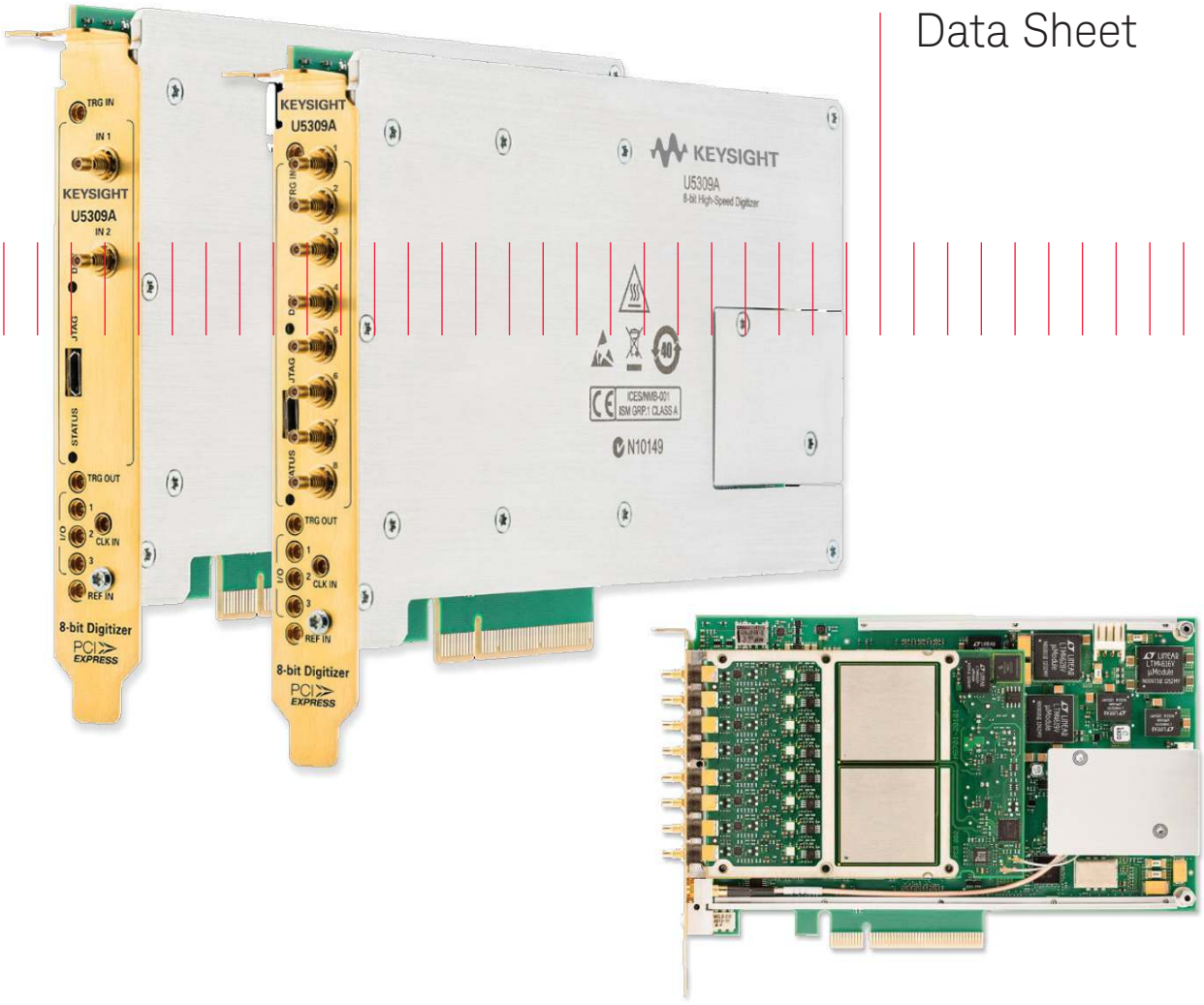
Keysight U5309A

PCIe High-Speed Digitizer with On-Board Processing

2 or 8 channels, 8-bit, up to 2 GS/s, DC to 500 MHz bandwidth

With custom firmware support, suited for embedded OEM applications

Data Sheet



KEYSIGHT TECHNOLOGIES

Overview

Introduction

The Keysight Technologies, Inc. U5309A is a fast 8-bit multi-channel PCIe® digitizer with programmable on-board processing, making it ideal for commercial, industrial, and aerospace & defense. The U5309A is particularly suited for OEM applications with its fast PCI Express 2.0 eight lanes connection.

Product Description

The U5309A occupies a single full-length PCIe slot of the host controller. Featuring two or eight high-speed channels with an analog bandwidth of DC to 500 MHz, and a large DDR3 memory for long acquisition time, the U5309A also includes a Xilinx Virtex-6 FPGA allowing implementation of custom real-time processing algorithms using the available FPGA development kit.

The standard digitizer firmware included allows signal acquisition to the on-board memory and subsequent transfer to the host PC via the PCIe bus.

For information on other firmware options please contact: digitizers@keysight.com

Example Applications

- Emission monitoring
- Analytical time-of-flight
- Laser ranging
- Ultrasonic imaging
- Pulsed radar
- Advanced research experiments

Product Features

- Up to 8 channels with 8-bit resolution
- Up to 2 GS/s sampling rate
- DC to 500 MHz analog bandwidth
- 50 Ω input impedance
- Selectable 250 mV to 5 V input full scale range (FSR)
- ±0.5x FSRmax input voltage offset range
- Up to 2 GB DDR3 on-board memory
- On-board data processing unit using a Xilinx Virtex-6 FPGA
- Support for loading custom real-time processing
- PCI Express 2.0 eight lanes (x8)
- IVI-C and IVI-COM drivers available
- Support for Windows and Linux

Uncompromising Values

- Eight-channel (dual-channel option available)
- Fast PCIe 8-bit digitizer with on-board processing
- Capture wide bandwidth signals
- Large on-board memory
- Accurate measurements
- Custom firmware implementation
- Capable of fast switching between multiple firmware programs
- Very high digitized data throughput
- Software support including multiple programmable interfaces for easy integration into existing environments
- Reduced development time, fast time to market

Easy to Design-In, Deploy, and Upgrade

Hardware Platform

Product overview

Benefitting from the very high data transfer rates of the PCIe 2.0 interface, and occupying a single x8 slot in a host PC, the U5309A offers high performance in a small footprint, making it an ideal platform for many commercial, industrial and aerospace & defense embedded systems.

On-board real-time processing

At the heart of the U5309A is a data processing unit (DPU) based on the powerful Xilinx Virtex-6 FPGA. This DPU is responsible for controlling the module functionality, data flow and real-time signal processing. This powerful feature allows data reduction and storage to be carried out at the digitizer level, minimizing transfer volumes and speeding-up analysis.

U5340A - FPGA Development Kit [1]

The FPGA development kit is primarily intended to open the design of the FPGA to specific user requirements by providing a development framework that interfaces to the underlying hardware.

The FPGA development kit combines capabilities to:

- Achieve multi GS/s real-time processing on a full digitizerframework by leveraging the full density and speed of the FPGA
- Shorten time-to-market with turn-key, easy-to-use development flow and debug

There are several rationales to consider developing custom signal processing such as:

- Data throughput optimization
- Real time processing
- Implementation of custom IP and OEM technical know-how
- Re-usability and upgradability

The FPGA development kit includes everything you need: source code, ready-to-use base design, a set of cores to easily interface to the underlying hardware, a test-bench environment for design and simulation, and automated building script.

Please contact Keysight for standard firmware options.

1. This standalone software package must be acquired separately.

Block Diagram 2 channels

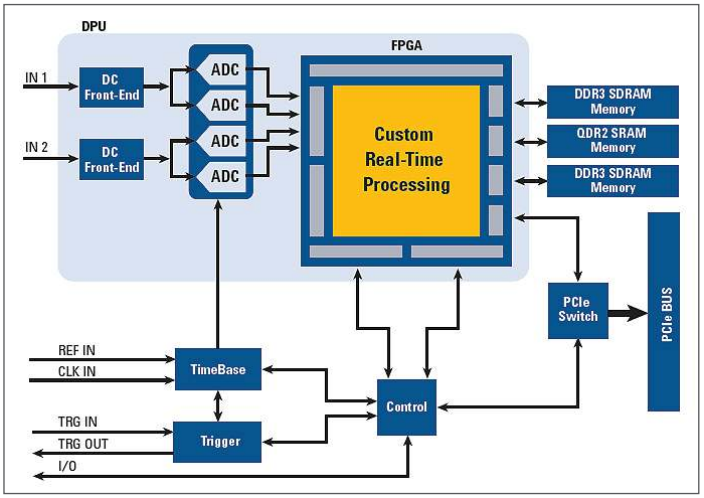


Figure 1. Simplified block diagram of the U5309A 2 channels PCIe high-speed digitizer with on-board processing.

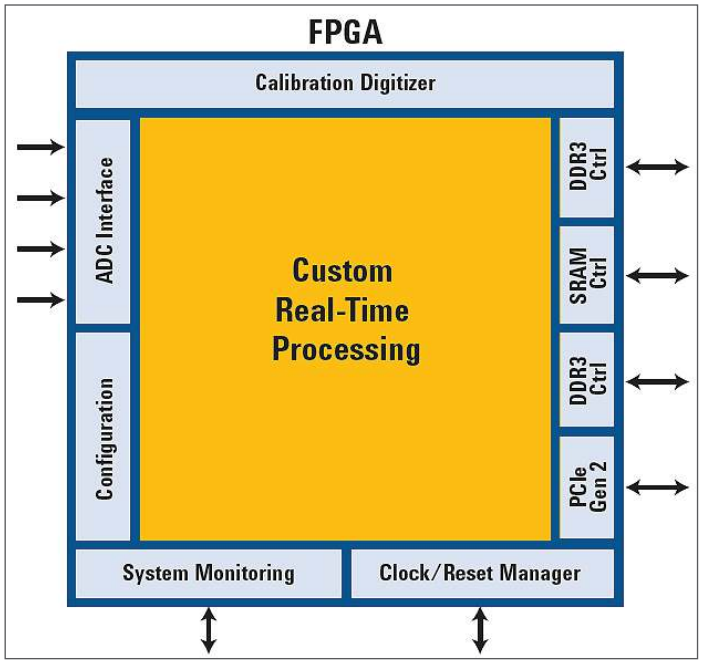


Figure 2. Enlarged block diagram of the FPGA Xilinx Virtex-6

Predefined Keysight IP cores
Custom real-time processing (using the FPGA development kit)

Easy to Design-In, Deploy, and Upgrade (continued)

Software Platform

Keysight Software Suite

Keysight IO Libraries Suite offers FAST and EASY access to the U5309A using a standardized interface and ensuring compatibility and upgradability of the software applications.

Drivers

The module comes with the Keysight MD2 IVI-COM and IVI-C standard software 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.

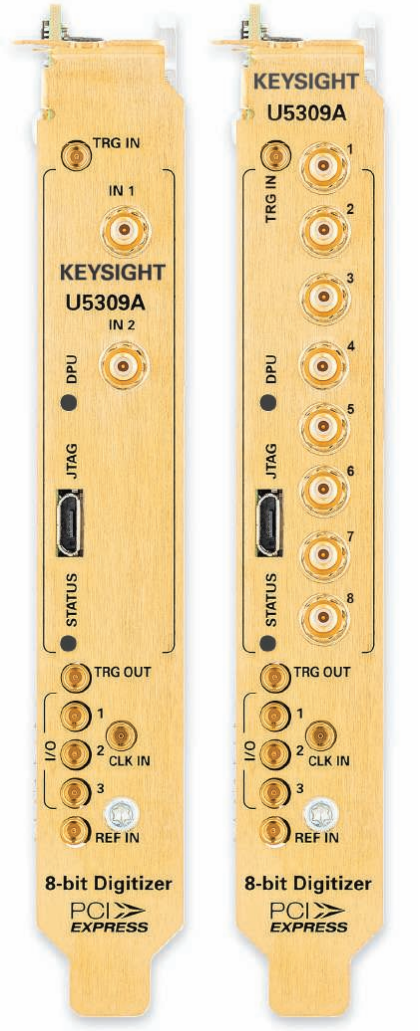


Figure 3. 2 and 8 channels U5309A front panels with analog inputs and multiple I/O signals.

Easy software integration

To help you get started and complete complex tasks quickly, the U5309A digitizer is supplied with a comprehensive portfolio of module drivers, documentation and examples, to help you quickly develop test systems with your software platform of choice.

Compliance

The U5309A is compliant with PCI Express 2.0 standard. Designed to benefit from fast data interfaces, the product can be integrated into PCI Express slots.

Calibration intervals

The U5309A is factory calibrated and shipped with a certificate of calibration.

Easy to Design-In, Deploy, and Upgrade (continued)

Firmware options

The U5309A PCIe high-speed digitizer provides several firmware options:

- -DGT : Digitizer firmware
- -FDK [1] : Custom firmware capable (Required to load FPGA firmware created with U5340A)
- -AVG 1 : Firmware for real-time sampling and averaging
- -PKD 1 : Firmware for real-time signal peak detection
- -TSR 1 : Firmware for triggered simultaneous acquisition and readout.

	Channel Configuration			
	-CH2			-CH8
	Sampling Rate			Sampling Rate
Firmware	-SR0	-SR1	-SR2	-SR1
-DGT	√	√	√	√
-FDK	√	√	√	-
-AVG	√	√	√ [2]	-
-PKD	√	√	√ [2]	-
-TSR	√	√	√	-

Table 1. Firmware options versus sampling rate.

DGT digitizer firmware

This is the standard digitizer firmware which:

- Allows standard data acquisition, including: digitizer initialization, setting of the acquisition and clocking modes, management of channel triggering for best synchronization, storing data in the internal memory and/or transferring them through the backplane bus.
- Implements multi-record acquisition functionality.
- Supports fixed internal clocking frequency with internal, external or backplane reference, and variable frequency external clock.

FDK custom firmware capable

This option enables loading of custom firmware created with the U5340A FPGA development kit.

AVG firmware for real-time sampling and averaging [3]

Synchronous real-time sampling and accumulation up to 2 GS/s on single-channel and 1 GS/s on dual-channel with:

- Accumulation of 1 up to 520,000 triggers per record in steps of 8 triggers 4.
- Effective acquisition length of up to 480 KSamples in single channel or 240 KSamples per channel in dual-channel.
- Noise suppressed accumulation (NSA).
- Self-trigger mode for minimal synchronous noise.

PKD firmware for real-time signal peak detection [3]

Synchronous real-time sampling and peak detection up to 2 GS/s on single-channel and 1 GS/s on dual-channel with:

- Effective acquisition length of up to 480 KSamples in single channel or 240 KSamples per channel in dual-channel.
- Self-trigger mode for minimal synchronous noise.

TSR firmware for triggered simultaneous acquisition and readout

The triggered simultaneous acquisition and readout concept guarantees no lost triggers at high repetition rate for specific configuration [5]:

- Larger memory size increases the maximum margin for host PC processing time, and allows for short to very long record size.
- The architecture allows to continuously acquire new records while reading previous ones.
- PCIe 2.0 with 8 lanes allows fast data throughput.
- High precision integrated time to digital converter can be used to increase time measurement accuracy.

Easy firmware switch

A simple call to the configuration

1. A calibration digitizer function is available with each firmware.
2. Averager on 1 channel only.
3. -AVG and -PKD are not available with the combination of -CH2 and -SR2 options.
4. Expected for 8 first triggers.
5. Please contact Keysight to find out the repetition rate that can be achieved in your application.

Technical Specifications and Characteristics

Analog Input (SSMC Connectors)		
Number of channels		2 or 8 (simultaneously sampled)
Impedance		50 Ω ±2% [1]
Coupling		DC
Full scale range (FSR)		250 mV to 5 V in 1-2.5-5 sequence
Maximum input voltage		±3.4 V
Input voltage offset		±0.5x FSR
Frequency Range (–3 dB Bandwidth)		DC to 500 MHz (nominal) (option F05) DC to 300 MHz (nominal) (option F03)
Effective Number Of Bits (ENOB) [2]	@ 100 MHz	6.8 (typical)
Signal-to-Noise Ratio (SNR) [2]	@ 100 MHz	43 dB (typical)
Spurious-Free Dynamic Range (SFDR) [2]	@ 100 MHz	50 dB (typical)
Total Harmonic Distortion (THD) [2]	@ 100 MHz	–48 dB (typical)

1. Input impedance is 150 Ω during the calibration process.
2. Measured at 2.0 GS/s and 1 V FSR for a –1 dBFS input signal in internal clock mode with -F05 option.

Block Diagram 8 channels

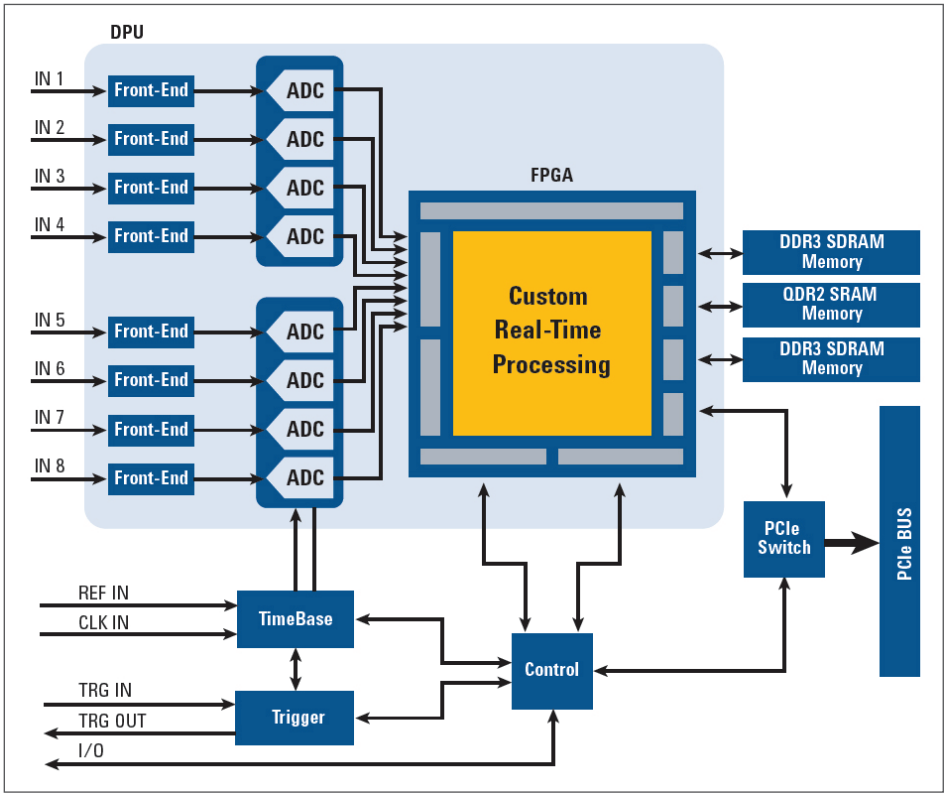


Figure 4. Simplified block diagram of the U5309A 8 channels PCIe high-speed digitizer with onboard processing.

Technical Specifications and Characteristics (continued)

Digital Conversion		
Resolution		8 bits
Acquisition memory (total)		128 MB (option M01) 512 MB (option M05) 2 GB (option M20) When using the -AVG or -PKD option exclusively, it is recommended to select the smallest memory option.
Sample clock sources		Internal or external
Internal clock source		Internal, external reference
	Real-time sampling rates	See the table 2 below
	Sampling jitter	500 fs (nominal)
	Clock accuracy	±1.5 ppm
External clock source (CLK IN MMCX connector)		
	Impedance	50 Ω (nominal)
	Frequency range (Fext)	See the table 3 below
	Signal level	+5 dBm to +15 dBm (nominal), 0 V DC
	Coupling	AC
External reference clock source (REF IN MMCX connector)		
	Impedance	50 Ω (nominal)
	Frequency range	100 MHz to ±100 kHz (nominal)
	Signal level	–3 dBm to +3 dBm (nominal)
	Coupling	AC
Acquisition modes		Single shot, sequence (up to 131072 records. Record maximum length = memory size/number of channels)

	Max Sampling Rate		
Firmware	**-SR0**	**-SR1**	**-SR2**
-DGT	0.5 GS/s	1 GS/s	2 GS/s
-FDK	√	1 GS/s	–

Table 2. Real-time sampling rates with internal clock source.

			Max Sampling Rate		
Channel Configuration	**Nominal Frequency**	**Frequency Range**	**-SR0**	**-SR1**	**-SR2**
-CH2	2 GHz	1.8 GHz to 2.2 GHz [1]	Fext / 4	Fext / 2	Fext / 1
-CH8	4 GHz	3.6 GHz to 4.4 GHz [1]	–	Fext / 4	–

Table 3. External clock source frequency range.

1. Specifications guaranteed only at nominal frequency.

Technical Specifications and Characteristics (continued)

Trigger		
Trigger modes		Edge (positive, negative)
Trigger sources		External, Software, Channel (digital)
External trigger (TRG IN MMCX connector)		
Coupling		DC
Impedance		50 Ω (nominal)
Level range		±5 V (nominal)
Minimum amplitude		0.5 V pk-pk
Frequency range		DC to 2 GHz (nominal)
Maximum time stamp duration		52 days
Trigger time interpolator resolution	External	8 ps [1] (nominal)
	Channel	1 sample
Trigger time interpolator precision	External	15 ps RMS [1] (nominal)
	Channel	1 sample
Rearm time (deadtime)		< 500 ns (nominal)
Trigger out (TRG OUT MMCX connector) [2]		1 (programmable), 50 Ω source
Signal level		0.8 Vpp amplitude ±2.5 V offset (nominal) into high impedance
Control IO (I/O 1 and 2 MMCX Connectors) [3]		
Output functions		Acquisition active Trigger is armed Trigger accept resynchronization 100 MHz reference clock divided by 2 [4] Sampling clock divided by 32 [4] Low level High level FPGA synchronization
Input/Output function		FPGA programmable I/O

1. For -CH2 option.
2. At 10 MHz on a 50 Ω load.
3. /O 3 reserved for future use.
4. Only I/O 1.

Technical Specifications and Characteristics (continued)

Environmental and Physical [1]			
Temperature Range		Operating	0°C to +45°C (10,000 to 15,000 feet) [2]
			0°C to +45°C (10,000 to 15,000 feet) [2]
		Non-operating	–40 °C to +70 °C
Altitude			Up to 15,000 feet (4'572 meters)
EMC			Complies with European EMC Directive 2004/108/EC – IEC/EN 61326-1 – CISPR Pub 11 Group 1, class A – AS/NZS CISPR 11 – ICES/NMB-001 This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.
Acoustic			European Machinery Directive 2002/42/EC, 1.7.4.2u Acoustic noise emission LpA <70 dB Operator position Normal operation mode
Power Dissipation [3]			
+ 3.3 V	+ 3.3 VAUX	+ 12 V	Power on PCIe edge connector
0.8 A *(typical)*	0.2 A *(typical)*	2.7 A *(typical)*	36 W (typical)
+ 5 V		+ 12 V	Power on additional power cable [3]
1.8 A *(typical)*		0.9 A *(typical)*	20 W (typical)
Mechanical Characteristics			
Form Factor			PCIe x8 standard (full length with fan)
Size	Without fan [4]		17.6 mm W x 126.3 mm H x 169.5 mm D
	With fan [5]		40.6 mm W x 126.3 mm H x 252.1 mm D
Weight	With fan		0.575 kg (1.268 lbs)

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. PC internal ambient temperature at intake of the digitizer's fan, operating temperature is respectively 0°C to +40°C and 0°C to +35°C for option -CH8.
3. Additional power cable mandatory to ensure adequate power distribution as per PCIe standard. Current and power are provided for the -CH2 option.
4. 60 m^3/h airflow is required. The unit must be operated with the included fan.
5. Optional card retainer recommended to stabilize the PCIe card in the PC.

Technical Specifications and Characteristics (continued)

System Requirements (Contact us at digitizers@keysight.com for a list of recommended host computers)		
Topic	Windows 7 Requirements	Linux
Operating Systems	Windows 7 (32-bit and 64-bit), All versions	Linux Kernel 2.6 or higher (32 or 64-bit), Debian 7.0, CentOS 6
Processor speed	1 GHz 32-bit (x86), 1 GHz 64-bit (x64), no support for Itanium 64	As per the minimum requirements of the chosen distribution
Available Memory	1 GB minimum	As per the minimum requirements of the chosen distribution
Available Disk Space [1]	1.5 GB available hard disk space, includes: – 1 GB available for Microsoft .NET Framework 3.5 SP1 [2] – 100 MB for Keysight IO Libraries Suite	100 MB
Video	Support for DirectX 9 graphics with 128 MB graphics memory recommended (Super VGA graphics is supported)	No graphics required (for headless system), or X Windows
Browser	Microsoft Internet Explorer 7 or greater	Distribution supplied browser

1. Because of the installation procedure, less disk space may be required for operation than is required for installation. The amount of space listed above is required for installation.
2. NET Framework Runtime Components are installed by default with Windows 7. Therefore, you may not need this amount of available disk space.

Definitions for specifications

Specifications describe the warranted performance of calibrated cards that have been stored for a minimum of 2 hours within the operating temperature range of 0 to 50 °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, but that is not covered by the product warranty. Characteristics are often referred to as Typical or Nominal values.

- Typical describes characteristic performance, which 80% of cards 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.

Configurations and Ordering Information

Software information

Supported operating systems and host computers	See system requirements
Standard compliant drivers	IVI-COM, IVI-C, LabVIEW, MATLAB
Supported application development environments (ADE)	VisualStudio (VB.NET, C#, C/C++), VEE, LabVIEW, LabWindows/CVI, MATLAB

Software information

	Model	Description
	U5309A	PCIe 8-bit Digitizer with on-board processing Includes: -Software, example programs and product information on CD -MMCX to BNC cable -Additional power supply cables -Fan assembled on module -Return to Keysight Warranty extended to 3 years
	Configurable Options	
	Channel Configuration	
√	U5309A-CH2	2 channels [1]
	U5309A-CH8	8 channels [1]
	Sampling Rate	
	U5309A-SR0	500 MS/s sampling rate version [2]
√	U5309A-SR1	1 GS/s sampling rate version
	U5309A-SR2	2 GS/s sampling rate version [2]
	Bandwidth	
	U5309A-F03	DC to 300 MHz bandwidth version
√	U5309A-F05	DC to 500 MHz bandwidth version
	Memory	
	U5309A-M01	128 MB acquisition memory
√	U5309A-M05	512 MB acquisition memory
	U5309A-M20	2 GB acquisition memory
	Data Processing Unit	
√	U5309A-LX2	DPU FPGA: LX195T
	Firmware	
√	U5309A-DGT	Digitizer firmware
	U5309A-FDK	Custom firmware capable [2] (Required to load FPGA firmware created with the U5340A)
	U5309A-AVG	Real-time averager firmware
	U5309A-PKD	Real-time peak detection firmware
	U5309A-TSR	Triggered simultaneous acquisition and readout
	Card Retainer	
√	U5300A-001	With card retainer
	U5300A-002	No card retainer

√ Recommended configuration.
1. Please contact Agilent for other channel configuration.
2. Only available with -CH2 option.

Figure 5. The Keysight 2 and 8 channels U5309A PCIe 8-bit digitizers with on-board processing offers a small size for easy integration.

Related products

Model	Description
U5340A	FPGA Development Kit for High-Speed Digitizers
U1092A-CB3	SSMC to SMA cable, 1 m
Advantage Services: Calibration and Warranty	
Agilent Advantage Services is committed to your success throughout your equipment's lifetime.	
Included	3-year warranty (return to Keysight), standard
R-51B-001-5Z	5-year return to Keysight warranty assurance plan

Please contact Keysight for other options not shown:
digitizers@keysight.com

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KEYSIGHT TECHNOLOGIES

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