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Acqiris U5309A
PCIe High-Speed ADC Card with FPGA Signal Processing

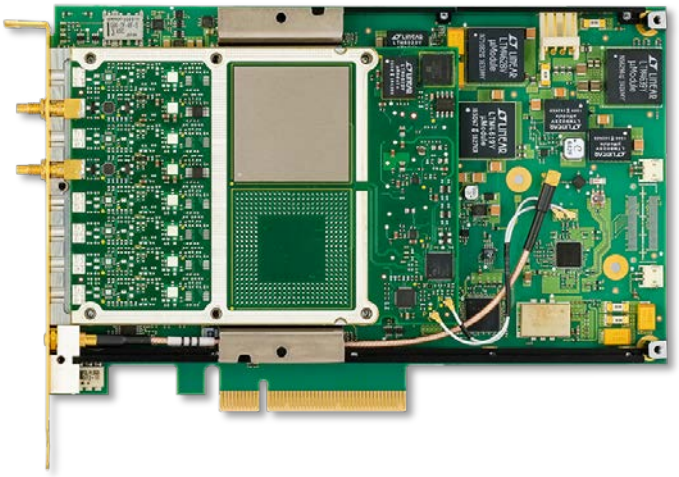
2 channels, 8-bit, from 500 MS/s to 2 GS/s,
DC up to 500 MHz bandwidth

Datasheet



PCI EXPRESS

Overview





Introduction

The 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.

Product description

The U5309A ADC card occupies a single full-length PCIe slot of the host computer and captures signal on 1 or 2 channels at 2 GS/s, 1 GS/s or 500 MS/s. Featuring an analog bandwidth from DC to 500 MHz, and a large DDR3 memory for long acquisition time, the U5309A also includes a Xilinx FPGA allowing implementation of custom real-time processing algorithms.

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

Applications

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

Features

- 8-bit resolution
- 1 or 2 channels at up to 2 GS/s
- DC to 500 MHz analog bandwidth
- 50 Ω input impedance
- Selectable 250 mV to 5 V input full scale range (FSR)
- Optional low voltage range (LVR), enabling selectable 50 mV to 1 V input full scale range.
- ±0.6 FSR input voltage offset range
- Up to 2 GB DDR3 on-board memory
- On-board data processing unit using a Xilinx FPGA
- Real-time averaging and peak detection options (-AVG/-PKD)
- Support for loading custom real-time processing
- IVI-C and IVI.NET drivers available
- Support for Windows and Linux

Customer values

- 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
- High digitized data throughput
- Software support including multiple programmable interfaces for easy integration into existing environments
- Reduced development time, fast time to market

For information on other firmware options please contact us:
hello@acqiris.com

Hardware platform

Integration

The U5309A 8-bit ADC Card occupies a single full length PCIe x8 slot in a host computer or in an external chassis. It is compliant with PCI Express 2.0 standard, and benefits from the very fast data interface, making it an ideal platform for many OEM applications.

On-board real-time processing

At the heart of the U5309A ADC card is a data processing unit (DPU) based on the Xilinx Virtex-6 FPGA. This DPU controls the digitizer functionality by implementing digitization of the signal, data storage in the DDR3 SDRAM memory and transfer through the PCIe connection to the host computer.

Moreover, this powerful feature allows real time signal processing and data reduction to be carried out onboard, minimizing transfer volumes and speeding-up analysis.

Block diagram: 2 channels version (-CH2)

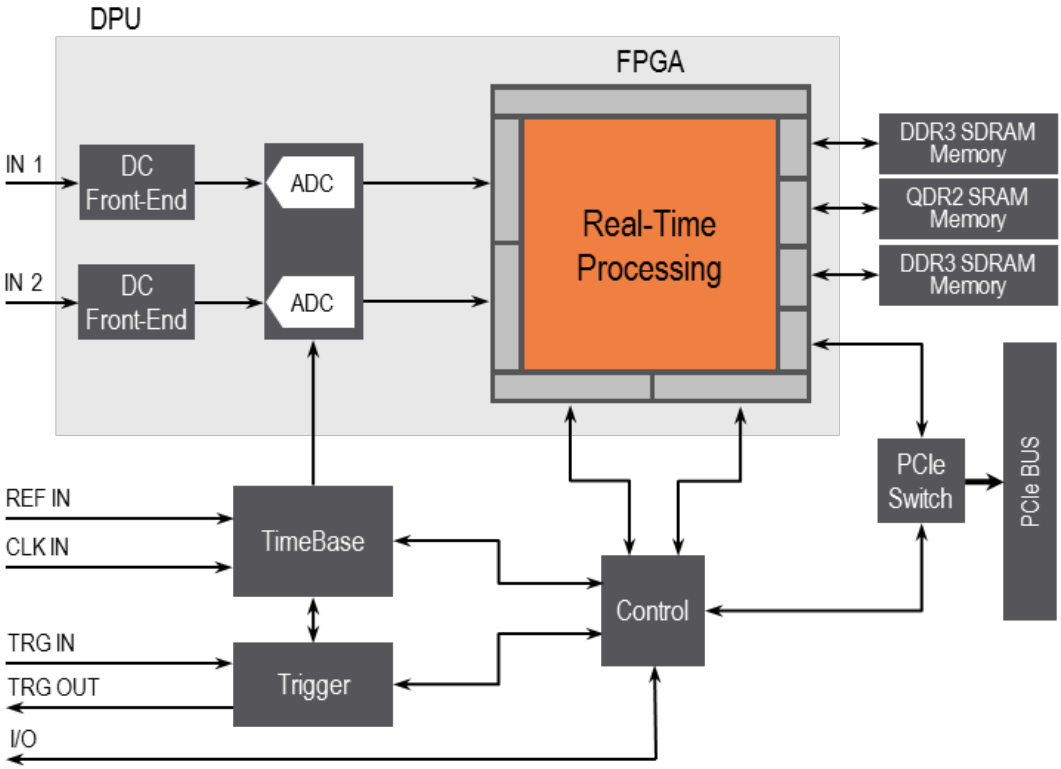


Figure 1. Simplified block diagram of the U5309A PCIe ADC card, with on-board real-time processing.

Award earned by the U5309A

GOLDEN MOUSETRAP AWARDS 2015 WINNER

ECN 2015 FINALIST iMPACT Awards

Hardware platform *(continued)*

Channel options

The U5309A proposes two channel versions:

- CH1: Single acquisition channel[1]
- CH2: Dual acquisition channels

With the large choice of channel versions and sampling rate option, the U5309A is a versatile ADC card covering a wide range of applications.

Table 1. Sampling rate option.

Sampling rate option	Max. sampling rate
-SR0	500 MS/s
-SR1	1 GS/s
-SR2	2 GS/s

1 or 2 channels version (-CH1 or -CH2)



Figure 2. The U5309A front panels with analog inputs and multiple I/O signals.



Figure 3. The U5309A PCIe 8-bit digitizers with on-board processing offers a small size for easy integration.

1. With U5309A-CH1 version, IN 2 is not active.

Software Platform

Drivers

The ADC card comes with the Acqiris MD3 Software for Signal Acquisition Cards. It includes IviDigitizer class compliant IVI.NET and IVI-C drivers that work in the most popular development environments including Visual C/C++, C#, VB.NET.

Linux is also supported using a supplied IVI-C driver.

The software End User License Agreement is available for information at https://www.acqiris.com/SoftwareEULA.

Easy software integration

To help you get started and complete complex tasks quickly, the U5309A ADC card is supplied with a comprehensive portfolio of module drivers, documentation, examples, and software tools.

Software applications

The U5309A also includes the MD3 soft front panel (SFP) graphical user interface.

This software application can be initially used to explore the ADC Card capabilities and serves as a friendly and convenient tool for capturing and displaying the acquired data in time or frequency domain.

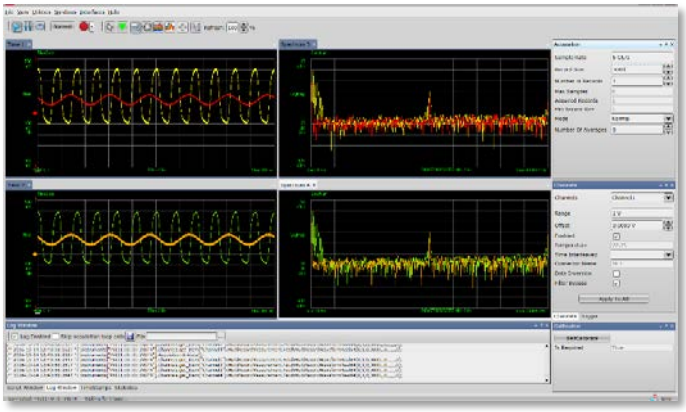


Figure 2. MD3 software front panel (SFP) interface.

Firmware Options

The U5309A PCIe high-speed ADC Card provides several firmware options:

- DGT : Digitizer firmware
- FDK[1]: Custom firmware capability
- AVG[1] : Firmware for real-time sampling and averaging
- PKD[1] : Firmware for real-time signal peak detection
- TSR[1]: Triggered simultaneous acquisition and readout

Table 2. Firmware options versus sampling rate.

Firmware	500 MS/s -SR0	1 GS/s -SR1	2 GS/s -SR2
-DGT	√	√	√
-FDK	√	√	√
-AVG	√	√	√[2]
-PKD	√	√	√[2]
-TSR	√	√	√

Easy firmware switch

A simple call to the configuration function will enable to switch to the required option.

DGT digitizer firmware

The digitizer firmware:

- 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 or external reference, and variable frequency external clock.
- Includes programmable binary decimation[3] to lower the sample rate by a factor of 2^n where *n* is defined in the range of 1 to 10 for single record. For example, for a U5309A-SR2 you can select from 2 GS/s down to 1.953125 MS/s.

Lastly, the implemented trigger time interpolator (TTI) is a high precision integrated time to digital converter, guarantying time measurement accuracy.

FDK custom firmware capability

This option enables loading custom firmware. Contact support at support@acqiris.com for additional information.

AVG firmware for real-time sampling and averaging[2]

Averaging signals reduces random noise effects, improving the signal-to-noise ratio, as well as increasing resolution and dynamic range.

This option enables synchronous real-time sampling and accumulation up to 2 GS/s on single-channel and 1 GS/s in dual-channel, featuring:

- Accumulation of 1 up to 520,000 triggers.
- 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[2]

The peak detection firmware allows real-time acquisition and peak detection with the possibility to generate a histogram of peak versus time for successive acquisitions.

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

- Accumulation of 1 up to 520,000 triggers.
- Effective acquisition length from 1 to 480 kSamples in single channel or 240 kSamples per channel in dual-channel.

1. A calibration digitizer function is available with each firmware.
2. With the combination of -CH2 and -SR2 options, -AVG and -PKD acquisitions are available on one channel only (IN 1).
3. Programmable decimation is supported with -CH1 and -CH2 version only.

Firmware Options *(continued)*

TSR triggered simultaneous acquisition and readout

The triggered simultaneous acquisition and readout architecture allows to continuously acquire new records while reading previous ones.

TSR solution is dedicated to applications requiring no trigger loss, achieving longer recording time when compares with standard digitizer (-DGT).

TSR option main features:

- High trigger rate with guaranteed no lost trigger for specific configuration[1].
- Easy to use solution, implementing an optimal and automated control of memory addressing.
- Selecting larger memory size option allows longer record size and provides larger buffer for data transfer to host computer, especially useful for applications with non-periodic trigger or very high trigger rate during a limited period.

AVG/TSR Combining real-time averaging and streaming

Combining -AVG and -TSR firmware allows signal acquisition, real time averaging and data readout simultaneously, on a single or dual channels. This acquisition mode performs multiples and successive averaging sequences up to 2 GS/s, without missing any trigger.

Providing the same unique features than -AVG firmware (NSA, triggering, …), the addition of -TSR enables simultaneous real time averaging and streaming of average records to host computer. The readout can be performed as soon an “averager record” is acquired and during the next average accumulation, minimizing the dead time between accumulations.

This acquisition mode is compatible with all the sampling rate options.

1. Please contact Acqiris to find out the repetition rate that can be achieved in your application.

Technical Specifications and Characteristics

Analog input (IN 1 and IN 2 SSMC connectors)		
Number of channels	-CH1 -CH2	1 ch 2 ch (simultaneously sampled)
Impedance[1]		50 Ω ± 2 %
Coupling		DC
Full scale ranges (FSR)	Standard -LVR	250 mV, 500 mV, 1 V, 2.5 V, and 5 V 50 mV, 100 mV, 200 mV, 500 mV, and 1 V
Maximum input voltage		± 5 V DC
Input voltage offset		± 0.6 FSR
Input frequency range (-3 dB bandwidth)	-F03 -F05	DC to 300 MHz (*nominal*) DC to 500 MHz (*nominal*)
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 dBc (*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, measured at 200 mV FSR for option -LVR.

Technical Specifications and Characteristics *(continued)*

Digital conversion		
Resolution		8 bits
Acquisition memory (total)	-M01/CH2 -M01/CH1 -M20/CH2 -M20/CH1	128 MB (64 MSamples/ch) 64 MB (64 MSamples) 2 GB (1 GSamples/ch) 1 GB (1 GSamples) When using the -AVG or -PKD option exclusively, it is recommended to select the smallest memory option that provides the same performance. When combining -AVG/TSR, it is recommended to select the largest memory option that enables longer acquisition time at high trigger rate.
Sample clock sources		Internal or external
Internal clock source		Internal, external reference
Real-time sampling rates	-SR0 -SR1 -SR2	500 MS/s 1 GS/s 2 GS/s
Sampling clock jitter		500 fs *(nominal)*
Clock accuracy		± 1.5 ppm
External clock source (CLK IN MMCX connector)		
Impedance		50 Ω *(nominal)*
Frequency range[1] (F_{ext})		1.8 GHz to 2.2 GHz
Nominal frequency		2 GHz
Maximum sampling rate	-SR0 -SR1 -SR2	$F_{ext}/4$ $F_{ext}/2$ $F_{ext}/1$
Signal level		+5 dBm to +15 dBm *(nominal)*, 0 V DC
Coupling		AC
External reference clock (REF IN MMCX connector)		
Impedance		50 Ω (*nominal*)
Frequency range		100 MHz ± 100 kHz *(nominal)*
Signal level		-3 dBm to +3 dBm *(nominal)*
Coupling		AC
Acquisition modes (depending on firmware options)		Single record, Multi-record
Maximum number of records		131072

1. Specifications guaranteed only at nominal frequencies.

Technical Specifications and Characteristics *(continued)*

Trigger		
Trigger modes		Positive or negative edge
Trigger sources		External, Channel, Software
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 Channel	8 ps[1] *(nominal)* 1 sample
Trigger time interpolator precision	External Channel	15 ps RMS *(nominal)* 1 sample
Rearm time (deadtime)		< 500 ns *(nominal)*
Trigger out (TRG OUT MMCX connector)		1 (programmable), 50 Ω source
Signal level		0.8 Vpp ± 2.5 Voffset *(nominal)* into high impedance
Control IO (I/O 1 and 2 MMCX connectors)[2]		
Output functions		Acquisition active Trigger is armed Trigger accept resynchronization 100 MHz reference clock divided by 2.[3] Sampling clock divided by 32.[3] Low level High level

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

Technical Specifications and Characteristics *(continued)*

Environmental and physical [1]			
Temperature range		Operating [2]	0 to +50 °C (sea-level to 10,000 feet)
			0 to +45 °C (10,000 to 15,000 feet)
		Non-operating	-40 to +70 °C
Altitude			Up to 15,000 feet (4'572 meters)
EMC			Complies with European EMC Directive – 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 à la norme NMB-001 du Canada.
Acoustic			European Machinery Directive Acoustic noise emission LpA < 70 dB Operator position Normal operation mode
Power dissipation [3]			
+ 3.3 V	+ 3.3 V_{AUX}	+ 12 V	Power on PCIe edge connector
0.8 A *(nominal)*	0.2 A *(nominal)*	2.7 A *(nominal)*	36 W *(nominal)*
+ 5 V		+ 12 V	Power on additional power cable [4]
1.8 A *(nominal)*		0.9 A *(nominal)*	20 W *(nominal)*
Mechanical characteristics			
Form Factor			PCIe x8 standard (full length with fan)
Size		Without fan[5]	17.6 W x 126.3 H x 169.5 D mm
		With fan[6]	40.6 W x 126.3 H x 252.1 D mm
Weight			0.575 kg (1.268 lbs)

1. Samples of this product have been type tested 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. Host computer internal ambient temperature at intake of the ADC Card's fan.
3. With the DGT firmware.
4. Additional power cable mandatory to ensure adequate power distribution as per PCIe standard.
5. 60 m^3/h airflow is required. The unit must be operated with the included fan, without obstruction of the airflow into the fans inlet and out of the card's sides.
6. Optional rail guide can be ordered to stabilize the PCIe card in the host computer.

Technical Specifications and Characteristics *(continued)*

System requirements (contact us at support@acqiris.com for a list of recommended host computers)		
Topic	Windows	Linux
Operating systems	Windows 10 (32-bit and 64-bit), All versions Windows 8.1 (32-bit and 64-bit), All versions Windows 7 (32-bit and 64-bit), All versions	Linux Kernel 2.6 or higher (32 or 64-bit), Debian 8, Ubuntu-16.04, CentOS-7
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 [1]	As per the minimum requirements of the chosen distribution
Available disk space	2.5 GB available hard disk space, includes: 1 GB for Keysight IO Libraries Suite 1 GB for Microsoft .NET Framework	100 MB
Display	Minimum of 1024 x 768, 96 or 120 DPI	No display required

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.

Calibration

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

1. On older host computers with minimum RAM, installation can take a long time when installing the IO Libraries Suite and the .NET Framework.

Configuration and Ordering Information

Software information

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

Related products

Model	Description
U5310A	PCIe 10-bit ADC Card with on-board processing
U5303A	PCIe 12-bit ADC Card with on-board processing
Advantage services: calibration and warranty	
Included	3-year warranty, standard
Optional	5-year warranty

Accessories

Model	Description
U5300A-101	MMCX male to SMA male cable, 1m
U5300A-102	MMCX male to BNC male cable, 1m
U5300A-001	Card retainer (recommended if the card is assembled horizontally or in harsh environment)
U5300A-003	Short card retainer
U5300A-KTA1	Kit: Startup Guide, Cable MMCX/BNC, 2x Power cables
U5300A-KTA2	Kit: Startup Guide, 2x Power cables

Ordering information

	Model	Description
U5309A		PCIe 8-bit ADC Card with on-board processing Includes: – Fan assembled on module – 3-year warranty
Configurable options		
Channel configuration		
	U5309A-CH1	1 channel
√	U5309A-CH2	2 channels
Sampling rate		
√	U5309A-SR0	500 MS/s sampling rate
	U5309A-SR1	1 GS/s sampling rate
	U5309A-SR2	2 GS/s sampling rate
Bandwidth		
√	U5309A-F03	DC to 300 MHz bandwidth versions
	U5309A-F05	DC to 500 MHz bandwidth versions
Memory[1]		
√	U5309A-M01	Standard acquisition memory
	U5309A-M20	Large acquisition memory
Full scale range		
√	Standard	Standard voltage range 5 V
	U5309A-LVR	Low voltage range 1 V
Firmware		
√	U5309A-DGT	Digitizer firmware
	U5309A-AVG	Real-time averager firmware
	U5309A-PKD	Real-time peak detection firmware
	U5309A-TSR	Triggered simultaneous acquisition and readout

√ These options represent the standard configuration.

Ordering number format is U5309A-xxxx.

Please contact Acqiris for other options or specific requirements support@acqiris.com.

This information is subject to change without notice.

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1. When using the -AVG or -PKD option exclusively, it is recommended to select the smallest memory option which provides the same performance.

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