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Startup
Guide

Keysight U5309A
PCIe High-Speed Digitizer

2 or 8 channels, 8-bit, up to 2 GS/s, DC to 500 GHz bandwidth, with custom firmware support



KEYSIGHT TECHNOLOGIES

Notices

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Regulatory Compliance

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

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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.

The following safety precautions should be observed before using this product and any associated instrumentation.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the

safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product.

WARNING

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

The types of product users are:

- Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring operators are adequately trained.
- Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.
- Maintenance personnel perform routine procedures on the product to keep it operating properly (for example, setting the line voltage or replacing consumable materials). Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.
- Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

WARNING

Operator is responsible to maintain safe operating conditions. To ensure safe operating conditions, modules should not be operated beyond the full temperature range specified in the Environmental and physical specification. Exceeding safe operating conditions can result in shorter lifespans, improper module performance and user safety issues. When the modules are in use and operation within the specified full temperature range is not maintained, module surface temperatures may exceed safe handling conditions which can cause discomfort or burns if touched. In the event of a module exceeding the full temperature range, always allow the module to cool before touching or removing modules from chassis.

Keysight products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits – including the power transformer, test leads, and input jacks – must be purchased from Keysight. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keysight to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call an Keysight office for information.

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers. For continued protection against fire hazard, replace fuse with same type and rating.

PRODUCT MARKINGS:



The CE mark is a registered trademark of the European Community.



Australian Communication and Media Authority mark to indicate regulatory compliance as a registered supplier.



This symbol indicates product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001). It also identifies the product is an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 4).



South Korean Class A EMC Declaration. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home. A 급 기기 (업무용 방송통신기자재) 이 기기는 업무용 (A 급) 전자파적합기기로서 판 매자 또는 사용자는 이 점을 주 의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으로 합니다 .



This product complies with the WEEE Directive marketing requirement. The affixed product label (above) indicates that you must not discard this electrical/electronic product in domestic household waste. **Product Category**: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as "Monitoring and Control instrumentation" product. Do not dispose in domestic household waste. To return unwanted products, contact your local Keysight office, or for more information see http://about.keysight.com/en/companyinfo/environment/takeback.shtml.



This symbol indicates the instrument is sensitive to electrostatic discharge (ESD). ESD can damage the highly sensitive components in your instrument. ESD damage is most likely to occur as the module is being installed or when cables are connected or disconnected. Protect the circuits from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any built-up static charge by touching the outer shell of any grounded instrument chassis before touching the port connectors.



This symbol on an instrument means caution, risk of danger. You should refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.



This symbol 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.



This symbol denotes a hot surface. The side cover of the module will be hot after use and should be allowed to cool for several minutes.

CLEANING PRECAUTIONS:

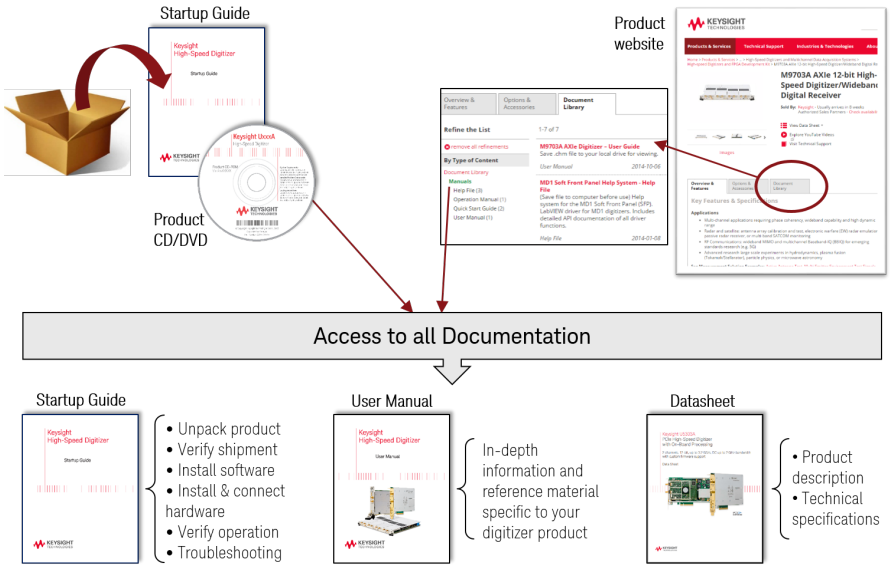
WARNING

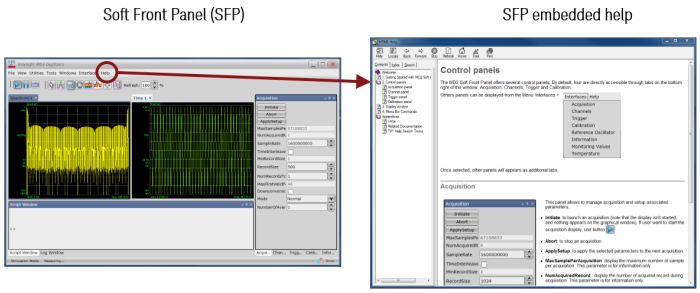
To prevent electrical shock, disconnect the Keysight Technologies instrument from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally. To clean the connectors, use alcohol in a well-ventilated area. Allow all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

Contents

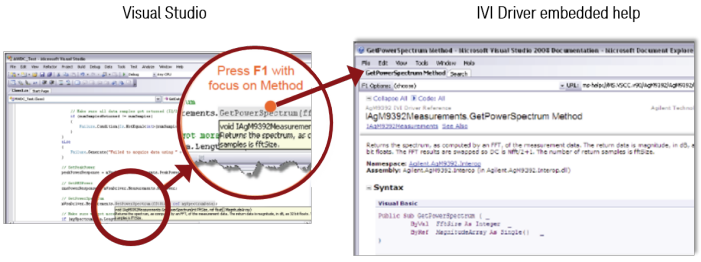
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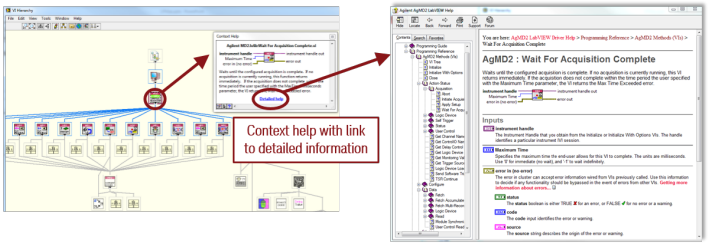




- Product Theory of operation
- Configuration
- Self test
- Field calibration
- Error report



- IVI-COM and IVI-C driver programmer's reference



- Labview driver programmer's reference

U5309A PCIe High-Speed Digitizer Introduction

The scope of this Startup Guide is to detail the processes of receiving and installing the Keysight U5309A PCIe High-Speed Digitizer, installing the required software, and verifying basic module operation.

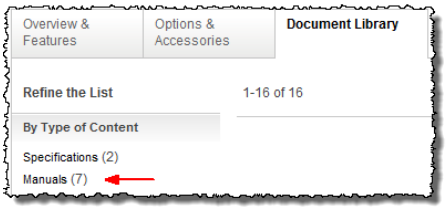
If you have any questions after reviewing this information, please contact your local Keysight representative or contact us through our website at www.keysight.com/find/contactus.

Related Documentation

This Startup Guide and the documentation listed below are contained on the CD supplied with your product. and at www.keysight.com/find/U5309A.

Select **Document Library> Manuals**

- U5309A User Manual
- Help system for the Soft Front Panel
- Help systems for the Keysight device drivers (IVI-C and IVI-COM, and LabVIEW G)



Or select **Document Library> Specifications**

- Product specifications for the Datasheet.

Follow the Startup Sequence

This Start-Up Guide is intended to lead the user through the four steps of product installation as summarized in the diagram below. An optional fifth step shows how to perform an operational verification of the U5309A PCIe High-Speed Digitizer.

Step 1: Unpack and Inspect



Step 2: Verify Shipment



Step 3: Install Drivers and Software



Step 4: Install Modules

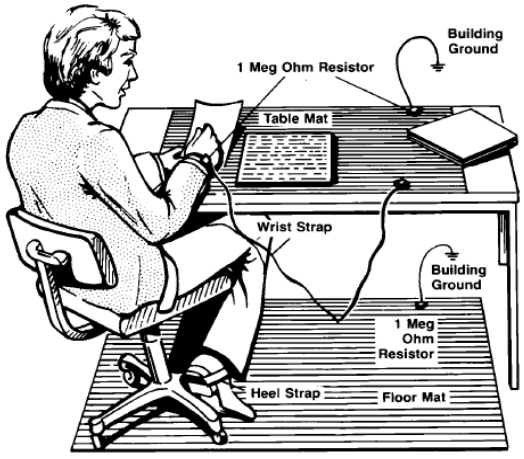


WARNING Closely follow the startup process flow in this document. Deviating from the sequence can cause unpredictable system behavior, damage your system, and may cause personal injury.

Step 1: Unpack and Inspect the Module

CAUTION The module is shipped in materials which prevent damage from static. The module should only be removed from the packaging in an anti-static area ensuring that correct anti-static precautions are taken. Store all modules in anti-static envelopes when not in use.

Electrostatic Discharge (ESD) Precautions



Electrostatic discharge (ESD) can damage or destroy electronic components. Use a static-safe work station to perform all work on electronic assemblies. The figure (left) shows a static-safe work station using two types of ESD protection: conductive table-mat and wrist-strap combination, and conductive floor-mat and heel-strap combination. Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone. To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground.

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

Inspect for Damage

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

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

NOTE See http://www.keysight.com/find/tips for information on preventing damage to your Keysight equipment.

Return a Module for Service

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

1. Review the warranty information shipped with your product.
2. Contact Keysight to obtain a Return Material Authorization (RMA) and return address. For assistance finding Keysight contact information, go to www.keysight.com/find/assist (worldwide contact information for repair and service) or refer to the “Support” information on the product web page at www.keysight.com/find/U5309A.
3. Write the following information on a tag and attach it to the malfunctioning equipment:
   - Name and address of owner. A P.O. box is not acceptable as a return address.
   - Product model number (for example, U5309A).
   - Product serial number. The serial number label is located on the top cover of the module. The serial number can also be read from the Soft Front Panel interface, but only after the hardware is installed.
   - Description of failure or service required.
4. Pack the module in its original ESD bag and packing carton. If the original carton is not available, use bubble wrap or packing peanuts and place the instrument in a sealed container and mark the container “FRAGILE”.
5. On the shipping label, write ATTENTION REPAIR DEPARTMENT and the RMA number.

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

Step 2: Verify U5309A Shipment Contents

The following items are also included with your U5309A PCIe High-Speed Digitizer order:

Part Number	Quantity	Description
U5309A	1	PCIe High-Speed Digitizer.
U1092-80001	1	Coaxial cable, MMCX (male) to BNC (male), 1 m.
8121-2531	1	Auxiliary power cable, 4-Pin Male to Female 4-Conductor Floppy.
8121-2533	1	Auxiliary power cable, 15-Pin SATA Power Male to Power 4-Pin Floppy.
M9700-10001	1	Keysight MD2 High-Speed Digitizer Software & Product Information DVD.
E2094-60003	1	Keysight IO Libraries Suite CD.
U5309-90001	1	Startup Guide in hard copy.
5962-0476	1	Certificate of Calibration.
5964-8178	1	Form-determining recalibration due date.
9320-6741	1	ROHS (China addendum).

NOTE All the files contained on the CDs are available for download at www.keysight.com/find/U5309A.

Step 3: Install the Software

System Requirements

Item	Requirements	
Operating system	Windows 7® (32 or 64-bit), All versions. Windows 8.1® (32 or 64-bit), All versions.	Linux Kernel 2.6 or higher (32 or 64-bit), Debian 7.0, CentOS 6.
Processor speed	1 GHz 32-bit (x86), 1 GHz 64-bit (x64), no support for Itanium64	As per the minimum requirements of the chosen distribution
Available memory	1 GB minimum	As per the minimum requirements of the chosen distribution
Available disk space[1]	2.5 GB available hard disk space, includes: 1.5 GB for Keysight IO Libraries Suite 1 GB for Keysight MD2	100 MB
Video	Support for DirectX 9 graphics with 128 MB graphics memory recommended (Super VGA graphics is supported)	No graphics required (for headless system), or X Windows
Browser	Microsoft Internet Explorer 7.0 or higher	Distribution supplied browser

[1] Because of the installation procedure, less disk space may be required for operation than is required for installation. The amount of space listed above is required for installation.

Hardware Requirements

A PC running one of the above operating systems.

Recommended models are: HP Z420, HP Z440, or Dell T5810.

Install the Software

CAUTION **If the Keysight MD2 software is installed on your computer, first uninstall the Keysight MD2 software from the *Control Panel* > *Programs and Features* before installing the Keysight MD2 High-Speed Digitizer Software.**

Keysight IO Libraries Suite (IOLS)

The Keysight IO Libraries Suite (IOLS) contains the Keysight Connection Expert. This software is included with your shipment (CD part number E2094-60003), and is also available at www.keysight.com/find/IOsuite. This software must be installed first.

1. From the Keysight IOLS CD (E2094-60003) browser launch the installer.
2. Follow the installer prompts to install the IO libraries.

NOTE **For Keysight IO Libraries Suite, it is recommended to use the version included with your shipment. If you are downloading Keysight IO Libraries Suite from www.keysight.com/find/IOsuite, the recommended version is indicated on MD2 Driver DVD or on www.keysight.com/find/MD2.**

Instrument Software

The Instrument software, which includes device drivers (IVI-C, IVI-COM) and documentation is delivered with your shipment (part number M9700-10001).

1. From the Keysight MD2 High-Speed Digitizer Software & Product Information DVD launch the installer.
2. Follow the installer prompts. Choose a "Complete" installation to install all software and documentation, or a "Custom" installation to select from a listing of components and other features.
3. After installation is complete, please shut-down the PC.

NOTE **Version 1.8 or higher of the Keysight MD2 High-Speed Digitizer Software is required.**

High-Speed Digitizers Applications DVD for Windows

The High-Speed Digitizers Applications DVD installs the software required for the application options[1] your have ordered. This software is included with your shipment (DVD part number U5300-10001).

NOTE **The installation of the DVD is required only for users having ordered an application option[1]. It can provide information on the possible extension of the digitizer.**

1. First install Keysight MD2 High-Speed Digitizer Software.
2. From the High-Speed Digitizers Applications DVD launch the installer.
3. Follow the installer prompts and select the applications your want to install.

[1] For complete list of application options supported by your digitizer, please refer to product's datasheet.

Step 4: Install the Module

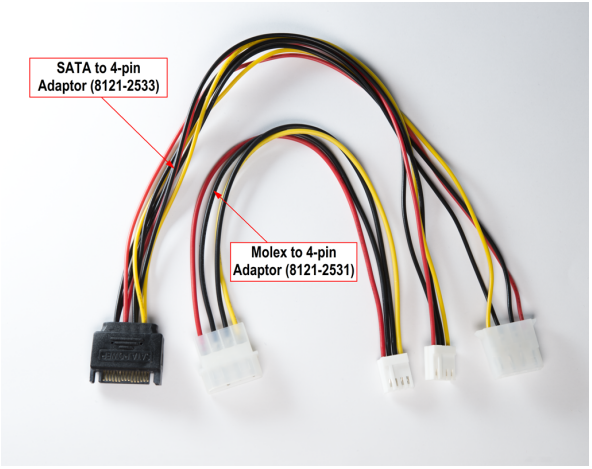
1. Ensure that the PC is switched off, and disconnect the power cord. Open the PC case.

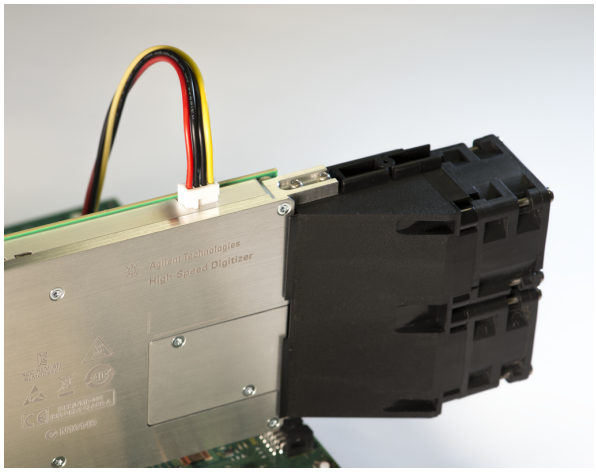
CAUTION **Follow ESD precautions when handling and installing the U5309A.**

2. The U5309A features a x8 PCIe bus interface, and should be installed in either a x8 or x16 PCIe slot.
3. When installing the U5309A, ensure that it has optimum cooling. Do not install it in a position where the integrated cooling fans may be obstructed.
4. The module requires an additional auxiliary 4-pin power connection to the white connector at top edge of the module. If your PC has a free 'floppy drive power' connector, simply attach this.

   If your PC does not have a free connector of this type you may use one of the two supplied adapters.

   - If your PC has spare 4-pin Molex power connectors, use the supplied adapter 8121-2531.
   - If your PC only has the newer SATA power connectors, use the supplied adapter 8121-2533.

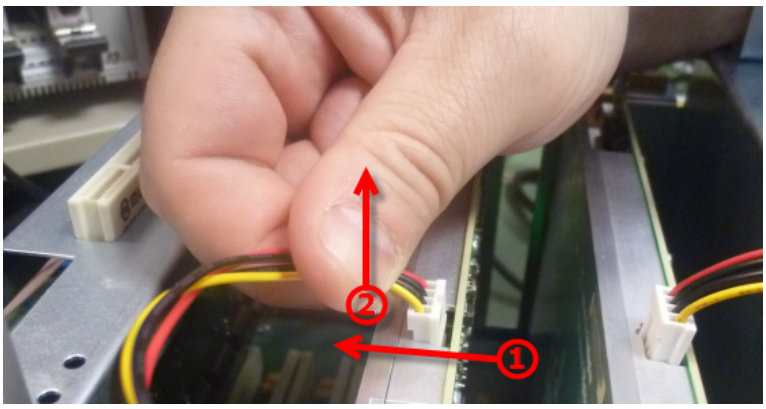




CAUTION **Be careful there is no mechanical part of the PC that could damage the power adaptor cable.**

5. Replace any covers and switch-on the PC. Check the module front panel indicators - a few seconds after the boot process, both the '*Status*' and '*DPU*' LEDs should be green.

CAUTION When disconnecting the auxiliary power cable, it is important to push it away from the PCB side of the U5309A in order to disengage the friction lock. Failure to do this could cause the module side of the connector to be withdrawn at the same time thus damaging it.



Note that the U5309A is optionally supplied with a card retainer (included if ordered as U5309A-001, or available separately by ordering stand alone extender (please contact support for the reference)) which is able to pick up on slots at the end the full-length PCIe slot and provide additional support for the module. Use of this card retainer is highly recommended, in particular when the PC motherboard is oriented vertically. However if your PC hardware does not provide end slots, the card retainer may be removed from the module.

It is also possible to reverse the orientation of the fan assembly in the case that two modules must be placed in adjacent slots, or other PC hardware obstructs the fitting. These three procedures are detailed below.

Fitting the module with the optional card retainer into your PC

1. Loosen (but do not remove) the screw (A) holding the rear card retainer, and slide it towards the fans.
2. Insert the module into the PCIe slot of the PC, ensuring that it is fully seated into the PCIe bus connector.
3. Fix the module to the PC either by fitting a screw, or by using a method compliant with your PC model.
4. Fully extend the card retainer and ensure that it is inside the PC chassis support slot.
5. Tighten the screw (A) (0.5 Nm torque).

NOTE If the PC is a T5810, the PCIe-card retention (support slots) has to be removed and adapted by removing two of the extension blocks before inserting the U5309A. For details, please contact support www.keysight.com/find/assist.

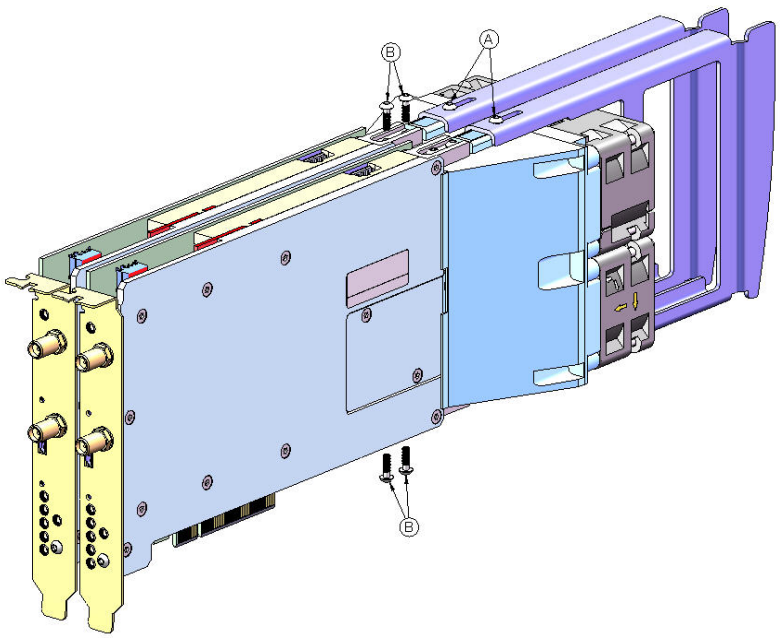


Diagram showing fan/support assembly fixings (U53xxA shown as example).

Removing the card retainer

1. Remove the screw (A in the figure).
2. Withdraw the card retainer.

Installing the card retainer (if not previously fitted)

1. Slide the card retainer onto the fan module and fit screw (A) to the top of the retainer.

Reversing the orientation of the fan assembly

1. Remove the four screws (B) nearest to the front of the fan unit.
2. Slide the fan unit approximately 15 mm to the rear until it clears the circuit board, disconnect the power cables, and rotate the fan unit by 180°.
3. Reconnect the power cables.
4. Slide the fan unit back towards the module until it is fully seated into the support slots.
5. Refit the four screws, push the fan unit upwards away from the circuit board and tighten the four screws (0.5 Nm torque).

U5309A Front Panel Features

Front Panel Connectors



Connector	Type	Description
TRG IN	MMCX female	External trigger signal input, 50 Ω terminated. Level range is ±5 V.
IN 1 to IN 2 [1] 1 to 8 [2]	SSMC male	Analog signal input. DC-coupled and 50 Ω terminated. Maximum input voltage ±3.4 V DC (or ±5 V DC)[3].
JTAG	Micro USB	Provides connection to the DPU for use with the U5340A FPGA Development Kit.
TRG OUT	MMCX female	Trigger Out signal.
I/O 1, 2, 3	MMCX female	User configurable Input / Output signal. 3.3 V CMOS and TTL compatible.
CLK IN	MMCX female	External clock input. AC coupled and 50 Ω terminated, signal level: +5 to +15 dBm. Please refer to datasheet for details.
REF IN	MMCX female	External reference clock input, AC coupled and 50 Ω terminated. It can accept a 100 MHz signal from -3 to +3 dBm.

Note: It is recommended to first connect the SSMC end of the input cable and tighten using the torque wrench (U1092A-WCK) before connecting the SMA end, this minimizes strain on the connector. A 1 m SSMC to SMA cable is available as an accessory (U1092A-CB3) A 1 m SSMC to BNC cable is also available (U5300A-100).

[1] For the 2 channels version (U5309A-CH2 option)
[2] For the 8 channels version (U5309A-CH8 option)
[3] For modules delivered after April 2015. The driver automatically adjusts offset accordingly.

Front Panel LEDs

Indicator	Purpose	Color	State	Meaning
DPU	DPU status		Off	DPU is not configured
			Green, blinking	Module initialization in progress
			Green	Module OK (firmware not yet loaded)
			White	DPU firmware loaded (ready)
STATUS	Module status		White, blinking	Firmware initialization in progress
			Green, blinking	Module initialization in progress
			Yellow, blinking	Warning
			Red, blinking	Error
			Green	OK (ready)

NOTE **If warning or error status is observed, please try the following steps:**

- Power-cycle the PC (If using a PCIe expansion chassis, observe the power sequence requirements)
- If the error persists please contact Keysight technical support http://www.key-sight.com/find/assist.

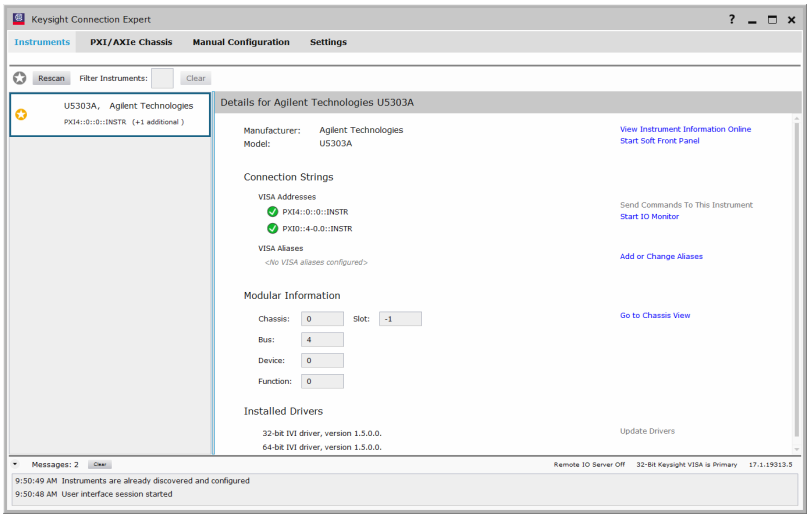
Step 5: Verify Operation of the U5309A Module

Keysight Connection Expert

The intention of this step is to verify correct operation of the newly installed module. Run **Keysight Connection Expert** by clicking the task bar icon , and select **Connection Expert**.

The list of installed modules is displayed. The instrument properties may be viewed by clicking on the desired instrument from the list on the left.

Review the configuration data and then click on **Start soft front panel** to launch the **MD2 Soft Front Panel**. This will provide control of the module for calibration, test and other operational verification procedures.

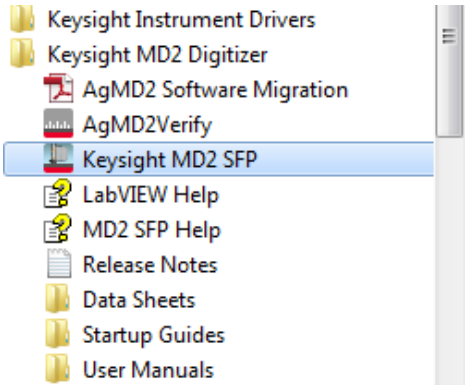


NOTE **If the module does not appear in the Keysight Connection Expert, first try the Rescan button. If that does not work, restart your PC or embedded controller and restart Keysight Connection Expert again.**

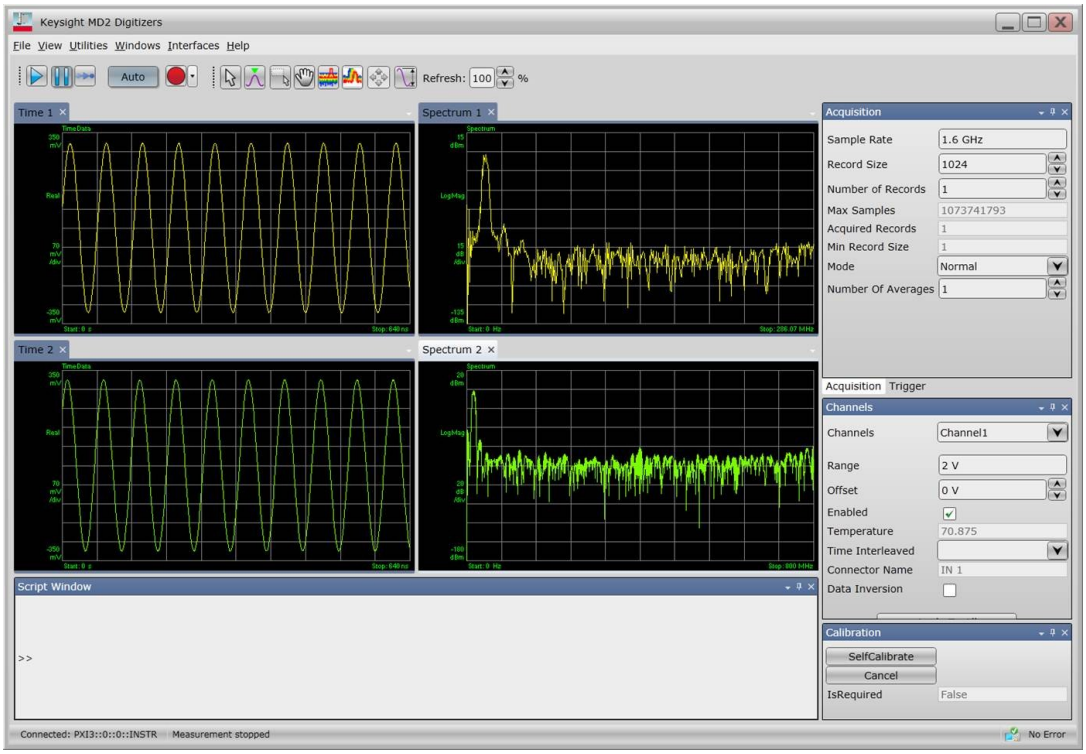
Driver Graphical Interface: MD2 Soft Front Panel

The **Keysight MD2 SFP** (Soft Front Pannel) is a graphical interface for High-Speed Digitizer Instrument Drivers that enables the control of any supported digitizers.

The MD2 SFP can be launched from **Keysight Connection Expert**, directly from the **Windows Start Menu > Keysight MD2 Digitizer>Keysight MD2 SFP**.



The **Connection window** opens with the selection of the digitizer to monitor. After selecting your digitizer, click **Connect**. For details, please refer to **MD2 SFP Help**.



Perform a Verification of the U5309A (optional)

Requirements for Verification

The correct operation of the U5309A may be verified by the use of a simple application which carries out several performance checks on a signal acquired from an external Function Generator.

Required Hardware

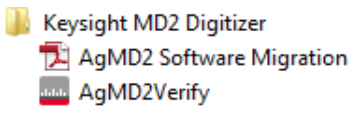
An external signal source is required. Almost any sine wave or function generator capable of generating a signal with an amplitude of 300 mV rms into 50 Ω at a frequency of 1 MHz may be used.

Hardware	Description
RF Analog Signal Generator	e.g. Keysight N5181B
SSMC cable	50 Ω Coaxial cable with SSMC(f). A 1 m SSMC to SMA cable is available as an accessory (U1092A-CB3)

Operational Verification Procedure

CAUTION **Do not exceed the maximum voltage level at the INPUT connector (±3.4 V DC or ±5 V DC for modules delivered after April 2015)**

1. Configure the RF Generator to produce a Sine signal with a Frequency of 1.0 MHz, an Amplitude of 300 mV rms (+2.55 dBm).
2. Connect the Signal Generator output to the IN 1 connector, and turn on the output.
3. Launch the *AgMD2Verify* utility from **Windows Start Menu > Keysight MD2 Digitizer > AGMD2Verify**.



A command shell window will open.

4. **Press any key** to start the test. The screen capture below shows the result of a successful verification:



NOTE AgMD2Verify checks the version of the Control FPGA firmware. If the version is not up-to-date, the tool will automatically propose to update the firmware using the "Firmware Update Utility". Once the Control FPGA firmware has been updated successfully, please power off your computer and restart it again for the update to take effect. You may then proceed with the AgMD2Verify utility as described in this section.

If a Problem is Found

1. Verify that you have made all configuration settings as shown above.
2. Verify that the RF generator is ON and producing the desired signals at the end of the cable. This can be done with an oscilloscope.
3. Verify that the problem is reproducible.
4. Contact Keysight technical support for assistance. Contact details may be found at: www.keysight.com/find/assist.

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