Configuration and Measurement Instructions

Keysight M9703B High-Speed Digitizers Hardware Extension of 89600 VSA Software
NOTES

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Safety Information
Please refer to the Startup Guide or User
Manual which was delivered with your
product for safety information.

Sales and Technical Support
To contact Keysight for sales and technical
support, refer to the “support” links on the
following Keysight web resources:
www.keysight.com/find/digitizer
www.keysight.com/find/assist (worldwide
contact information for repair and service).
Information on preventing damage to your
Keysight equipment can be found at
www.keysight.com/find/tips.
Introduction

The 89600 VSA software (89601B) supports the Keysight M9703B High-Speed Digitizer. This VSA measurement hardware configuration offers broadband vector signal analyzer capabilities. The maximum analysis bandwidth is model dependent.

<table>
<thead>
<tr>
<th>Model</th>
<th>Option</th>
<th>Maximum Span (Analysis Bandwidth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9703B</td>
<td>-SR1-F05</td>
<td>390 MHz (650 MHz in interleaved mode)</td>
</tr>
<tr>
<td></td>
<td>-SR1-F10</td>
<td>390 MHz (781 MHz in interleaved mode)</td>
</tr>
<tr>
<td></td>
<td>-SR2-F05</td>
<td>625 MHz (650 MHz in interleaved mode)</td>
</tr>
<tr>
<td></td>
<td>-SR2-F10</td>
<td>625 MHz (1.25 GHz in interleaved mode)</td>
</tr>
</tbody>
</table>

The present document aims to describe how to configure and use VSA software with Keysight High-Speed Digitizers.

For details about VSA 89600 software usage, please refer to VSA software help (http://rfmw.em.keysight.com/wireless/helpfiles/89600B/WebHelp/89600.htm).

Software installation

The latest VSA (89601B) software version can be downloaded from http://www.keysight.com/find/VSA.

The support of M9703B digitizer also requires installing a plugin so that VSA can recognize this hardware. This MD2 Hardware Extension for VSA software can be accessed from following link:

MD2 Digitizers Hardware Extension for 89600 VSA Software

or found from M9703B product page (www.keysight.com/find/M9703B) > Technical Support > Drivers, Firmware, and Software.

Once downloaded, execute MD2DigitizersHwExt_Setup-<versions>.exe and follow the installation process.

**NOTE** VSA (89601B) gets updated frequently to support new hardware. You must reinstall the above plugin anytime you upgrade the VSA software version.

Checking if your hardware is included in VSA’s extension manager

**Start > All Programs > VSA Extension Manager**

![Image of VSA Extension Manager]

Look for your hardware at the bottom, if not listed, then install the hardware extension as described above.
Updating MD2 Digitizer Hardware Extension after the installation of a new 89600 VSA Software version

When updating your 89600 VSA Software version, the MD2 Digitizer Hardware Extension has to be re-installed.
There are two solutions:

Option 1

From Windows > Control Panel > Programs > Programs and Features, select and right click on Keysight MD2 Digitizers Extension of Keysight 89600 VSA.

And select Change.
The InstallShield Wizard opens.
Select Repair and click Next.

This automatically installs the MD2 Digitizers Hardware Extension in the new 89600 VSA Software version.
Option 2

There is a tool allowing to install/desinstall the **MD2 Digitizers Hardware Extension** on all of the different VSA versions installed in the system.

In order to proceed, execute:

```
C:\Program Files\Keysight\MD2\89600 VSA Connectivity\MD2Digitizers\89600VSAIntegration.exe
```

(or using your installation path)

Follow the installation process.

Click **OK**.

The installation of the **MD2 Digitizers Hardware Extension** in the new **89600 VSA Software** version is now completed.
89600 VSA Software Configuration

Configuring the 89600 VSA software application to use the digitizer hardware

Create a configuration for Keysight M9703B digitizer

1. Start the 89600 VSA software application.
2. Configure the digitizer as the VSA measurement input by creating an 'Analyzer Configuration' that uses your digitizer as the Logical Instrument (ADC) by performing the following steps:
   a. From the menu, go to Utilities > Hardware > Configurations, and click on Add New Configuration button (1). The 'New Hardware Configuration' dialog opens.
   b. De-select 'Simulate Hardware' if it is selected (1).
   c. Select Keysight MD2 digitizers(2) from the list of 'Possible Logical Instrument' and drag it or click on the button (3) to add it to the 'Configuration' box.
In the box below, ensure that the digitizer appears as the 'ADC' entry, and if you have more than one digitizer connected - select the required unit using the drop-down list (4).

You may either use the default name or specify another name for this analyzer configuration (5).

Click OK to close the 'New Hardware Configuration' dialog (6).

Before closing the 'Hardware Configurations' dialog, use the Current Analyzer Configuration drop-down to select the newly created as the current item (Digitizer1 in the example below).
Options and settings specific to high-speed digitizers

For specific acquisition modes, you may need to use high-speed digitizer specific settings. These settings are available through the digitizer hardware extension, and can be managed from: Input > Extensions.

- **Calibration equalization**: This feature is not supported with M9703B digitizer.
- **ControlIO1 signal**: The digitizer supports multi-purposes I/Os. This option allows to select the signal used for the ControlIO1. For details about the possible signals, please refer to the User manual of your digitizer, section Multi-Purpose Inputs and Outputs.
- **Enable external clock**: See External Clock (page 12)
- **Enable interleaving**: See Interleaved Mode (page 11)
- **Error on overrange**: This feature is not supported with M9703B digitizer.
- **External clock frequency**: See External Clock (page 12)
- **Force Software DDC**: This option is effective only if your product has been ordered with the -DDC option (Digital Down-Conversion). By default, this mode is disabled, meaning that the downconversion is done by the hardware (in the digitizer FPGA). When enabling Force Software DDC, you disable the DDC mode of the digitizer and only use the software DDC from 89600 VSA. This can allow you to visualize the difference and see the efficiency of the hardware DDC.
- **MD2 Auto Calibration**: See **Calibration (page 10)**
- **Multiboard synchronization**: See **Multi-Module Measurements (page 19)**

## Calibration

By default 89600 VSA software automatically detects when a change of parameter requires a new calibration of the digitizer module. This requirement is indicated on the bottom right of the screen.

When a calibration is needed, user can either launch it from **Utilities > Calibration** or by clicking on **CAL: Needed**.

It is possible to let the digitizer automatically performs a selfcalibration when required by a change of the acquisition or digitizer parameter. To proceed, you have to enable the option **MD2 Auto Calibration** from **Input > Extensions** window, then to manually start the calibration once. The following calibrations will be automatic.

However, the **MD2 Auto Calibration** mode is not recommended when you are modifying several parameters, since it can be time consuming to perform a calibration after each parameter change, especially for multi-channel digitizer.

## Multi-Channel Measurements

When using the Keysight High Speed Digitizers in VSA configuration, the digitizer forms the measurement front-end data acquisition hardware for the 89600 VSA software.

The M9703B digitizer supports single channel I+jQ, and cross channel measurement configurations.

The M9703B also supports 4 channels Dual I + jQ.

The analysis bandwidth and maximum sample rate depend on the digitizer model.
Configure extension parameters for specific acquisition modes

Interleaved Mode

The option of combining two channels of the digitizer in interleaved mode is available if your product has been ordered with the -INT option.

Interleaving allows to double the sampling rate with the trade-off of halving the available center frequency range, as shown in the table below:

<table>
<thead>
<tr>
<th>Model</th>
<th>Option</th>
<th>Mode</th>
<th>Center Frequency Range</th>
<th>ADC Sampling Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9703B</td>
<td>-SR1</td>
<td>Normal (non-interleaved)</td>
<td>0 - 1 GHz</td>
<td>1 GS/s</td>
</tr>
<tr>
<td></td>
<td>-SR2</td>
<td>Normal (non-interleaved)</td>
<td>0 - 1.6 GHz</td>
<td>1.6 GS/s</td>
</tr>
<tr>
<td></td>
<td>-SR1</td>
<td>Interleaved</td>
<td>0 - 1.4 GHz</td>
<td>2 GS/s</td>
</tr>
<tr>
<td></td>
<td>-SR2</td>
<td>Interleaved</td>
<td>0 - 1.4 GHz</td>
<td>3.2 GS/s</td>
</tr>
</tbody>
</table>

**TIP** For best measurement fidelity, you should ensure that the signal center frequency + (analog bandwidth/2) does not cross the Nyquist frequency.
Interleaved mode can be enabled by opening the Input > Extensions... window from the menu bar. Then select the Enable Interleaving option, changes are applied immediately.

External Clock

The sampling rate can be tuned thanks to the external clock. This clock must be continuously present if the mode is selected otherwise an error will occur. The range of clock input frequency is model dependent, as shown in the table below:

<table>
<thead>
<tr>
<th>Models</th>
<th>Option</th>
<th>Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9703B</td>
<td>-SR1</td>
<td>1.8 to 2 GHz</td>
</tr>
<tr>
<td></td>
<td>-SR2</td>
<td>1.8 to 3.2 GHz</td>
</tr>
</tbody>
</table>

To use this option, first connect an external clock signal in the accepted range to the CLK IN connector on the digitizer front panel. Please, refer to the your digitizer datasheet for external clock specification.

Then open the Input > Extensions..., window from the menu bar. Select the Enable external clock option, and double click the External clock frequency value to bring up the editing window. You may then set the value of the external clock frequency being applied. As shown below:
M9703B Hardware Extension of 89600 VSA Software
Measurement Setup Parameters

This section provides measurement and parameter setup information which are specific to the 89600 VSA software when used along with the M9703B High Speed Digitizer. This information can help you to properly setup the VSA in this hardware configuration to make measurements using your digitizer.

Measurement Setup Parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment / Calibration</td>
<td>Preset</td>
</tr>
<tr>
<td>Channels</td>
<td>Range</td>
</tr>
<tr>
<td>Connection</td>
<td>Recording</td>
</tr>
<tr>
<td>Coupling</td>
<td>Setup Save/Recall</td>
</tr>
<tr>
<td>Center Frequency Range</td>
<td>Span</td>
</tr>
<tr>
<td>Frequency Counter</td>
<td>Trigger Holdoff</td>
</tr>
<tr>
<td>Hardware</td>
<td>Triggering</td>
</tr>
<tr>
<td>Overlap</td>
<td></td>
</tr>
</tbody>
</table>

Alignment/Calibration: Whenever the digitizer configuration is changed, an internal calibration is required if this new configuration has not yet been calibrated in the current session. A manual calibration can be performed at any time from the menu Utilities > Calibration.

**NOTE**

The 89600 VSA software uses asynchronous polling to check the calibration status of connected instruments. A **CAL: Needed** message may appear after a configuration change. This message disappears after performing a new calibration.

**TIP**

If a signal is present on the input of the digitizer, it may affect the internal calibration. If the input signal is preventing a successful internal calibration, a pop-up warning message is raised. In such a case, please perform a manual calibration with the signal turned off or disconnected to allow a successful internal calibration.
Measurement Setup Parameters

Channels: From the menu **Input > Channels**, available options are:
- 1 channel through \( n \) channels (\( n \) depends on your digitizer model),
- I+jQ (IN1+jIN2)
- Dual I+jQ (IN1+jIN2, IN3+jIN4)
- Triple I+jQ (IN1+jIN2, IN3+jIN4, IN5+jIN6)
- Quad I+jQ (IN1+jIN2, IN3+jIN4, IN5+jIN6, IN7+jIN8)

The custom channel configuration can be used to specify a non-standard mapping between the digitizer input and the VSA logical channel. The default mapping of the logicals channel to the digitizer inputs is:

<table>
<thead>
<tr>
<th>Logical Channel</th>
<th>Digitizer Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IN1</td>
</tr>
<tr>
<td>2</td>
<td>IN3</td>
</tr>
<tr>
<td>3</td>
<td>IN5</td>
</tr>
<tr>
<td>4</td>
<td>IN7</td>
</tr>
<tr>
<td>5</td>
<td>IN2</td>
</tr>
<tr>
<td>6</td>
<td>IN4</td>
</tr>
<tr>
<td>7</td>
<td>IN6</td>
</tr>
<tr>
<td>8</td>
<td>IN8</td>
</tr>
</tbody>
</table>

From the menu **Input > Analog** the following parameters can be set:

- **Range**: The digitizer offers several full scale range. Please refer to product datasheet for details.
- **Coupling**: DC
- **Input Impedance**: 50 Ohms.
- **Connection**: Single Ended.

The frequency measurement parameters can be configured from the **MeasSetup > Frequency** menu.

- **Frequency**: The default setup is shown below as example.

<table>
<thead>
<tr>
<th>Model Option</th>
<th>Band</th>
<th>Center</th>
<th>Span</th>
<th>Start</th>
<th>Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>-SR1</td>
<td>0 to 390.625 MHz</td>
<td>195.3125 MHz</td>
<td>390.625 MHz</td>
<td>0</td>
<td>390.625 MHz</td>
</tr>
<tr>
<td>-SR2</td>
<td>0 to 625 MHz</td>
<td>312.5 MHz</td>
<td>625 MHz</td>
<td>0</td>
<td>625 MHz</td>
</tr>
</tbody>
</table>

- **Span**: The maximum span is dependent upon both the sampling rate and the analog bandwidth of the particular digitizer model.
<table>
<thead>
<tr>
<th>Model Option</th>
<th>Maximum Span (Analysis Bandwidth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-SR1 -F05</td>
<td>390.625MHz (650 MHz in interleaved mode)</td>
</tr>
<tr>
<td>-SR1 -F10</td>
<td>390.625MHz (781.25 MHz in interleaved mode)</td>
</tr>
<tr>
<td>-SR2 -F05</td>
<td>625 MHz (650 MHz in interleaved mode)</td>
</tr>
<tr>
<td>-SR2 -F10</td>
<td>625 MHz (1.25 GHz in interleaved mode)</td>
</tr>
</tbody>
</table>

The maximum span is obtained with following formula:

\[ \text{Maximum Span} = \min\left( \frac{\text{Sample Rate}}{2.56}, \text{Analog Bandwidth} \right) \]

The analog bandwidth depends on the digitizer, the option (-Fxx) and interleaving mode (see product datasheet for details).

Maximum span depends also on the digitizer sampling rate.

For details, please refer to VSA software help (http://rfmw.em.keysight.com/wireless/helpfiles/89600B/WebHelp/89600.htm).

**TIP**

For digitizer with -DDC option, by default, the down-conversion is done by the hardware when span: < 320 MHz (-SR2) or for span < 180 MHz (-SR1).

If the specified frequency differs from the instantaneous analysis bandwidth (IBW) supported by the hardware digital down-converter, the down-conversion is done by the hardware at the closest highest IBW and remaining processing is managed by VSA (Please refer to your digitizer user manual or datasheet for the list of IBW supported by the hardware).

**TIP**

For digitizer with -LDC option, by default, the down-conversion is done by the hardware when span: < 80 MHz (-SR2) or for span < 50 MHz (-SR1).

If the specified frequency differs from the instantaneous analysis bandwidth (IBW) supported by the hardware digital down-converter, the down-conversion is done by the hardware at the closest highest IBW and remaining processing is managed by VSA (Please refer to your digitizer user manual or datasheet for the list of IBW supported by the hardware).

**ResBW:** Standard VSA parameter. Can be configured by user.

**Main Time Length:** Standard VSA parameter. Can be configured by user. Maximum value depends on the memory option of your module.
**Center Frequency Range:** The range depends on which model you are using:

<table>
<thead>
<tr>
<th>Model</th>
<th>Option</th>
<th>Mode</th>
<th>Center Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9703B</td>
<td>-SR1</td>
<td>Normal (non-interleaved)</td>
<td>0 - 1 GHz</td>
</tr>
<tr>
<td></td>
<td>-SR2</td>
<td>Normal (non-interleaved)</td>
<td>0 - 1.6 GHz</td>
</tr>
<tr>
<td></td>
<td>-SR1</td>
<td>Interleaved</td>
<td>0 - 1.4 GHz</td>
</tr>
<tr>
<td></td>
<td>-SR2</td>
<td>Interleaved</td>
<td>0 - 1.4 GHz</td>
</tr>
</tbody>
</table>

**Frequency Counter:** Not available.

Trigger settings can be accessed via the Input > Trigger menu:

<table>
<thead>
<tr>
<th>Trigger Type</th>
<th>Level</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td>-5 V to +5 V</td>
<td>2V</td>
</tr>
<tr>
<td>Channel</td>
<td>must be set within Offset ± FSR</td>
<td>-</td>
</tr>
<tr>
<td>Magnitude²</td>
<td>0 to 1.414 V</td>
<td>10 mV</td>
</tr>
</tbody>
</table>

The following trigger parameters are available:
- **Style:** Free Run¹, External, Magnitude², and Channel
- **Slope:** available for External, Magnitude and Channel
- **Level:** available for External, Magnitude and Channel
- **Delay:** available for External, Magnitude and Channel
- **Trigger Holdoff:** not supported by the digitizer.

**Soft Front Panel Control:** The 'Disconnect' feature can be used to pause the VSA and release its control of the digitizer. Then the digitizer can be used independently from the VSA, for example, using the MD2 SFP application. Independent control must be released before resuming VSA measurements. When returning to the VSA software and starting or resuming a measurement, the VSA restores the digitizer state that was set before being disconnected.

**Hardware:** Set up an Analyzer Configuration with the digitizer as the Logical Instrument, as described in 89600 VSA Software Configuration (page 7).

¹On **Segmented Capture** mode the free run triggered is not supported. (Segmented Capture feature may be accessed via the MeasSetup > Time menu)
²-DDC option is required for Magnitude triggering.
Overlap: The digitizer does not support overlap processing. However, overlap processing is available during recording playback.

Recording: The VSA application enables time data recording from the digitizer to the PC’s disk drive. The length of waveform recording time is limited by the memory available on the digitizer.

Setup Save/Recall: The digitizer state is not saved when the VSA application is closed. When a setup is recalled into the VSA, the digitizer state is set appropriately based on the recalled VSA setup.
Multi-Module Measurements

The M9703B supports multi-module synchronization.
To synchronize two or more M9703Bs, you should create a configuration with several instruments:

From the menu, go to Utilities > Hardware > Configurations, and click on Add New Configuration button ( ). The ‘New Hardware Configuration’ dialog opens.

a. Select your Keysight MD2 digitizers from the list of ‘Possible Logical Instrument’ and drag it or click on the button to add it to the ‘Configuration’ box.

b. Select Keysight MD2 digitizers from the list of ‘Possible Logical Instrument’ and drag it or click on the button to add it to the ‘Configuration’ box. Repeat this step for each digitizer to be synchronized.

![Image of New Hardware Configuration dialog]

a. In the box below, select the units to be synchronized using the drop-down list: a digitizer per Keysight MD2 Digitizer configuration previously selected.
b. Select the name for this analyzer configuration.
c. Click OK to close the ‘New Hardware Configuration’ dialog.
d. Before closing the ‘Hardware Configurations’ dialog, use the Current Analyzer Configuration drop-down to select the newly created Configuration as the current item.
Then the multi-module mode should be enabled from the menu bar > Input window > Extensions tab. Then select the Multiboard synchronization option. This operation is only required at the master (instrument 1).

![Multiboard synchronization](image)

e. Define the channels to acquire. Menu path select Input > Channel > Custom. Use the Channel Configuration GUI to reconfigure the channel mapping from the physical hardware input ports to the VSA measurement channel inputs (See picture below).

**TIP** By default, only the channel of the first digitizer (master) is mapped in output. Thus you have to add all the slave(s) channels you want to analyze.

f. The multi-module synchronization will be effective after the next calibration.
The frequency reference is different with a single digitizer and in multi-module mode. The frequency reference can be accessed from Utilities > Frequency reference
- Using a single digitizer: the frequency reference is the internal reference of the instrument.
- Using Multi-modules: the frequency reference is the AXIe chassis reference.