Keysight M8131A 16/32 GSa/s Digitizer

KEYSIGHT

USER'S GUIDE

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CAUTION

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

WARNING

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

Safety Summary

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

Initial Inspection

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

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

General

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

Laser Safety Information

Class 1 Laser product according IEC60825-1 (2007).

Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate within a temperature range of 0 °C – 40 °C (32 °F – 105 °F) at a maximum relative humidity of 80% and at altitudes of up to 2000 meters.

This module can be stored or shipped at temperatures between -40 °C and +70 °C. Protect the module from temperature extremes that may cause condensation within it.

Before Applying Power

Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.

Line Power Requirements

The Keysight M8131A operates when installed in an Keysight AXIe mainframe.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Instrument Markings

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

Table 1 Instrument Markings

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

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

Compliance and Environmental Information

Table 2 Compliance and Environmental Information

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

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3 Soft Front Panel

1 Introduction

This chapter provides an overview of M8131A digitizer module.

M8131A Overview

The Keysight M8131A is a 16/32 GSa/s digitizer with high bandwidth and channel density. It offers up to 1.6 GSa waveform memory. The M8131A is ideally suited to address following key applications:

- Wideband RF/μW – analyses extremely wideband RF signals with an instantaneous bandwidth of DC to 12.5 GHz for aerospace/defense and communication applications.
- Physics, chemistry, and electronics research – analyses any mathematically defined arbitrary waveforms, ultra-short yet precise pulses and extremely wideband chirps.
- Gapless optical streaming of 10-bit digitized data to DSP module, AWG or storage system for radar, electronic warfare, satellite or 5G.

Key Features

The M8131A is a digitizer with high sample rate, bandwidth, and channel density:

- Wide bandwidth
  - 4 channels 6.5GHz, sample rate 16 GSa/s on each channel or
  - 2 channels 12.5GHz, sample rate 32 GSa/s on each channel

- Vertical resolution: 10 bits
- Outstanding signal fidelity with respect to SFDR, ENOB, harmonic distortion
- Full speed 4 x 16 GSa/s or 2 x 32 GSa/s gapless optical streaming via ODI (standardized Optical Data Interface), e.g. to an external storage system or customer‘s device or DSP module
- Total ODI streaming throughput: 4 x 160 GBit/s equals 640 GBit/s
- Real-time DDC and decimation
- On board memory 1.6 GSa per module
- Form factor: 2-slot AXIe module controlled via external PC or embedded AXIe system controller M9537A

Feature Options

The following feature options are available for M8131A:

Table 3 M8131A feature options

Option	Functionality
STR	Streaming: access to ODI interfaces
DDC	Digital Down Conversion
SEG	Segmentation

Instrument Options

The following instrument options are available for M8131A:

Table 4 M8131A instrument options

Option	Bandwidth	Maximum Sample Rate	Inputs
011, 012, 014	1.6 GHz	4 GSa/s	Single ended inputs, adjustable sensitivity.
061, 062, 064	6.5 GHz	16 GSa/s	
131, 132	12.5 GHz	32 GSa/s	
FD1, FD2, FD4	12.5 GHz	32 GSa/s	Differential inputs, fixed sensitivity.

Front Panel

Figure 1 on page 21 illustrates the front panel of the M8131A instrument.

Figure 1 M8131A front panel

The M8131A front panel has the following input/output ports:

Inputs/Outputs

- **Input** - The four analog input ports (In 1/2/3/4) can be used to receive the analog data.
- **ODI** - The four Optical Data Interface ports (ODI 1/2/3/4) can be used for optical data streaming.
- **Trig In** - The Trigger Input can be used for external triggering. Triggering source can be an external pulse generator connected. This will be used only when the trigger source is “Trigger Input”.
- **Trig Out** - The Trigger Output can be used to trigger external instruments or DUTs.
- **Sync In** - The Sync Input can be used to synchronize two or more modules to a common system clock. It is connected to the Sync Out of another module.
- **Sync Out** - The Sync Output can be used to synchronize two or more modules to a common system clock. It is connected to the Sync In of another module.
- **Sample Clk In** - The Sample Clock Input can be used, if an external clock source shall be used to clock the analog to digital to converters.
- **Sample Clk Out** - The Sample Clock Output can be used to output the clock signal from the internal sample clock or the sample clock input.

  When an internally generated sample clock of the M8131A is used, the **Sample CLK Out** must be connected with **Sample Clk In** with a semi-rigid cable as shown in the Figure 2 on page 22. However, if an external 8 GHz sample clock is used, the semi-rigid cable is not required.

Figure 2 Sample Clk Out/In connection

- **Ref Clk In** - The Reference Clock Input can be used to synchronize to an external clock.
- **Ref Clk Out** - The Reference Clock Output can be used to synchronize a DUT to the M8131A.
- **FPGA Config** - The FGPA Config functionality is for future use and is currently not supported.
- **Control In/Out** - The Control In/Out functionality is for future use and is currently not supported.

LEDs

The M8131A front panel has the following LEDs:

- **Status LEDs**

  The “Fail” and “Access” LEDs are available at the front panel to indicate the status of the M8131A module:

  - The green “Access” LED indicates that the controlling PC exchanges data with the M8131A module.
  - The red “Fail” LED has following functionality:
    - It is ‘ON’ for about 30 seconds after powering the AXIe chassis.
    - After about 30 seconds the LED is switched ‘OFF’. If an external PC is used to control the AXIe chassis, this PC can be powered after this LED has switched OFF.
    - During normal operation of the module this LED is ‘OFF’. In case of an error condition such as e.g. a self-test error, the LED is switched ‘ON’.
    - In case the output relay has shut-off because of an external overload condition, this LED flashes.

Related Documents

To access documentation related to the Keysight M8131A digitizer, use one of the following methods:

- **CD** - Browse the product CD for M8131A documentation.
- **Start** > **All Programs** > **Keysight M8131** > **Keysight M8131 Documentation** - Provides links to all product documentation.
- Go to the product web site (http://www.keysight.com/find/M8131A) and browse the manuals under **Document Library** tab.

Additional Documents

Additional documentation can be found at:

- http://www.keysight.com/find/M8131A for documentation describing how to calibrate the M8131A using the N2136A calibration module.
- http://www.keysight.com/find/M9502A for 2-slot chassis related documentation.
- http://www.keysight.com/find/M9505A for 5-slot chassis related documentation.
- http://www.keysight.com/find/M9506A for 5-slot chassis related documentation.
- http://www.keysight.com/find/M9514A for 14-slot chassis related documentation.
- http://www.keysight.com/find/M9537A for embedded AXIe controller related documentation.

2 Software Installation

This chapter explains the steps required to install M8131A software package.

Pre-Requisites

The following are the pre-requisites for installing Keysight M8131A software:

The supported operating systems are:

- Windows 10 (32 bit or 64 bit)

Ensure that you have Keysight IO Libraries Suite 2017 Update 1 or higher installed on your system. The Keysight IO Libraries Suite can be found on the CD that is part of shipment content or at http://www.keysight.com/find/iosuite

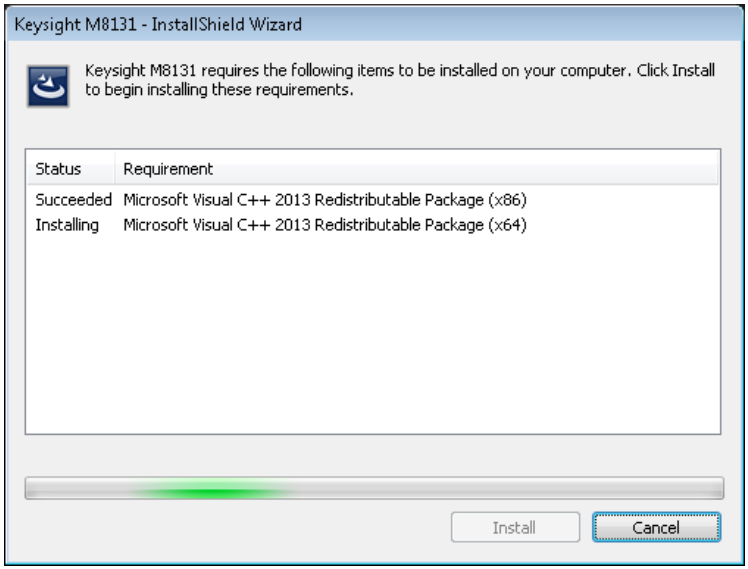
NOTE **Even if a non-Keysight VISA is already installed on your PC, it is still necessary to install the Keysight IO Libraries Suite. The Keysight IO Libraries Suite will install as "secondary" VISA in this case.**

Installation Process

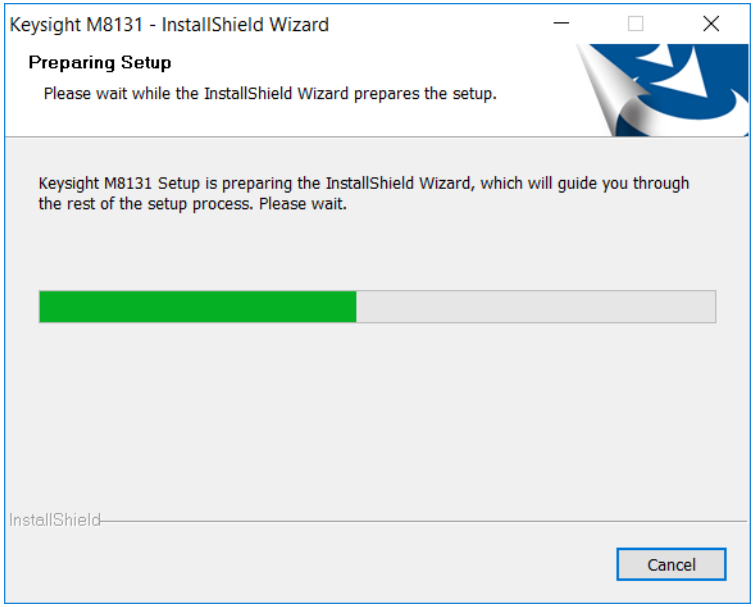
Follow the given steps to install Keysight M8131A software on your system:

1 Double-click the executable (M8131_Setup.exe). This executable file is available either on CD or Web.

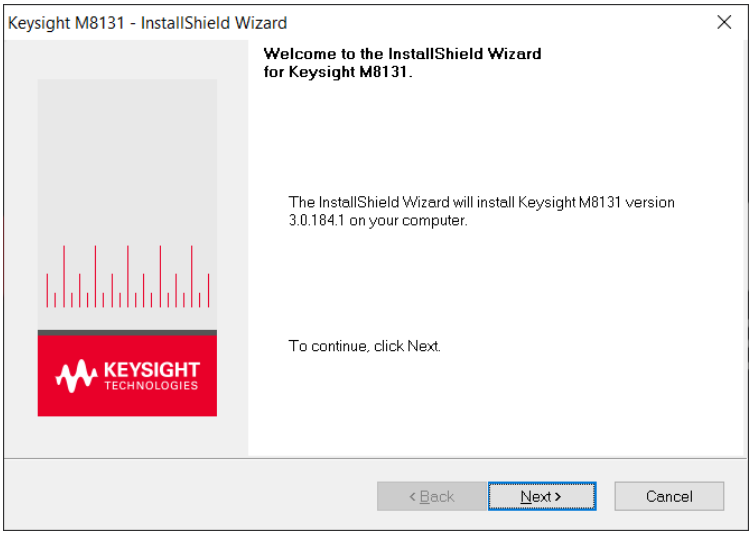
NOTE The installer will first check and list some pre-requisites. Click **Install** to install them. It is possible that your PC requests a reboot during this step. Reboot your PC, if requested.



2 The Keysight **M8131A Setup** will prepare the **InstallShield Wizard** for the installation process. The following window will appear.

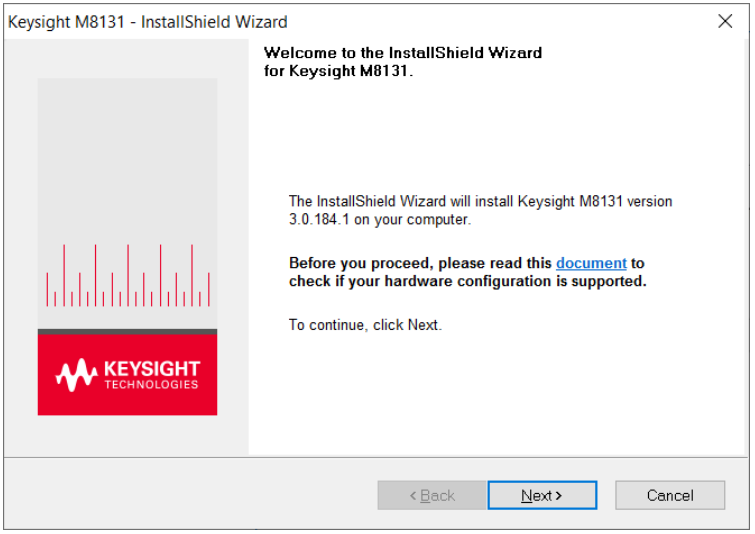


3 Follow the on-screen instructions to begin the installation process. Click **Next**.

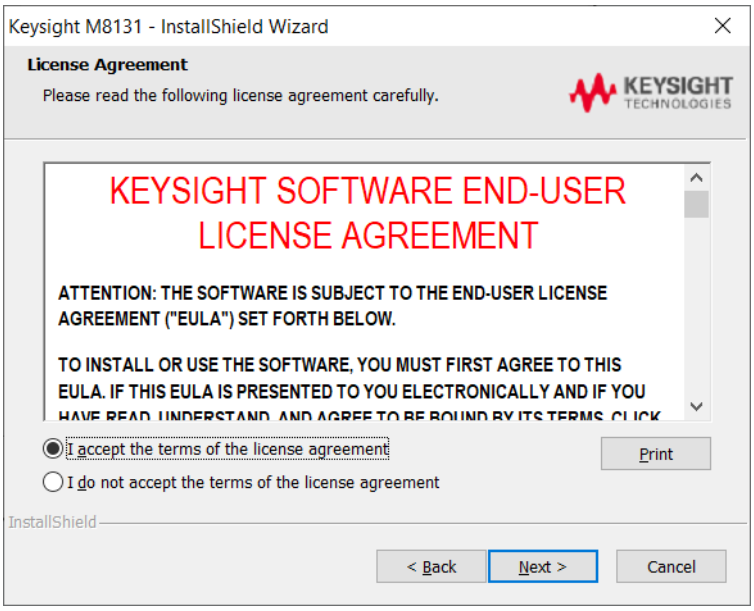


4 We recommend you to read the document to check if your hardware configuration is supported.

Click **Next** to proceed to the license agreements.

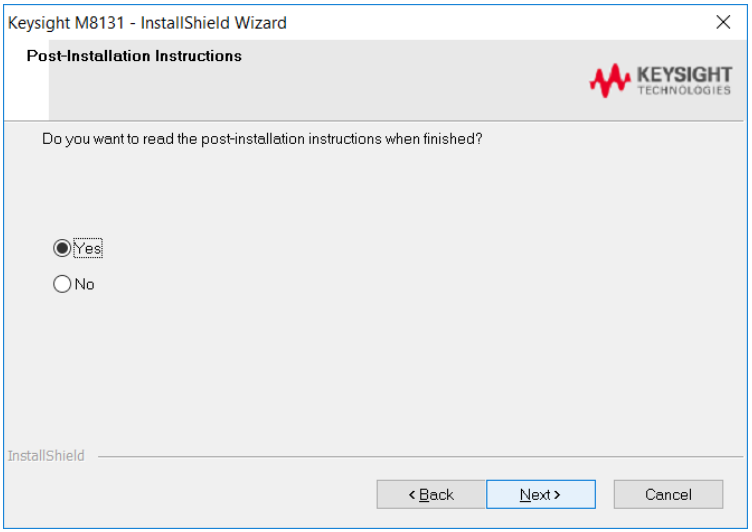


5 Accept the terms of Keysight software end-user license agreement and click **Next**.

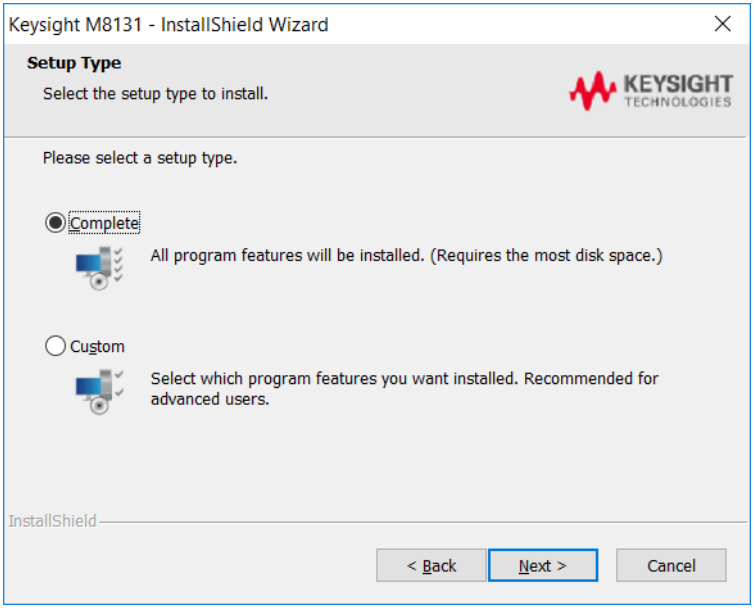


6 Select **Yes** if you want to read the post-installation instructions when finished.

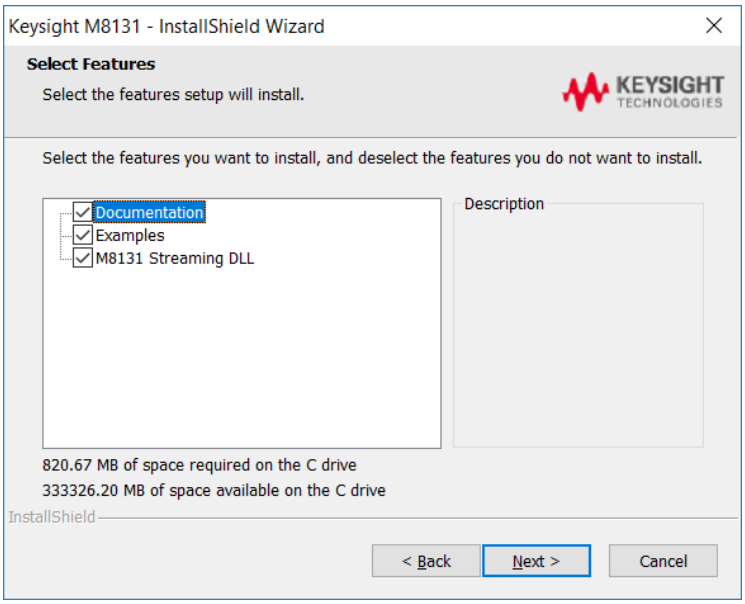
Click **Next** to select setup type.



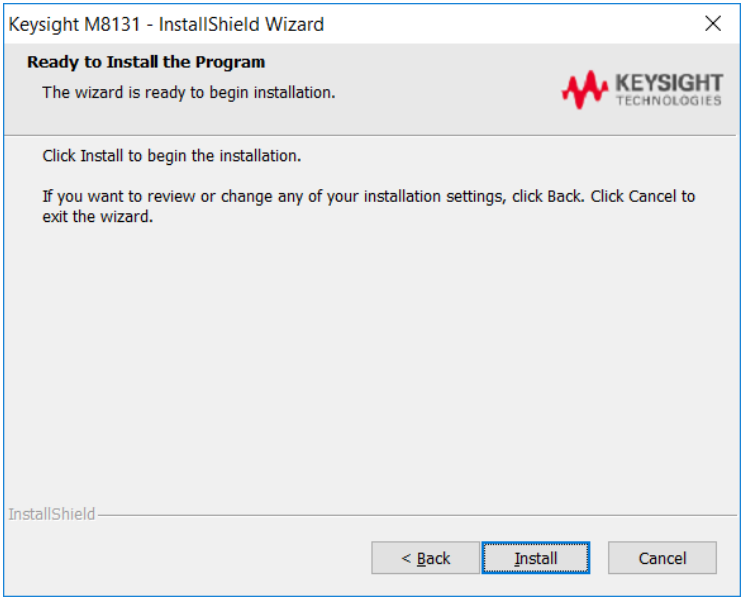
7 Select a setup type either **Complete** or **Custom**. Click **Next**.



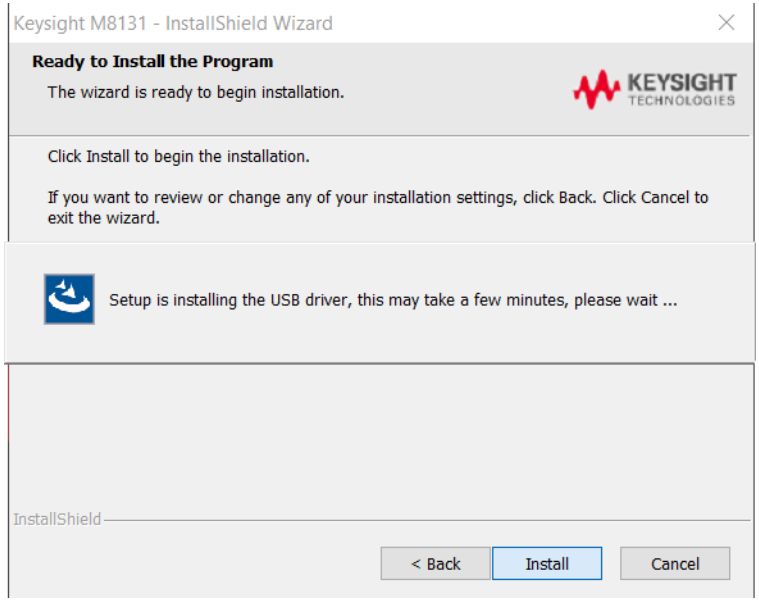
8 If you select **Custom** and click **Next**, you can specify which optional features will be installed:



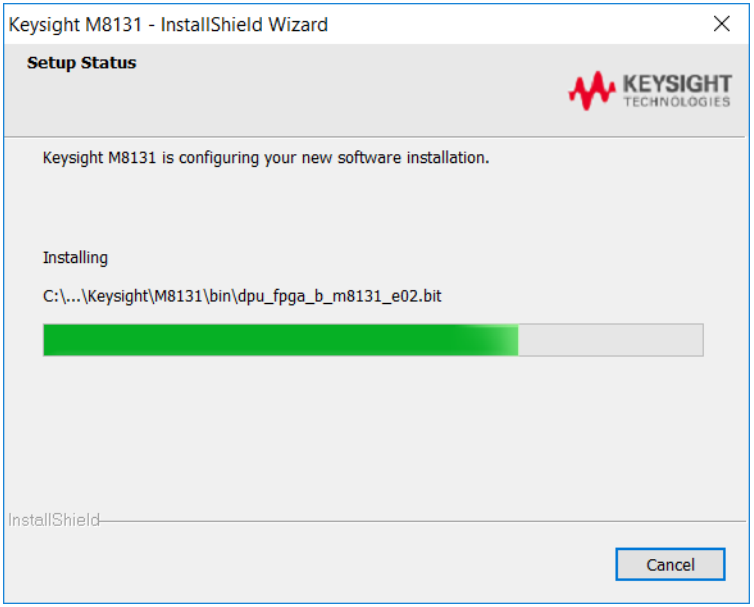
9 Click **Next** to begin installation.



10 The **Setup Wizard** will now install M8131 beginning with the kernel driver installation. If you have clicked “Always trust Keysight” before you won’t get this dialog anymore.

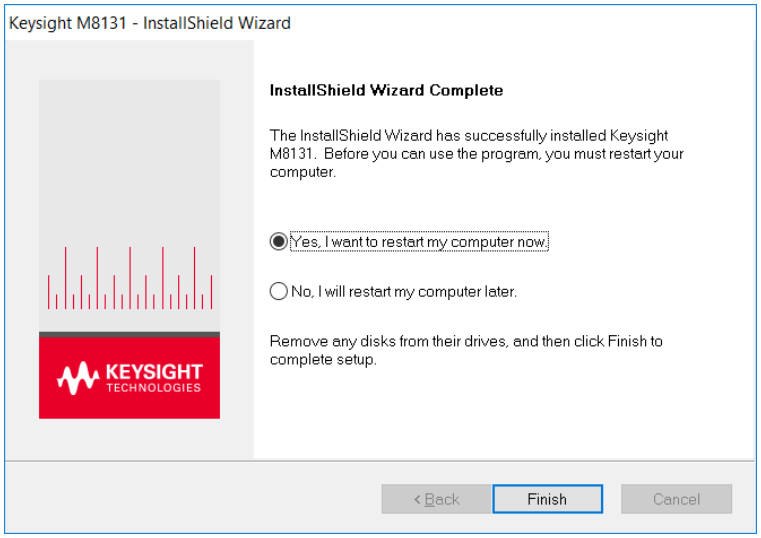


11 The Keysight M8131A will configure the new software installation.



The following screen will appear once the Keysight M8131A software is successfully installed on your system.

Click **Finish** to restart your system. Do not connect the AXIe chassis to your system using the PCIe or USB cable during this reboot.



12 This completes the Keysight M8131A software installation.

Post Installation Steps

Follow the post installation steps as shown below:

NOTE If M8131A is already powered up and connected to PC using the PCIe, just reboot the PC and start with step 5. No such reboot step is required in case of USB connection.

1 Shut down PC and instrument.
2 Connect the instrument to the PC using the PCIe or USB cable.
3 Switch on the instrument. Wait until the “Access” LED of the M8131A has switched from red to green.
4 Switch on the PC.
5 The PC should automatically recognize the instrument.

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

- In case of PCIe:

  The instrument should be visible in the device tree as Keysight Technologies Modular Devices > M8131A
- In case of USB:

  The instrument should be visible in the device tree as Keysight Modular Platform (AMP/AXIe) > Keysight Technologies USB AMP/AXIe Chassis.

NOTE In case of PCIe, post installation steps must be followed strictly in the same order as mentioned for successful connection of the PC with M8131A. However, in case of USB no such restriction is applicable i.e. the PC can be powered before the M8131A is turned ON.

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

6 (PCIe only) Check if the M8131 is also visible in the Connection Expert. The connection expert can be opened by clicking its icon in the system tray.

If something went wrong and the instrument is not showing in the PXI section, it may be necessary to reboot the PC once more.

NOTE

In systems with a PCIe connection to the chassis, it is strongly recommended to switch-off Windows' "fast startup". Otherwise configuration changes may not get detected correctly.

1. Right-click the **Start Menu**, and then select **System.**
2. Under the **System** pane, click **Power & Sleep.**
3. Under the **Related settings** option, click **Additional power settings.**
4. Click **Choose what the power buttons do** option.
5. Under the **Change settings that are currently unavailable** pane, ensure that **Turn on fast startup** is not selected.

The steps above may vary depending on your Windows version.

How to use M8131A Instrument

In order to use the instrument:

1. If you use a PCIe link to control the M8131A, the AXIe chassis must be switched on before you start the PC. If you use an USB link to control the M8131A, it's not mandatory that the AXIe chassis is powered and has booted prior to turn-on the PC.
2. Start the M8131A Soft Front Panel (**Start Menu** > **Keysight M8131** > **Keysight M8131 Soft Front Panel**). The user interface will display the VISA resource strings for different kinds of connection. Please note that the hardware resource strings will be not shown if the "**Simulation Mode**" check box is selected.
3. Using the appropriate VISA resource string you can:
   - Start the Soft Front Panel (**Start** > **All Programs** > **Keysight M8131** > **Keysight M8131 Soft Front Panel**).
   - Control the instrument with your own application by adding it as a LAN instrument in the Keysight Connection Expert (TCPIP0::localhost::....) and control it using SCPI (with e.g. the **Interactive IO** or your own application).

You must start the M8131A Soft Front Panel in order to send SCPI commands to the instrument.

M8131A Maintenance

This system should be serviced only by authorized personnel.

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

ESD Protection

CAUTION All the connectors are very sensitive to electrostatic discharge (ESD). There are also several exposed components on the PCAs, on both sides of M8131A, which can be touched accidentally while handling the unit and can risk damage to the instrument, due to ESD. When you connect a device or cable that is not fully discharged to these connectors, you risk damage to the instrument and expensive instrument repairs.

CAUTION Electrostatic discharge (ESD) can damage the circuits of the M8131A. Avoid applying static discharges to the front-panel connectors. Avoid touching the front-panel connectors without first touching the frame of the instrument. Be sure the instrument and all connected devices (DUT, etc.) are properly earth-grounded (to a common ground) to prevent buildup of static charge and electrical over-stress.

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

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

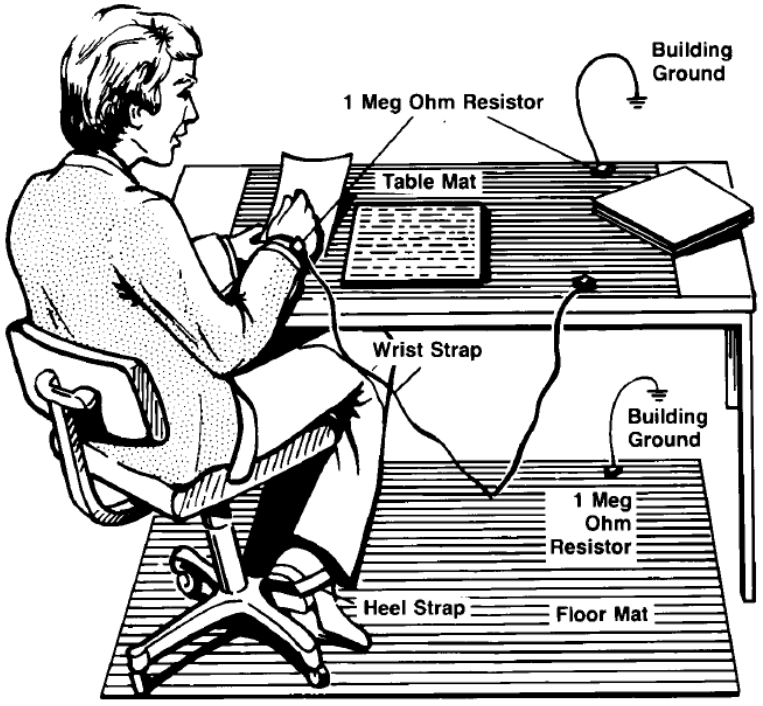


Figure 3 ESD protection

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

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

Power and Ventilation Requirements

For power and ventilation requirements, refer to:

- http://www.keysight.com/find/M9514A for 14-slot chassis related documentation.
- http://www.keysight.com/find/M9505A for 5-slot chassis related documentation.
- http://www.keysight.com/find/M9506A for 5-slot chassis related documentation.
- http://www.keysight.com/find/M9502A for 2-slot chassis related documentation.

Thermal Protection

Overheating Detection

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

Fan Failure

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

Battery

The M8131A does not have a battery.

Operating Environment

For details on operative environment for M8131A, refer to the section Operating Environment on page 197.

3 Soft Front Panel

This chapter describes the M8131A Soft Front Panel.

Launching the M8131A Soft Front Panel

There are two ways to launch the M8131A Soft Front Panel:

1 Select **Start Menu** > **All Programs** > **Keysight M8131** > **Keysight M8131 Soft Front Panel** from the **Start** menu.

2 From the **Keysight Connection Expert** select the discovered M8131 module, select the "**Installed Software**" tab and press the "**Soft Front Panel**" icon. Please note that only instruments connected via PCIe are shown in the **Keysight Connection Expert**.

The following **Connect to Instrument** dialog will appear:

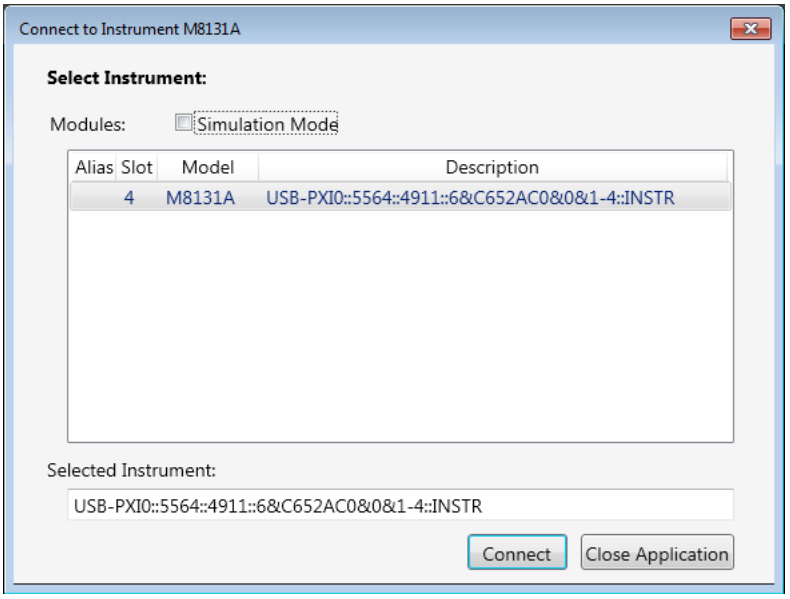


Figure 4 M8131A connected to PC

This dialog shows the addresses of the discovered M8131A modules. Select a module from the list and press "Connect".

If no M8131A module is connected to your PC, you can select "Simulation Mode" to simulate an M8131A module.

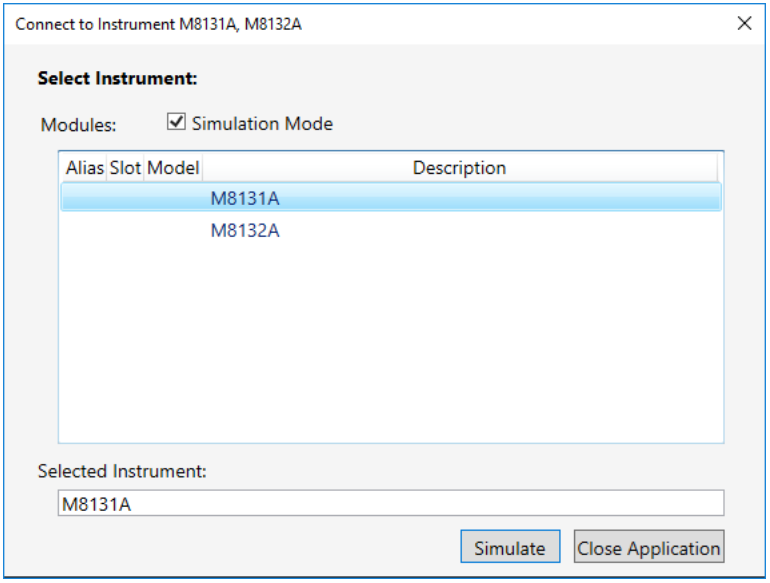


Figure 5 M8131A in simulation mode

Next, a M8131A software startup screen will be displayed as shown in Figure 6 on page 46.

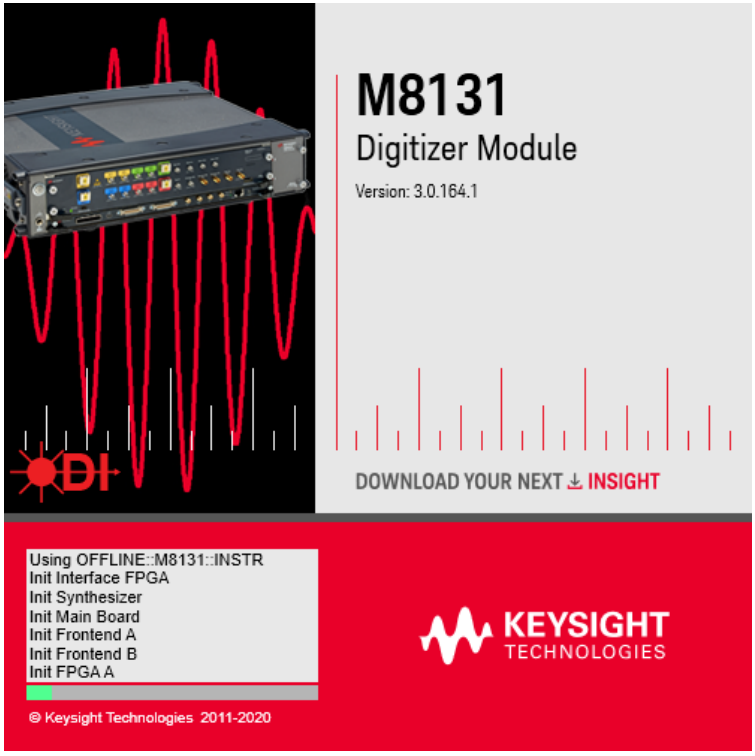


Figure 6 M8131A startup screen

Command Line Arguments

(See Communication on page 48 for details about /Socket, /Telnet, /Inst, /HiSLIP, /AutoID, /NoAutoID, /FallBack).

Table 5 Command line arguments

Option	Description
/Socket socketPort	Set the socket port at which the Soft Front Panel waits for SCPI commands.
/Telnet telnetPort	Set the telnet port at which the Soft Front Panel waits for SCPI commands.
/Inst instrumentNumber	Set the instrument number (instN, hislipN) at which the Soft Front Panel waits for SCPI commands on VXI-11.3 and HiSLIP connections (if not specified with /HiSLIP).
/HiSLIP hislipNumber	Set the instrument number for HiSLIP SCPI communication. If not specified, the same number as for VXI-11.3 is used.
/AutoID	Automatically select ports and numbers for the connections (default behavior).
/NoAutoID	Disable the default behavior; i.e. do not automatically select ports and numbers for the connections.
/FallBack	Try to find unused ports and number if starting a server fails.
/NoSplash	Don't show the splash screen.
/Minimized	Start with the SFP window minimized to the Windows task bar.
/Title “title”	Additional information shown in the SFP window title.
/OutputDir	Set the output directory for the log file and temporary files.
/r resourceName	Visa PXI resource string of the module to connect to, e.g. PXI12::0::0::INSTR. “auto” selects the next free instrument.

Communication

Depending on the command line arguments /Socket, /Telnet, /Inst, /AutoID, /NoAutoID, /FallBack, the Soft Front Panel starts several servers to handle SCPI commands. (Refer to the table above.)

/Socket, /Telnet, /Inst, /HiSLIP: If -1, do not start the respective servers

Defaults:

- Socket port: 5025 (e.g. TCPIP0::localhost::5025::SOCKET)
- Telnet port: 5024
- HiSLIP: 0 (e.g. TCPIP0::localhost::hislip0::INSTR)
- VXI-11.3: 0 (e.g. TCPIP0::localhost::inst0::INSTR)

/FallBack: If starting a server fails because of a conflict, try using another port or number

- HiSLIP, VXI-11.3: increase the index until a server can be started successfully
- Socket, Telnet: start with port 60000, then increase it until the servers can be started successfully. If neither socket nor telnet is disabled, the Soft Front Panel tries to start the servers on two consecutive ports (socket port = telnet port + 1)

/AutoID: Automatically select ports and number for the connections, which are unique per instrument.

This is the default behavior; it is not necessary to specify this argument on the command line.

If only one AXIe module is connected to this PC and it is an M8131A module, first try to use the command line arguments /Socket, /Telnet, /Inst, or their respective default values if they are not specified. If starting the servers fails, proceed with the steps below.

/Socket, /Telnet, /Inst, /HiSLIP are ignored (unless they are -1 and a server is disabled)

If the Soft Front Panel detects more than one AXIe module, use a special mechanism to obtain a number for the HiSLIP and VXI-11.3 servers, which makes sure that the Soft Front Panel uses always the same VISA resource string per module

The socket and telnet port are then calculated from the HiSLIP index:

- telnet port = 60000 + 2 * <HiSLIP index>
- socket port = 60000 + 2 * <HiSLIP index> + 1

NOTE Ports may already be in use by Windows or other applications, so they are not available for M8131A.

/NoAutoID: Do not automatically select ports and number for the connections, use the values specified with /Socket, /Telnet, /Inst, /HiSLIP or their respective default values instead.

If both /NoAutoID and /AutoID are specified, /AutoID overrides /NoAutoID.

NOTE The first port not assigned by IANA is 49152 (IANA, Internet Assigned Numbers Authority, http://www.iana.org)

M8131A Soft Front Panel

The **M8131A Soft Front Panel** and its elements are illustrated in Figure 7 on page 50.

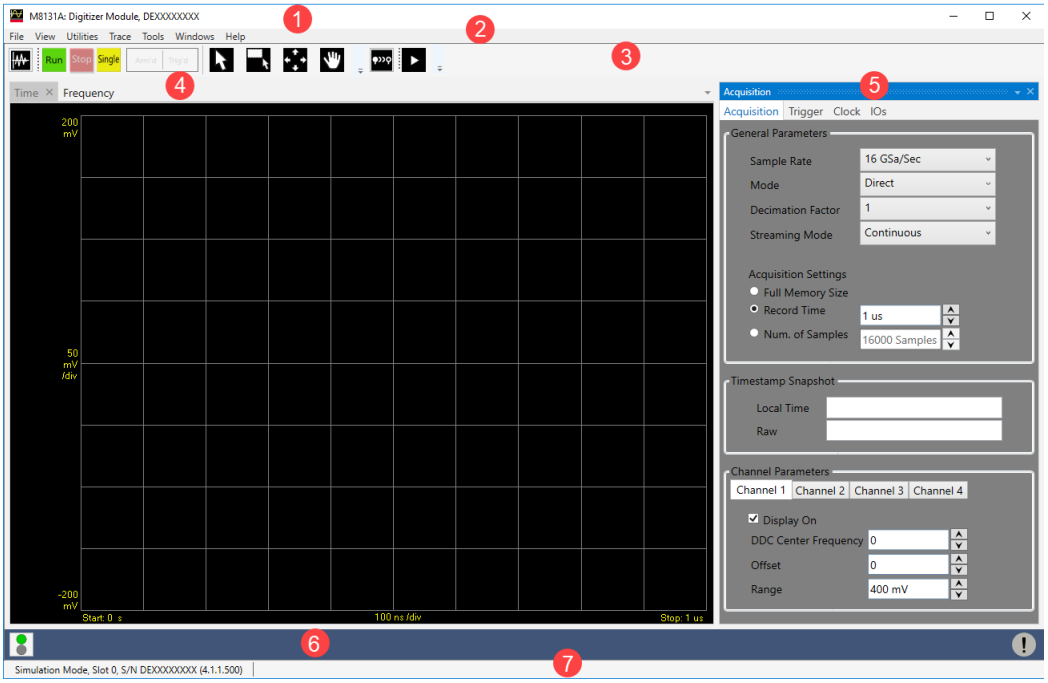


Figure 7 M8131A user interface

The M8131A Soft Front Panel includes the following elements:

1 Title Bar
2 Menu Bar
3 Tool Bar
4 Trace Window
5 Parameters Window
6 Lower Pane
7 Status Bar

Title Bar

The title bar contains the standard Microsoft Windows elements such as the window title and the icons for minimizing, maximizing, or closing the window.

Menu Bar

The menu bar consists of various pull down menus that provide access to the different functions and launch interactive GUI tools.

The menu bar includes the following pull down menus:

- File
- View
- Utilities
- Trace
- Tools
- Windows
- Help

Each menu and its options are described below.

File Menu

The **File** menu includes the following selections:

File > Connect...	Opens the "Connect to Instrument" dialog. See Launching the M8131A Soft Front Panel on page 44.
File > Save Configuration As...	Saves configuration as a text file.
File > Load Configuration...	Loads the previously saved configuration file.
File > Export Waveform	Exports the data of a channel to a text file with a header. See :MMEMory:STORe:WAVeform command for a description of the file format.
File > Exit	Exits the M8131A application.

View Menu

The **View** menu includes the following selections:

View > Hide	Minimizes the GUI to notify icon.

Utilities Menu

The **Utilities** menu includes the following selections:

Utilities > Calibration	Opens the Calibration dialog. For instructions on how to calibrate the instrument, see Calibration Manager on page 74.
Utilities > Identify	Identifies the instrument by flashing the green “Access” LED on the front panel for a certain time.
Utilities > Reset	Resets the instrument, reads the state and updates all fields.
Utilities > Self Test...	Opens a window to start the self-test and display the result after completion. Not functional in the current software release.

Trace Menu

The **Trace** menu includes the following selections:

Trace > Time Window	Opens a new instance of time window.
Trace > Frequency Window	Opens a new instance of frequency window.

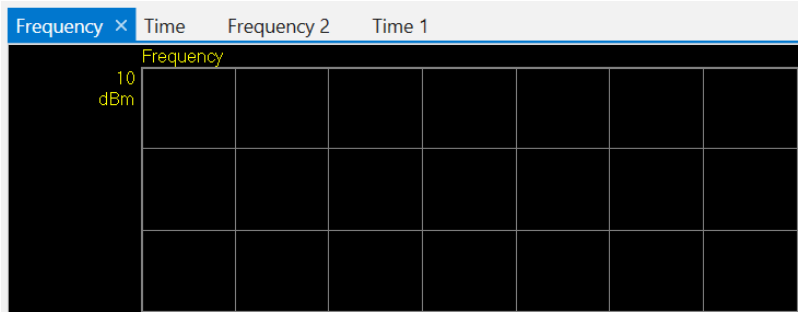
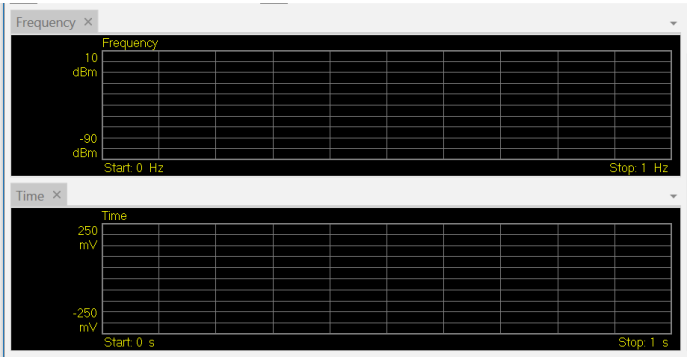
Tools Menu

The **Tools** menu includes the following selections:

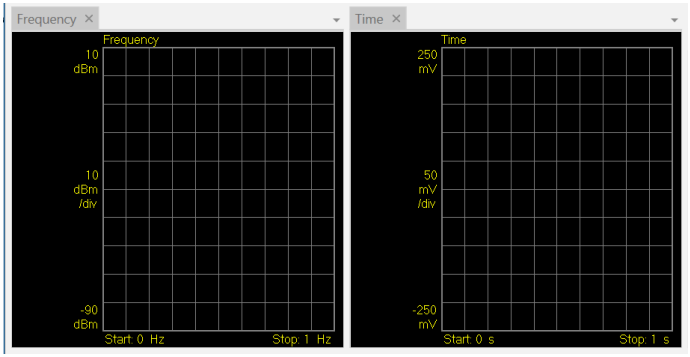
Tools > Acquisition	Switch to the “Acquisition” tab on Parameters window if it is already open. If not, it adds “Acquisition” tab first. For details, see Acquisition Tab on page 64.
Tools > Trigger	Switch to the “Trigger” tab on Parameters window if it is already open. If not, it adds “Trigger” tab first. For details, see Trigger Tab on page 67.
Tools > Clock	Switch to the “Clock” tab on Parameters window if it is already open. If not, it adds “Clock” tab first. For details, see Clock Tab on page 69.
Tools > IOs	Switch to the “IOs” tab on Parameters window if it is already open. If not, it adds “IOs” tab first. For details, see IOs Tab on page 70.

Windows Menu

The **Windows** menu allows you to change the layout/arrangement of time and frequency windows. It provides the following selections:

Windows > Close All Windows	Closes all trace windows.
Windows > Cascade	Arranges the open trace windows as cascaded tabs, so that the content of one tab at a time is visible. 
Windows > Tile Horizontally	Aligns the multiple opened windows in a horizontal sequence. The following figure shows the horizontal sequence of two different windows. 

Windows > Tile Vertically	Aligns open windows in a vertical sequence. The following figure shows the vertical sequence of two different windows.



Help Menu

The **Help** menu includes the following selections:

Help > User Guide	Opens the M8131A User's Guide.
Help > Examples	Opens the Examples directory.
Help > Online Support	Opens the instrument's product support web page.
Help > About	Displays product information including version number, build date, build info, installed licenses, available options and web links for M8131A information and support.

Tool Bar

The tool bar provides the following convenient functions:

	Capturing	This is an icon to mark the buttons to its right to be related to capturing. A capture is done via Single and Run buttons. Its functionality expects at least one selected channel (a channel can be selected from Acquisition Tab > Channel Parameters > Display On check-box). After completion of every capture, the current data buffer is cleared and replaced by the new measured values, and the corresponding time and frequency signals are plotted in trace windows.
	Run	This icon enables you to start a repetitive capturing.
	Stop	This icon enables you to stop a capture.
	Single	This icon enables you to start a single capture.
	Use mouse to control marker	If selected, a marker is added to the selected trace. Using the mouse, the marker can be moved on the trace in order to read the value of desirable points. To set the marker to a different channel, right click on graph panel (the black area) and select the desirable channel number from Marker > Set to Channel X. Set to Channel X is disabled if its corresponding channel number from Acquisition Tab > Channel Parameters > Display On check-box is not selected.
	Use mouse to zoom	Use this tool to select a rectangular area of a trace for closer examination.
	Auto scale once	Auto Scale adjusts All open windows' scaling so that the whole traces are visible. An auto-scale for one window can be done via Auto Scale inside graph panel's context menu (i.e. right-click and use context menu).

	Use mouse to pan	Use the pan/hand tool to move the area of viewing in the desired direction.
	Streaming	This is an icon that marks the buttons to its right to be related to streaming. Click the start button  to start the streaming process. Once the process has started, it can be terminated by pressing the stop button  .
	Start Streaming	This icon enables you to start a streaming.

Lower Pane

The lower pane provides the following options:

	Show Status Window	Opens the Status Window. This feature is currently not implemented.
	Show Error List Window	Opens the window that shows the list of errors and warnings. For details, see Errors List Window on page 58.

Errors List Window

Use this window to view errors, warnings, and information.

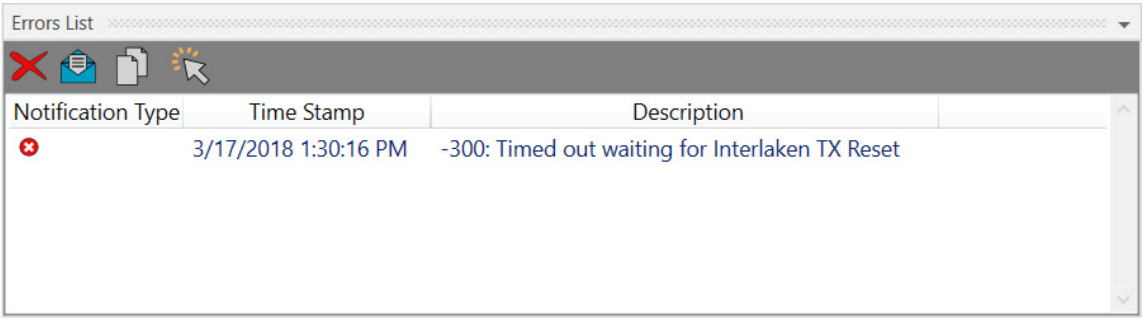


Figure 8 Error list window

For each error, it shows error details i.e. notification type, time stamp and description.
It has the following controls, signs, and columns:

	(Clear All)	Click this button to clear all the errors from the errors list window.
	Open On Error	Click this toggle button to automatically open the errors list window whenever an error occurs (default) or not.
	Copy	Click this button to copy the selected message(s).
	Select All	Click this button to select all messages inside the list.

Status Bar

The status bar contains the following fields from left to right:

- Connection state:
  - "Not Connected" – No instrument is connected.
  - "Connected: <Instrument resource string>" – An instrument is connected. The resource string, for example PXI36::0::0::INSTR is displayed.
  - "Simulation Mode" – No real instrument is connected. The user interface is in simulation mode. Click this field to open the Instrument Selection Dialog.
- Instrument status - Displays the instrument status, for example "Reset complete" after issuing a reset command.

Parameters Window

The **Parameters** Window provides various tabs which are used to configure the parameters of the M8131A instrument. These tabs include: Acquisition, Trigger, Clock, and IOs.
Figure 9 on page 60 illustrates an example of the **Parameters** Window.

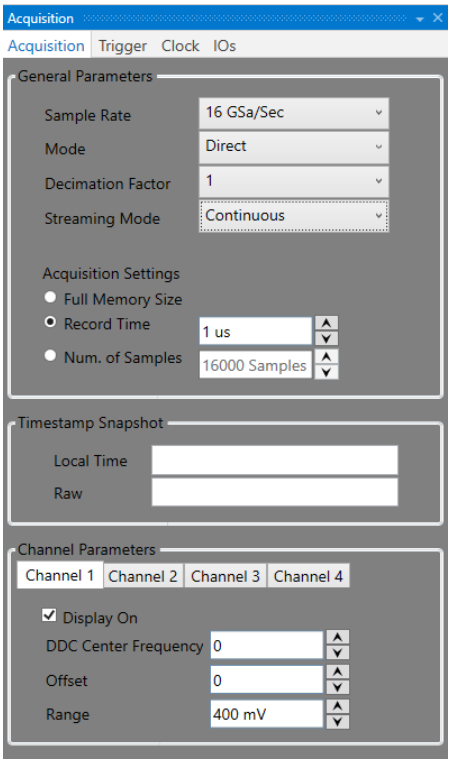


Figure 9 Parameters window

NOTE You can use the numeric controls to adjust the values and units. For details on how to use numeric control, refer to the section Numeric Control Usage on page 72.

Trace Window

The trace window contains time and frequency graph panels. A graph panel is an area on which the plotted graphs for a signal is shown.

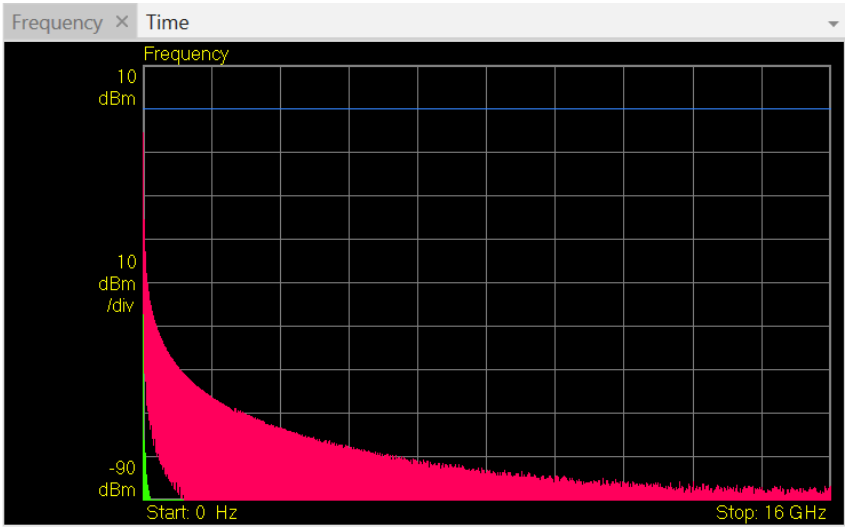


Figure 10 Frequency graph

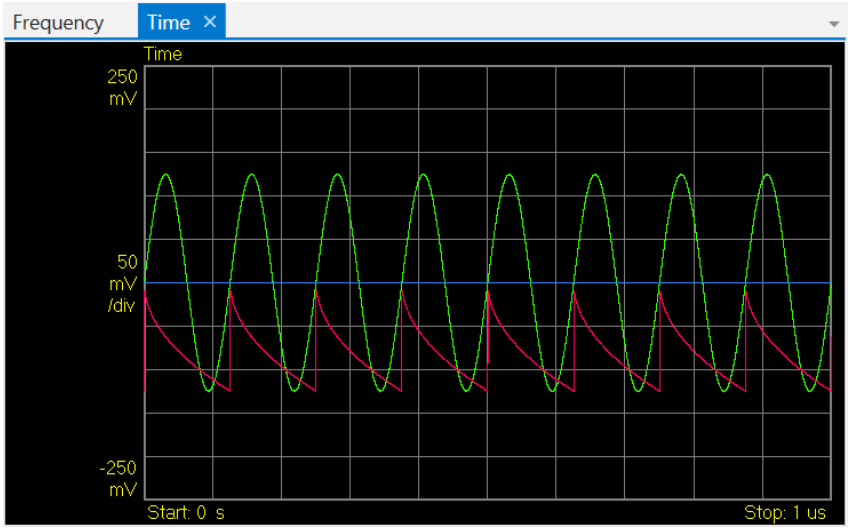


Figure 11 Time graph

The context-menu of a graph panel provides the following features which are effective on the current graph only:

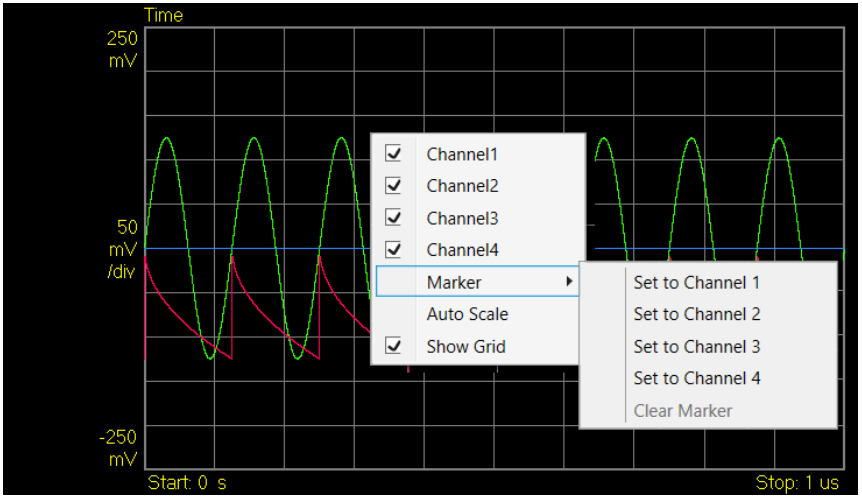


Figure 12 Context menu of a graph

- **Channel Selection**: Turns on/off the display of relevant channel. If "Display On" check-box for one Channel is deselected (Acquisitions > CHX > Display On), its corresponding field inside context-menu is not accessible (grayed-out).
- **Markers**: It sets a marker on desirable trace. Refer to toolbar menu > control marker for more information.
- **Auto Scale**: It scales the current graph panel. Refer to toolbar menu > Auto-scale once, for more information.
- **Show Grid**: Use this check-box to show/hide grids from the graph.
- **Clear Marker**: It clears the selected marker from the graph panel. It is only enabled when a marker is selected.

Acquisition Tab

The **Acquisition** tab manages acquisition and its associated parameters. It includes the General Parameters, Timestamp Snapshot, and Channel Parameters.

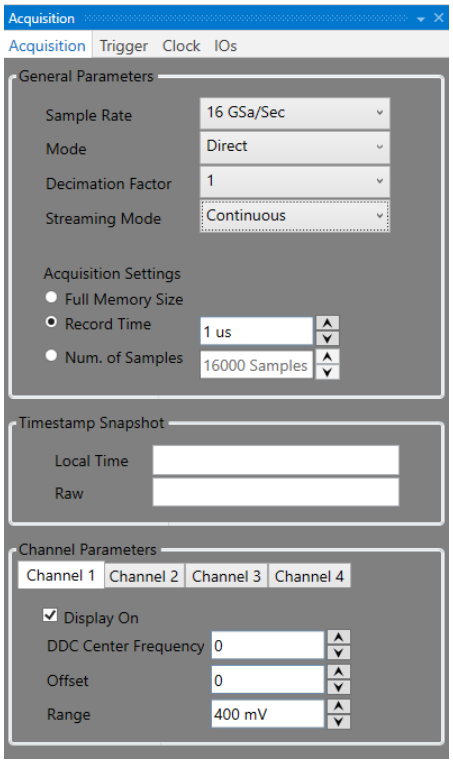


Figure 13 Acquisition tab

General parameters

- Sample Rate - Based on available options, a sample rate of 16 GSa/s or 32 GSa/s can be selected.
- Mode - The following two modes are available:
  - Direct Mode - The direct mode is available for both 16 GSa/s or 32 GSa/s sample rates.

  - DDC Mode - The DDC (Digital Down Conversion) mode is available for both 16 GSa/s or 32 GSa/s sample rates.
- Decimation Factor - The decimation factor depends upon the sample rate and mode. The following decimation factors are available:

Sample Rate	Mode	Decimation Factor
16 GSa/s	Direct	1, 2, 4
16 GSa/s	DDC	4, 8, 16, 32, 64, 128, 256, 512
32 GSa/s	Direct	1,2, 4
32 GSa/s	DDC	4, 8, 16, 32, 64, 128, 256, 512

NOTE With option 01x the minimum decimation factor is 4, i.e. the effective maximum sample rate is 4GSa/s.

- Streaming Mode - Enables you to select the appropriate streaming mode. The following streaming modes are available:
  - Continuous
  - Continuous Packetized
  - Segmented Fixed
  - Segmented Variable

  For more information, refer to Streaming and Segmentation on page 85.

Timestamp Snapshot

In streaming segmented modes (i.e., Continuous Packetized, Segmented Fixed, and Segmented Variable), one timestamp is assigned to each packet. It is saved in the packet header, and it represents the moment that the trigger arrived, and the packet started to capture.

- Local Time - Shows the last captured packet's timestamp as the local time and in seconds accuracy. In a non-segmented mode, this field is empty.
- Raw - This raw timestamp represents the number of picoseconds elapsed since midnight of January 1, 1970. In a non-segmented mode, this field is empty.

Channel Parameters

- Channel 1/2/3/4 - Selects the channel. The availability of channels depends upon the sample rate. For the 16 GSa/s sample rate, all four channels are available. However, in 32 GSa/s mode only two channels, 1 and 2, are available.
- Display On: Turns on or off the waveform memories for corresponding channel number and display its content in trace panel(s). The **Single** and **Run** buttons are functional only when at least one channel is selected.

  If the input signal's digitized value exceeds the maximum allowed range, clipping occurs. Depending on the number of available channels and the input channel in which the clipping has occurred, this would be marked with OV1, OV2, OV3 or OV4 labels in time-domain display. To avoid the clipping, reduce the amplitude of the input signal or alternatively, increase the Range parameter up to the maximum allowed value.
- DDC Center Frequency- Sets the digital down conversion center frequency. The DDC Center Frequency parameter has a range of -8 GHz to 8 GHz when the Sample Rate is 16 GSa/S and a range of -16 GHz to 16 GHz when the Sample Rate is 32 GSa/S.
- Frontend Settings - The frontend settings are available, depending upon the installed options (see Instrument Options on page 20). These settings allow you to set the signal offset and range.

Trigger Tab

The **Trigger** tab provides the trigger settings to M8131A module.

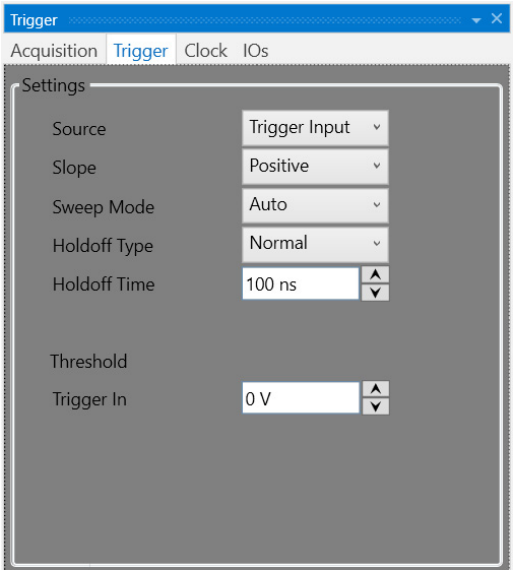


Figure 14 Trigger tab

Settings

- Source - Select the trigger source for sweep mode triggering. The following options are available:
  - Trigger Input - Signal acquisition starts when a positive/negative slope is received on the trigger input port of M8131A.
  - Channel 1 - Signal acquisition starts when a positive/negative slope is received on Channel 1 of M8131A.
  - Channel 2 - Signal acquisition starts when a positive/negative slope is received on Channel 2 of M8131A.
  - Channel 3 - Signal acquisition starts when a positive/negative slope is received on Channel 3 of M8131A.
  - Channel 4 - Signal acquisition starts when a positive/negative slope is received on Channel 4 of M8131A.
  - Sync Input - Signal acquisition starts when a positive/negative slope is received on the Sync input port of M8131A.

- Slope - Select a trigger input slope value from the Slope drop-down list. The following options are available:
  - Positive - Rising edge
  - Negative - Falling edge
- Sweep Mode - Select the trigger sweep value from the Sweep Mode drop-down list. The following options are available:
  - Auto - When a trigger event does not occur in a certain time, the instrument automatically forces a trigger, which causes the instrument to sweep.
  - Triggered - When a trigger event occurs, instrument will sweep.
- Holdoff Type - Select an option from the Holdoff Type drop-down list. The following options are available:
  - Normal - Once the hold off time is elapsed, the M8131A waits for a trigger and then it triggers only after the trigger is received.
  - Above - Ignore triggers until the signal is above the threshold value (for negative slope and triggered sweep mode) for hold off time. Once the hold off time is elapsed, the M8131A triggers the signal.
  - Below - Ignore triggers until the signal is below the threshold value (for positive slope and triggered sweep mode) for hold off time. Once the hold off time is elapsed, the M8131A triggers the signal.
- Holdoff Time - The time period for which any trigger will not work. No trigger is received during that time count.
- Thresholds - Enter the threshold values for the following:
  - Trigger In - This parameter appears when the option **Trigger Input** is selected from the **Source** drop-down list. Signal acquisition starts when a positive/negative slope is received on the trigger input port of M8131A.
  - Channel 1/2/3/4 - This parameter appears when the option **Direct Mode** is selected under the **Acquisition** tab and the respective channel is selected from the **Source** drop-down list. Signal acquisition starts when a positive/negative slope is received on Channel 1/2/3/4 of M8131A.
  - IFMagnitude 1/2/3/4 - This parameter appears when the option **DDC Mode** is selected under the **Acquisition** tab, and the respective channel is selected from the **Source** drop-down list. Signal acquisition starts when a positive/negative transition of the power level expressed in dBm is received on Channel 1/2/3/4 after a time period. For more information, refer to :TRIGger:LEVel:IFMagnitude on page 181.

Clock Tab

The **Clock** tab provides the clock settings to M8131A module.

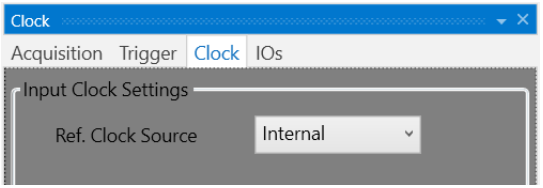


Figure 15 Clock tab

Input Clock Settings

- Ref. Clock Source - A clock reference input is provided on the front panel of the M8131A module. It is used as the clock reference for all four analog channels of that M8131A. The options are:
  - Internal
  - External 10MHz
  - External 100MHz

IOs Tab

The **IOs** tab provides input and output settings for analog and optical data interfaces.

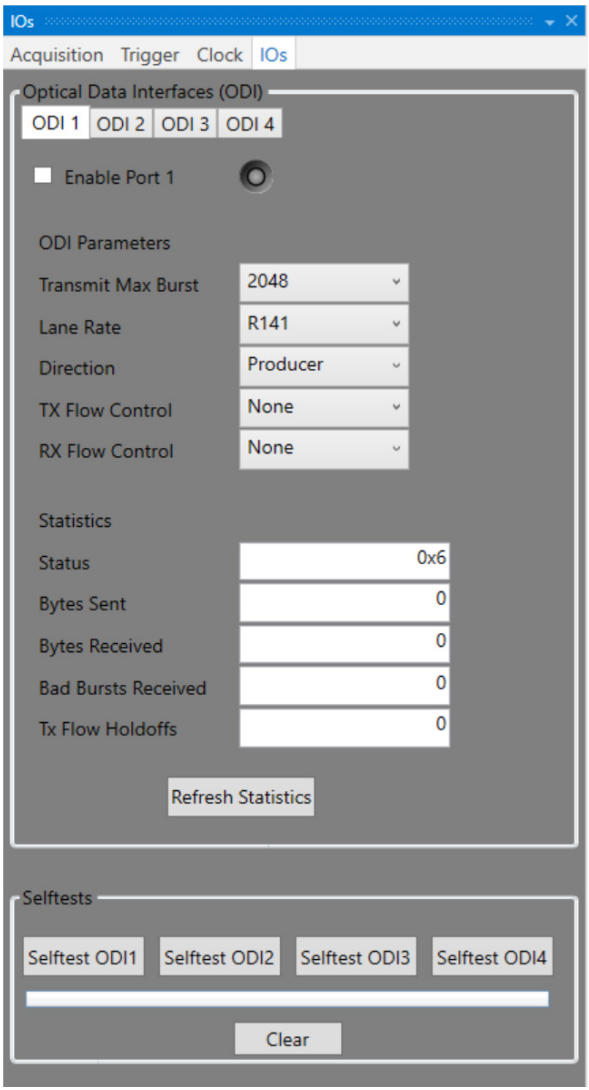


Figure 16 IOs tab

- Optical Data Interfaces (ODI) - Select a tab from ODI1, ODI2, ODI3, or ODI4 to set the respective parameters.
- Enable Port - The respective ODI ports can be activated/deactivated by selecting this check-box. An error for loss of signal will be shown, if a check-box is asserted without making the physical connections.
- ODI Parameters - The following ODI Parameters are available:
  - Transmit Max Burst - This is the maximum burst size.
  - Lane Rate - Currently R141 is the only supported lane rate.
  - Direction - The direction is always Producer.
  - TX Flow Control - The only available choice is **None**, i.e. no flow control.
  - RX Flow Control - The only available choice is **None**, i.e. no flow control.
- Statistics - Display the ODI statistics. The following options are available:
  - Status – It is a hexadecimal value corresponds to a 32-bit register, which shows the current status of the port. Hover on the numeric field to open the tooltip which provides information about every bit and its current value.
  - Bytes Sent- Number of bytes sent over the ODI link.
  - Bytes Received - Number of bytes received over the ODI link.
  - Bad Bursts Received - Number of bad bursts received over the ODI link.
  - Tx Flow Holdoffs - The number of ODI clock cycles during which the transmitter was held off, irrespective of whether there was something to transmit or not.
  - Refresh Statistics: Updates the statistics.
- Selftests - This option tests whether the particular ODI port is functional or not. Connect a loopback connector to the respective port and run a self-test. It will test whether the port allows proper transmission of data. The test reports the connection status, and in case of failure, the status of each individual lane. All failed test steps are shown. Possible errors are PLL lock failures, burst, overflow, underflow, CRC, and alignment errors

Working with M8131A Front Panel

Numeric Control Usage

The numeric control is used to adjust the value and units. Whenever you bring the mouse pointer over the numeric control, a tool tip appears which shows the possible values in that range.

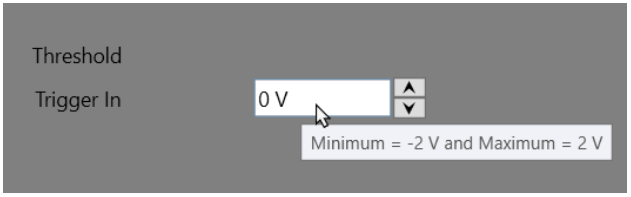


Figure 17 Tool tip showing possible values in the range

The numeric controls can be used in the following ways:

Use the up/down arrows to change the value. The control automatically stops at the maximum/minimum allowed value.

You can increase or decrease the value starting at a specific portion of the value. To do this, place the cursor to the right of the targeted digit and use the up/down arrows. This is especially useful when changing a signal characteristic that is immediately implemented, and observing the result in another instrument. For example, you can change the signal generator's frequency by increments of 10 MHz and observe the measured result in a signal analyzer:

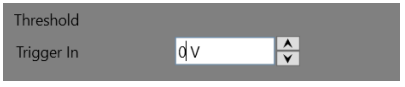


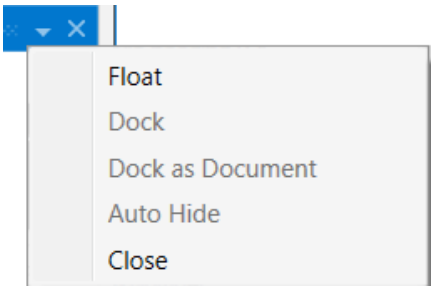
Figure 18 Typing directly into the field

Type directly into the field and press the Enter key. If you enter a value outside the allowed range, the control automatically limits the entered value to the maximum or minimum allowed value.

When you type the value, you can type the first letter of the allowed unit of measure to set the units. For example, in the Frequency control you can use "H", "K", "M", or "G" to specify Hz, KHz, MHz or GHz , respectively. (The control is not case sensitive.)

The controls allow scientific notation if it is appropriate to the allowed range. Type the first decimal number, enter an "E", and omit any trailing zeroes. For example, in the Frequency control you can type 2.5e+9 and press [Enter] to set the frequency to 2.5 GHz. (The plus sign is automatically inserted if it is omitted.)

Window Controls Usage



The window options allow you to float or dock anywhere in the application window. It provides quick access to logically grouped features from one location. For example, you can select and generate various layouts from the single window.

You can move a window anywhere on the screen or to a different monitor. You can also close the floating windows.

Calibration Manager

Calibration is required to compensate some hardware distortions and to have a proper symmetric signal leveled at zero volt. After a successful calibration, the system stores the results and reloads them upon a power cycle. Refer to the 'Keysight N2125A/6A/7A and N2136A Calibration Modules' User's Guide that can be found at http://www.keysight.com/find/M8131A for documentation describing how to calibrate the M8131A using the N2136A calibration module.

NOTE

The M8131A 16/32 GSa/s digitizer with single ended input (options -011, -012, -014, -061, -062, -064, -131, -132) requires a N2136A calibration module. The M8131A 16/32 GSa/s digitizer with differential input (options -FD1, -FD2, -FD4) does not require a calibration module.

The calibration process differs, depending on the module type – single ended or differential inputs.

- Single ended: Connect N2136A calibration module to channel one, start calibration step, wait until it is finished, connect the module to the next channel.
- Differential inputs: One calibration step, start it and wait until it is finished.

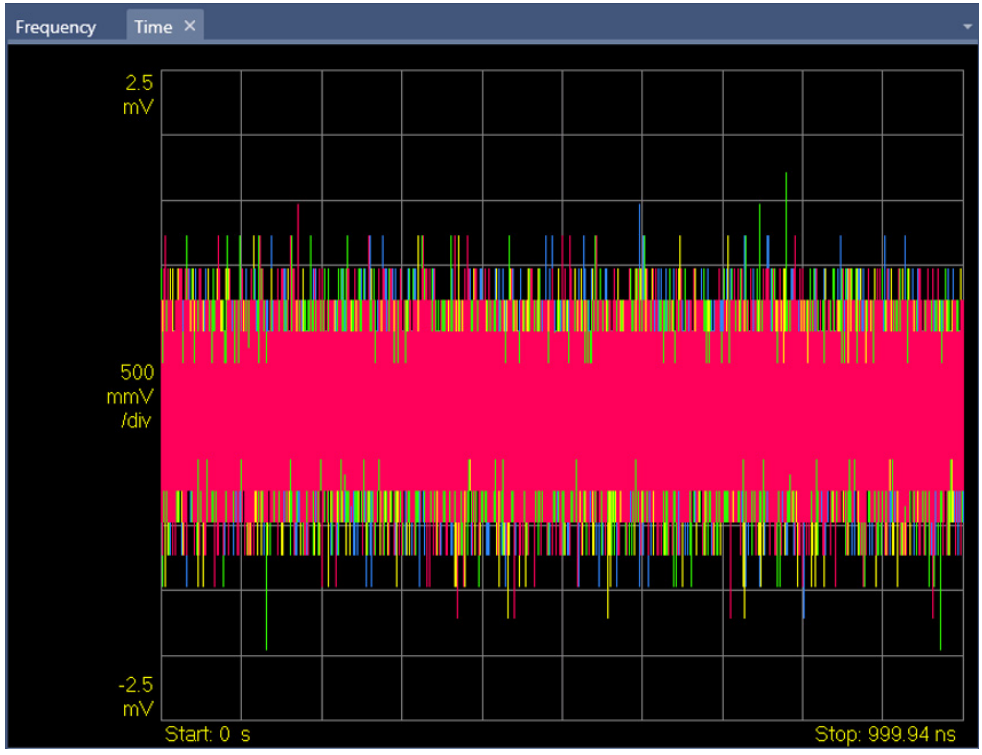


Figure 19 Calibrated zero volts on all channels with 50-ohm resistor caps installed

The calibration dialog is used to calibrate M8131A module. You can also save and load the calibration for future use.

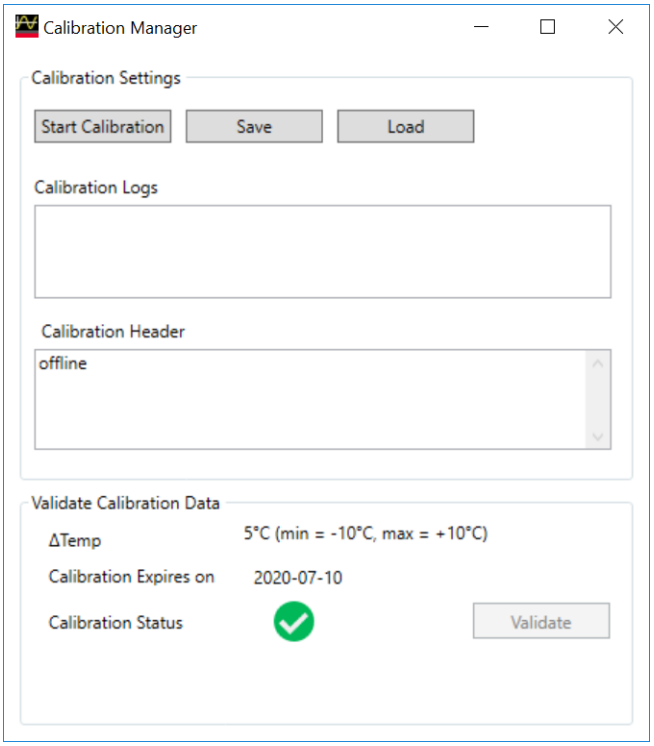


Figure 20 Calibration dialog

Starting Calibration Process

To start the calibration:

1 Go to **Utilities > Calibration**.

The **Calibration Manager** dialog box appears.

2 Click on the **Start Calibration** button. The **Process Result** will display the message “Calibration has been started”. At any point of time, you can quit the calibration process by clicking on the **Abort** button.

Saving and Loading Calibration

The calibration can be saved under the defined file name and location and can be later used for testing purpose.

To save the calibration;

1 Click on the **Save** button. A standard Windows **Save As** dialog box will appear.

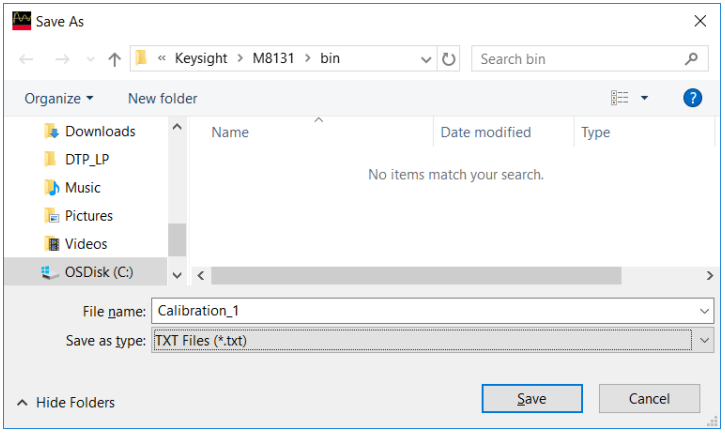


Figure 21 Saving calibration

2 Specify the name (*.TXT*) and location

3 Click **Save**.

To load the calibration;

1 Click on the **Load** button. A standard Windows **Open** dialog box will appear.

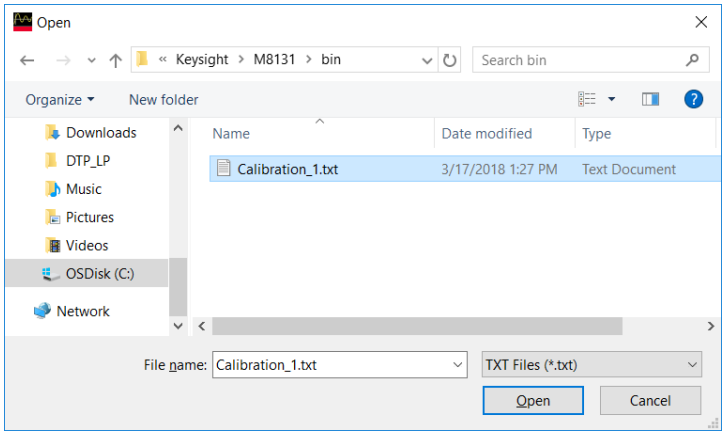


Figure 22 Loading calibration

2 Locate the calibration file (*.TXT*).

3 Click **Open**.

Exporting Waveforms

Waveforms can be exported to the available channels (channel 1/2/3/4).

To save a waveform;

1 Go to **File** > **Export Waveform** and then select a channel. A standard Windows **Save Waveform to File** dialog box will appear.

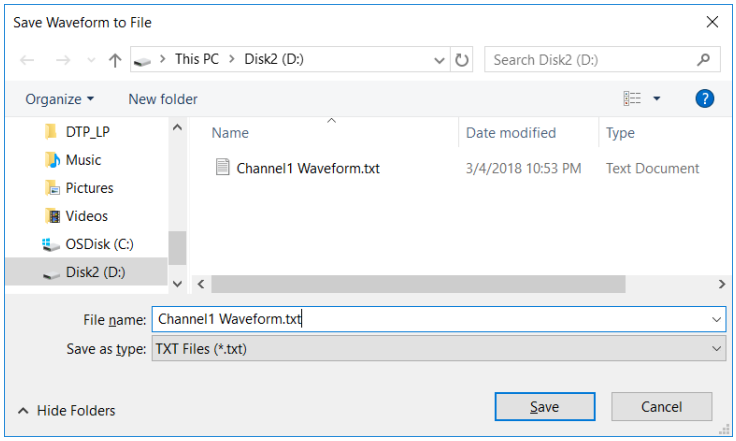


Figure 23 Exporting waveforms

2 Specify the name (*.TXT*) and location

3 Click **Save**.

Integrating 89600 VSA with M8131A

The M8131A Digitizer Soft Front Panel installer includes an integration with the Keysight 89600 VSA. To use the M8131 Digitizer with the 89600, the M8131 Digitizer SFP must be installed with the optional VSA integration on the same machine as the VSA.

The Keysight 89600 VSA connects to the M8131A Digitizer Soft Front Panel (SFP), either locally or remotely over LAN.

The M8131 VSA Extension requires Keysight 89600 VSA Version 2019 at the earliest.

While the Keysight 89600 VSA is in control of M8131A Digitizer, the user will be unable to make changes to the instrument directly via the SFP. The SFP shows a yellow banner indicating this. Changes to settings such as Decimation Rate or Center Frequency are made by the 89600 VSA software according to the requirements of configured measurements.

NOTE The Hardware Sample Rate (dependent upon hardware and licensing options) chosen in the SFP is persistent through the 89600 connection to the SFP. To change the sample rate, first disconnect or close the 89600 VSA software, then change the Hardware Sample Rate via the SFP.

NOTE Reference Clock: The Reference Clock used by the M8131 Digitizer can be configured from within the 89600 VSA, via the menu Utilities->Frequency Reference. If the M8131 is configured with an external reference clock that it is unable to synchronize with, it will automatically revert to the internal ('INT') clock. To reconnect, the user will need to first change the setting back to the internal frequency reference, before connecting again to the external clock.

Follow the given steps to configure M8131A with 89600 VSA:

1 Get the HiSLIP information

a Start the M8131A Soft Front Panel.

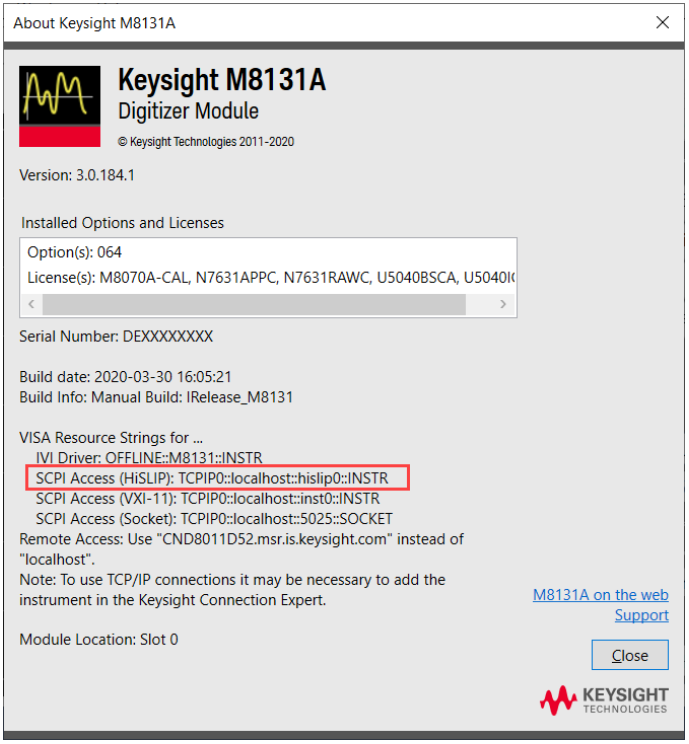
b On the menu bar, click **Help** > **About**.

c Copy the HiSLIP information from the dialog.

NOTE

In the About box, the local HiSLIP address can be copied to the clip board with Ctrl+C, the remote address with Ctrl-R.

You can also right-click to open a context menu.



2 Run Connection Expert

a Run the **Keysight IO Libraries Suite Connection Expert** tool.

b Click the **Keysight IO Libraries Suite** icon in the Windows application task bar, then click **Connection Expert**.

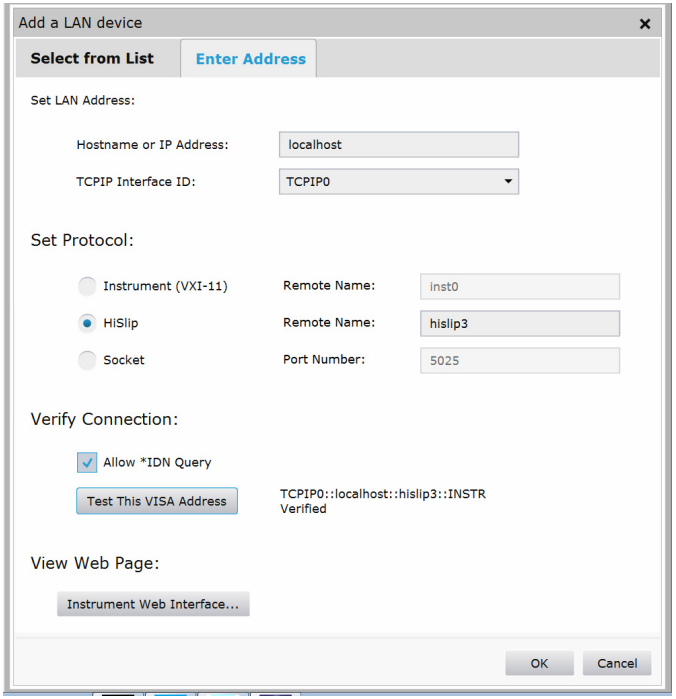
c Auto-scan/Rescan will automatically detect many (but not all) LAN instruments on your local LAN subnet. If an instrument is not automatically discovered, you must manually add the instrument:

d Click **Add**, select **LAN Instrument** from the context list. This opens the list of discovered LAN instruments.

e Click the **Enter Address** tab.

f Enter the LAN address or hostname, select the protocol used to communicate with the instrument.

g Click **OK**.



3 Integrate 89600 VSA with M8131A

a Start the 89600 VSA application.

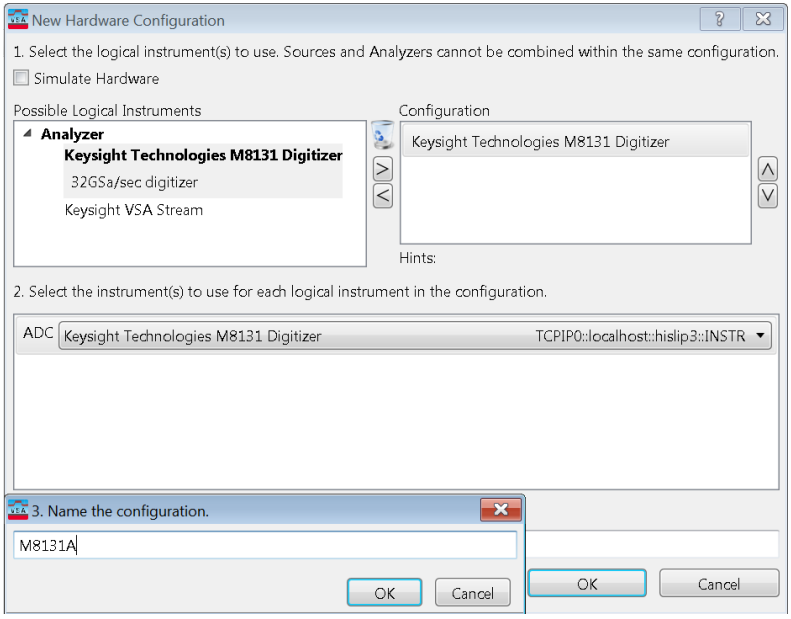
b From the menu bar, click **Utilities** > **Hardware** > **Configuration**. The **Hardware** dialog box will appear.

c Click the Refresh button in the **Discovered Instruments** tab. The M8131A should be now available.

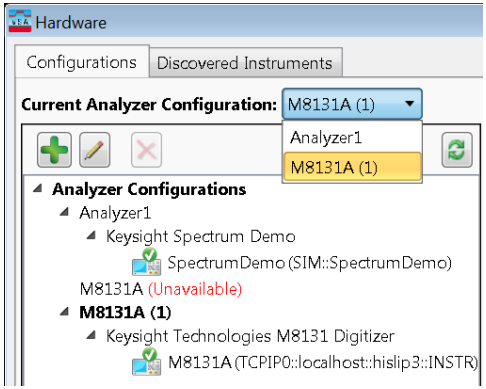
d Click the **Configurations** tab and click the green plus sign . The **New Hardware Configuration** dialog box will appear:

e Select M8131 and click [>]

f Rename the configuration as per your choice and click **OK**.



g Select the new **Analyzer Configuration** (M8131A(1)) as shown in the following figure:



h The 89600 VSA will now acquire the M8131A.

i Close the **Hardware** dialog and start the measurement.

4 Streaming and Segmentation

This chapter provides an overview of data streaming over ODI.

The following table gives an overview about the different streaming modes:

Streaming Mode Name	Required Options	Time Stamp	Segmentation	Deterministic Latency
Continuous	-STR	No	No	No
Continuous with deterministic latency	-STR	No	No	Yes
Continuous Packetized VITA-49	-STR, -SEG	Yes	Yes	No
Segmented Fixed VITA-49	-STR, -SEG	Yes	Yes	No
Segmented Variable VITA-49	-STR, -SEG	Yes	Yes	No

The following table gives an overview about Trigger capabilities in the different streaming modes:

Streaming Mode Name	Trigger Sweep Mode	Trigger Source	Allowed
Continuous	Auto or Triggered	Trigger Input or Channel n	Yes
Continuous with deterministic latency	Auto or Triggered	Trigger Input or Channel n	Yes
Continuous Packetized VITA-49	Auto or Triggered	Trigger Input or Channel n	Yes
Segmented Fixed VITA-49	Auto	Trigger Input or Channel n	No
	Triggered	Trigger Input or Channel n	Yes
Segmented Variable VITA-49	Auto	Trigger Input or Channel n	No
	Triggered	Input Channel n	No Yes

Continuous Streaming

Continuous streaming is typically used to stream data over ODI to a storage system such as a RAID or SSD.

Continuous streaming can also be used to steam data over ODI to a DSP module (e.g., the M8132A from Keysight) or an AWG (e.g., the M8121A from Keysight) if the overall latency through the system may vary from e.g., power cycle to power cycle.

In case the latency through the system (M8131A Digitizer to M8132A DSP module to M8121A AWG) must be deterministic, do use Continuous Streaming with Deterministic Latency .

Cabling

For continuous streaming, the ODI cable must be connected from the M8131A (data source) to the data sink (storage system or DSP module or AWG). It's not necessary to connect a cable to the Sync Output.

Continuous streaming:

- Start of streaming: Both trigger conditions, triggered and auto are possible.
- The length of the data stream is infinite.
- Stop of streaming: By user.

NOTE **While capture to waveform memory is active, continuous streaming cannot be started.**

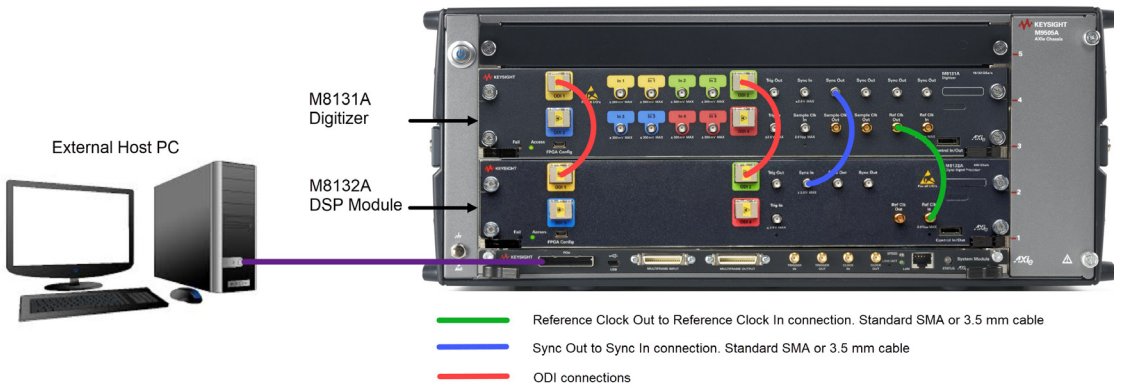
Capture to waveform memory:

- While streaming is inactive, Start & Stop of capture is possible.
  - Start: Both trigger conditions, triggered and auto are possible.
  - Stop: By user or defined number of samples are captured.
- While continuous streaming is active:
  - It is possible to monitor the traffic that is streamed over the ODI port.
  - Only capture without waiting for a trigger condition is possible (i.e., software start activity on the Trigger Input is ignored).
  - Capture affects only one M8131A module and not multiple modules in a synchronous system.
  - Mode: Single or repetitive.

Continuous Streaming with Deterministic Latency

The M8131A can be initialized using SCPI commands to achieve a deterministic latency to Keysight instruments, for example, the M8121A AWG or M8132A DSP module.

Besides the M8131A digitizer, there must always be involved at least one additional instrument to achieve deterministic latency from the Data Input of the M8131A digitizer to the Data Output of the M8121A AWG or to the Trigger Output of the M8132A DSP module. An initialization process for all instruments in the chain must be performed to bring the instruments in deterministic latency mode. This initialization process is performed by sending SCPI commands to the instruments. Refer to the example program Continuous Streaming with Deterministic Latency to DSP Module on page 193.



The instruments must be connected according to following cabling instructions before running the deterministic latency initialization process.

After running the deterministic latency initialization process,

- The latency of a signal through the instruments is deterministic.
- The M8131A is in deterministic latency mode.
- All enabled data channels of the M8131A module are operating in deterministic latency mode.

In deterministic latency mode:

- Streaming over ODI has started.
- It is possible to monitor the traffic that is streamed over the ODI port by capturing data.
  - Only capture without waiting for a trigger condition is possible (i.e., software trigger is possible – activity on the Trigger Input is ignored).
  - Capture affects only one module and not multiple modules in a synchronous system.
  - Mode: Single or repetitive.
- Stop streaming leaves the deterministic latency mode.

When changing one of the following parameters, deterministic latency mode is left, and the initialization process must run again to enter deterministic latency mode.

- Change the decimation factors
- Change the sample rate (16GSa/s or 32 GSa/s)
- Change streaming mode from ‘Continuous’ to any other Streaming Mode.
- Stop streaming
- Disable ODI ports
- Disable or enable channels for data capture

Segmented Streaming

Three options -STR, -SEG, DDC must be installed to enable segmented streaming.

Segmented streaming is available in 16 GSa/s DDC mode.

Segmented streaming is not available in direct mode.

Segmented streaming is not available in 32 GSa/s mode.

When segmented streaming has been selected, all channels of the M8131A (or all channels of a synchronous systems of multiple M8131A) operate in segmented streaming mode. Also, the sub-streaming mode must be identical for all channels.

Triggers always drive all channels within one single M8131A module. For synchronous systems of multiple M8131A, only the primary module can be used to generate triggers.

Trigger on IF Magnitude: Triggers are applied to IQ data past DDC & decimation.

The following table explains the difference between segment and packet:

Streaming Mode Name	Number of Packets per Segment	Comment
Continuous Packetized VITA-49	Variable	The segment consists of a continuous stream of packets. Each packet is encapsulated in a VITA-49 header and trailer.
Segmented Fixed VITA-49	1	Each segment always consists of one packet. This packet is encapsulated in a VITA-49 header and trailer.
Segmented Variable VITA-49	Variable	Each segment consists of a variable number of packets. The number is variable as each recorded segment length can be different. Segment recording starts when a trigger condition is valid, and the recording of this segment ends when an idle condition is detected. Each packet is encapsulated in a VITA-49 header and trailer. The packet length defines the granularity of the segment length.

VITA-49 Encoding

Each packet is always encapsulated in the VITA-49 data format, including a 28 bytes header and 4 bytes trailer.

VITA-49 encoding of the M8131A is implemented according to ODI-2.1 (High Speed Data Formats) Revision 3.0, January 3, 2019

The VITA-49 header includes time stamp information. The M8132A supports 'UTC time plus picoseconds' according to ODI-2.1 Figure 3-11 (TSI=01; TSF=10) as the time stamp format.

Time Stamp Generation

The time stamp marks the beginning of the first sample of the corresponding packet. The time stamp does not mark the trigger position in the packet.

A time stamp is added to the header of each packet.

- The time stamp for each packet is encoded as VITA-49 header and streamed over ODI.
- For monitoring purposes, one waveform segment including the time stamp of its first packet can be stored in the waveform memory.

During the initialization of the M8131A, the controlling PC loads the local time of this PC to the M8131A in the UTC data format. After this initialization, the M8131A uses its internal timing reference to measure time and increment the internal clock, or it uses the timing reference applied to the Reference Clock Input pin.

The time stamp counter of the M8131A (UTC time) can be controlled by:

- SCPI API
- SFP

In a synchronous system consisting of two or more M8131A, the time stamp counters of each M8131A must be initialized individually.

There are three sub-modes available for segmented streaming:

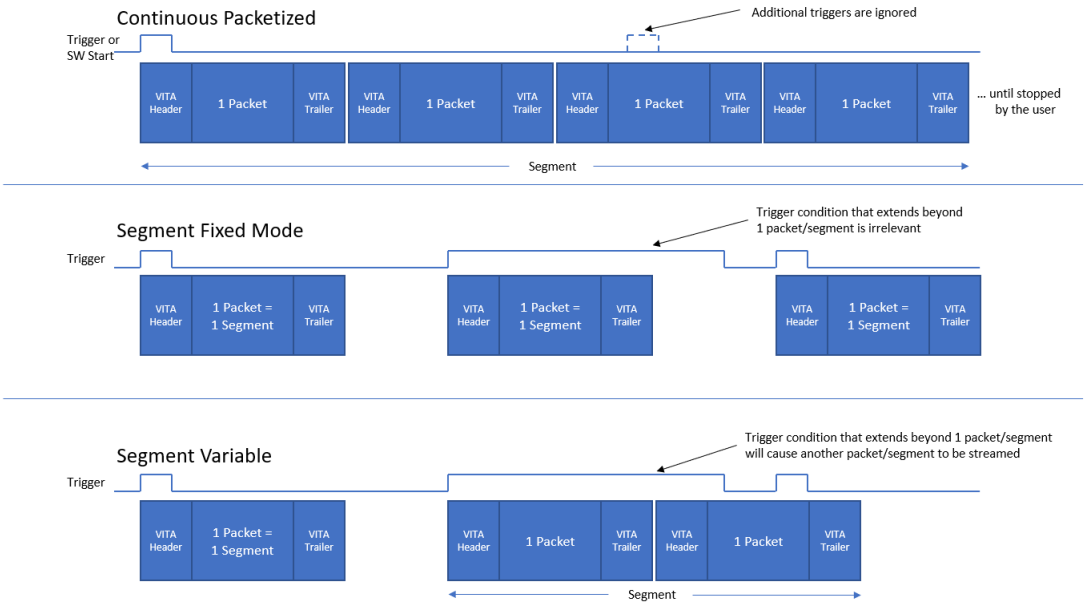
- Continuous Packetized VITA-49.
  - Streaming is started once and runs continuously until aborted by the user. This continuous data stream is divided into individual VITA-49 packets, each having an individual time stamp.
  - The packet length can be adjusted.

- Segmented Fixed VITA-49.
  - This mechanism is a very effective way for data compression for bursted RF traffic or radar pulse recording. This mode is best suited, if the segment length is always the same.
  - Streaming of each segment requires an individual trigger condition. If the defined trigger condition is met, exactly one segment of a pre-defined segment length is streamed over ODI. No data is streamed over ODI until the next trigger condition starts streaming the next segment.
  - The number of segments that are streamed can be between $1...2^{32}-1$ and infinite.
  - The packet length can be adjusted.
- Segmented Variable VITA-49.
  - This mode is best suited, if the segment length varies from segment to segment. E.g., radar pulses generated from multiple uncorrelated sources generate this type of traffic.
  - Each segment consists of a variable number of packets. Each packet is encapsulated in VITA-40 header and trailer.
  - Streaming of each segment requires an individual trigger condition. If the defined trigger condition is met, the streaming of packets of over ODI is started. Streaming of packets ends when the trigger condition is not met anymore, and an idle condition has been detected. As a result, a segment of a variable length, each consisting of a variable number of packets can be recorded. This mechanism is a very effective way for data compression for bursted RF traffic or radar pulse recording.
  - The number of segments that are streamed can be between $1...2^{32}-1$ and infinite.
  - The packet length defines the granularity of a segment with variable length. The packet length can be adjusted.
  - The end of capturing a segment of variable length is determined by detecting an idle period the exceeds a user-defined duration. Idle is defined as:
    - Rising edge, IF magnitude: The IF magnitude is below the IF magnitude for the idle duration or longer.
    - Falling edge, IF magnitude: The IF magnitude is above the IF magnitude for the idle duration or longer.

In all three sub-modes of segmented streaming (Continuous Packetized VITA-49, Segmented Fixed VITA-49, Segmented Variable VITA-49) it is possible to monitor the traffic that is streamed over the ODI port.

- Only capture without waiting for a trigger condition is possible (i.e., software start –activity on the Trigger Input is ignored).
- Exactly one segment of fixed or variable length including time stamp information is stored in capture memory.
- Capture affects only one M8131A module and not multiple modules in a synchronous system.
- Mode: Single or repetitive.

The following figure describes the differences between the streaming modes Continuous Packetized VITA-49, Segmented Fixed VITA-49, and Segmented Variable VITA-49.



5 Synchronization of Multiple M8131A

KEYSIGHT TECHNOLOGIES

Instrument Modes Supporting Synchronization

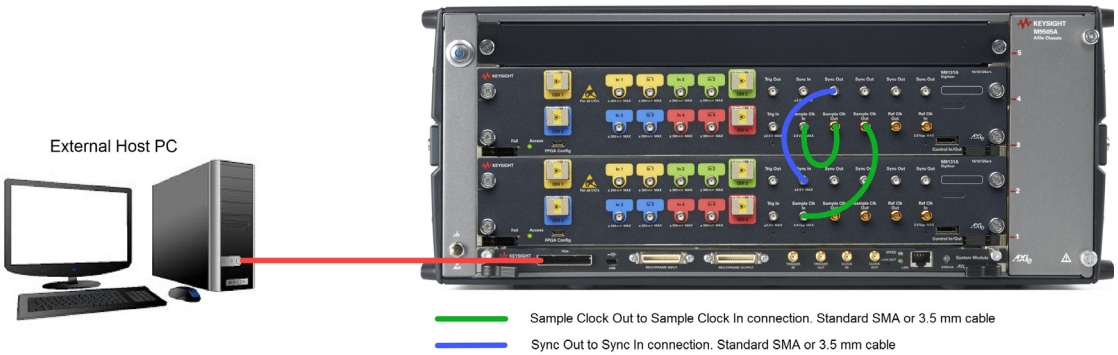
The following table shows M8131A modes of operation that support the synchronization of multiple M8131A.

ADC Sample Rate	DDC	Decimation factor	Synchronization Supported
16 GSa/s	Off	1, 2, 4	Yes
16 GSa/s	On	4, 8, ..., 512	No
32 GSa/s	Off	1, 2, 4	Yes
32 GSa/s	On	4, 8, ..., 512	No

Cabling Instructions

Synchronization of two M8131A modules

The following figure displays the synchronization of two M8131A modules in a 5-slot chassis.



The synchronization of two M8131A modules results in eight channels at 16 GSa/s or four channels at 32 GSa/s.

One-time instrument-to-instrument de-skew is required to compensate for the cable length variations. This process is described below.

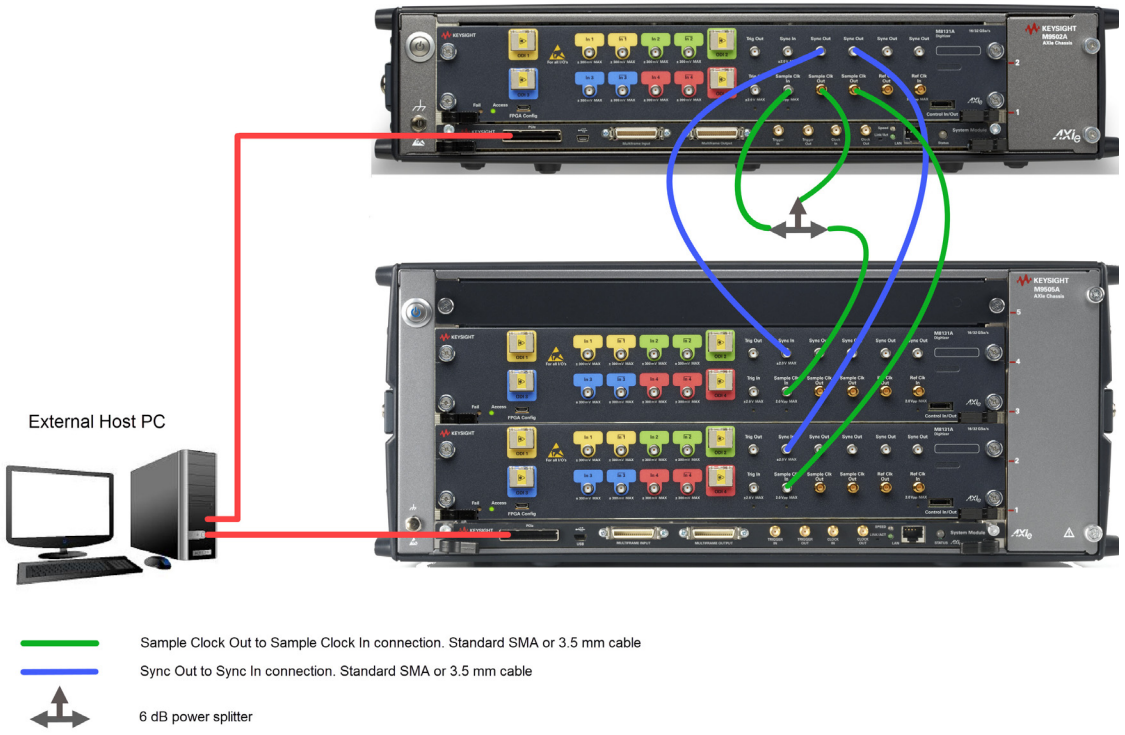
After de-skew, the channel-to-channel skew across all eight channels at 16GSa/s (or four channels at 32 GSa/s) is:

- within <0.5 ps from capture to capture*
- within +/-1 ps from power cycle to power cycle*

* Constant ambient temperature

Synchronization of three M8131A modules

The following figure displays the synchronization of three M8131A modules (two M8131A modules in a 5-slot chassis + one M8131A module in a 2-slot chassis).



The synchronization of three M8131A modules result in 12 channels at 16 GSa/s or six channels at 32 GSa/s.

One-time instrument-to-instrument de-skew is required to compensate for the cable length variations. This process is described below.

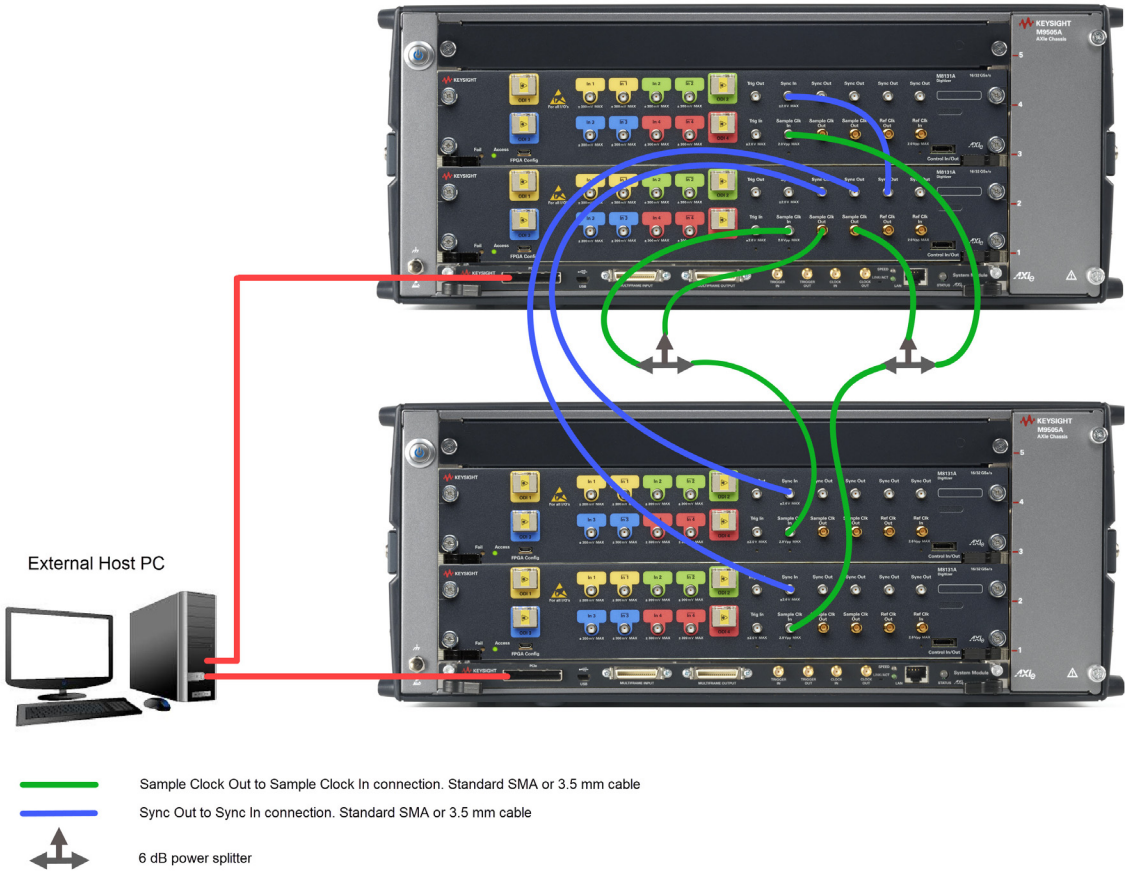
After de-skew, the channel-to-channel skew across all 12 channels at 16GSa/s (or six channels at 32 GSa/s) is:

- within <0.5 ps from capture to capture*
- within +/-1 ps from power cycle to power cycle*

* Constant ambient temperature

Synchronization of four M8131A modules

The following figure displays the synchronization of four M8131A modules (two M8131A modules in one 5 slot chassis + two M8131A modules in one 5-slot chassis).



The synchronization of four M8131A modules result in 16 channels at 16 GSa/s or eight channels at 32 GSa/s.

One-time instrument-to-instrument de-skew is required to compensate for the cable length variations. This process is described below.

After de-skew, the channel-to-channel skew across all 16 channels at 16GSa/s (or eight channels at 32 GSa/s) is:

- within <0.5 ps from capture to capture*
- within +/-1 ps from power cycle to power cycle*

* Constant ambient temperature

One-time Instrument-to-Instrument De-skew

- The timing skew between different M8131A modules depends on the length of the electrical cables used for Sample Clock and Sync Signal distribution. To minimize this skew, it is recommended to use the following:
  - Cables for Sample Clock distribution of the same length having the same propagation delay. Also, the same type of power splitter should be used.
  - Cables for Synch Signal distribution of the same length having the same propagation delay.
- To characterize the remaining skew, an external signal must be applied to channel 1 of the synchronous system's different M8131A. There is flexibility in the external signal type, for example, the rising edge of a rectangular signal. This signal shall be distributed using a power splitter to both channel 1 of two M8131A. One measures the skew between the two signals using the SFP. This measured skew value can be used to correct the delay when reading the different digitizers' timing information.
- In case three or four digitizers are within the synchronous system, the skew must be measured between the different digitizers.
- This configuration can be characterized by connecting the two cables to channel one and channel two of the same digitizer to compensate for an error caused by the external power splitter and their cables.

Synchronization Procedure

- To synchronize multiple M8131A modules, a synchronization procedure must be executed. For more information on how to execute the synchronization, refer to Synchronization of Two M8131A Modules on page 190.
- The synchronization between the M8131A gets lost, and the synchronization procedure must be executed after the following events:
  - Power cycles
  - Execution of *RST
  - Change of the sample rate between 16GSa/s and 32GSa/s
  - Change the decimation factor in direct mode

6 Digital Down Conversion

Option -DDC must be installed to enable Digital Down Conversion.

Each analog channel has a separate DDC. The IF frequency can be adjusted for each channel separately. The decimation factor is the same for all channels in the M8131A.

Spectrum mirroring: Negative IF frequencies can be adjusted. This results in a mirrored spectrum of the down-converted data.

The data format in DDC mode is 32-bit IQ. This is 16-bit I plus 16-bit Q.

The following table gives an overview of the DDC modes with an ADC sample rate of 32 GSa/s. Following M8131A product options offer an ADC sample rate of 32 GSa/s: -131, -132, -FD1, -FD2, -FD4. 6}

Decimation factor	Sample rate after decimation	Data rate over ODI	Modulation bandwidth
4	8 GSa/s	256 Gbit/s	6.4 GHz
8	4 GSa/s	128 Gbit/s	3.2 GHz
16	2 GSa/s	64 Gbit/s	1.6 GHz
32	1 GSa/s	32 Gbit/s	800 MHz
64	500 MSa/s	16 Gbit/s	400 MHz
128	250 MSa/s	8 Gbit/s	200 MHz
256	125 MSa/s	4 Gbit/s	100 MHz
512	62.5 MSa/s	2 Gbit/s	50 MHz

[1] In 32 GSa/s mode, 2 ODI links per ADC channel are required.

The following table gives an overview of the modes of the DDC with an ADC sample rate of 16 GSa/s. Following M8131A product options offer an ADC sample rate of 16 GSa/s: -061, -062, -064, -FD1, -FD2, -FD4.

Decimation factor	Sample rate after decimation	Data rate over ODI	Modulation bandwidth
4	4 GSa/s	128 Gbit/s	3.2 GHz
8	2 GSa/s	64 Gbit/s	1.6 GHz
16	1 GSa/s	32 Gbit/s	800 MHz
32	500 MSa/s	16 Gbit/s	400 MHz
64	250 MSa/s	8 Gbit/s	200 MHz
128	125 MSa/s	4 Gbit/s	100 MHz
256	62.5 MSa/s	2 Gbit/s	50 MHz
512	31.25 MSa/s	1 Gbit/s	25 MHz

The DDC functionality for M8131A product options -011, -012, -014 is shown in the following table. For these product options, the ADC sample rate is 16 GSa/s. The minimum decimation factor is 8 resulting in a maximum modulation bandwidth of 1.6 GHz.

Decimation factor	Sample rate after decimation	Data rate over ODI	Modulation bandwidth
8	2 GSa/s	64 Gbit/s	1.6 GHz
16	1 GSa/s	32 Gbit/s	800 MHz
32	500 MSa/s	16 Gbit/s	400 MHz
64	250 MSa/s	8 Gbit/s	200 MHz
128	125 MSa/s	4 Gbit/s	100 MHz
256	62.5 MSa/s	2 Gbit/s	50 MHz
512	31.25 MSa/s	1 Gbit/s	25 MHz

7 Remote Programming

KEYSIGHT TECHNOLOGIES

Remote Programming Overview

This chapter introduces the basics for remote programming of an M8131A instrument using SCPI commands.

Instructions

Instructions, both commands and queries, normally appear as strings embedded in a statement of your host language, such as Visual Basic for Applications (VBA), Visual Basic .NET, C#, C, etc.

The only time a parameter is not meant to be expressed as a string is when the instruction's syntax definition specifies <binary_block _data>, such as with the `:SYSTem:SET` command. There are only a few instructions that use block data.

Instructions are composed of two main parts:

- The header, which specifies the command or query to be sent.
- The program data, which provides additional information to clarify the meaning of the instruction.

Instruction Header

The instruction header is one or more command mnemonics separated by colons (:). They represent the operation to be performed by the instrument. Queries are formed by adding a question mark (?) to the end of the header. Many instructions can be used as either commands or queries, depending on whether or not you include the question mark. The command and query forms of an instruction usually have different program data. Many queries do not use any program data.

White Space (Separator)

White space is used to separate the instruction header from the program data. If the instruction does not require any program data parameters, you do not need to include any white space. In this manual, white space is defined as one or more spaces. ASCII defines a space to be character 32 in decimal.

Braces

When several items are enclosed by braces, { }, only one of these elements may be selected. Vertical line (|) indicates "or". For example, {ON | OFF} indicates that only ON or OFF may be selected, not both.

Ellipsis

... An ellipsis (trailing dots) indicates that the preceding element may be repeated one or more times.

Square Brackets

Items enclosed in square brackets, [ ], are optional.

Program Data

Program data is used to clarify the meaning of the command or query. It provides necessary information, such as whether a function should be on or off, or which waveform is to be displayed. Each instruction's syntax definition shows the program data and the values they accept.

When there is more than one data parameter, they are separated by commas (,). You can add spaces around the commas to improve readability.

Status Commands

This section describes the structure of the SCPI status system used by the M8131A. The status system records various conditions and states of the instrument in several register groups as shown on the following pages. Each of the register groups is made up of several low level registers called Condition registers, Event registers, and Enable registers which control the action of specific bits within the register group.

These groups are explained below:

A condition register continuously monitors the state of the instrument. The bits in the condition register are updated in real time and the bits are not latched or buffered. This is a read-only register and bits are not cleared when you read the register. A query of a condition register returns a decimal value which corresponds to the binary-weighted sum of all bits set in that register.

An event register latches the various events from changes in the condition register. There is no buffering in this register; while an event bit is set, subsequent events corresponding to that bit are ignored. This is a read only register. Once a bit is set, it remains set until cleared by query command (such as `STAT:QUES:EVEN?`) or a `*CLS` (clear status) command. A query of this register returns a decimal value which corresponds to the binary-weighted sum of all bits set in that register.

An enable register defines which bits in the event register will be reported to the Status Byte register group. You can write to or read from an enable register. A `*CLS` (clear status) command will not clear the enable register but it does clear all bits in the event register. A `STAT:PRES` command clears all bits in the enable register. To enable bits in the enable register to be reported to the Status Byte register, you must write a decimal value which corresponds to the binary weighted sum of the corresponding bits.

Transition Filters are used to detect changes of the state in the condition register and set the corresponding bit in the event register. You can set transition filter bits to detect positive transitions (PTR), negative transitions (NTR) or both. Transition filters are read/write registers. They are not affected by `*CLS`.

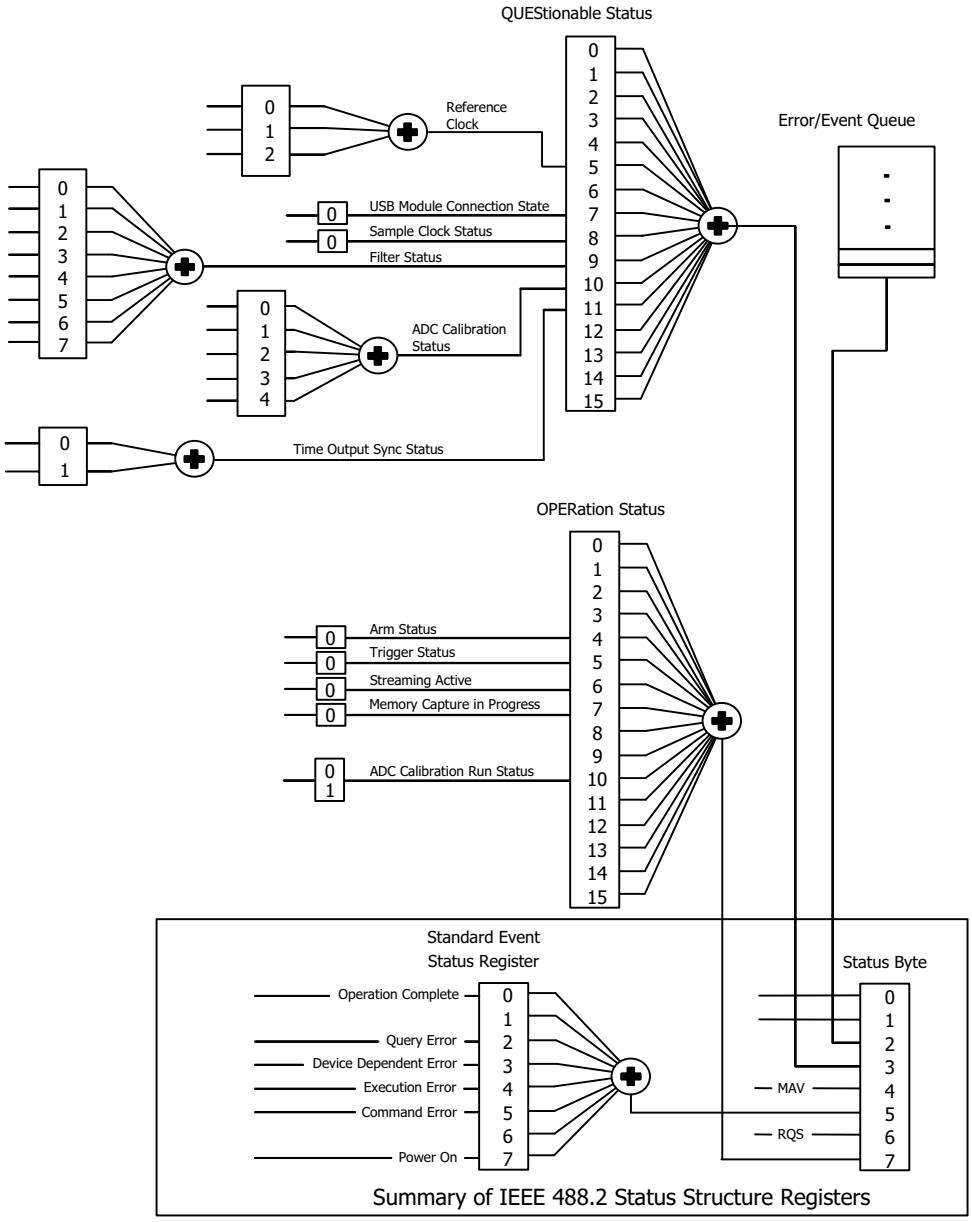


Figure 24 Status register structure

STATus:PRESet

Clears all status group event registers. Presets the status group enables PTR and NTR registers as follows:

```
ENABle = 0x0000, PTR = 0xffff, NTR = 0x0000
```

Status Byte Register

The Status Byte summary register reports conditions from the other status registers. Data that is waiting in the instrument's output buffer is immediately reported on the "Message Available" bit (bit 4) for example. Clearing an event register from one of the other register groups will clear the corresponding bits in the Status Byte condition register. Reading all messages from the output buffer, including any pending queries, will clear the "Message Available" bit. To set the enable register mask and generate an SRQ (service request), you must write a decimal value to the register using the `*SRE` command.

Table 6 Status byte register

Bit Number		Decimal Value	Definition
0	Not used	1	Not Used. Returns "0"
1	Not used	2	Not Used. Returns "0"
2	Error Queue	4	One or more errors are stored in the Error Queue
3	Questionable Data	8	One or more bits are set in the Questionable Data Register (bits must be enabled)
4	Message Available	16	Data is available in the instrument's output buffer
5	Standard Event	32	One or more bits are set in the Standard Event Register
6	Master Summary	64	One or more bits are set in the Status Byte Register
7	Operational Data	128	One or more bits set in the Operation Data Register (bits must be enabled)

Questionable Data Register Command Subsystem

The Questionable Data register group provides information about the quality or integrity of the instrument. Any or all of these conditions can be reported to the Questionable Data summary bit through the enable register.

Table 7 Questionable data register

Bit Number		Decimal Value	Definition
0	Not used	1	Returns “0”
1	Not used	2	Returns “0”
2	Not used	4	Returns “0”
3	Not used	8	Returns “0”
4	Not used	16	Returns “0”
5	Reference Clock Status	32	Instable or missing external reference clock.
6	Not used	64	Returns “0”
7	USB disconnected	128	USB module connection state
8	Sample Clock Status	256	Instable or missing sample clock
9	Filter Status	512	Filter input overload or output clipped for at least one channel
10	ADC Calibration Status	1024	For more details, see ADC Calibration Status Subsystem on page 114.
11	Not used	2048	Returns “0”
12	Not used	4096	Returns “0”
13	Not used	8192	Returns “0”
14	Not used	16384	Returns “0”
15	Not used	32768	Returns “0”

Operation Status Subsystem

The Operation Status register contains conditions which are part of the instrument's normal operation.

Table 8 Operation status register

Bit Number		Decimal Value	Definition
0	Not used	1	Returns "0"
1	Not used	2	Returns "0"
2	Not used	4	Returns "0"
3	Not used	8	Returns "0"
4	Arm Status	16	Trigger is armed.
5	Trigger Status	32	Trigger received.
6	Streaming Active	64	Data streaming has been started and not stopped yet.
7	Memory Capture in Progress	128	Memory capture has been started and not completed yet.
8	Not used	256	Returns "0"
9	Not used	512	Returns "0"
10	ADC Calibration Run Status	1024	ADC calibration is running.
11	Not used	2048	Returns "0"
12	Not used	4096	Returns "0"
13	Not used	8192	Returns "0"
14	Not used	16384	Returns "0"
15	Not used	32768	Returns "0"

Reference Clock Status Subsystem

The Reference Clock Status register contains information about the validity of the 10 or 100 MHz external reference clock of the module.

The following SCPI commands and queries are supported:

```
:STATus:QUEStionable:REFClock[:EVENt]?
:STATus:QUEStionable:REFClock:CONDition?
:STATus:QUEStionable:REFClock:ENABle[?]
:STATus:QUEStionable:REFClock:NTRansition[?]
:STATus:QUEStionable:REFClock:PTRansition[?]
```

Table 9 Reference clock status register

Bit Number		Decimal Value	Definition
0	Amplitude too small	1	Amplitude of external reference signal too small.
1	Amplitude too big	2	Amplitude of external reference signal too big.
2	Frequency out-of-range	4	Frequency of external reference signal out-of-range.

Connection Status Subsystem

The Connection Status register contains the state of the USB connection to the M8131A module.

The following SCPI commands and queries are supported:

```
:STATus:QUEStionable:CONNection[:EVENt]?
:STATus:QUEStionable:CONNection:CONDition?
:STATus:QUEStionable:CONNection:ENABle[?]
:STATus:QUEStionable:CONNection:NTRansition[?]
:STATus:QUEStionable:CONNection:PTRansition[?]
```

Table 10 Connection status register

Bit Number		Decimal Value	Definition
0	USB disconnected	1	USB module connection state

ADC Calibration Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:QUEStionable:CALibration:ADC[:EVENt]?
:STATus:QUEStionable:CALibration:ADC:CONDition?
:STATus:QUEStionable:CALibration:ADC:ENABle[?]
:STATus:QUEStionable:CALibration:ADC:NTRansition[?]
:STATus:QUEStionable:CALibration:ADC:PTRansition[?]
```

Table 11 ADC calibration status register

Bit Number		Decimal Value	Definition
0	Calibration data invalid	1	ADC calibration data is invalid.
1	Calibration necessary	2	ADC re-calibration is necessary.
2	Calibration not finished successfully.	4	Cleared after a successful calibration.
3	Calibration aborted	8	ADC calibration was aborted by the user.
4	Calibration failed	16	ADC calibration failed.

NOTE Upon software start, bit 2 is set and bits 3, 4 are cleared. When a calibration was run, the bits are updated accordingly.

Filter Status Subsystem

The Filter Status register contains the frequency response correction filter input overload and output clipped status per channel.

The following SCPI commands and queries are supported:

```
:STATus:QUEStionable:FILTer[:EVENt]?
:STATus:QUEStionable:FILTer:CONDition?
:STATus:QUEStionable:FILTer:ENABle[?]
:STATus:QUEStionable:FILTer:NTRansition[?]
:STATus:QUEStionable:FILTer:PTRansition[?]
```

Table 12 Filter status register

Bit Number		Decimal Value	Definition
0	Channel 1 Filter input overload	1	A sample with a minimum or maximum possible ADC code (-511 or +511, respectively) was detected at the filter input.
1	Channel 2 Filter input overload	2	
2	Channel 3 Filter input overload	4	
3	Channel 4 Filter input overload	8	
4	Channel 1 Filter output clipped	16	A sample with an ADC code outside the valid range of -511 to +511 was detected after filtering at the filter output
5	Channel 2 Filter output clipped	32	
6	Channel 3 Filter output clipped	64	
7	Channel 4 Filter output clipped	128	

Sample Clock Status Subsystem

The Sample Clock Status register contains the status of the 8 GHz clock signal connected to the Sample Clk In.

The following SCPI commands and queries are supported:

```
:STATus:QUEStionable:SCLock[:EVENt]?
:STATus:QUEStionable:SCLock:CONDition?
:STATus:QUEStionable:SCLock:ENABle[?]
:STATus:QUEStionable:SCLock:NTRansition[?]
:STATus:QUEStionable:SCLock:PTRansition[?]
```

Table 13 Sample clock status register

Bit Number		Decimal Value	Definition
0	Sample Clock invalid	1	No sample clock signal is connected to Sample Clk In, or the connected sample clock is invalid and cannot be used, because its amplitude or frequency is out-of-range.

ADC Calibration Run Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:OPERation:CALibration:ADC[:EVENt]?
:STATus:OPERation:CALibration:ADC:CONDition?
:STATus:OPERation:CALibration:ADC:ENABle[?]
:STATus:OPERation:CALibration:ADC:NTRansition[?]
:STATus:OPERation:CALibration:ADC:PTRansition[?]
```

Table 14 Run status register

Bit Number		Decimal Value	Definition
0	Calibration Run Status	1	Indicates that an ADC calibration is running
1	Calibration Step Running	2	Indicates that an ADC calibration step is running

NOTE

In modules with differential inputs, only bit 0 is important. It is set while the calibration is active and is cleared when the calibration is finished.

In modules with single ended inputs, where an external N2136A calibration module must be connected for the calibration, this is different. These modules are calibrated channel by channel and for each step the calibration module must be connected to the next channel.

Bit 0 is set when the calibration for the first channel is started and cleared when calibration for the last channel is finished.

Bit 1 is set while the calibration for a single channel is running. A ‘0’ indicates that the calibration module can be connected to the next channel and the :CALibrate:ADC:NEXT SCPI command can be issued again.

Arm Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:OPERation:ARMed[:EVENt]?
:STATus:OPERation:ARMed:CONDition?
:STATus:OPERation:ARMed:ENABle[?]
:STATus:OPERation:ARMed:NTRansition[?]
:STATus:OPERation:ARMed:PTRansition[?]
```

Table 15 Arm status register

Bit Number		Decimal Value	Definition
0	Trigger Arm	1	The trigger system is armed and waiting for a trigger.

Trigger Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:OPERation:TRIGgered[:EVENt]?
:STATus:OPERation:TRIGgered:CONDition?
:STATus:OPERation:TRIGgered:ENABle[?]
:STATus:OPERation:TRIGgered:NTRansition[?]
:STATus:OPERation:TRIGgered:PTRansition[?]
```

Table 16 Trigger status register

Bit Number		Decimal Value	Definition
0	Trigger Status	1	A trigger was detected.

Memory Capture Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:OPERation:MEMCapture[:EVENt]?
:STATus:OPERation:MEMCapture:CONDition?
:STATus:OPERation:MEMCapture:ENABle[?]
:STATus:OPERation:MEMCapture:NTRansition[?]
:STATus:OPERation:MEMCapture:PTRansition[?]
```

Table 17 Memory Capture status register

Bit Number		Decimal Value	Definition
0	Memory Capture in Progress	1	Memory capture has been started and not completed yet.

Data Streaming Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:OPERation:STReam[:EVENt]?
:STATus:OPERation:STReam:CONDition?
:STATus:OPERation:STReam:ENABle[?]
:STATus:OPERation:STReam:NTRansition[?]
:STATus:OPERation:STReam:PTRansition[?]
```

Table 18 Data Streaming status register

Bit Number		Decimal Value	Definition
0	Data Streaming in Progress	1	Data streaming has been started and not stopped yet.

ODI Time Output Sync Status Subsystem

The following SCPI commands and queries are supported:

```
:STATus:OPERation:TOSync[:EVENt]?
:STATus:OPERation:TOSync:CONDition?
:STATus:OPERation:TOSync:ENABle[?]
:STATus:OPERation:TOSync:NTRansition[?]
:STATus:OPERation:TOSync:PTRansition[?]
```

Table 19 Time Output Sync status register

Bit Number		Decimal Value	Definition
0	Time Sync in Progress	1	Time Sync procedure is started but not complete.
1	Time Sync in Progress	2	Time is synchronized

Acquire Commands

The ACQuire subsystem commands set up conditions for executing a :DIGitize, :DIGitize:NDISplay or :RUN root level command to acquire waveform data into capture memory or a :STReam root level command to stream waveform data out of the ODI links. The commands in this subsystem select the sampling frequency and the number of data points.

:ACQuire: SRATe[?]

Command `:ACQuire:SRATe {S16G | S32G}`

The command sets the acquisition sampling rate.

`S16G` 16GSa/s

`S32G` 32GSa/s

Query `:ACQuire:SRATe?`

The query returns the acquisition sampling rate.

Example

```
Command
:ACQuire:SRATe S16G
```

:ACQuire:POINts[?]

Command `:ACQuire:POINts <points_value>`

The command sets the requested memory depth for an acquisition into capture memory.

`<points_value>` An integer representing the memory depth per channel. When raw data is captured, the value denotes the number of samples. When IQ data is captured, the value denotes the number of IQ sample pairs.

The minimum and maximum values and the granularity of the points available for a channel depend on the sampling rate, the data processing mode (Direct/DDC) and the decimation factor. If the passed parameter does not fulfill the granularity the value is adjusted to the next higher supported value.

Sample Rate 16 GSa/s	Minimum	Maximum	Granularity
Direct, No Decimation	400	419430400	400
Direct, Decimation by 2	64	268435456	64
Direct, Decimation by 4	64	268435456	64
DDC	32	134217728	32

Sample Rate 32 GSa/s	Minimum	Maximum	Granularity
Direct, No Decimation	800	838860800	800
Direct, Decimation by 2	128	536870912	128
Direct, Decimation by 4	128	536870912	128
DDC	64	268435456	64

Query `:ACQuire:POINts?`

The query returns the value of the memory depth.

Returned Format `[:ACQuire:POINts] <points_value><NL>`

:ACQuire:SEGMented:PCOunt[?]

Command `:ACQuire:SEGmented:PCOunt <number of packets to stream>`

This command sets the total number of packets that will be streamed (unless “infinite” is specified).

Query `:ACQuire:SEGMented:PCOunt?`

This query returns the total number of packets that will be streamed (unless “infinite” is specified).

Example

```
Command
:ACQuire:SEGmented:PCOunt 10
```

:ACQuire:SEGMented: PCOunt:INFinite[?]

Command `:ACQuire:SEGMented:PCOunt:INFinite <value>`

This command sets the number of packets in segmented mode to the maximum possible value.

Query `:ACQuire:SEGMented:PCOunt:INFinite?`

This query returns whether the number of packets available is infinite or not.

Example

```
Command
:ACQuire:SEGMented:PCOunt:INF 1
```

:ACQuire:SEGMented:PLENgth[?]

Command `:ACQuire:SEGMented:PLENgth <samples>`

This command sets the length of one packet in segmented or continuous packetized mode. When a capture is taken while streaming is active, the amount of captured data depends on the streaming mode:

Continuous: The capture is independent of streaming.

Continuous Packetized: One packet is captured

Segmented Fixed: One segment (= one packet) is captured.

Segmented Variable: One segment (= a number of contiguous packets, up to memory size) is captured.

Query `:ACQuire:SEGMented:PLENgth?`

The query returns the length of one packet in segmented or continuous packetized mode.

:ACQuire:STReaming:MODE

Command `:ACQuire:STReaming:MODE {CONTinuous | CPACketized| SFIXed | SVARiable}`

The command sets the streaming mode. There are four streaming modes available:

Continuous, Continuous Packetized VITA-49, Segmented Fixed VITA-49 and, Segmented Variable VITA-49. For more information about each mode, refer to Streaming and Segmentation on page 85.

Query `:ACQuire:STReaming:MODE?`

The query returns the streaming mode.

:ACQuire:TSTamp

Command `:ACQuire:TSTamp`

The command sets the time stamp when a capture has been started.

Query `:ACQuire:TSTamp?`

This query returns a list of three commas separated uint32 values in the order of appearance, seconds, the high fraction of picoseconds, and the low fraction of picoseconds.

Example `:ACQ:TST?`

ADC Calibration Commands

The CALibration subsystem contains commands to re-calibrate the ADC of the digitizer and to calibrate the deterministic latency in the data path to another module.

ADC Calibration Commands

The ADC calibration commands allow to re-calibrate the ADC of the digitizer, to query the calibration status and to save and load calibration data.

:CALibrate:ADC[:STARt]

Command `:CALibrate:ADC[:STARt]`

Description The command starts the self-calibration of the ADC module.

NOTE In modules with single ended inputs, where a calibration requires an external calibration module, this command starts the calibration of the first channel.

:CALibrate:ADC:NEXT

Command `:CALibrate:ADC:NEXT`

Description The command starts the next step of the ADC module's self-calibration.

NOTE This command applies only to the modules with single ended inputs, where a calibration requires an external calibration module.

:CALibrate:ADC:ABORt

Command `:CALibrate:ADC:ABORt`

Description The command aborts a running self-calibration of the ADC module.

:CALibrate:ADC:INFormation?

Query	`:CALibrate:ADC:INFormation?`
Description	The query returns information about the last calibration of the ADC module.
Returned Format	`[:CALibrate:ADC:INFormation] <information_string><NL>`
	`<information_string>` Contains information about type (“User” or “Factory”) and date of last calibration.
Example	Query
	`:CALibrate:ADC:INFormation?`
	`“M8131A Setup:`
	`Mode: 16GHz on 4 channels`
	`Calibration Loaded:`
	`1(User): 2018-03-09 17:33:44”`

:CALibrate:ADC:RECommended?

Query	`:CALibrate:ADC:RECommended?`
Parameters	`None`
Description	This query returns a Boolean value, indicating if an ADC calibration is recommended.
Return Format	`[:CALibrate:ADC:RECommended] <recommended><NL>`
Example	:CAL:ADC:REC? → 0

:CALibrate:ADC:DATE[:RECommended]?

Query	`:CALibrate:ADC:DATE[:RECommended]?`
Parameters	`None`
Description	This query returns the date when the next ADC calibration is recommended.
Return Format	`[:CALibrate:ADC:DATE:RECommended] <date><NL>`
Example	:CAL:ADC:DATE? → “2020-07-01”

:CALibrate:ADC:TEMPerature:DELTa[:CURRent]?

Query	`:CALibrate:ADC:TEMPerature:DELTa[:CURRent]?`
Parameters	`None`
Description	This query returns the ADC temperature difference to the last ADC calibration.
Return Format	`[:CALibrate:ADC:TEMPerature:DELTa[:CURRent]] <temperature difference><NL>`
Example	:CAL:ADC:TEMP:DELT? → 1.00000000000000E+00

:CALibrate:ADC:TEMPerature:DELTa:MAXimum?

Query	`:CALibrate:ADC:TEMPerature:DELTa:MAXimum?`
Parameters	`None`
Description	This query returns the maximum ADC temperature difference to the last ADC calibration before a new calibration is recommenced.
Return Format	`[:CALibrate:ADC:TEMPerature:DELTa:MAXimum?] <max temperature difference><NL>`
Example	:CAL:ADC:TEMP:DELT? → 1.00000000000000E+01

:CALibrate:ADC:TEMPerature:DELTa:MINimum?

Query	`:CALibrate:ADC:TEMPerature:DELTa:MINimum?`
Parameters	`None`
Description	This query returns the minimum ADC temperature difference to the last ADC calibration before a new calibration is recommenced.
Return Format	`[:CALibrate:ADC:TEMPerature:DELTa:MAXimum?] <min temperature difference><NL>`
Example	:CAL:ADC:TEMP:DELT? → -1.00000000000000E+01

:CALibrate:ADC:SAVE

Command `:CALibrate:ADC:SAVE <file_name>`

Description The command saves the calibration data of the ADC module to a file.

`<file_name>` A quoted ASCII string with a maximum of 254 characters including the entire path name, if used. The filename assumes the present working directory, if a path does not precede the file name.

:CALibrate:ADC:LOAD

Command `:CALibrate:ADC:LOAD <file_name>`

Description The command loads the calibration data of the ADC module from a file.

`<file_name>` A quoted ASCII string with a maximum of 254 characters including the entire path name, if used. The filename assumes the present working directory, if a path does not precede the file name.

Latency Calibration Commands

The Latency Calibration commands are used to initialize the deterministic latency in the data path between the M8131A digitizer and another module connected via ODI links, for example a DSP or an AWG.

The digitizer, as the module connected upstream in the data path, will be referred to as the primary module in the command description. The module connected downstream in the data path will be referred to as the secondary module. For deterministic latency initialization, a defined sequence of commands must be sent to the primary and secondary module. Refer to Continuous Streaming with Deterministic Latency to DSP Module on page 193.

The Latency Calibration commands are also used to initialize the Sync Out to Sync In connection of multiple M8131A digitizer modules operating as a synchronous system. The digitizer sending out trigger pulses on Sync Out will be referred to as the primary module in the command description. The modules receiving trigger pulses on Sync In will be referred to as secondary module. For the initialization of a synchronous system, a defined sequence of commands must be sent to the primary and secondary module. Refer to Synchronization of Two M8131A Modules on page 190.

:CALibrate:SYNC:INPut:LEVel

Command `:CALibrate:SYNC:INPut:LEVel <level>`

Description This command sets the threshold level of the Sync In. The threshold level is set by default to the optimum voltage level to match the output voltage range of the Sync Out of the M8131A or M8132A. Do not change the Sync In threshold when connected to a Sync Out of the M8131A or M8132A.

<level> The threshold level in V.

Query `:CALibrate:SYNC:INPut:LEVel?`

Description This query returns the current threshold level of the Sync In.

:CALibrate:LATency:LCMPeriod

Command `:CALibrate:LATency:LCMPeriod <lcm_period>`

Description This command sets the Least Common Multiple (LCM) period value to be used for core clock phase alignment. On the primary module, this value determines the frequency of the signal sent out at the Sync Out. On the

secondary module, this value determines the frequency of the signal used to compare with the signal received at the Sync In. The formula for the frequency is:

f = 400MHz / LCM period.

<lcm_period> The LCM period as an even integer between 2 and 32768.

Query `:CALibrate:LATency:LCMPeriod?`

Description This query returns the current LCM period.

:CALibrate:LATency:MODE

Command `:CALibrate:LATency:MODE {SEParate | COMBined}`

Description This command selects the latency calibration mode.

- SEParate – Phase alignment to the primary module's core clock and latency calibration are separate steps. This mode is used for latency setup between M8131A and M8132A DSP.
- COMBined - Phase alignment to the primary module's core clock and latency calibration are done in the same step. This mode is used for latency setup between M8131A and M8121A AWG.

Query `:CALibrate:LATency:MODE?`

Description This query returns the current latency calibration mode.

:CALibrate:LATency[:STEP]

Command `:CALibrate:LATency[:STEP] {GSYNc | ALIGnphase | SSYNc | ARMadjust | PREPare}`

Description This command executes a step in the latency calibration of the data path between the primary and secondary module. As mentioned in brackets, some commands are sent to and affect only the primary module and some only the secondary module. It is indicated as well, when commands are relevant only for one calibration mode (SEParate, COMBined).

- GSYNc - Generate clock signal at Sync Out (primary module, SEParate).
- ALIGnphase - Use the clock signal received at Sync In to align the phase of the core clock (secondary module).
- SSYNc - Stop the clock signal generation at Sync Out (primary module).

- ARMadjust - Arm the module for latency adjustment (secondary module). When the primary module starts sending data over the ODI, the latency is measured in the secondary module and the FIFOs are adjusted accordingly.
- PREPare - Set the Sync Out to pulse mode (primary module, SEParate). When data streaming is started, a single pulse is sent at the Sync Out.

:CALibrate:LATency:CKSYnc:OFFSet[?]

Command `:CALibrate:LATency:CKSYnc:OFFSet <value>`

Description This command sets the offset value of the sync clock.

Query `:CALibrate:LATency:CKSYnc:OFFSet?`

Description This query returns the current offset value of the sync clock.

:CALibrate:LATency:SPDelay

Command `:CALibrate:LATency:SPDelay {A|B}, <sync_pulse_delay>`

Description This command sets the synchronization pulse delay for the selected FPGA in multiples of the core clock period (5ns).

A Selects FPGA A.

B Selects FPGA B.

<sync_pulse_delay> The synchronization pulse delay as an unsigned integer between 0 and 1023.

Query `:CALibrate:LATency:SPDelay? {A|B}`

Description This query returns the synchronization pulse delay for the selected FPGA.

Channel Commands

The CHANnel subsystem contains commands and queries for the following:

- Selection of channels for memory capture.
- Configuration of voltage range and offset for digitizer modules with single-ended inputs
- Configuration of Digital-Down-Conversion (DDC), if the option -DDC is installed.
- Configuration of the correction filter.

:CHANnel<N>:DISPlay

Command `:CHANnel<N>:DISPlay {{ON | 1} | {OFF | 0}}`

Description The command selects or deselects a channel for waveform data capture to memory. Additionally, it turns the data display of the specified channel on or off.

<N> An integer, 1-4

Query `:CHANnel<N>:DISPlay?`

The query returns the current display condition for the specified channel.

Returned Format `[:CHANnel<N>:DISPlay] {1 | 0}<NL>`

:CHANnel<N>:OFFSet

Command `:CHANnel<N>:OFFSet <offset>`

Description The command sets the voltage value that is represented at the center of the display for the selected channel.

<N> An integer, 1-4

<offset> The offset, valid values are -400 mV to 400 mV.

Example `:CHAN1:OFFS 2.00000000000000E-01`

Query :CHANnel<N>: OFFSet?

The query returns the current offset value for the specified channel.

Returned Format `[:CHANnel<N>:OFFSet] <offset><NL>`

NOTE In modules with differential inputs, the query always returns 0.00000000000000E+00 and setting any value not equal to 0 results in an error.

:CHANnel<N>:RANGe

Command	`:CHANnel<N>:RANGe <range>`
Description	The command defines the full-scale vertical axis of the selected channel. The values represent the full-scale deflection factor of the vertical axis in volts. <N> An integer, 1-4
<range>	The full-scale range of the ADC, valid values are 40 mV to 400 mV.
Example	`:CHAN1:RANG 2.00000000000000E-01`
Query	:CHANnel<N>: RANGe? The query returns the current range value for the specified channel.
Returned Format	`[:CHANnel<N>:RANGe] <range><NL>`

NOTE In modules with differential inputs, the query always returns 5.00000000000000E-0 and setting any value not equal to 0.5 results in an error.

:CHANnel<N>:DPRocessing:DDC:CFRequency

Command	`:CHANnel<N>:DPRocessing:DDC:CFRequency {<frequency_value>}`
Description	The command sets the center frequency of the DDC for the specified channel. <N> An integer, 1-4 <frequency_value> A floating point value representing the center frequency of the input signal. The valid range for a sample frequency of 16 GSa/s is from -8 GHz to +8 GHz, for 32 GSa/s from -16 GHz to +16 GHz.
Query	`:CHANnel<N>:DPRocessing:DDC:CFRequency?`

The query returns the current center frequency of the DDC for the specified channel.

Returned Format `[:CHANnel<N>:DPRocessing:DDC:CFRequency] <frequency_value><NL>`

:CHANnel<N>:DPRocessing: CHARacteris[:VALue]

Query `:CHANnel<N>:DPRocessing:CHARacteris[:VALue]? [{S16G | S32G}]`

Description The query returns the frequency and phase response data for a channel as a string of comma-separated values.

<N> An integer, 1-4

Returned Format [:CHANnel<N>:DPRocessing: CHARacteris[:VALue]]

<freq_resp><NL>

<freq_resp> A comma-separated list of 321 triples. Each triple consists of:

- Input frequency in Hz starting at 0 Hz with a spacing of 25 MHz for a sample rate of 16 GSa/s and 50 MHz for a sample rate of 32 GSa/s.
- Corresponding relative magnitude in linear scale
- Corresponding phase in radians

Example of the returned frequency response data for 32 GSa/s mode:

0.000000000E+00,1.000000000E+00, 0.000000000E+00,

5.000000000E+07,9.998865128E-01,-4.444515407E-01,

...

1.595000013E+10,3.858275712E-01,-9.671807861E+01,

1.600000000E+10,3.722717166E-01,-9.718323517E+01

:CHANnel<N>:DPRocessing:FILTer[:VALue]

Command `:CHANnel<N>:DPRocessing:FILTer[:VALue] {[{S16G | S32G}], filter_values}`

Description The command sets the 49 correction filter coefficients for the specified channel. If the optional parameter of sample rate mode is given, it sets the filter values for the specified sample rate otherwise for the current sample rate mode. The correction filter is applied directly after the conversion by the ADC and before further processing, for example by the DDC.

<N> An integer, 1-4

S16G Selects the coefficients for 16GSa/s

S32G Selects the coefficients for 32GSa/s

<filter_values> The set of 49 coefficients as comma separated ASCII list or binary block of doubles. Each coefficient is in the range [-2;+2]. The frequency response of the correction filter is not allowed to exceed a gain of 2.0 over the entire frequency range.

Query :CHANnel<N>:DPRocessing:FILTer[:VALue]? [{S16G | S32G}]

The query returns the current coefficients for the correction filter for the specified channel. If the optional parameter of sample rate mode is given, it returns the filter values for the specified sample rate otherwise for the current sample rate mode.

Returned Format :[:CHANnel<N>:DPRocessing:FILTer[:VALue]] <filter_values> <NL>

:CHANnel<N>:DPRocessing:FILTer:DEFault

Command `:CHANnel<N>:DPRocessing:FILTer:DEFault [{S16G | S32G}]`

Description The command sets the default values for the 49 correction filter coefficients for the specified channel. If the optional parameter of sample rate mode is given, it sets the default filter values for the specified sample rate otherwise for the current sample rate mode.

<N> An integer, 1-4

S16G Selects the coefficients for 16GSa/s

S32G Selects the coefficients for 32GSa/s

Query :CHANnel<N>:DPRocessing:FILTer:DEFault? [{S16G | S32G}]

The query returns the default values for the coefficients for the correction filter for the specified channel. If the optional parameter of sample rate mode is given, it returns the default filter values for the specified sample rate otherwise for the current sample rate mode.

Returned Format [:CHANnel<N>:DPRocessing:FILTer:DEFault] <filter_values> <NL>

:CHANnel<N>:DPRocessing:FILTer:SCALe

Command `:CHANnel<N>:DPRocessing:FILTer:SCALe <scale>`

Description The command sets the correction filter scaling factor for a channel.

<N> An integer, 1-4

<scale> The correction filter scaling factor between 0 and 2.

Query :CHANnel<N>:DPRocessing:FILTer:SCALe?

The query returns the current correction filter scaling factor for a channel.

Returned Format [:CHANnel<N>:DPRocessing:FILTer:SCALe] <scale> <NL>

:CHANnel<N>:DPRocessing:FILTer:STATe

Command `:CHANnel<N>:DPRocessing:FILTer:STATe {ON | 1} | {OFF | 0}`

Description The command sets the state of the correction filter - on or off.

<N> An integer, 1-4

Query :CHANnel<N>:DPRocessing:FILTer:STATe?

The query returns the current state of the correction filter for a channel.

Returned Format [:CHANnel<N>:DPRocessing:FILTer:STATe] {1 | 0} <NL>

:CHANnel<N>:DPRocessing:DDC:CFRequency:QUOTient?

Query `:CHANnel<N>:DPRocessing:DDC:CFRequency:QUOTient?`

Description This query gives the exact center frequency f_C as a list of numbers: sign, upper 32 bit of the numerator (Num_H), lower 32 bit of the numerator (Num_L), upper 32 bit of the denominator ($Denom_H$), lower 32 bit of the denominator ($Denom_L$).

The sign is a signed value and can be "-1" or "+1". The other four values are unsigned. The resulting quotient has to be multiplied by the sample rate f_S to get the center frequency according to this formula:

$f_C = sign * (Num_H * 2^{32} + Num_L) / (Denom_H * 2^{32} + Denom_L) * f_S$

<N> An integer, 1-4

Example The sample rate is 16GHz.

:CHANnel1:DPRocessing:DDC:CFRequency:QUOTient?

1,8601,2576980378,65536,0

$f_C = 1 * (8601 * 2^{32} + 2576980378) / (65536 * 2^{32} + 0) * 16GHz =$

2.100 000 000 000 022 GHz

Data Processing Commands

:DPRocessing[:MODE]

Command `:DPRocessing[:MODE] {DIRect|DDC}`

Description The command selects the data processing mode for all channels. The selected mode determines, which type of data is forwarded to the capture memory and the ODI port.

`DIRect:` No data processing, the raw ADC samples are forwarded to the capture memory and the ODI port.

`DDC:` Digital-down conversion, the ADC samples are down-converted from the center frequency to baseband followed by a decimation and then forwarded to the capture memory and the ODI port.

Query `:DPRocessing[:MODE]?`

The query returns the current data processing mode for the specified channel.

Returned Format `:DPRocessing[:MODE]] {DIRect | DDC}<NL>`

:DPRocessing:DDC:DECimation

Command `:DPRocessing:DDC: DECimation {POW2 | POW3 |POW4|POW5 | POW6 | POW7 |POW8 | POW9}`

Description The command sets the decimation factor of the DDC for all channels. All decimation factors are powers of 2.

`POW2` 2^2

`POW3` 2^3

`POW4` 2^4

`POW5` 2^5

`POW6` 2^6

`POW7` 2^7

`POW8` 2^8

`POW9` 2^9

Query `:DPRocessing:DDC:DECimation?`

The query returns the current decimation factor of the DDC for the specified channel.

Returned Format `<N>:DPRocessing:DDC: DECimation] {POW2 | POW3 | POW4 |POW5 | POW6 | POW7 | POW8| POW9} <NL>`

:DPRocessing:DIRect:DECimation

Command `DPRocessing:DIRect:DECimation {POW0 | POW1 |POW2}`

Description The command sets the decimation factor of the Direct mode for all channels. All decimation factors are powers of 2.

Parameters `POW0` 2^0

`POW1` 2^1

`POW1` 2^2

Example Command

```
:DPR:DIR:DEC POW1
```

Query

```
:DPR:DIR:DEC? -> POW1
```

The query returns the current decimation factor of the Direct mode for the specified channel.

:DPRocessing:CAPability:DECimation?

Query `:DPRocessing:CAPability:DECimation?`

Description The query returns the list of all the available decimation factors.

:DPRocessing:DDC:RESet

Command	`:DPRocessing:DDC:RESet [<channel_mask>]`
Description	The command resets the phase of the DDC.
<channel_mask>	Bit field specifying, for which channel the DDC phase should be reset. Bit 0: channel 1 Bit 1: channel 2 Bit 2: channel 3 Bit 3: channel 4 If the parameter is omitted, the DDC phases of all channels are reset.

Common Commands

*IDN?

Read the instrument's identification string which contains four fields separated by commas. The first field is the manufacturer's name, the second field is the model number, the third field is the serial number, and the fourth field is a revision code which contains four numbers separated by dots and a fifth number separated by a dash:

`Keysight Technologies, M8131A,<serial number>, x.x.x.x-h`

`x.x.x.x`= Soft Front Panel revision number, e.g. 2.0.0.0

`h`= Hardware revision number

*CLS

Clear the event register in all register groups. This command also clears the error queue and cancels a `*OPC` operation. It doesn't clear the enable register.

*ESE

Enable bits in the Standard Event Status Register to be reported in the Status Byte. The selected bits are summarized in the "Standard Event" bit (bit 5) of the Status Byte Register. The `*ESE?` query returns a value which corresponds to the binary-weighted sum of all bits enabled decimal by the `*ESE` command. These bits are not cleared by a `*CLS` command. Value Range: 0–255.

ESR?

Query the Standard Event Status Register. Once a bit is set, it remains set until cleared by a `*CLS` (clear status) command or queried by this command. A query of this register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

*OPC

Set the "Operation Complete" bit (bit 0) in the Standard Event register after the previous commands have been completed.

*OPC?

Return “1” to the output buffer after the previous commands have been completed. Other commands cannot be executed until this command completes.

*OPT?

Read the installed options. The response consists of any number of fields separated by commas.

*RST

Reset instrument to its factory default state.

*SRE[?]

Enable bits in the Status Byte to generate a Service Request. To enable specific bits, you must write a decimal value which corresponds to the binary-weighted sum of the bits in the register. The selected bits are summarized in the “Master Summary” bit (bit 6) of the Status Byte Register. If any of the selected bits change from “0” to “1”, a Service Request signal is generated. The `*SRE?` query returns a decimal value which corresponds to the binary-weighted sum of all bits enabled by the `*SRE` command.

*STB?

Query the summary (status byte condition) register in this register group. This command is similar to a Serial Poll but it is processed like any other instrument command. This command returns the same result as a Serial Poll but the “Master Summary” bit (bit 6) is not cleared by the `*STB?` command.

*TST?

Execute Self Tests. If self-tests pass, a 0 is returned. A number lager than 0 indicates the number of failed tests.

To get actual messages, use `:TEST:TST?`

*LRN?

Query the instrument and return a binary block of data containing the current settings (learn string). You can then send the string back to the instrument to restore this state later. For proper operation, do not modify the returned string before sending it to the instrument. Use `:SYST:SET` to send the learn string. See :SYSTem:SET[?] on page 155.

*WAI?

Prevents the instrument from executing any further commands until the current command has finished executing.

Mass Memory Commands

The MMEMory subsystem allows to access files on the host executing the M8131A firmware.

NOTE **MMEM commands requiring <directory_name> assume the current directory if a relative path or no path is provided. If an absolute path is provided, then it is ignored.**

:MMEMory:CATalog?

Query `:MMEMory:CATalog? [<directory_name>]`

Description Query disk usage information (drive capacity, free space available) and obtain a list of files and directories in a specified directory in the following format:

`<numeric_value>,<numeric_value>,{<file_entry>}`

The command returns two numeric parameters and as many strings as there are files and directories. The first parameter indicates the total amount of storage currently used in bytes. The second parameter indicates the total amount of storage available, also in bytes. The `<file_entry>` is a string. Each `<file_entry>` indicates the name, type, and size of one file in the directory list:

`<file_name>,<file_type>,<file_size>`

As the Windows file system has an extension that indicates file type, `<file_type>` is always empty. `<file_size>` provides the size of the file in bytes. In case of directories, `<file_entry>` is surrounded by square brackets and both `<file_type>` and `<file_size>` are empty.

Example Query

```
:MMEM:CAT?
```

:MMEMory:CDIRectory

Command `:MMEMory:CDIRectory [<directory_name>]`

Description The command changes the default directory for a mass memory file system. The `<directory_name>` parameter is a string. If no parameter is specified, the directory is set to the `*RST` value. At `*RST`, this value is set to the default user data storage area, that is defined as System.Environment.SpecialFolder.Personal

e.g. `C:\Users\Name\Documents`

`MMEMory:CDIRectory?` – Query returns full path of the default directory.

Parameter `<directory_name>`

Example Command

```
:MMEM:CDIR "C:\Users\Name\Documents"
```

Query

```
:MMEM:CDIR?
```

:MMEMory:COPY

Command `:MMEMory:COPY <string>,<string>[,<string>,<string>]`

Description The command copies an existing file to a new file or an existing directory to a new directory. Two forms of parameters are allowed. The first form has two parameters. In this form, the first parameter specifies the source, and the second parameter specifies the destination.

The second form has four parameters. In this form, the first and third parameters specify the file names. The second and fourth parameters specify the directories. The first pair of parameters specifies the source. The second pair specifies the destination. An error is generated if the source doesn't exist or the destination file already exists.

Parameters `<string>,<string>`

Example Command

```
:MMEM:COPY "C:\data.txt", "C:\data_new.txt"
```

:MMEMory:DELete

Command `:MMEMory:DELete <file_name>[,<directory_name>]`

Description The command removes a file from the specified directory. The `<file_name>` parameter specifies the file to be removed.

Parameters `<file_name>`

Example Command

```
:MMEM:DEL "C:\data.txt"
```

:MMEMory:DATA

Command `:MMEMory:DATA <file_name>, <data>`

Description The command form is `MMEMory:DATA <file_name>,<data>`. It loads `<data>` into the file `<file_name>`. `<data>` is in 488.2 block format. `<file_name>` is string data.

Parameters `<file_name>, <data>`

Example Command

```
:MMEM:DATA "C:\data.txt", #14test
```

:MMEMory:DATA:APPend

Command `:MMEMory:DATA:APPend <file_name>, <data>`

Description The command form is MMEMory:DATA:APPend <file_name>,<data>. It appends <data> to the existing file <file_name>. <data> is in 488.2 block format.

<file_name> is string data.

Parameters `<file_name>, <data>`

Example Command

```
:MMEM:DATA:APP "C:\data.txt", #14test
```

:MMEMory:DATA?

Query `:MMEMory:DATA? <file_name>`

Description The query form is `MMEMory:DATA? <file_name>` with the response being the associated `<data>` in block format.

Parameters `<file_name>`

Example Query

```
:MMEM:DATA? "C:\data.txt"
```

:MMEMory:MDIRectory

Command `:MMEMory:MDIRectory <directory_name>`

Description The command creates a new directory. The `<directory_name>` parameter specifies the name to be created.

Parameters `<directory_name>`

Example Command

```
:MMEM:MDIR "C:\data_dir"
```

:MMEMory:MOVE

Command `:MMEMory:MOVE <string>,<string>[,<string>,<string>]`

Description The command moves an existing file to a new file or an existing directory to a new directory. Two forms of parameters are allowed. The first form has two parameters. In this form, the first parameter specifies the source, and the second parameter specifies the destination.

The second form has four parameters. In this form, the first and third parameters specify the file names. The second and fourth parameters specify the directories. The first pair of parameters specifies the source. The second pair specifies the destination. An error is generated if the source doesn't exist or the destination file already exists.

Parameters `<string>,<string>`

Example Command

```
:MMEM:MOVE "C:\data_dir","C:\newdata_dir"
```

:MMEMory:RDIRectory

Command `:MMEMory:RDIRectory <directory_name>`

Description The command removes a directory. The `<directory_name>` parameter specifies the directory name to be removed. All files and directories under the specified directory are also removed.

Parameters `<directory_name>`

Example Command

```
:MMEM:RDIR "C:\newdata_dir"
```

:MMEMory:LOAD:CSTate

Command `:MMEMory:LOAD:CSTate <file_name>`

Description Current state of instrument is loaded from a file.

Parameters `<file_name>`

Example Command

```
:MMEM:LOAD:CST "C:\data.txt"
```

:MMEMory:STORe:CSTate

Command `:MMEMory:STORe:CSTate <file_name>`

Description Current state of instrument is stored to a file.

Parameters `<file_name >`

Example Command

```
:MMEM:STOR:CST "C:\data.txt"
```

:MMEMory:STORe:WAVeform

Command `:MMEMory:STORe::WAVeform CHANnel<N>, "<file_name>" [,<format>[,<header>]]`

Description Saves a waveform from the selected channel to a file.

`<N>` An integer, 1-4.

`<file_name>` A quoted ASCII string with a maximum of 254 characters including the entire path name, if used. The filename assumes the present working directory if a path does not precede the file name.

`<format>` {TXT } ASCII file format. If the `DPRocessing:MODE` is `DIRect`, data consists of voltage values separated by a carriage return and line feed. If the `DPRocessing:MODE` is `DDC`, data consists of IQ value pairs separated by a carriage return and line feed. The two values of a pair are separated by a comma.

`<header> {{ON | 1} | {OFF | 0}}`

`ON | 1` A header precedes the data.

`OFF | 0` Only data without header (default).

Example: File header and beginning of data for a waveform captured in DIRect mode:

```
Revision: 0
Type:     raw
Points:   1600
XInc:     6.25e-11
XOrg:     0
XUnits:   second
YInc:     0.0005
YOrg:     0
YUnits:   Volt
Data:
3.23486E-02
3.33252E-02
...
```

Example: File header and beginning of data for a waveform captured in DDC mode:

```
Revision: 0
Type:     iqd
Points:   1600
XInc:     6.25e-11
XOrg:     0
XUnits:   second
YInc:     0.0005
YOrg:     0
YUnits:   Volt


Data:
1.23486E-02, 1.33252E-02
1.25348E-02, 1.39842E-02
...
```

Example Command

```
:MMEM:STORe:WAVeform CHANnel1, "waveform.txt", TXT,
ON
```

Root Level Commands

The Root Level commands control many of the basic operations of the digitizer.

:DIGitize

Command `:DIGitize`

The command initializes the selected channels, then starts acquisition of ADC samples into capture memory. When all waveforms are completely acquired, the acquisition is stopped.

In Direct mode the captured ADC samples are displayed in the time and frequency domain windows of the GUI. In DDC mode they are only displayed in the frequency domain window.

When the digitizer receives this command, it initializes the selected channels according to the current acquire and trigger settings. It sets the Memory Capture in Progress bit of the Memory Capture Status Subsystem and returns to the caller. When the capture is completed, the Memory Capture in Progress bit is reset to 0. Before reading the data from the capture memory using the :WAVeform:DATA query, the caller should verify, that the Capture in Progress bit is 0. For more information on Memory Capture Status Subsystem, refer to Memory Capture Status Subsystem on page 119.

:DIGitize:NDISplay

Command `:DIGitize:NDISplay`

Same as the :DIGitize command, but the GUI displays are not updated.

:RUN

Command `:RUN`

This command is equivalent to repetitively calling the :DIGitize command. Command execution can be stopped with the :STOP command.

:STOP

Command `:STOP`

The command causes the digitizer to stop acquiring data into capture memory. It can be used to abort a :DIGitize, :DIGitize:NDISplay or :RUN command.

:STReam

Command `:STReam`

This command is only available with option STR. It starts ODI streaming on all ports, that are activated and for which the data producer is activated. See commands :ODI:PORT<N>:ACTivate on page 168 and :ODI:PRODucer<N>:ACTivate on page 173. If the DDC (Digital Down Conversion) is switched on, IQ samples are streamed. If the DDC is switched off, raw data samples are streamed.

Example: Stream out IQ data samples on ODI port 1

// Activate ODI port as producer.

:ODI:PORT1:ACT R141, 2048, PROD, NONE, NONE, ""

// Activate ODI port as consumer on the other side of the ODI link.

// Read ODI port communication status and wait until ODI link is up.

// Active, TxReady and RxReady (bits 0-3) of the returned status should // all be 1.

:ODI:PORT1:CST?

// Activate the data producer.

:ODI:PROD1:ACT 0, NHE, IQ16B1CH, ODIC, NTIM, 1, 26214

// Activate the data consumer on the other side of the ODI link.

// Start ODI streaming.

:STR

:SSTReam

Command `:SSTReam`

This command is only available with option STR. It stops ODI streaming on all ports.

Example: Stop the data streaming on ODI port 1.

// Stop ODI streaming.

:SSTR

// De-activate the data producer.

:ODI:PROD1:DEAC

// De-activate the data consumer on the other side of the ODI link.

// De-activate ODI port.

:ODI:PORT1:DEAC

// De-activate ODI port on the other side of the ODI link.

System Commands

:SYSTem:ERRor[:NEXT]?

Query `:SYSTem:ERRor?`

Description The query read and clear one error from the instrument's error queue.

A record of up to 30 command syntax or hardware errors can be stored in the error queue. Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. Errors are cleared as you read them.

If more than 30 errors have occurred, the last error stored in the queue (the most recent error) is replaced with "Queue overflow". No additional errors are stored until you remove errors from the queue.

If no errors have occurred when you read the error queue, the instrument responds with 0,"No error".

The error queue is cleared by the `*CLS` command, when the power is cycled, or when the Soft Front Panel is re-started.

The error queue is not cleared by a reset (`*RST`) command.

The error messages have the following format (the error string may contain up to 255 characters):

error number,"Description", e.g.

-113,"Undefined header".

Example Query

```
:SYST:ERR?
```

:SYSTem:HELP:HEADers?

Query `:SYSTem:HELP:HEADers?`

Description The query returns all SCPI commands and queries and IEEE 488.2 common commands and common queries implemented by the instrument. The response is a <DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA> element. The full path for every command and query is returned separated by linefeeds.

The syntax of the response is defined as: The <nonzero digit> and sequence of <digit> follow the rules in IEEE 488.2, Section 8.7.9. A <SCPI header> is defined as: It contains all the nodes from the root. The <SCPI program mnemonic> contains the node in standard SCPI format. The short form uses uppercase characters while the additional characters for the long form are in lowercase characters. Default nodes are surrounded by square brackets ([]).

Example Query

```
:SYST:HELP:HEAD?
```

:SYSTem:LICense:EXTended:LIST?

Query `:SYSTem:LICense:EXTended:LIST?`

Description The query lists the licenses installed.

Example Query

```
:SYST:LIC:EXT:LIST?
```

:SYSTem:SET[?]

Command `:SYSTem:SET[?] <binary block data>`

Description In query form, the command reads a block of data containing the instrument's complete set-up. The set-up information includes all parameter and mode settings, but does not include the contents of the instrument setting memories or the status group registers. The data is in a binary format, not ASCII, and cannot be edited.

In set form, the block data must be a complete instrument set-up read using the query form of the command.

This command has the same functionality as the `*LRN` command.

Parameters <binary block data>

Example Command

```
:SYST:SET <binary block data>
```

Query

```
:SYST:SET?
```

:SYSTem:VERSion?

Command `:SYSTem:VERSion?`

Description The query returns a formatted numeric value corresponding to the SCPI version number for which the instrument complies.

Example Query

```
:SYST:VERS?
```

:SYSTem:COMMunicate:*?

Command `:SYSTem:COMMunicate:*?`

Description The query returns information about the instrument Soft Front Panel's available connections. If a connection is not available, the returned value is -1.

This is only useful if there is more than one Keysight module connected to a PC, otherwise one would normally use the default connections (HiSLIP and VXI-11 instrument number 0, socket port 5025, telnet port 5024)

One can never be sure if a socket port is already in use, so one could e.g. specify a HiSLIP number on the command line (AgM8131SFP.exe /AutoID /Inst5 /FallBack /r ...) and let the Soft Front Panel find an unused socket port. Then this socket port can be queried using the HiSLIP connection.

Example Query

```
:SYST:COMM:*?
```

:SYSTem:COMMunicate:INSTr[:NUMBer]?

Command `:SYSTem:COMMunicate:INSTr?`

Description The query returns the VXI-11 instrument number used by the Soft Front Panel.

Example Query

```
:SYST:COMM:INST?
```

:SYSTem:COMMunicate:HISLip[:NUMBer]?

Command `:SYSTem:COMMunicate:HISLip?`

Description The query returns the HiSLIP number used by the Soft Front Panel.

Example Query

```
:SYST:COMM:HISL?
```

:SYSTem:COMMunicate:SOCKet[:PORT]?

Command `:SYSTem:COMMunicate:SOCKet?`

Description The query returns the socket port used by the Soft Front Panel.

Example Query

```
:SYST:COMM:SOCK?
```

:SYSTem:COMMunicate:TELNet[:PORT]?

Command `:SYSTem:COMMunicate:TELNet?`

Description The query returns the telnet port used by the Soft Front Panel.

Example Query

```
:SYST:COMM:TELN?
```

:SYSTem:COMMunicate:TCPip:CONTrol?

Command `:SYSTem:COMMunicate:TCPip:CONTrol?`

Description The query returns the port number of the control connection. You can use the control port to send control commands (for example “Device Clear”) to the instrument.

Example Query

```
:SYST:COMM:TCP:CONT?
```

:SYSTem:ERRor:COUNt?

Command	`:SYSTem:ERRor:COUNt?`
Parameters	None
Description	This query returns the error count.
Examples	Query `:SYST:ERR:COUNt? -> "5"`

Time Base Commands

The TIMebase subsystem commands control the reference clock source of the digitizer.

:TIMebase:REFClock

Command `:TIMebase:REFClock{INTernal | E010 | E100}`

Description The command selects the reference clock source.

`INTernal` Internal 10 MHz reference oscillator (default)

`E010` External 10 MHz reference

`E100` External 100 MHz reference

The following errors are detected, when an external reference clock source is selected:

- Amplitude of external reference signal too small.
- Amplitude of external reference signal too big.
- Frequency of external reference signal out-of-range.

These errors are reported in the STATus subsystem. After selecting a new reference clock source, the status should be queried. In all these error cases, the external reference signal is not usable, and the module automatically selects the internal reference oscillator.

Query `:TIMebase:REFClock?`

The query returns the currently selected reference clock source.

Returned Format `[:TIMebase:REFClock] {INTernal | E010 | E100}<NL>`

Waveform Commands

The Waveform subsystem is used to transfer waveform data between a computer and the digitizer. It contains commands to set up the waveform transfer and to receive waveform records from the digitizer.

:WAVeform:BYTeorder

Command `:WAVeform:BYTeorder {MSBFirst | LSBFirst}`

Description The command selects the order in which bytes are transferred from the digitizer using WORD format.

`MSBFirst` The most significant byte is transferred first.

`LSBFirst` The least significant byte is transferred first (default).

Query `:WAVeform:BYTeorder?`

The query returns the current setting for the byte order.

Returned Format `[:WAVeform:BYTeorder] {MSBFirst | LSBFirst}<NL>`

:WAVeform:DATA?

Query `:WAVeform:DATA? CHANnel<N>, <start>,<size>`

Description The query outputs waveform data to the computer over the remote interface. The data is copied from a channel given by the first parameter. The waveform data is ASCII formatted. The data consists of waveform data values converted to volts and is formatted as a string of ASCII characters with each value separated from the next value by a comma. The values are formatted in floating point engineering notation. For example:

8.0836E+2,8.1090E+2,...,-3.1245E-3

If `DPRocessing` is set to `DIRect`, 10-bit ADC samples in signed 16-bit integer representation are transferred. If set to `DDC`, 16-bit I and 16-bit Q samples interleaved in signed 16-bit integer representation are transferred.

<N> An integer, 1-4.

`<start>` An integer value which is the starting point in the source memory which is the first waveform point to transfer.

<size> An integer value which is the number of points in the source memory to transfer. If the size specified is greater than the amount of available data, then the size is adjusted to be the maximum available memory depth minus the <start> value.

Returned Format `[:WAVeform:DATA] {ascii_list}<NL>`

:WAVeform:DATA:BLOCk?

Query `:WAVeform:DATA:BLOCk? CHANnel<N>, <start>,<size>`

Description The query outputs waveform data to the computer over the remote interface. The data is copied from a channel given by the first parameter. The waveform data is in binary block format. The data is transferred as signed 16-bit integers. If :WAVeform:BYTeorder is set to MSBFirst, the most significant byte of each word is sent first. If the BYTeorder is LSBFirst, the least significant byte of each word is sent first.

If DPRocessing is set to DIRect, 10-bit ADC samples in signed 16-bit integer representation are transferred. If set to DDC, 16-bit I and 16-bit Q samples interleaved in signed 16-bit integer representation are transferred.

<N> An integer, 1-4.

<start> An integer value which is the starting point in the source memory which is the first waveform point to transfer.

<size> An integer value which is the number of points in the source memory to transfer. If the size specified is greater than the amount of available data then the size is adjusted to be the maximum available memory depth minus the <start> value.

Returned Format `[:WAVeform:DATA:BLOCk] {binary_block_data}<NL>`

:WAVeform:XINCrement?

Command `:WAVeform:XINCrement? CHANnel<N>`

Description This query returns the time difference between consecutive data points for the channel given by the first parameter.

<N> An integer, 1-4.

Example `:WAVeform:XINCrement? CHAN1 -> 6.25000000000000E-11`

:WAVeform:XORigin?

Command `:WAVeform:XORigin? CHANnel<N>`

Description This query returns the time value of the first point in the data record for the channel given by the first parameter.

<N> An integer, 1-4.

Example `:WAVeform:XORigin? CHAN1 -> 0.00000000000000E+00`

:WAVeform:YINCrement?

Command `:WAVeform:YINCrement? CHANnel<N>`

Description This query returns the y-increment voltage for the channel given by the first parameter. This voltage value is the voltage difference between two adjacent waveform data digital codes.

<N> An integer, 1-4.

Example `:WAVeform:YINCrement? CHAN1 -> 5.00000000000000E-04`

:WAVeform:YORigin?

Command `:WAVeform:YORigin? CHANnel<N>`

Description This query returns the y-origin voltage value for the channel given by the first parameter. The voltage value returned is the voltage value represented by the waveform data digital code zero.

<N> An integer, 1-4.

Example `:WAVeform:YORigin? CHAN1 -> 0.00000000000000E+00`

Instrument Commands

The INSTrument subsystem contains queries to get information like occupied AXIe slot number, M8131A hardware revision, available channels and capture memories.

:INSTrument:SLOT[:NUMBer]?

Query	`:INSTrument:SLOT[:NUMBer]?`
Description	The query returns the instrument's slot number in its AXIe frame
Returned Format	`[:INSTrument:SLOT[:NUMBer]] {slot_number}<NL>`

:INSTrument:IDENtify

Command	`:INSTrument:IDENtify <seconds>`
Description	The command identifies the instrument by flashing the green "Access" LED on the front panel for a certain time. `<seconds>` Optional length of the flashing interval in seconds, default is 10.

:INSTrument:IDENtify:STOP

Command	`:INSTrument:IDENtify:STOP`
Description	The command stops the flashing of the green "Access" LED before the flashing interval has elapsed.

:INSTrument:HWRevision?

Query	`:INSTrument:HWRevision?`
Description	The query returns the instrument's hardware revision number.
Returned Format	`[:INSTrument:HWRevision] {hw_revision}<NL>`

:INSTrument:AINPuts?

Query `:INSTrument:AINPuts?`

Description The query returns the usable analog input channels as a string. The channel names are separated by commas. The returned value depends on the installed options and the selected sample rate.

Returned Format `[:INSTrument:AINPuts] {active_channels_string}<NL>`

:INSTrument:AMEMory?

Query `:INSTrument:AMEMory?`

Description The query returns the usable capture memories as a string. The memory names are separated by commas. The returned value depends on the installed options and the selected sample rate.

Returned Format `[:INSTrument:AMEMory] {active_channels_string}<NL>`

:INSTrument:MONitor:TEMPerature?

Query `:INSTrument:MONitor: TEMPerature? {ADC | LACal | FA | FB}`

Description The query returns the temperature for the selected component.

ADC Current ADC temperature

LACal Temperature of last ADC calibration

FA Temperature of FPGA A

FA Temperature of FPGA B

Returned Format `[:INSTrument:MONitor:TEMPerature] <value>`

Example `:INST:MON:TEMP? ADC -> 7.09999990463257E+01`

Optical Data Interface Commands

The Optical Data Interface subsystem is used to setup the optical ports of the M8131A. These commands are only available with option -STR. An example sequence of commands to set up the ODI ports for data streaming is shown in the description of the :STReam command. This product implements a subset of the “Application Programming Interface for Test and Measurement - Optical Data Interface, Revision 2.0”.

The complete specification can be found here:
http://axiestandard.org/odispecifications.html

:ODI:ACHannels?

Command	`:ODI:ACHannels?`
Description	The query returns the usable optical channels as a string. The channel names are separated by commas. The returned value depends on the installed options and the selected sample rate. <N> An integer to select the ODI port, 1-4.
Returned Format	`[:ODI:ACHannels] {active_channels_string}<NL>`

:ODI:PORT:COUNt?

Query	`:ODI:PORT:COUNt?`
Description	The query returns the total number of ODI channels.
Return Format	`[:ODI:PORT:COUNt] <ports><NL>`
Example	`:ODI:PORT:COUNt? -> 4`

:ODI:PORT<N>:CAPability:DIRection?

Query	`:ODI:PORT<N>:CAPability:DIRection?`
Description	The query returns the list of data transfer directions supported by this port.
Return Format	`[:ODI:PORT<N>:CAPability:DIRection] <direction-list><NL>`

<direction-list>: [BIDirection | PRODucer | CONSumer | DUDirection] [,…]

Example :ODI:PORT:CAP:DIR? -> "CONSumer, BIDirection"

:ODI:PORT<N>:CAPability:FCONtrols?

Query :ODI:PORT1:CAPability:FCONtrols?

Parameters None

Description The query returns the list of flow control types supported by this port.

Return Format [:ODI:PORT1:CAPability:FCONtrols] <flow-control-list><NL>

<flow-control-list>: [NONE | IBANd | IBPChannel | OOBWire | OOBBplane<M>] [,…]

<M> An integer, 0 - 13

Example :ODI:PORT1:CAP:FCON? -> "NONE, IBANd"

:ODI:PORT<N>:CAPability:LANes?

Query :ODI:PORT<N>:CAPability:LANes?

Parameters None

Description The query returns the number of lanes supported by this port.

Return Format [:ODI:PORT<N>:CAPability:LANes] <lanes><NL>

Example :ODI:PORT1:CAP:LAN? -> 12

:ODI:PORT<N>:CAPability:NAME?

Query :ODI:PORT<N>:CAPability:NAME?

Parameters None

Description The query returns the name of the port.

Return Format [:ODI:PORT<N>:CAPability:NAME] <name><NL>

Example :ODI:PORT:CAP:NAME? -> "ODI1"

:ODI:PORT<N>:CAPability:RATes?

Query	`:ODI:PORT1:CAPability:RATes?`
Parameters	None
Description	The query returns the list of lane rates supported by this port.
Return Format	`[:ODI:PORT1:CAPability:RATes] <rate-list><NL>` `<rate-list>: [R125 | R141] [,…]`
Example	`:ODI:PORT1:CAP:RAT? -> "R141"`

:ODI:PORT<N>:CAPability:RBMax?

Query	`:ODI:PORT<N>:CAPability:RBMax?`
Parameters	None
Description	The query returns the supported receiver maximum burst values.
Return Format	`[:ODI:PORT<N>:CAPability:RBMax] <burst-max-list><NL>` `<burst-max-list>: [256 | 2048] [,…]`
Example	`:ODI:PORT:CAP:RBM? -> 2048`

:ODI:PORT<N>:CAPability:TBMax?

Query	`:ODI:PORT<N>:CAPability:TBMax?`
Parameters	None
Description	The query returns the supported transmitter maximum burst values.
Return Format	`[:ODI:PORT<N>:CAPability:TBMax] <burst-max-list><NL>` `<burst-max-list> ::= [256 | 2048] [,…]`
Example	`ODI:PORT:CAP:TBMax? -> 256,2048`

:ODI:PORT<N>:CAPability:TRMatch?

Query `:ODI:PORT:CAPability:TRMatch?`

Parameters None

Description The query returns a Boolean value, indicating if transmission rate matching is supported.

Return Format `[:ODI:PORT:CAPability:TRMatch] <rate-match><NL>`

Example `:ODI:PORT:CAP:TRM? -> 0`

:ODI:PORT<N>:NAME?

Query `:ODI:PORT:NAME?`

Parameters None

Description The query returns the name of the port.

Return Format `[:ODI:PORT:NAME] <name><NL>`

Example `:ODI:PORT:NAME? -> "ODI1"`

:ODI:PORT<N>:ACTivate

Command `:ODI:PORT<N>:ACTivate <lane_rate>, <tx_burst_max>, <directionality>, <tx_flow_control>, <rx_flow_control>, <options>`

Description The command switches on the optical port using the specified parameters.

`<N>` An integer to select the ODI port, 1-4.

`<lane_rate>` Lane rate

`R141` 14.1 Gbit/s.

`<tx_burst_max>` Maximum transmit burst size in bytes. Possible values are 256 and 2048

`<directionality>` Directionality

`PRODucer` Transmit direction

`CONSumer` Receive direction

`<tx_flow_control>` Transmit flow control

`NONE`

IBANd In-band

<rx_flow_control> Receive flow control

NONE

IBANd In-band

<options> String to pass additional instrument-specific settings. For future expansion. Currently not used.

Query :ODI:PORT<N>:ACTivate?

Description When the port is active, this query returns the parameter values used in the command to activate the port.

:ODI:PORT<N>:DEACtivate

Command `:ODI:PORT<N>:DEACtivate`

Description The command switches off the optical port.

<N> An integer to select the ODI port, 1-4.

Example `:ODI:PORT1:DEAC`

:ODI:PORT<N>:CSTatus?

Query `:ODI:PORT<N>:CSTatus?`

Description The query returns the communication status of an optical port.

<N> An integer to select the ODI port, 1-4.

Returned Format `[:ODI:PORT<N>:CSTatus] <status><NL>`

<status> 32-bit integer, meaning of the status bits is described in Table 20 on page -170.

Table 20

Name	Bits	Description
Active	0	Port activated by software. Actual readiness to send and receive will depend upon the opposite end of the link and flow control configuration.
TxReady	1	Ready to transmit and flow control allows. If flow control is disabled, transmit will always be ready to send. If flow control is enabled, the port will not be 'ready to send' until receiver is ready and indicating XON via flow control. To troubleshoot TxReady not becoming set in this case, troubleshoot the receive path starting with RxSignalLoss.
RxReady	2	Receiver ready. All lanes synchronized and aligned.
RxLaneError	3	Error in one or more lanes since last GetStatus.
RxBurstMaxError	4	Received too large a burst since last GetStatus.
RxCrcError	5	Received bad burst CRC since last GetStatus.
RxOverrun	6	Receiver data overrun since last GetStatus
RxSignalLoss	7	Received signal loss. Optical power too low.
RxSyncPending	8	Receiver activated but has not achieved synchronization
	9 to 15	Unused
RxFcStatus	16	Received link-level flow control status. 1 is XON, 0 is XOFF. From Interlaken idle/control word bit 55 or from an out-of-band flow control signal.
RxFcStatus0 to RxFcStatus14	17 to 31	Received per-channel flow control status bits. 1 is XON, 0 is XOFF. Bit 17 is channel 0 from bit 54 of the Interlaken idle/control word, bit 18 is channel 1 from bit 53 of the control word, and so on.

Status bits described with "since last GetStatus" are cleared by `:ODI:PORT<N>:CSTatus?` query. All status bits will be 0 on an inactive port.

:ODI:PORT<N>:PSTatistics:BBURsts?

Query `:ODI:PORT<N>:PSTatistics:BBURsts?`

Parameters None

Description This query returns the bad burst received by the ODI port.

Example `:ODI:PORT1:PST:BBUR? -> <integer>`

:ODI:PORT<N>:PSTatistics:RBYTes?

Query	`:ODI:PORT<N>:PSTatistics:RBYTes?`
Parameters	None
Description	This query returns the number of bytes received by the ODI port.
Example	`:ODI:PORT1:PST:RBYT? -> <integer>`

:ODI:PORT<N>:PSTatistics:TBYTes?

Query	`:ODI:PORT<N>:PSTatistics:TBYTes?`
Parameters	None
Description	This query returns the number of bytes transmitted by the ODI port.
Example	`:ODI:PORT1:PST:TBYT? -> <integer>`

:ODI:PORT<N>:PSTatistics:THOFfs?

Query	`:ODI:PORT<N>:PSTatistics:THOFfs?`
Parameters	None
Description	This query returns the transmission holdoffs.
Example	`:ODI:PORT1:PST:THOF? -> <integer>`

:ODI:PRODucer:COUNt?

Command	`:ODI:PRODucer:COUNt?`
Parameters	None
Description	This query returns the number of current producer count in the collection.
Example	`:ODI:PORD:COUN? -> 4`

:ODI:PRODucer<N>:CAPability:CLIDs?

Command	`:ODI:PRODucer<N>:CAPability:CLIDs?`
Parameters	None
Description	This query returns the class IDs.
Example	`:ODI:PROD1:CAP:CLID? -> "IQ16B1CH"`

:ODI:PRODucer<N>:CAPability:CCIDs?

Command	`:ODI:PRODucer<N>:CAPability:CCIDs?`
Parameters	None
Description	This query returns the context class IDs.
Example	`:ODI:PROD1:CAP:CCID? -> "ODIContext"`

:ODI:PRODucer<N>:CAPability:NAME?

Command	`:ODI:PRODucer<N>:CAPability:NAME?`
Parameters	None
Description	This query returns the name of the producer.
Example	`:ODI:PROD1:CAP:NAME? -> "Ch1 DDC to ODI1"`

:ODI:PRODucer<N>:CAPability:PFORmats?

Command	`:ODI:PRODucer<N>:CAPability:PFORmats?`
Parameters	None
Description	This query returns the name of the packet formats available.
Example	`:ODI:PROD1:CAP:PFOR? -> "NHEader"`

:ODI:PRODucer<N>:NAME?

Command	`ODI:PRODucer<N>:NAME?`
Parameters	None
Description	This query returns name of the producer. Useful if a port object passed by reference in programming environments.
Example	`:ODI:PROD1:NAME? -> "Ch1 DDC to ODI1"`

:ODI:PRODucer<N>:IFSupported

Command	`ODI:PRODucer<N>:IFSupported?`
Parameters	None
Description	This query returns if the combination of packet format and binary data format (classId) is supported.
Example	`:ODI:PRODucer2:IFSupported? NHEader,RE10B1CH-> 1`

:ODI:PRODucer<N>:ACTivate

Command	`:ODI:PRODucer<N>:ACTivate <link_channel>, <packet_format>, <class_id>, <context_class_id>, <time_stamp_format>, <stream_id>, <packet_size_limit>`
Description	The command configures the data producer stream and activates it for use. Data sources in the digitizer are the 4 channels. This command is used to prepare streaming of the digitized data out of the digitizer's optical ports. The stream is started by the `:STReam` commands (see :STReam on page 152).

`<N>` An integer to select the ODI port, 1-4.

`<link_channel>` Interlaken channel tag to apply to stream (not the measurement channel). Must be 0.

`<packet_format>` Specifies format of packet header.

`NHEader` Raw binary samples with no header.

<class_id> Specifies the binary data format of the packet payload.

Valid class ids are RE10B1CH, RE16B1CH, or IQ16B1CH, depending upon the instrument settings. All possible class ids can be determined using the :ODI:PRODUCER<N>:CAPABILITY:CLIDS? query. If a combination of packet format and binary data format (classId) is supported, can be determined using the ODI:PRODucer<N>:IFSupported? query.

RE10B1CH Real-only, 10-bit signed, 1 channel.

RE16B1CH Real-only, 16-bit signed, 1 channel.

IQ16B1CH Complex (IQ), 16-bit signed, 1 channel.

<context_class_id> Specifies format of context packets

NONE No context packet

ODIContext Specify Vita49 ODI context.

<time_stamp_format> Format of the time stamp

NTIMestamp Timestamp not used.

<stream_id> Specifies VITA-49 Stream Identifier value to be placed in the IF Data Packet when using the VITA-49 packet format. The default stream id for Vita49 carried over ODI is 4096.

<packet_size_limit> Specifies a maximum size for packets, in bytes. 0 indicates default of 262144.

:ODI:PRODucer<N>:DEACtivate

Command	`:ODI:PRODucer<N>:DEACtivate`
Parameters	None
Description	This command deactivates the stream, stops any data flow, and frees resources.
Example	`:ODI:PROD1:DEAC`

ODI Time Output Synchronization Subsystem

The ODI time output synchronization subsystem enables accurate synchronization of timestamps placed in ODI packets with an external time source, for example, the GPS in an M9506A AXIe chassis.

To synchronize the time, a pulse input on SYNC_IN or TRIG_IN front panel connectors at a known time is used to set up the time handling circuit. Subsequently, the time counters for individual ODI channels can be adjusted.

:ODI:TOSync

Command `:ODI:TOSync "<time>"`

Description Synchronize the clock used to timestamp ODI packets to the specified time when a synchronization pulse is received. The synchronization pulse can be received on either 'Sync In' or 'Trig In' as specified by :ODI:TOSync:Source

<time> The time to be applied when the sync pulse is received, as a string. The string may either:

The decimal fraction form of number of seconds that have elapsed since January 1, 1970 (midnight UTC/GMT).

Or/

A time string specified as an ISO 8601 format string.

The fractional second in both cases is parsed to 12 decimal places

NOTE Certain other operations, especially those relating to signal clocks, will be disabled until the synchronization pulse is received. In the event of the pulse not being received, the :ODI:TOSync:CANCel command may be used to cancel the pending synchronization operation.

NOTE Timestamp output and synchronization is only supported when DDC is active. Any change to sample mode or DDC decimation rate will reset the synchronization to local system time.

Example
```
:ODI:TOSync "1577836800.000000000000"
:ODI:TOSync "2000-02-22T16:19:11.8008352000+00:00"
```

:ODI:TOSync:CANCel

Command	`:ODI:TOSync:CANCel`
Description	Cancel a pending ODI time synchronization. In the event of failure to emit the synchronization pulse, this command may be necessary to restore access to other commands.
Example	`:ODI:TOSync:CANCel`

:ODI:TOSync:SOURce

Command	`:ODI:TOSync:SOURce <source>`
Query	`:ODI:TOSync:SOURce?`
Description	Specify the signal source used to synchronize the time output in ODI timestamps. When the :ODI:TOSync command is active and a pulse is received on the specified input. <source> The synchronization source, may be either TRIG or SYNC.
Example	`:ODI:TOSync:SOURce TRIG`

NOTE **Sync input maximum safe voltage is 1V. If Sync input is connected with a trigger output from M9506A, the output must be configured as 50 Ohm Push/Pull. An external 6db attenuator must be connected to the "Sync In" port connector to avoid damage to input circuitry.**

:ODI:TOSync:PORT<N>:ADJust <picoseconds>

Command	`:ODI:TOSync:PORT<N>:ADJust <picoseconds>`
Parameter	An integer time adjustment in picoseconds, positive or negative.
Description	The command allows the timestamp counter for an individual channel to be adjusted, to allow compensation for cable length for example. Adjustments are cumulative
Example	`:ODI:TOSync:PORT<N>:ADJust 10000`

Trigger Commands

The digitizer trigger circuitry helps you locate the waveform you want to view. The type of triggering used is edge triggering. Edge triggering identifies a trigger condition by looking for the slope (rising or falling) and voltage or power level (trigger level) on the source you select. Any of the four input channels and the external trigger input can be used as the trigger source. Additionally, the Sync Input can be used as a trigger source, when two or more digitizers are operating as a synchronous system. The commands in this subsystem define the conditions for triggering.

Trigger arming behavior

After the :DIGitize command is received, the trigger system tries to arm the trigger. When at least one complete vector, where all samples don't fulfill the trigger condition is received, the trigger system goes to armed state. In the worst case (the first sample not fulfilling the trigger condition is the second sample of a vector), this means that twice the vector size minus one sample not fulfilling the trigger condition must be received. When the trigger system is in the armed state, the next sample, that fulfills the trigger condition causes a trigger event.

In Data Processing Mode DIRect the vector size refers to the samples received from the ADC without further processing. In Data Processing Mode DDC the vector size refers to the samples after decimation and DDC processing.

Pre-trigger-time

Sample rate 16GSa/s, Data Processing Mode DIRect

A vector consists of 40 samples. The pre-trigger-time is 20ns for all decimation values.

Decimation	Sample Time (ns)	Vector Time (ns)	Vectors Before Trigger	Pre-Trigger Time (ns)
1	0.0625	2.5	8	20
2	0.125	5	4	20
4	0.25	10	2	20

Sample rate 32GSa/s, Data Processing Mode DIRect

A vector consists of 80 samples. The pre-trigger-time is 20ns for all decimation values.

Decimation	Sample Time (ns)	Vector Time (ns)	Vectors Before Trigger	Pre-Trigger Time (ns)
1	0.03125	2.5	8	20
2	0.0625	5	4	20
4	0.125	10	2	20

Sample rate 16GSa/s, Data Processing Mode DDC

A vector consists of 16 I/Q sample pairs. The number of pre-trigger samples is the equivalent of 32 vectors. The following table lists the resulting pre-trigger-time dependent on the decimation value.

Decimation	Sample Time (ns)	Vector Time (ns)	Vectors Before Trigger	Pre-Trigger Time (ns)
4	0.25	4	32	128
8	0.5	8	32	256
16	1	16	32	512
32	2	32	32	1024
64	4	64	32	2048
128	8	128	32	4096
256	16	256	32	8192
512	32	512	32	16384

Sample rate 32GSa/s, Data Processing Mode DDC

A vector consists of 32 I/Q sample pairs. The number of pre-trigger samples is the equivalent of 32 vectors. The following table lists the resulting pre-trigger-time dependent on the decimation value.

Decimation	Sample Time (ns)	Vector Time (ns)	Vectors Before Trigger	Pre-Trigger Time (ns)
4	0.125	4	32	128
8	0.25	8	32	256
16	0.5	16	32	512
32	1	32	32	1024
64	2	64	32	2048
128	4	128	32	4096
256	8	256	32	8192
512	16	512	32	16384

: TRIGger:SWEep

Command `:TRIGger:SWEep {AUTO | TRIGgered}`

Description The command selects the sweep mode, which defines how the capture of digitized samples to memory or the ODI streaming is started.

AUTO Capture to memory or ODI streaming will start on trigger reception. If a trigger event does not occur within 20 ms, the digitizer automatically forces a trigger. If the frequency of your waveform is 50 Hz or less, you should not use the AUTO sweep mode, because it is possible that the digitizer will automatically trigger before your waveform trigger occurs.

TRIGgered Capture to memory or ODI streaming will start on trigger reception. If no trigger occurs, capture to memory or ODI streaming will not start.

Query :TRIGger:SWEep?

The query returns the current setting for the sweep mode.

Returned Format [:TRIGger:SWEep] {AUTO | TRIGgered}<NL>

: TRIGger:EDGE:SOURce

Command `:TRIGger:EDGE:SOURce {EXTernal | CHANnel<N> | SYNCinput}`

Description The command selects the source for trigger events.

<N> An integer, 1-4.

EXTernal Use the external trigger input.

CHANnel<N> Use an analog input channel.

SYNCinput Use the Sync Input. This trigger source must be selected in the secondary module digitizer, when multiple digitizers are connected to allow synchronous capture to memory or synchronous ODI streaming. The Sync Output of the primary digitizer must be connected to the Sync Input of the secondary digitizers.

Query :TRIGger:EDGE:SOURce?

The query returns the current setting for the trigger source.

Returned Format [:TRIGger:EDGE:SOURce] {EXTernal | CHANnel<N> | SYNCinput}<NL>

: TRIGger:EDGE:SLOPe

Command `:TRIGger:EDGE:SLOPe {POSitive | NEGative}`

Description The command sets the slope of the trigger source. The slope setting is always the same for all trigger sources.

POSitive Trigger on a rising edge.

NEGative Trigger on a falling edge.

Query :TRIGger:EDGE:SLOPe?

The query returns the current setting for the trigger slope.

Returned Format [:TRIGger:EDGE:SLOPe] {POSitive | NEGative<N>}<NL>

:TRIGger:LEVel:EXTernal

Command	`:TRIGger:LEVel:EXTernal <level>`
Description	The command specifies the trigger level when the external trigger input is used as trigger source.
	<level> The trigger level in volts as a floating-point number.
Query	:TRIGger:LEVel:EXTernal?
	The query returns the current trigger level.
Returned Format	[:TRIGger:LEVel:EXTernal] <level><NL>

:TRIGger:LEVel[:CHANnel]

Command	`:TRIGger:LEVel[:CHANnel] CHANnel<N>, <level>`
Description	The command specifies the trigger level when an analog input channel is used as trigger source.
	<N> An integer, 1-4.
	<level> The trigger level in volts as a floating point number.
Query	:TRIGger:LEVel[:CHANnel]? CHANnel<N>
	The query returns the current trigger level.
Returned Format	[:TRIGger:LEVel[:CHANnel]] <level><NL>

:TRIGger:LEVel:IFMagnitude

Command	`:TRIGger:LEVel:IFMagnitude CHANnel<N>, <level>`
Description	The command specifies the Intermediate Frequency Magnitude trigger level when an analog input channel is used as trigger source and the data processing mode is DDC.
	A trigger event is generated, when the power $P_{Sample,dBm}$ of an IQ sample pair after DDC processing and decimation is above the specified trigger level in dBm according to the following formula:
	$P_{Sample} = (i^2 + q^2) * yInc^2 / 50\ \Omega$
	$P_{Sample,dBm} = 10 * \log_{10}(P_{Sample} / 1\ mW)$

yInc is the scaling factor to compute the voltage value from an ADC sample, see :WAVeform:YINCrement? on page 162.

This measure refers to the calculation of the power spectral density of the intermediate frequency passband signal and depicts the power level of a given complex signal within the DDC analysis bandwidth.

<N> An integer, 1-4.

<level> The trigger level in dBm as a floating-point number.

Query :TRIGger:LEVel:IFMagnitude?

CHANnel<N> The query returns the current trigger level.

Returned Format [:TRIGger:LEVel:IFMagnitude] <level><NL>

:TRIGger:HOLDoff

Command `:TRIGger:HOLDoff <holdoff_time>`

Description The command specifies the amount of time the digitizer should wait after receiving a trigger before enabling the trigger again. This is the behavior for the holdoff type NORMal. The behavior of the trigger holdoff time can be further modified by setting the holdoff type to ABOVe and BELow using the :TRIGger:HOLDoff:TYPE command.

<holdoff_time> The holdoff time in seconds as a floating-point number. It is the same for all trigger sources.

Query :TRIGger:HOLDoff?

The query returns the current holdoff time.

Returned Format [:TRIGger:HOLDoff] <holdoff_time><NL>

: TRIGger:HOLDoff:TYPE

Command `:TRIGger:HOLDoff:TYPE {NORMal | ABOVe | BELow}`

Description The command selects the trigger holdoff type. This setting defines how the holdoff time is used. It is the same for all trigger sources.

NORMal The trigger event is generated, when the holdoff time has elapsed after the last trigger event and the signal characteristic of interest crosses the threshold with the slope defined in the :TRIGger:EDGE:SLOPe command.

ABOVe This setting is only defined for negative slope and triggered sweep mode (TRIGger:SWEep TRIGgered). The trigger event is generated, if the signal characteristic of interest crosses the threshold (with negative slope) after having been above the threshold for at least the holdoff time. The trigger event is associated with the time the level was crossed.

BELow This setting is only defined for positive slope and triggered sweep mode (TRIGger:SWEep TRIGgered). The trigger event is generated, if the signal characteristic of interest crosses the trigger threshold (with positive slope) after having been below the threshold for at least the holdoff time. The trigger event is associated with the time the level was crossed.

Query :TRIGger:HOLDoff:TYPE?

The query returns the current setting for the holdoff type.

Returned Format [:TRIGger:HOLDoff:TYPE] { NORMal | ABOVe | BELow }<NL>

:TRIGger: SYNCout[?]

Command `:TRIGger:SYNCout {0 | OFF | 1 | ON}`

Description This command is used to support the synchronous start of the capture operation on multiple digitizers. It enables or disables the output of trigger pulses on the Sync Output. For synchronous operation the Sync Output of the primary digitizer must be connected to the Sync Input of the secondary digitizer. The capture is started by a received trigger event on the primary digitizer, which is distributed to all connected secondary digitizers.

0 | OFF No trigger pulses are output on Sync Output.

1 | ON Trigger pulses are output on Sync Output.

Query :TRIGger:SYNCout?

The query returns, if output of trigger pulses on the Sync Output is enabled or disabled.

:TRIGger:MODE[?]

Command `:TRIGger:MODE {EDGE}`

Description The command sets the trigger mode. Currently, “Edge” is the only supported mode.

Query :TRIGger:MODE?

The query returns the trigger mode.

:TRIGger:OUTPut:MODE

Command `:TRIGger:OUTPut:MODE {A|B}, {LOW|HIGH|TOGGle|FSM|BYPass}`

Description The command selects the trigger output mode for the selected FPGA.

Based on the selected Mode, the :TRIGger:OUTPut:SOURce provides the following outcomes on the trigger output.

The mode determines, which data the FPGA sends to the trigger output. The :TRIGger:OUTPut:SOURce command finally determines, which FPGA's data is displayed at the trigger output.

A Selects FPGA A.

B Selects FPGA B.

LOW Constant low-level

HIGH Constant high-level

TOGGle Low-level/high-level toggle pattern. 200 MHz square wave with 50% duty cycle.

Inside the FPGA is a trigger logic that consists of a 40-bit comparator and an FSM. To generate a trigger, the data (40 10-bit ADC Samples) flows to the comparator and enters the FSM. This last one will make sure a trigger is generated in case the outcome of at least one of the 40 evaluated samples is asserted. The evaluation requires parameters: Edge and Threshold, both can be manually adjusted by the user. Based on the type of edge (Positive or Negative) and the threshold value, the comparator's outcome will be determined and forwarded to the FSM. At this point, there is a distinction in the description between the FSM Mode and the BYPass Mode.

FSM

In case of an assertion provided by the comparator, the FSM will generate a trigger with a pulse equal to 100 ns. This pulse will be shown at the trigger output transceiver.

BYPass

The outcome of the 40-bit comparator will be shown at the trigger output transceiver bypassing the FSM.

This mode is used by the deterministic latency setup procedure.

Query :TRIGger:OUTPut:MODE? {A|B}

The query returns the current trigger output mode.

Returned Format [:TRIGger:OUTPut:MODE {A|B}] { LOW|HIGH |TOGGle|FSM|BYPass }<NL>

:TRIGger:OUTPut:SOURce

Command `:TRIGger:OUTPut:SOURce {A|B}`

Description The command selects, which FPGA's data is displayed at the trigger output.

A Selects FPGA A.

B Selects FPGA B.

Query :TRIGger:OUTPut:SOURce?

The query returns the current trigger output source.

Returned Format [:TRIGger:OUTPut:SOURce] {A|B }<NL>

Test Commands

:TEST:PON?

Query	`:TEST:PON?`
Parameters	None
Description	This query returns the result of the power on self-tests.
Example	Query `:TEST:PON?`

:TEST:TST?

Query	`:TEST:TST?`
Parameters	None
Description	This query is similar to `*TST?` but the actual test messages are returned.
Example	Query `:TEST:TST?`

8 Examples

KEYSIGHT TECHNOLOGIES

Introduction

In a standard installation, the examples can be found in the folder “C:\Program Files (x86)\Keysight\M8131\Examples”. They are all console applications and are provided as Microsoft Visual Studio 2019 solutions. Except for the <C++ Demo Connection Setup>, the programs are written in C# and use the VISA.NET library. The <C++ Demo Connection Setup> is written in C++ and uses the <library>.

Capture

This example program (Capture.sln) demonstrates how to set up the M8131A digitizer for capturing a test signal.

In the example, channel 1 of the digitizer is used. Data acquisition is done in direct mode with decimation factor 4. The program works with 16GSa/s and 32GSa/s ADC sample rate. The sample rate must be set before starting the program.

Cabling of Digitizer Connectors

- Analog input channel 1 - receives the test signal to be digitized

Setup Digitizer

Before starting the example program, start the M8131A and prepare the signal source to capture. If needed, change the sample rate in the M8131A.

Run Capture

The program uses "TCPIP0::localhost::hislip0::INSTR" to access the M8131A, and it assumes that an analog signal is connected to channel 1. It can be started with command line parameters to use other VISA resource strings for M8131A and another input channel.

Command line: Capture digitizer-resource channel

Example call: Capture "TCPIP0::localhost::hislip2::INSTR" 2

In each step after each SCPI command is sent to the digitizer, the execution status is read, and errors displayed.

1 Set the digitizer to Direct mode.
2 Set the trigger level on the input channel.
3 Set trigger source to the input channel.
4 Set sweep mode to Triggered.
5 Set the number of samples to capture.
6 Set up capture on the digitizer.
7 Set the decimation factor.
8 Start capturing data.
9 Wait until the acquisition is completed.
10 Set binary data upload format to big-endian.

11 Read captured data as a binary block. Finally, the example prints the first captured data to the console.

Synchronization of Two M8131A Modules

This example program (SynchronizeTwoM8131.sln) demonstrates how to synchronize two M8131A digitizer modules and then capture a test signal with both digitizers.

The synchronization is achieved with locked reference clock signals - primary module Ref Clk Out to secondary module Ref Clk In - and clock alignment signals – primary module Snyc Out to secondary module Snyc In.

In the example, channel 1 on both digitizers is used. Data acquisition is done in direct mode with decimation factor 4. The program works with 16GSa/s and 32GSa/s ADC sample rate. The sample rate must be set before starting the program.

Cabling of first (primary) Digitizer Connectors

- Analog input channel 1 - receives the test signal to be digitized.
- Sync Out to secondary digitizer Sync In - transmits a clock signal to the Sync In of the secondary digitizer for core clock alignment.
- Ref Clk Out to secondary digitizer Ref Clk In - provides the reference clock for the secondary digitizer.

Cabling of the second (secondary) Digitizer Connectors

- Analog input channel 1 - receives the test signal to be digitized.
- Sync In to primary digitizer Sync Out - receives the clock signal from the primary digitizer for core clock alignment.
- Ref Clk In to primary digitizer Ref Clk Out - receives the reference clock from the primary digitizer.

Setup Digitizers

Before starting the example program, start both M8131A and prepare the signal sources to capture. If needed, change the sample rates in the M8131A.

Run SynchronizeTwoM8131

The program uses "TCPIP0::localhost::hislip1::INSTR" to access the primary M8131A and "TCPIP0::localhost::hislip2::INSTR" to access the secondary M8131A. It assumes that analog signals are connected to channel 1 of both digitizers. It can be started with command line parameters to use other VISA resource strings for both M8131A.

Command line: Capture primary-resource secondary-resource

Example call: Capture "TCPIP0::localhost::hislip3::INSTR" "TCPIP0::localhost::hislip4::INSTR"

The program is divided into a part that synchronizes the M8131A and a part that captures data.

In each step after each SCPI command is sent to the digitizer, the execution status is read, and errors displayed.

Synchronize M8131A

1 Disable trigger output on Sync Out on both M8131A.
2 Set secondary module to use external 100 MHz reference clock from the primary module.
3 Set the secondary module sync input threshold to 410 mV.
4 Set an LCM period on both M8131A.
5 Set primary module to generate clock signal on Sync Out.
6 Align secondary module clock signal to sync signal received on Sync In.
7 Set primary module to stop clock signal on Sync Out.
8 Enable trigger output on Sync Out on both M8131A.

Capture signals

9 Set both M8131A to Direct mode.
10 Set the trigger level on the input channel on both M8131A.
11 Set primary module trigger source to input channel.
12 Set secondary module trigger source to Sync In.
13 Set sweep mode to Triggered on both M8131A.
14 Set the number of samples to capture on both M8131A.
15 Prepare capture on both M8131A.
16 Set the decimation factor on both M8131A.
17 Start capturing data on the secondary module.
18 Wait until arming on secondary module is completed.
19 Start capturing data on the primary module.

20 Wait until acquisition on primary module is completed.

21 Wait until acquisition on secondary module is completed.

22 Set binary data upload format to big-endian on both M8131A.

23 Read captured data as a binary block from both M8131A. Finally, the example prints the first captured data from both digitizers to the console.

Continuous Streaming with Deterministic Latency to DSP Module

This example program (M8131AToM8132ALatency.sln) demonstrates how to set up the M8131A digitizer and the M8132A DSP for Deterministic Latency Mode and stream digitized data from the M8131A digitizer to the M8132A DSP.

In the example, channel 1 of the digitizer is used. The program works with 16GSa/s and 32GSa/s ADC sample rate. For 32GSa/s an additional ODI connection between M8131A and M8132A is needed. The sample rate must be set before starting the program.

Cabling of Digitizer Connectors

- Analog input channel 1 - receives the test signal to be digitized and streamed to the DSP
- Trigger output - outputs high-level, when the digitized sample is positive, else low-level
- ODI1 to DSP ODI2 - streams digitized samples to the DSP (16GSa/s and 32GSa/s mode)
- ODI3 to DSP ODI4 - streams digitized samples to the DSP (32GSa/s mode)
- SyncOut to DSP SyncIn - transmits a clock signal to the SyncIn of the DSP for core clock alignment
- RefClkOut to DSP RefClkIn - provides the reference clock for the DSP

Cabling of DSP Connectors

- Trigger output - outputs high-level, when the sample received on ODI2 is positive, else low-level
- ODI2 to digitizer ODI1 - receives the samples from ODI1 of the digitizer (16GSa/s and 32GSa/s mode)
- ODI4 to digitizer ODI3 - receives the samples from ODI2 of the digitizer (32GSa/s mode)
- SyncIn to digitizer SyncOut - receives the clock signal from the digitizer for core clock alignment
- RefClkIn to digitizer RefClkOut - receives the reference clock from the digitizer

Setup Digitzer and DSP

Before starting the example program, start the M8131A and the M8132A. If needed, change the sample rate in the M8131A.

Run M8131AToM8132ALatency

The program uses "TCPIP0::localhost::hislip0::INSTR" to access the M8131A and "TCPIP0::localhost::hislip1::INSTR" to access the M8132A. It can be started with command line parameters to use other VISA resource strings for M8131A and M8132A.

Command line: M8131AToM8132ALatency dig-resource dsp-resource

Example call: M8131AToM8132ALatency "TCPIP0::localhost::hislip2::INSTR" "TCPIP0::localhost::hislip3::INSTR"

In each step after each SCPI command to the digitizer and the DSP the execution status is read, and errors displayed.

1 Set digitizer trigger source to channel 1. Without this setting, FPGA B would not forward data to the trigger output.
2 Set DSP to use a 100MHz external reference clock provided by the digitizer.
3 Set digitizer and DSP LCM period.
4 Set the latency calibration mode. For M8131A to M8132A, you need separate steps for phase alignment and latency calibration.
5 Generate a sync signal on Sync Out of digitizer.
6 Align the core clock of the DSP to the sync signal received on Sync In.
7 Stop the sync signal.
8 Switch on ODI1 and ODI3 (32G mode only) on digitizer and ODI2 and ODI4 (32G mode only) on DSP. Wait for all ODI ports to come up.
9 Arm the latency adjustment on DSP.
10 Prepare the start of the latency measurement on digitizer.
11 Prepare ODI1 and ODI3 (32G mode only) data streaming on the digitizer.
12 Set up the multiplexers in FPGA A of the DSP to receive data from ODI2 and ODI4 (32G mode only).
13 Set up the trigger output of digitizer and DSP to display the polarity of the received signal. A positive ADC sample generates a logical "1", a negative ADC sample a logical "0".
14 Set the synchronization pulse delay for FPGA A and B on the digitizer and the DSP.

15 Start ODI data streaming. Digitized data is streamed from the digitizer to DSP with deterministic latency until ODI data streaming is stopped in the next step. It is recommended to use a low-frequency square signal (below 500kHz) as input for digitizer channel 1. Then the established latency can be verified by measuring the time between the rising edges of the signals output on digitizer and DSP trigger output.

16 Stop ODI data streaming.

17 Switch off ODI1 and ODI3 (32G mode only) on digitizer and ODI2 and ODI4 (32G mode only) on DSP.

9 Characteristics

Performance Specification

The performance specification can be found in the Data Sheet of the M8131A at: http://www.keysight.com/find/M8131A.

Operating Environment

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

WARNING

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

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

General

Power consumption	350 W (nom)
Safety tested according to	IEC61010-1, ANSI/UL61010, CSA22.2 No. 61010-1 certified
EMC tested according to	IEC61326
Warm-up time	15 min
Calibration interval	1 year recommended
Cooling Requirements	When operating the M8131A choose a location that provides at least 80 mm of clearance at rear, and at least 30 mm of clearance at each side for the AXIe chassis.

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