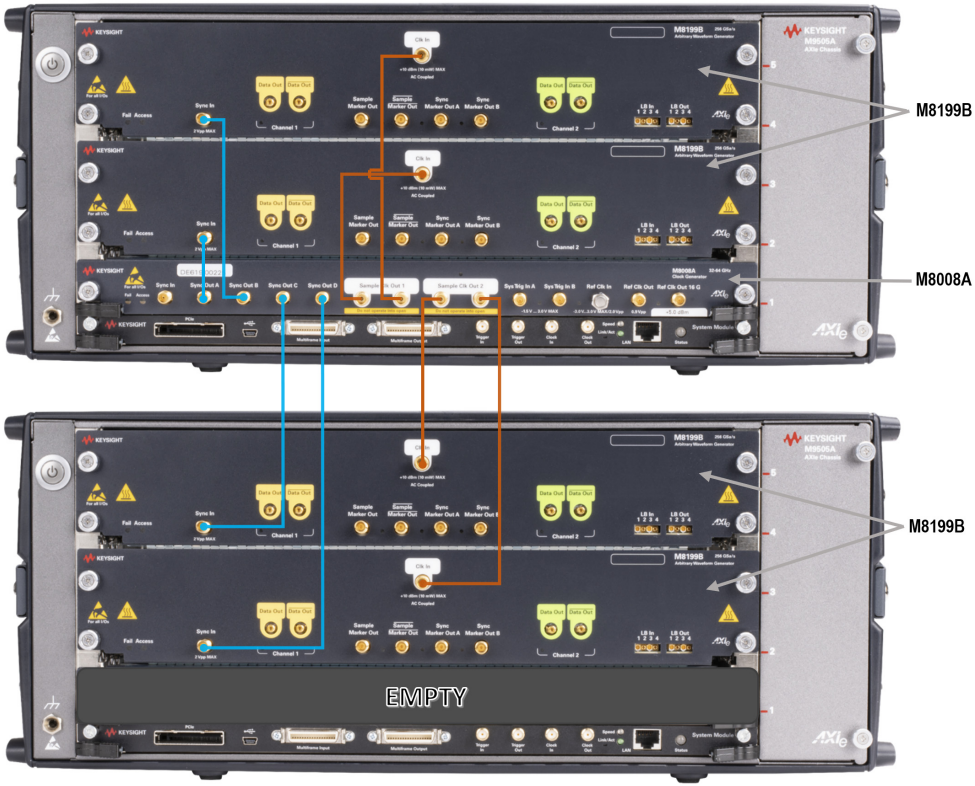


Figure 24 Connecting M8008A clock generator to four M8199B AWG modules

NOTE Enable the Ref Clk Out port in the primary chassis using the web interface. For details, refer to *Keysight M9505A AXIe Chassis Startup Guide*.

Connecting M8159A External Multiplexer to M8199B AWG Module

An M8199B with external multiplexer M8159A setup consists of two to four M8199B modules, one or two M8159A boxes plus corresponding cables, attenuators and balun.

To control M8199B/M8159A setup using the IQTools needs initial configuration and calibration. For more information, refer to "IQTools for M8199B with M8159A User Guide".

To address the different application needs, Keysight supports the following M8159A configurations:

- 448G Single Ended Configuration
- 448G Differential Configuration

448G Single-Ended Configuration

The following diagram provides an overview of the single-ended configuration without Balun:

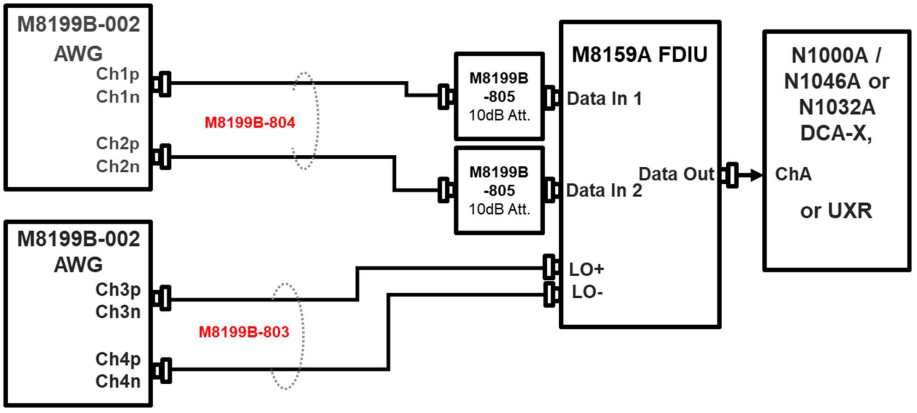


Figure 25 Single-Ended configuration without Balun

The following diagram provides an overview of the single-ended configurations with Balun:

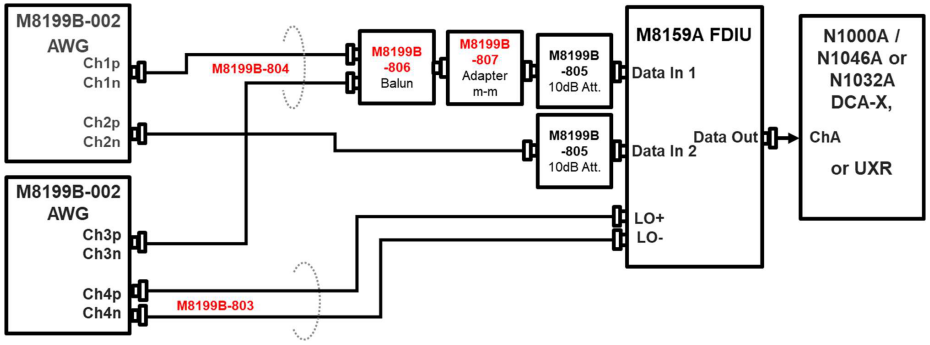


Figure 26 Single-Ended configuration with Balun

The items required for the single-ended configuration are listed in the Table 20 on page -61.

Table 20 Items required for single-ended configuration

Item	Description	Quantity
M8199B-002	Arbitrary Waveform Generator, 2 Channels 256GSa/s	2
M8008A	M8008A Clock Generator Module, 32- 64GHz, 1 Slot AXIe	1
M9505A	M9505A AXIe Chassis: 5-slot with Integrated System Module	1
M8159A	Frequency-Domain Interleave to generate 224GBaud Signals	1
M8199B-806	(Optional) Broadband Balun, 1.0 mm connectors, Female/Female	1
M8199B-807	(Optional, needed with M8199B-806) Precision adapter 1.0mm male/male	1
M8199B-804	RF Cable, 100mm, 1.0 mm Connectors, male/male	2
M8199B-805	10 dB att. 1.0 mm Connectors female / male	2

Item	Description	Quantity
M8199B-803	RF Matched Cable Pair, 300mm, 1.0 mm Connectors, male/male	1
M8199B-810	Replacement clock cable with angle connectors	2
M8199B-811	Replacement clock cables with angle connectors	2

448G Differential Configuration

The following diagram provides an overview of the differential configuration:

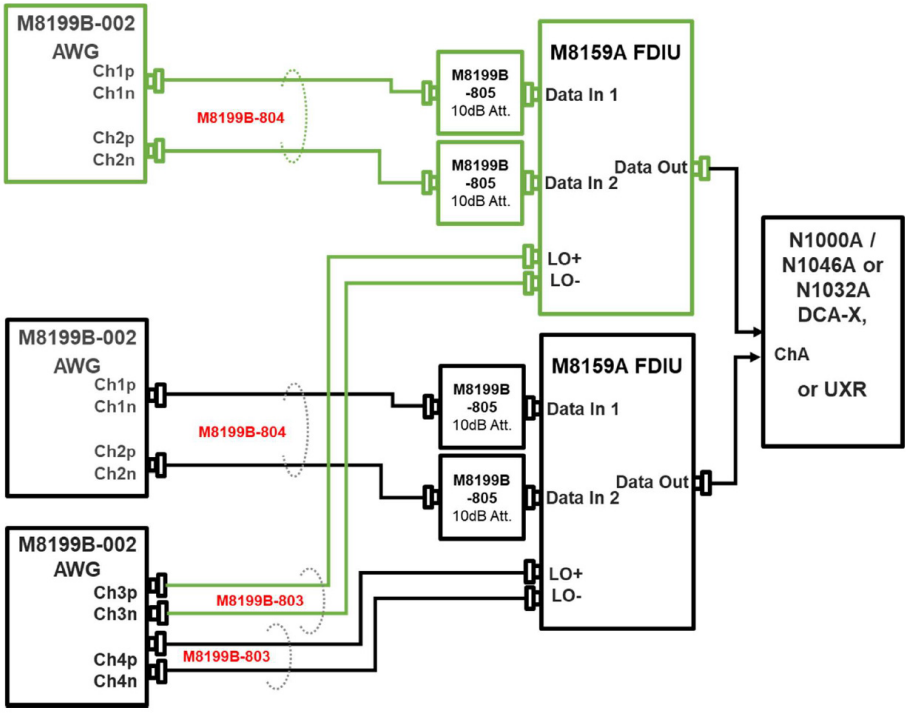


Figure 27 Differential configuration

The items required for the differential configuration are listed in the Table 21 on page -63.

Table 21 Items required for differential configuration

Item	Description	Quantity
M8199B-002	Arbitrary Waveform Generator, 2 Channels 256GSa/s	3
M8008A	M8008A Clock Generator Module, 32- 64GHz, 1 Slot AXIe	1
M9505A	M9505A AXIe Chassis: 5-slot with Integrated System Module	1
M8159A	Frequency-Domain Interleave to generate 224GBaud Signals	2
M8199B-804	RF Cable, 100mm, 1.0 mm Connectors, male/male	4
M8199B-805	10 dB att. 1.0 mm Connectors female / male	4
M8199B-803	RF Matched Cable Pair, 300mm, 1.0 mm Connectors, male/male	3
M8199B-801	RF Matched Cable Pair, 150 mm, 1.0 mm Connectors, male/male	1
M8199B-810	Replacement clock cable with angle connectors	3
M8199B-811	Replacement clock cables with angle connectors	3

M8159A Usage

This section describes how to initialize and operate the M8159A.

Step 1 – Setting up the M8159A

1 ESD Protection
   - Take appropriate measures to protect against electrostatic discharge (ESD) before handling or connecting equipment.

2 Disconnect Instruments
   - To protect the M8159A Input and Output ports, ensure all instruments are disconnected from the Input and Output ports before setup.

NOTE Ensure that no instruments are connected to the Input or Output ports of the M8159A before starting the setup.

3 Connect Power Supply
   - Connect the PWR I/O and the PSU using the D-sub cable.
   - Plug the AC/DC adapter into the DC IN port of the PSU.

4 Prepare the M8199B
   - Set up the M8199B AWG. (Refer to the *M8100A Series User Guide* for detailed instructions.)
   - Ensure that the Global Outputs of the M8199B AWG are turned off.

5 Signal Connections
   - Connect the AWG outputs to the M8159A input ports according to your setup (single-ended or differential).
   - Connect the DATA OUT of the M8159A to the electrical DCA input or to the DUT input port.

6 Power On
   - Turn on the PSU by pressing the LINE button.
   - Wait approximately 15 minutes to allow the internal temperature to stabilize before operating the unit.

Step 2 – Operating the M8159A

The following chapters of this User Guide will guide you through the IQTools setup procedure and operation of the M8159A Setup using IQTools.

Ensure that the amplitude settings of the M8199B do not exceed the damage thresholds of the M8159A input ports. Exceeding these levels may cause permanent damage.

Step 3 – Shutting Down the M8159A

1 Turn off the Global Output of the M8199B AWGs.

2 Press the OUTPUT button on the Power Supply Unit to switch off the M8159A.

3 When both the OUTPUT and POWER ON LEDs are off, press the LINE button on the Power Supply Unit.

NOTE Before powering down the M8199B AWG, DCA, or DUT, disconnect all cables from the INPUT and OUTPUT ports of the M8159A.

Mixed Mode Operation (M8199A + M8199B)

The mixed-mode operation supports various combinations of M8199A and M8199B AWG modules under the control of a common M8008A clock module. This includes configurations using M8199A modules in either interleaved (ILV) or non-interleaved (non-ILV) mode, as well as combinations with M8199B modules.

In general, mixed-mode operation (for example, M8199A ILV together with M8199B), no special handling of the sample clock frequencies is required. All modules operate according to the clock settings provided by the M8008A clock module.

A special case applies when combining an M8199A non-ILV module with M8199B AWG module under the control of a common M8008A clock module. In this configuration, both modules operate with a 2× sample rate relationship to ensure proper synchronization.

In mixed-mode operation, the M8199A AWG module operates within its specified sample-rate range of 200 GSa/s to 256 GSa/s. The effective output sample rate results from the selected clock frequency and the configured sample-rate relationship between the modules.

The M8008A clock module displays the actual clock frequency, while the module driver applies the required internal scaling to ensure correct timing and waveform output.

For the M8199A non-interleaved module, the downloaded waveform samples are played at half of the sample rate configured at the clock module.

Step 6 - Powering Up (if connecting via PCIe)

Power up all the connected hardware components in the M9505A AXIe Chassis.

1 Press the ON/Standby button on the front panel of the chassis to power on the chassis.

Figure 28 Chassis ON/standby button

2 After powering up the chassis, wait until the Status LED of the ESM is solid green. This ensures that the PCIe channel in the chassis is ready for the successful connectivity of the chassis to the host computer.

3 Wait until the Access LED(s) of the module(s) in the chassis is/are solid green.

4 Power up the host computer. By this time, the Status LED of the ESM in the chassis and the Access LED(s) of the module(s) should have been steady green indicating a power ready status of the setup.
The step to power up the host computer is not required if you are using the M9537A AXIe Embedded Controller module as the host computer because it gets powered on simultaneously with the chassis through the chassis backplane.

NOTE If you plan to connect one or more AWGs to a corporate LAN and the M9537A AXIe Embedded Controller is installed, you must use the Ethernet port available on the M9537A AXIe Embedded Controller or the LAN port on the external PC.

NOTE To power down a chassis, first turn off the host computer and then power down the chassis using the On/Standby button on its front panel.

If you are using the M9537A AXIe Embedded Controller module as the host computer, ensure that you first shut down the controller by executing the Windows shutdown process.

Do not use the circuit breaker for routine chassis turn off.

The module(s) are turned off automatically with the chassis.

Step 7 - Verifying Basic Operation of M8100 series AWG modules

After powering ON the connected hardware components, you can verify if you have correctly set up the hardware if:

- a steady green status light is displayed on the ESM of the M9505A AXIe Chassis indicating that the chassis has powered up successfully.
- the Access LED on the front panel of the instrument module turns on indicating that the module is in a power- ready state.
- the Out of Service (OOS) LED on the front panel of the M9537A AXIe Embedded Controller turns off. (Applicable only when you are using M9537A AXIe Embedded Controller as the host computer).

If the chassis does not power up to a steady green Status light, or powers up to a steady red light, the chassis has detected a failure and requires service.

If the Fail LED on the front panel of the instrument module is steady red and does not turn off, it indicates a power fault condition. In such a situation, the instrument module may require repair/service.

Contact your Keysight representative to replace or service the chassis/module. See Contacting Keysight Service and Support on page 81.

Step 8 - Installing Keysight IO Libraries Suite (not required for M8100A-BU6)

IO Libraries Suite version 17.1 or later is required. Always use the latest version of the Keysight IO Libraries.

NOTE **Perform this step if you are setting up an M8100A-BU5 system or if the host computer you are using along with the M8100 series modules requires I/O library installation.**

1 Disconnect any devices connected to the host computer.
2 If open, close all applications on the host computer.
3 Download and install the IO Libraries from www.keysight.com/find/iosuite.
4 Follow the instructions as prompted during the installation.
5 After installation, you will see the Keysight IO icon in the taskbar notification area of the host computer screen.

Step 9 - Installing M8070B Software (not required for M8100A-BU6)

NOTE **Perform this step if you are setting up an M8100A-BU5 system or if the host computer you are using along with the M8100 series modules requires I/O library installation.**

The M8070B software does not require any license for its installation. However, it can only be used to perform some basic operations. For advance operations, you need to install the driver packages in the M8070B software. For details, go to Step 11 - Installing Module Driver Package in the M8070B Software on page 70.

These driver packages need a valid license for their activation. For details, go to Step 12 - Installing the Licenses on page 71.

To install the software

1 Download the latest M8070B software from www.keysight.com/find/M8070B.
2 Double-click the setup (.exe) file.
The InstallShield Wizard is displayed.

3 If displayed, click **Install** to continue or click **Next** if the system controller meets the minimum system configuration requirements displayed by the wizard.

4 When displayed, accept the license agreement and click **Next**.

5 Click **Install** to start the installation then follow any on-screen prompts/instructions.

6 On your Windows OS, click **Start** > **Keysight M8070B** > **Keysight M8070B** to verify software installation.

NOTE

Verify your account permissions. Ensure that you have full administrative privileges (Run as Administrator) before you install or upgrade the M8070B software on a PC running Windows 10. Not doing so may result in an installation failure. Contact your system administrator to provide you the administrative rights.

Step 10 - Starting the M8070B Software

1 Ensure that the system is powered up and ready to start as described in the sections Basic Setup for M8100 on page 41.

2 On the host computer, click **Start** > **Keysight M8070B** > **Keysight M8070B**.

3 Select the module options from **M8070B Startup Options** dialog box. For details on the **M8070B Startup Options** dialog box, refer to *M8100 Series User Guide*. For information on SCPI command for remote programming of one or more AWG modules in the M8100 series, refer to the *M8100 Series Programming Guide*.

4 Click **OK**. The startup screen of the M8070B software should display.

Step 11 - Installing Module Driver Package in the M8070B Software

The M8070B system software supports module driver package. To use these packages, it is necessary to install the module driver package in the M8070B software.

Check the M8070B software version before using an AWG from the M8100 series modules:

- M8199A AWG requires M8070B software version 7.5 or later
- M8199B AWG requires M8070B software version 9.5 or later
- M8198A AWG requires M8070B software version 10.5 or later

To download the module driver package file for:

- M8199A AWG, navigate to www.keysight.com/find/M8199A
- M8199B AWG, navigate to www.keysight.com/find/M8199B
- M8198A AWG, navigate to www.keysight.com/find/M8198A

Currently, the M8070B software supports the following module driver packages:

- M8198A Arbitrary Waveform Generator
- M8199A Arbitrary Waveform Generator
- M8199B Arbitrary Waveform Generator
- M8008A Clock Generator

The M8070B software comes with a **Driver Package Manager** utility to simplify all the tasks related to driver package management. The **Driver Package Manager** allows you to install, remove, and upgrade the driver packages.

For complete details on how to install, update or remove driver packages, refer to the *M8000 Series User Guide*.

For information on SCPI command for remote programming of the M8100 series of AWG modules, refer to the *M8100 Series Programming Guide*.

NOTE

Verify your account permissions. Ensure that you have full administrative privileges (run as Administrator) before you install or upgrade the AWG module drivers on a PC running Windows 10. Not doing so may result in installation failure. Contact your system administrator to provide you the administrative rights.

Step 12 - Installing the Licenses

The usage of M8070B plugins is governed by Keysight Licensing. Keysight Licensing provides tools and processes for floating, USB portable, node-locked, and transportable licenses. These licenses can be installed using the **Keysight License Manager**. It helps you install licenses on your local machine (instrument or computer), or configure your local machine to use licenses from a remote license server.

Depending upon the license types, the following version of **Keysight License Manager** can be used to install the licenses:

- The node-locked and transportable licenses are installed by **Keysight License Manager 5**.
- The floating and USB probable licenses are installed by **Keysight License Manager 6**.

NOTE The Keysight License Manager 5 and Keysight License Manager 6 get installed on your system when you install M8070B system software.

For details on how to install these licenses, you can refer the following documents:

- M8000 Series User Guide (https://literature.cdn.keysight.com/litweb/pdf/M8000-91B08.pdf)
- Keysight Licensing Administrator's Guide (https://literature.cdn.keysight.com/litweb/pdf/5951-5739.pdf)

Installing Module Licenses (for upgrades only)

Installing module licenses is only necessary if you add module options onsite. Module licenses enable specific options in the modules of the M8100 series. Once a module license has been installed using the Keysight License Manager, the next time the M8070B software and M8100 hardware are started, the license is recognized by the M8070B software and compared to the module's serial number. If the PC Host ID and serial number match, the EEPROM in the module is programmed and the option is enabled. Even if the M8070B software license is transported to another host computer, the module option will remain enabled.

The following procedure shows how to redeem and install a module license.

1 Locate the Software License Entitlement Certificate (email or paper copy).
2 Follow the instructions on the Software License Entitlement Certificate to redeem your license.
3 You will receive a license file (in an email). The file has the suffix .lic.
4 Follow the instructions in the email to complete the installation of the license file.
5 In the M8070B software interface, verify that the license has been installed by selecting **Utilities** > **Licenses** then viewing the license status in the **Installed** column.

Step 13 - Starting the Driver Package Interface from M8070B Software

1 In Windows click on **Start** > **Keysight M8070B** > **Keysight M8070B**.
2 From the **M8070B Startup Options** dialog box, select a driver package.
   - To view the parameters for M8199A and M8008A modules, select *M8008A,M8199A*
   - To view the parameters for M8199B and M8008A modules, select *M8008A,M8199B*
   - To view the parameters for M8198A and M8008A modules, select *M8008A,M8198A*

   For details on the **M8070B Startup Options** dialog box, refer to *M8100 Series User Guide*.
3 Click **OK**.

   Figure 29 shows the appearance of the M8070B software with *M8008A,M8198A* selected as Startup Options.

   Figure 30 shows the appearance of the M8070B software with *M8008A,M8199A* selected as Startup Options.

   Figure 31 shows the appearance of the M8070B software with *M8008A,M8199B* selected as Startup Options.

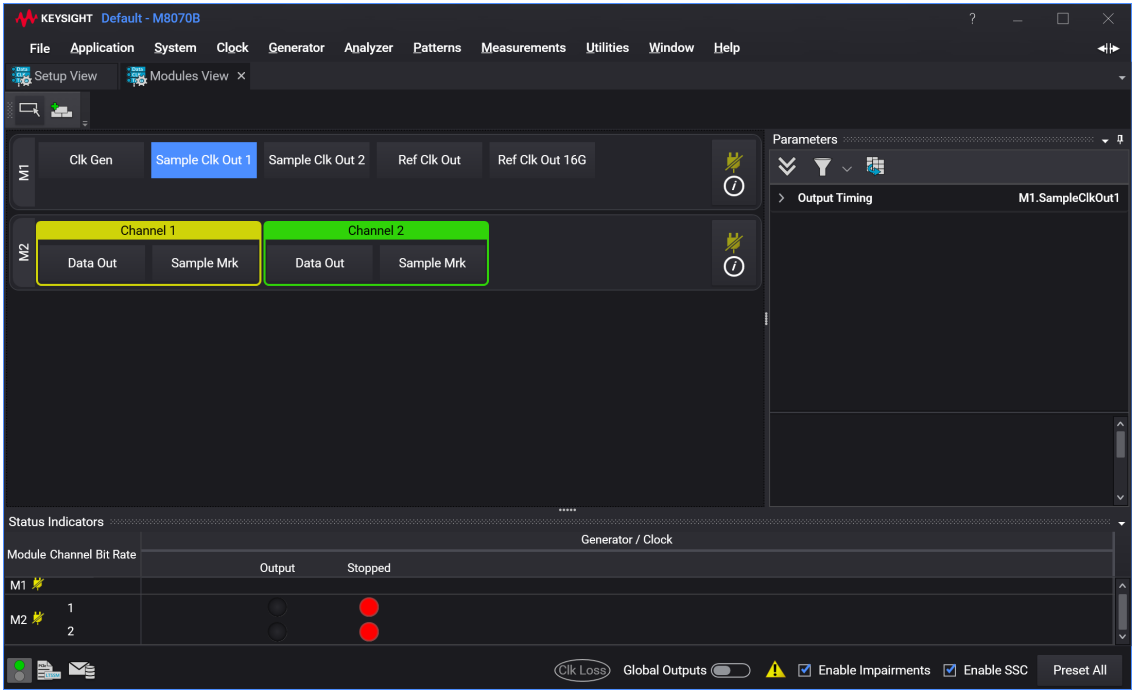


Figure 29 M8070B display with M8008A, M8198A selected at Startup Options

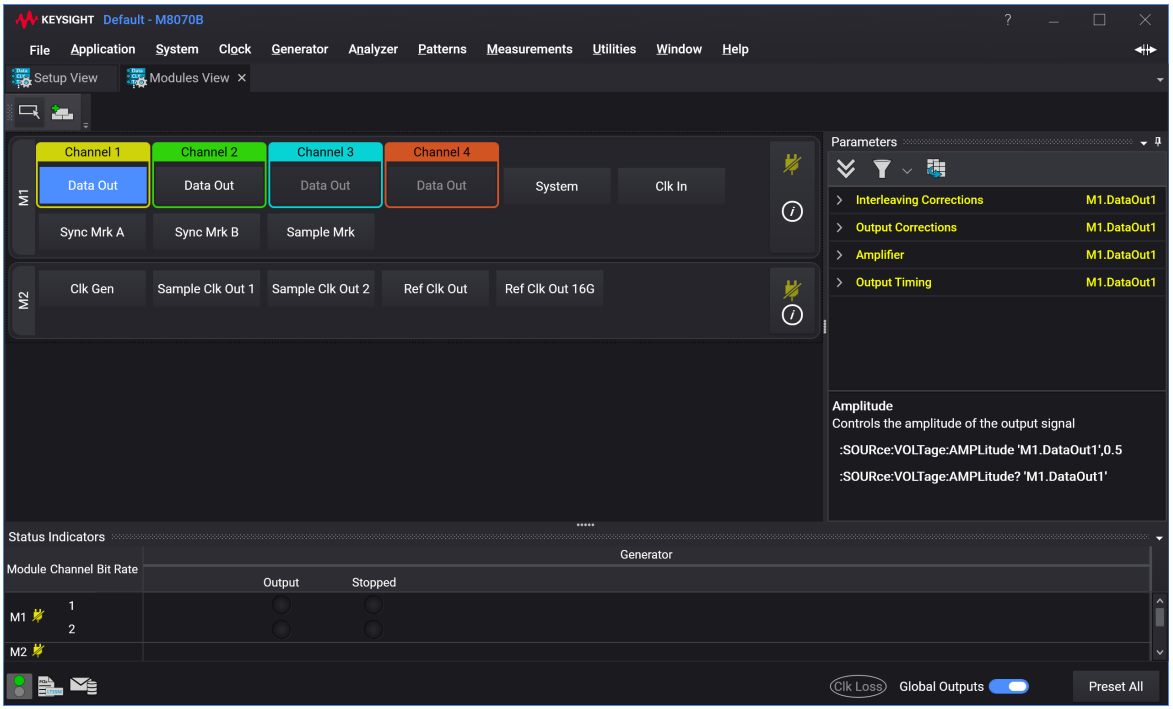


Figure 30 M8070B display with M8008A, M8199A selected at Startup Options

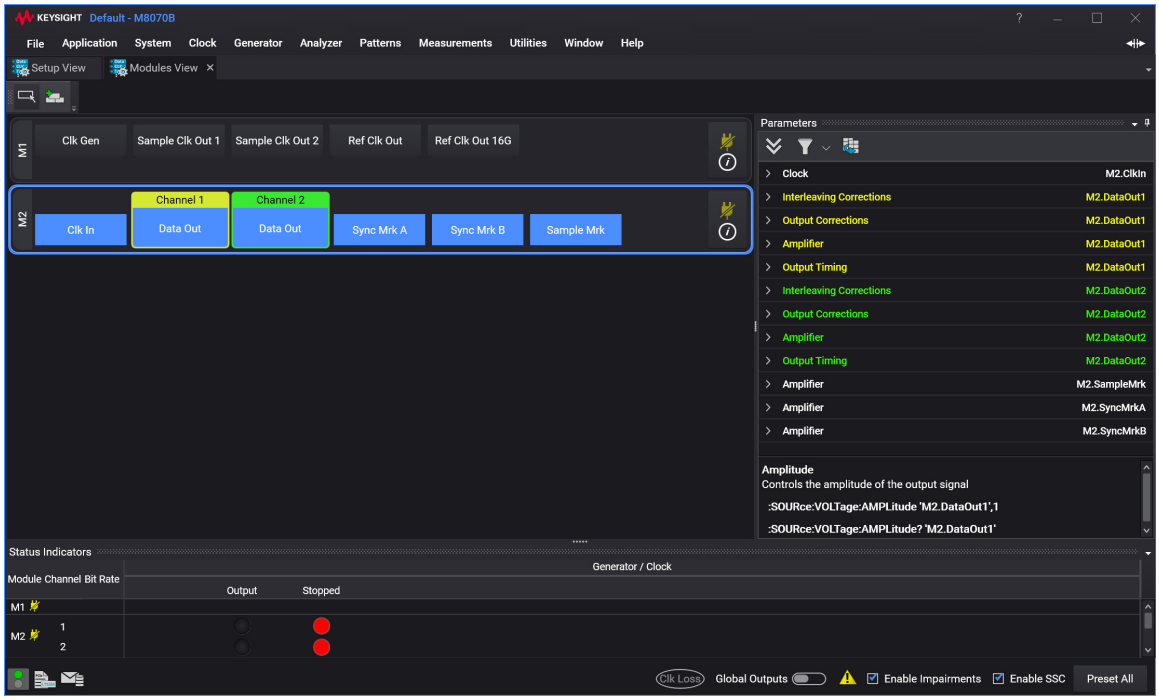


Figure 31 M8070B display with M8008A, M8199B selected at Startup Options

For details on the how to control one or more driver packages using M8070B software interface, refer to *M8100 Series User Guide*.

For information on SCPI commands used for the remote programming of the M8100 series AWG modules, refer to the *M8100 Series Programming Guide*.

Step 14 - Enabling/Disabling the Interleaving Mode in M8199A modules

There are two different interleaving (ILV) modes:

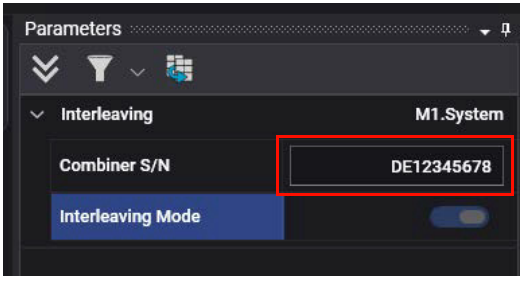
- **Non interleaved**: This mode is active when no combiner serial no. is registered, and no remote head is connected.
- **Interleaved**: This mode is active when a combiner serial no. is registered, or a remote head is connected. Interleaved mode is active when a remote head is connected even though no combiner serial no. is registered. The connection of a remote head is only checked at startup.

NOTE The registered combiner serial no. is persistently stored on the module.

To enable the ILV, do the following:

1 Go to **Parameters** > **Interleaving** > **Combiner S/N**.

2 Enter the serial no. of the ILV option (Combiner) into the **Combiner S/N** text field.



3 Restart the M8070B application. After the restart, the ILV mode will be enabled.

To disable the ILV, do the following:

1 Go to **Parameters** > **Interleaving** > **Combiner S/N**.

2 Delete the serial no. in the **Combiner S/N** text field and press **Enter**.

3 Restart the M8070B application. After the restart, the ILV mode will be disabled.

Step 15 - Powering off the Chassis and Modules (If Required)

Power off the chassis and module in the following sequence:

1 Power off the host computer. If you are using the Keysight AXIe Embedded Controller module as the host computer, ensure that you shut down the controller by executing the Windows shutdown process.

2 Power off the chassis by pressing the chassis ON/STANDBY switch on the front panel of chassis. Do not use the circuit breaker for routine power off. The module(s) are powered off automatically with the chassis.

3 Maintenance

KEYSIGHT TECHNOLOGIES

Locating Electronic Manuals

Various electronic manuals provide information on how to configure and use the supported instrument modules.

On installing the M8070B software, you will find documentation by clicking **Start** > **Keysight M8070B** > **Keysight M8070B Documentation**.

You can also visit www.keysight.com/find/M8100 to find the latest versions of various manuals and the data sheet for each module in the M8100 series.

Routine Care

NOTE Except for performing initial chassis verification or troubleshooting, do not operate the chassis with empty slots. Always insert a filler panel in empty slots. This is especially important for the slots on either side of an installed instrument module. This allows proper air flow and cooling, and provides EMI shielding for the chassis and installed components. Leaving slots empty can increase fan speed, raise ambient noise, overheat components, and can cause the module to shut down.

CAUTION Do not block the vent holes on the chassis. This overheats and damages their components. Leave a gap of at least 2” (50 mm) around all vent holes.

CAUTION Some instruments, such as M8158A, have an internal fan to keep the components cooled to normal operating temperatures. Make sure that there is enough clearance for adequate air-flow.

CAUTION The enclosure surface of the module may become hot during use. If you need to remove the module, first power down the AXIe chassis, allow the module to cool, and then pull the module out of the chassis.

NOTE For preventing damage, for usage tips, and for ESD information, read and follow the instructions in the "*M8100 Series Tips for Preventing Damage Guide*" (Document Part No. #M8000-91B30).

Updating Software Components

Updated versions of the M8070B and module specific software components are available on the Keysight website.

To download a software upgrade:

1 Go to http://www.keysight.com/find/M8070B.
2 Click the **Technical Support** tab.
3 Click **Drivers and Software**.
4 Type the model number of the instrument module for which software update is needed and click **Find**. Model number is located on the front panel of the module.
5 Click the **Driver and Software** link on the module page.
6 Download the required software update from the list of available updates.

Contacting Keysight Service and Support

To locate a sales or a service office near you, go to www.keysight.com/find/contactus.

Index

Edition 6.0, March 2026
Printed in Germany
M8100-91B20

KEYSIGHT
TECHNOLOGIES

www.keysight.com