

# Keysight Technologies M9710A

AXIe High-Speed Digitizer/DAQ

4 channels, 10-bit, up to 10 GS/s,  
DC up to 2.5 GHz bandwidth



**AXIe**

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## Overview



## Introduction

The M9710A is a 10-bit AXIe high-speed digitizer providing four synchronous channels and a sampling rate up to 10 GS/s across a wide 2.5 GHz bandwidth, making it ideal for multichannel applications in advanced physics experiments, and aerospace & defense.

## Product Description

The M9710A is a single-slot 10-bit high-speed digitizer, capturing signals from DC up to 2.5 GHz at 5 GS/s or 10 GS/s. It provides excellent measurement accuracy and high dynamic range across four phase-coherent channels within a single card. Optimized response enables few hundred picoseconds pulse analysis. An interleaving option allows two 5 GS/s channels to be combined to acquire at 10 GS/s in 2-channel mode, keeping excellent measurement fidelity.

The M9710A also provides up to 8 GB of DDR3 acquisition memory and real-time data processing capability with Xilinx FPGAs.

The M9710A high-speed digitizer can also be combined with the [Keysight 89600 VSA Software](#) and [Keysight U1092A Multichannel Acquisition Software](#) for advanced multichannel signal analysis.

## Applications

- Advanced research experiments
- Hydrodynamics experiments
- Multichannel experiments

## Product Features

- 10-bit ADC resolution
- 4 channels (2 when interleaving with -INT option)
- Up to 10 GS/s sampling rate (with -INT option)
- DC up to 2.5 GHz input frequency range
- Up to 8 GB (1.6 GSamples/ch) of DDR3 acquisition memory
- 50  $\Omega$  input impedance, DC coupled
- Selectable 250 mV or 1 V full scale range (FSR)
- $\pm$ FSR input voltage offset range
- 15 ps RMS trigger time interpolator (TTI) precision
- Low noise density and low distortion
- Optimized frequency response flatness
- Excellent and flat SFDR over a large analysis bandwidth (*> 56 dBc typical*)
- Support for Windows and Linux

## Uncompromising Values

- Fast AXIe 10-bit digitizer
- Capture wide bandwidth signals
- High dynamic range acquisition for better measurement fidelity
- Accurate measurement
- Large on-board memory
- Very high digitized data throughput
- Software support including multiple programmable interfaces for easy integration into existing environments
- Reduced development time, fast time to market

# Hardware Platform

## Hardware Overview

The M9710A is a modular AXIe 10-bit digitizer offering scalable features depending on application requirements. The standard configuration implements 4 synchronous channels of DC to 2.5 GHz instantaneous analog bandwidth (input frequency range), and acquiring data at 5 GS/s. An interleave option (-INT) also allows two channels to be combined and reach 10 GS/s in 2-channel acquisition mode.

## Block Diagram

The M9710A incorporates exclusive proprietary integrated circuits developed by Keysight.

In particular, it has a low noise and low distortion signal conditioning amplifier to drive interleaved ADCs, and specific clock distribution to minimize clock jitter and spurious signals.

Moreover, optimized frequency response flatness provides enhanced measurement accuracy over a wide bandwidth.

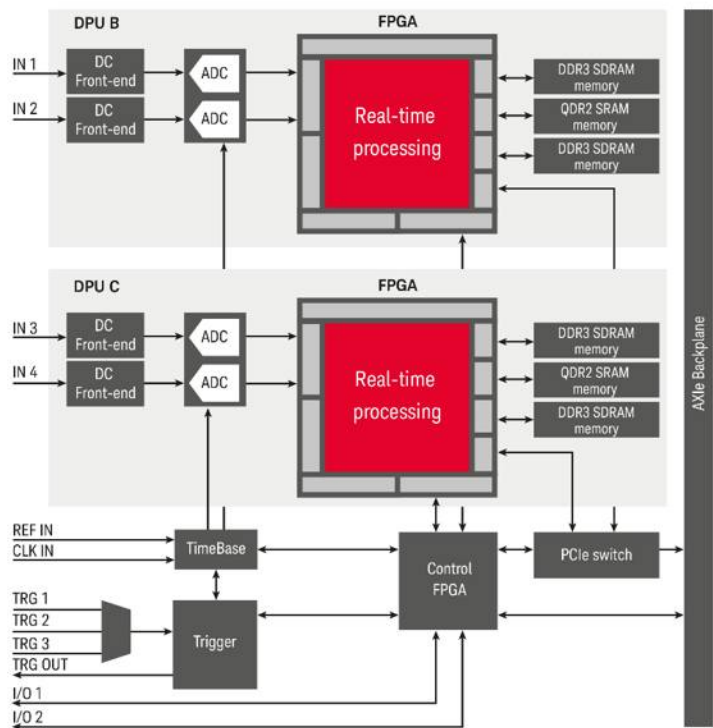
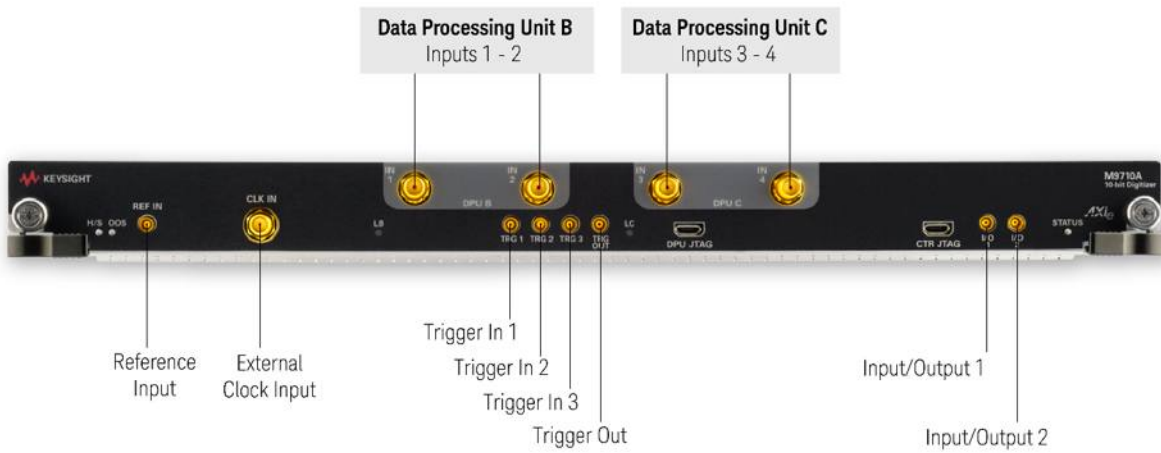


Figure 1: Simplified block diagram of the M9710A AXIe Digitizer.

## Data Processing

The M9710A includes Xilinx Virtex-6 FPGAs dedicated to data processing. The data processing units (DPU) implement full digitizer functionality firmware, allowing digitization of the signal, storage of the resulting data in the onboard memory and transfer through the PCIe connection to the AXIe backplane bus.

## Front View



## Top View



## Multichannel Data Acquisition Systems

The M9710A occupies a single slot of AXIe chassis. The architecture is modular and extensible, to provide a fully operational multichannel system in a compact format.

The examples below show some of the possible configurations:

- Two M9710A digitizers in the M9502A 2-slot AXIe chassis delivers an 8-channel 10-bit system
- Five M9710A digitizers in the M9505A 5-slot AXIe chassis delivers a 20-channel 10-bit system
- Thirteen M9710A digitizers in the M9514A 14-slot AXIe chassis delivers a 52-channel 10-bit system



Figure 2. Two M9710A digitizers installed in the M9502A 2-slot chassis, forming an 8-ch 10-bit acquisition system.



Figure 3. Five M9710A digitizers installed in the M9505A 5-slot chassis, forming a 20-ch 10-bit acquisition system.

## Software Platform

### I/O Libraries

**Keysight IO Libraries Suite** offers fast and easy access to the M9710A digitizer using a standardized interface and ensuring compatibility and upgradability of the software applications.

The Keysight IO Libraries Suite displays all the modules in your system. From here you can view information about the installed software or launch the modules' soft front panel directly from Keysight Connection Expert (KCE). In addition, KCE offers an easy way to find the correct driver for your instrument.

### Drivers

The module comes with the IviDigitizer class compliant Keysight MD2 IVI-COM and IVI-C drivers that work in the most popular development environments including Visual C/C++, C#, VB.NET, MATLAB, and LabVIEW. Linux is also supported using the IVI-C driver.

### Easy Software Integration

To help you get started and complete complex tasks quickly, the M9710A high-speed DAQ is supplied with a comprehensive portfolio of module drivers, documentation, examples, and software tools to help you quickly develop test systems with your software platform of choice.

### Compliance

The M9710A digitizer is compliant with AXIe and AdvancedTCA (ATCA) formats. Designed to benefit from fast data interfaces, the product can be integrated into AXIe or ATCA chassis slots. Based on ATCA, the AXIe standard implements extensions for instrumentation and test, and uses clever techniques to add powerful timing features.



## Software Applications

In addition, the M9710A includes the Keysight MD2 soft front panel (SFP) graphical interface. This software application can be used to control, verify the functionality and explore the capabilities of the Keysight modular high-speed digitizers.

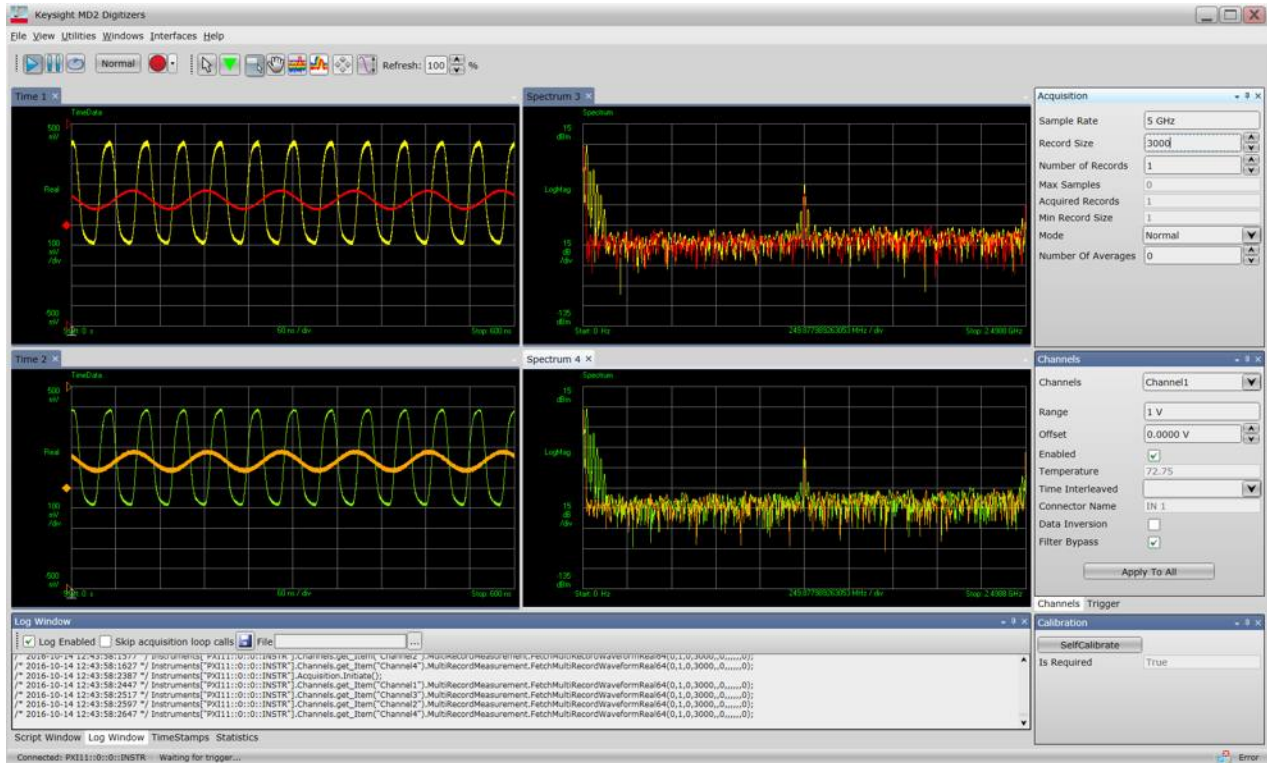


Figure 4. MD2 software front panel (SFP) interface.

The M9710A is also supported by the [Keysight U1092A Multichannel Acquisition Software](#). This provides easy control and monitoring of advanced data acquisition systems with many channels, and is ideal for single-shot/event applications.

For advanced measurement analysis, the M9710A AXIe high-speed digitizer can be combined with [Keysight's 89600 VSA Software](#), the industry's standard for signal analysis and demodulation. Thanks to the high data throughput of its PCIe backplane bus, the M9710A allows a much faster connection to the 89600 VSA software, compared to traditional instruments.

## Firmware Options

The M9710A high-speed digitizer provides two firmware options:

- DGT: Digitizer firmware
- INT: Interleaved channel sampling functionality

### DGT Digitizer Firmware

This is the standard digitizer firmware which:

- Allows standard data acquisition, including: digitizer initialization, setting of acquisition and clocking modes, management of channel triggering for best synchronization, storing data in internal memory and/or transferring data through the backplane bus.
- Implements multi-record acquisition functionality.
- Delivers fixed internal clocking frequency with internal or external reference, and external clock.
- Offers programmable binary decimation to lower the sample rate by a factor of  $2^n$ , where n is an integer in the range of 1 to 5. i.e. Enabling decimated sampling rates at 2.5 GS/s, 1.25 GS/s, 625 MS/s, 312.5 MS/s and 156.25 MS/s.

The -DGT firmware also includes frequency equalization capabilities. Two equalization modes are available:

- "Smooth roll off" mode minimizes overshoot and ringing.
- "Sharp roll off" mode optimizes frequency response flatness.

Lastly, the -DGT firmware also implements the trigger time interpolator (TTI), a high precision integrated time to digital converter that guarantees time measurement accuracy.

### INT Interleaved Channel Sampling Functionality

This interleave option allows two channels to be combined to reach 10 GS/s in one channel acquisition mode (one channel per DPU).

## Technical Specifications and Characteristics

### Analog Input (IN1 to IN4 SMA Connectors)

|   |   |                         |
|---|---|-------------------------|
| Number of channels                              | 4 (without -INT option), 4 or 2 (with -INT option)  |                         |
| Impedance                                       | 50 $\Omega$ $\pm$ 4 %                               |                         |
| Coupling  | DC  |                         |
| Full scale ranges (FSR)                         | 250 mV and 1 V                                      |                         |
| Maximum input voltage                           | 250 mV FSR: $\pm$ 0.5 Vpk<br>1 V FSR: $\pm$ 1.5 Vpk |                         |
| Input voltage offset                            | $\pm$ FSR   |                         |
| Input frequency range (-3 dB bandwidth)         | -F25  | DC to 2.5 GHz (typical) |
| Bandwidth limit filters                         | 2 GHz (nominal)                                     |                         |
| Channel-to-channel skew <sup>1</sup>            | $\pm$ 30 ps (nominal)                               |                         |
| Effective number of bits (ENOB) <sup>2</sup>    | @ 100 MHz   | 7.0 (7.3 typical)       |
|   | @ 648 MHz   | 7.0 (7.2 typical)       |
|   | @ 924 MHz   | 6.9 (7.2 typical)       |
|   | @ 1.9 GHz   | 6.6 (6.9 typical)       |
| Signal to noise ratio (SNR) <sup>2</sup>        | @ 100 MHz   | 44 dB (46 dB typical)   |
|   | @ 648 MHz   | 44 dB (45 dB typical)   |
|   | @ 924 MHz   | 44 dB (45 dB typical)   |
|   | @ 1.9 GHz   | 41 dB (44 dB typical)   |
| Spurious free dynamic range (SFDR) <sup>2</sup> | @ 100 MHz   | 58 dBc (typical)        |
|   | @ 648 MHz   | 57 dBc (typical)        |
|   | @ 924 MHz   | 57 dBc (typical)        |
|   | @ 1.9 GHz   | 56 dBc (typical)        |
| Total harmonic distortion (THD) <sup>2</sup>    | @ 100 MHz   | -61 dB (typical)        |
|   | @ 648 MHz   | -57 dB (typical)        |
|   | @ 924 MHz   | -57 dB (typical)        |
|   | @ 1.9 GHz   | -55 dB (typical)        |

1. The channel-to-channel skew is defined as the magnitude of time delay difference between the four digitized channel inputs, granted the same signal is provided to each channel at the exact same time. The measurement results from a sine-fit method of a 100 k samples using sinusoid signal whose frequency is swept over 50 MHz to 2 GHz, and is an average of 5 measurements.
2. Measured for a -1 dBFS input signal in internal clock mode at 5.0 GS/s (-SR4).

| <b>Digital Conversion</b>                             |                                      |  |
|---|--------------------------------------|--|
| Resolution  |                                      | 10 bits  |
| Acquisition memory                                    | -M05                                 | 512 MB (100 MSamples/ch); standard   |
|   | -M80                                 | 8 GB (1.6 GSamples/ch); option   |
| Sample clock sources                                  |                                      | Internal or external   |
| Internal clock source                                 |                                      | Internal, external reference, or backplane reference   |
|   | Maximum real-time sampling rate -SR4 | 5 GS/s per channel   |
|   | Sampling jitter                      | 80 fs (nominal) <sup>1</sup>   |
|   | Clock accuracy                       | ±1.5 ppm   |
| External clock source (CLK IN SMA connector)          |                                      |  |
|   | Impedance                            | 50 Ω (nominal)   |
|   | Frequency <sup>2</sup>               | 5 GHz  |
|   | Signal level                         | +5 dBm to +15 dBm (nominal), 0 V DC  |
|   | Coupling                             | AC   |
| External reference clock (REF IN MCX connector)       |                                      |  |
|   | Impedance                            | 50 Ω (nominal)   |
|   | Frequency range                      | 100 MHz ±1 kHz (nominal)   |
|   | Signal level                         | -3 dBm to +3 dBm (nominal)   |
|   | Coupling                             | AC   |
| Acquisition modes                                     |                                      | Single record<br>Sequence (multi-record) <sup>3</sup>  |
| <b>Trigger</b>  |                                      |  |
| Trigger modes   |                                      | Positive or negative edge  |
| Trigger sources                                       |                                      | External, Software, Channel, AXIe Synchronization  |
| Channel trigger frequency range                       |                                      | DC to 2.6 GHz (nominal)  |
| External trigger (TRG 1, TRG 2, TRG 3 MCX connectors) |                                      |  |
|   | Coupling                             | DC   |
|   | Impedance                            | 50 Ω (nominal)   |
|   | Level range                          | ± 5 V (nominal)  |
|   | Amplitude                            | 0.5 V pk-pk (nominal)  |
|   | Frequency range                      | DC to 2 GHz (nominal)  |
| Maximum time stamp duration                           |                                      | 20 days  |
| Trigger time interpolator resolution                  |                                      | 8 ps (nominal)   |
| Trigger time interpolator precision                   |                                      | 15 ps RMS (nominal)  |
| Rearm time (deadtime)                                 |                                      | 800 ns (nominal)   |
| Trigger out (TRG OUT MCX connector)                   |                                      | 1 (programmable), 50 Ω source  |
|   | Signal level <sup>4</sup>            | 0.8 V <sub>pp</sub> ±2.5 V <sub>offset</sub> (nominal) into high impedance   |
| <b>Control IO (I/O 1 and I/O 2 MCX connectors)</b>    |                                      |  |
| Output functions                                      |                                      | Acquisition active<br>Trigger is armed<br>Trigger accept resynchronization<br>100 MHz reference clock divided by 2 (I/O 1 only)<br>Sampling clock divided by 128 (I/O 1 only)<br>Low level<br>High level |
| Input functions                                       |                                      | Arm Trigger<br>Trigger enable  |

1. Jitter figure based on phase noise integration from 12 kHz to 10 MHz in internal reference.
2. The sampling rate corresponds to the external clock frequency in non-interleaved mode. In interleaved mode (only available with the -INT option), the sampling rate corresponds to twice the external clock frequency.
3. Up to 131,072 records. Record maximum length = memory size/number of channels.
4. At 10 MHz on a 50 Ω load.

## Environmental and Physical<sup>1</sup>

|                   |               |                                       |
|-------------------|---------------|---------------------------------------|
| Temperature range | Operating     | 0 to +45°C (sea-level to 10,000 feet) |
|                   | Non-operating | -40 to +70°C                          |

|          |                                  |
|----------|----------------------------------|
| Altitude | Up to 10,000 feet (3,048 meters) |
|----------|----------------------------------|

|     |  |
|-----|--|
| EMC | Complies with European EMC Directive <ul style="list-style-type: none"><li>- IEC/EN 61326-1</li><li>- CISPR Pub 11 Group 1, class A</li><li>- AS/NZS CISPR 11</li><li>- ICES/NMB-001</li></ul> This ISM device complies with Canadian ICES-001.<br>Cet appareil ISM est conforme à la norme NMB-001 du Canada. |
|-----|--|

## Power Dissipation

|                 |                 |
|-----------------|-----------------|
| -48 V           | Total Power     |
| 3.7 A (typical) | 180 W (nominal) |

## Mechanical Characteristics

|             |             |
|-------------|-------------|
| Form factor | 1 slot AXIe |
|-------------|-------------|

|      |                                 |
|------|---------------------------------|
| Size | 30 mm W x 322.2 mm H x 280 mm D |
|------|---------------------------------|

|        |                     |
|--------|---------------------|
| Weight | 3.25 kg (7.165 lbs) |
|--------|---------------------|

## System Requirements

| Topic                | Windows  | Linux   |
|----------------------|--|---|
| Operating systems    | Windows 10 (32-bit and 64-bit), All versions<br>Windows 8.1 (32-bit and 64-bit), All versions<br>Windows 7 SP1 (32-bit and 64-bit)   | Linux Kernel 2.6 or higher (32 or 64-bit), Debian 7.0, CentOS 6 |
| Processor speed      | 1 GHz 32-bit (x86), 1 GHz 64-bit (x64),<br>no support for Itanium 64   | As per the minimum requirements of<br>the chosen distribution   |
| Available memory     | 1 GB minimum <sup>2</sup>  | As per the minimum requirements of<br>the chosen distribution   |
| Available disk space | 2.5 GB available hard disk space, includes: <sup>3</sup> <ul style="list-style-type: none"><li>- 1 GB for Keysight IO Libraries Suite</li><li>- 1 GB for Microsoft .NET Framework</li></ul>                                      | 100 MB  |
| Display              | Minimum of 1024 x 768, 96 or 120 DPI   | No display required   |
| Browser              | Use a supported version of Internet Explorer; see<br><a href="https://support.microsoft.com/en-gb/help/17454/lifecycle-faq-internet-explorer">https://support.microsoft.com/en-gb/help/17454/lifecycle-faq-internet-explorer</a> | Distribution supplied browser                                   |

1. Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.
2. On older host computers with minimum RAM, installation can take a long time when installing the IO Libraries Suite and the .NET Framework.
3. Because of the installation procedure, less disk space may be required for operation than is required for installation. The amount of space listed above is required for installation. The .NET Framework Runtime Components are installed by default with most Windows installations, so you may not need this amount of available disk space.

## Supplemental Characteristics

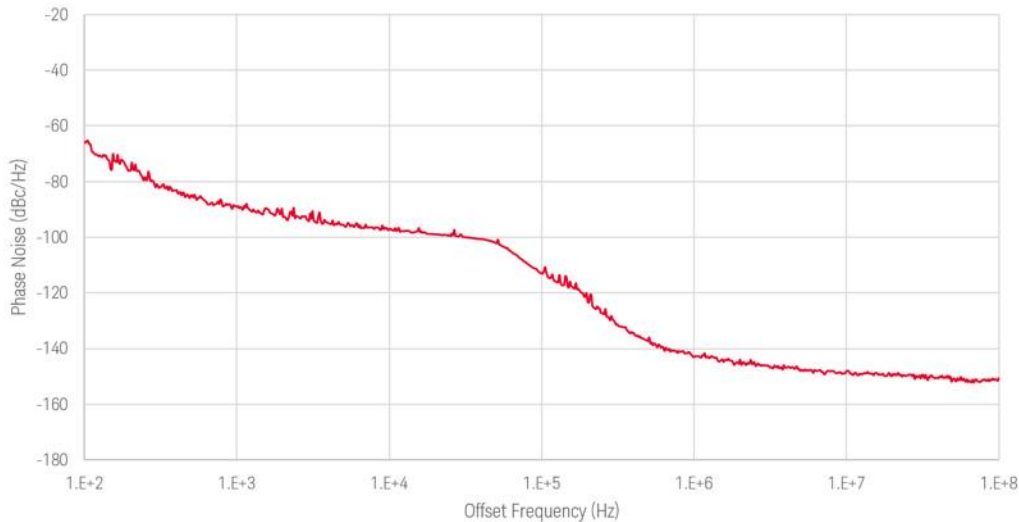


Figure 5. Measured sampling clock phase noise with 5 GHz internal reference clock.

## Definitions for Specifications

**Specifications** describe the warranted performance of calibrated instruments that have been stored for a minimum of 2 hours within the operating temperature range of 0 to 45°C, unless otherwise stated, and after a 45 minute warm-up period. Data represented in this document are specifications unless otherwise noted.

**Characteristics** describe product performance that is useful in the application of the product. Characteristics are often referred to as Typical or Nominal values.

- **Typical** describes characteristic performance, which 80% of instruments will meet when operated over a 20 to 30°C temperature range. Typical performance is not warranted.
- **Nominal** describes representative performance that is useful in the application of the product when operated over a 20 to 30°C temperature range. Nominal performance is not warranted.

*Note: All graphs contain measured data from several units at room temperature unless otherwise noted.*

## Calibration Intervals

The M9710A is factory calibrated and shipped with a calibration certificate.

Calibration is recommended every year in order to verify product performance.

## Configuration and Ordering Information

### Software Information

|   |  |
|---|--|
| <b>Chassis slot compatibility: AXIe, ATCA</b> |  |
| Supported operating systems                   | See system requirements  |
| Keysight IO libraries                         | Includes: VISA libraries, Keysight Connection Expert, IO Monitor |

### Related Products

| Model      | Description  |
|------------|--|
| M9502A     | 2-slot AXIe Chassis                                    |
| M9505A     | 5-slot AXIe Chassis                                    |
| M9514A     | 14-slot AXIe Chassis                                   |
| M9048A     | PCIe Desktop Adapter, PCIe Gen 2 (x8)                  |
| Y1202A     | PCIe Cable, 2.0 m Long, PCIe Gen 3 (x8)                |
| M9537A     | AXIe High Performance Embedded Controller              |
| U1092A-S0x | Keysight AcqirisMAQS Multichannel Acquisition Software |
| M9703B     | AXIe 12-bit Digitizer, 8 Channels                      |
| M9709A     | AXIe 8-bit Digitizer, 32 Channels                      |

### Accessories

| Model      | Description                                |
|------------|--|
| U5300A-104 | MCX Male to SMA Male Cable, 1 m Long       |
| U5300A-105 | MCX Male to BNC Male Cable, 1 m Long       |
| U5300A-110 | XA110 SMA Input Overvoltage Protection Kit |

### Typical System Configuration

| Model  | Description                             |
|--------|---|
| M9710A | AXIe 1-bit Digitizer, 4 Channels        |
| M9505A | 5-slot AXIe Chassis                     |
| M9048A | PCIe Desktop Adapter, PCIe Gen 2 (x8)   |
| Y1202A | PCIe Cable, 2.0 m Long, PCIe Gen 3 (x8) |

## Ordering Information

| Model  | Description   |
|--------|---|
| M9710A | AXIe High-Speed Digitizer/DAQ, 10-bit, 10 GS/s, DC to 2.5 GHz Bandwidth                                       |
|        | Includes: Software, example programs and product information on CD<br>MCX male to BNC male cable, 1 m (qty 2) |

### Configurable Options

#### Sampling Rate

✓ M9710A-SR4 5 GS/s sampling rate version

#### Bandwidth

✓ M9710A-F25 DC to 2.5 GHz bandwidth

#### Memory

✓ M9710A-M05 512 MB (100 MSample/ch) acquisition memory

M9710A-M80 8 GB (1.6 GSamples/ch) acquisition memory

#### Firmware

✓ M9710A-DGT Digitizer firmware

M9710A-INT Interleaved channel sampling functionality

### Calibration

M9710A-UK6 Commercial Calibration Certificate with Test Data

M9710A-A6J ANSI Z540-1-1994 Calibration

M9710A-1A7 Calibration + Uncertainties + Guardbanding (not Accredited)

### Recalibration Service Plans

R-50C-011-3 Calibration Assurance Plan - Return to Keysight - 3 years

R-50C-011-5 Calibration Assurance Plan - Return to Keysight - 5 years

✓ These options represent the standard configuration.



## Instrument Upgrades

| Description                            | Upgrade number | Additional information                |
|--|----------------|---------------------------------------|
| Memory upgrade from 512 MB to 8 GB     | M9710AU-M80    | Customer installable license key      |
| Upgrade to enable Interleaved sampling | M9710AU-INT    | <b>Return to Keysight for upgrade</b> |

Learn more at: [www.keysight.com](http://www.keysight.com)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

