Acqiris SA220E
14-bit ADC Module, 2 channels
2 GS/s or 1 GS/s
with FPGA signal processing

DATASHEET

See deeper and sharper than before

Figure 1. SA220E ADC module with USB-C Thunderbolt 3 interface

New generation of Signal Acquisition cards and modules

The SA2 is Acqiris's high-performance 14-bit ADC card platform, performing fast signal acquisitions from 1 GS/s up to 10 GS/s, with excellent signal fidelity across a wide bandwidth. This new generation focuses on addressing unique OEM application needs.

The SA220E is the entry model and the serial module version of the SA2 product line, offering flexibility and modularity. This unique DC coupled 14-bit digitizer captures waveforms at up to 2 GS/s simultaneously on two channels.

Features depending on your application (options)

Increased recording time:

- Up to 8 GB memory allowing for 4 GSamples
- Streaming capability up to 2 GB/s

Real-time processing:

- High digitized data throughput thanks to Thunderbolt 3 connection
- Kintex UltraScale FPGA for on-board signal processing
- Custom real time-processing

Essential features

Accurate and precise measurement

- 14-bit resolution
- 2 channels simultaneously sampling
- 2 sampling rate versions: 2 GS/s or 1 GS/s
- DC up to 1.2 GHz bandwidth
- DC coupled, 50 Ω input impedance
- Selectable full scale range: 500 mV or 2.5 V (FSR)
- Programmable DC offset (± FSR/2)

Signal fidelity

- Low noise density and low distortion
- Optimized frequency response flatness
- Excellent and flat SFDR over a large analysis bandwidth (70 dBc)
- Optimized response allows few hundred picoseconds pulse analysis.
- Unique 15 ps RMS trigger time interpolator precision.

Product description

All the ADC cards from the SA2 generation implement a proprietary low noise front-end enabling undisputed spurious-free dynamic range (SFDR) and signal noise ratio (SNR) performances in high frequencies.

This makes the ADC modules ideal for OEM applications requiring digitizer sampling at wide bandwidth and very high dynamic range, especially at 500 mV full scale range.

The USB-C Thunderbolt 3 link enables high data transfer rate and streaming capabilities to the remote computer at up to 2 GB/s.

The SA220E offers modularity and high performance in a small footprint.

For information on specific application please contact us: support@acqiris.com.

Integration in your system

Benefit from responsive signal acquisition solutions for your application.

Applications

Because each OEM project is unique, we develop data acquisition cards and modules based on standard platform that can be fine-tuned to address your particular challenges.

We propose signal acquisition solutions easy to integrate in your system, fitting your actual requirements, and including only what you need.

The SA220E includes on-board FPGA offering real-time signal processing capability such as waveform averaging or peak listing. We also propose to open the FPGA for custom real-time processing.

More than a digitizer, the ADC module's programmable I/O signals allow for system control.

This data acquisition module with advanced real-time processing capabilities is specially designed for embedded OEM applications in a variety of challenging measurements, imaging and processing systems, including:

- Analytical time-of-flight (TOF)
- Ultrasonic non-destructive testing
- Medical research and imaging instrumentation
- Environmental monitoring using laser scanning (LiDAR)
- Distributed strain and temperature sensors (DSTS)

Overall performance of the SA220E enables deeper, faster and more accurate measurement and analysis for final products.

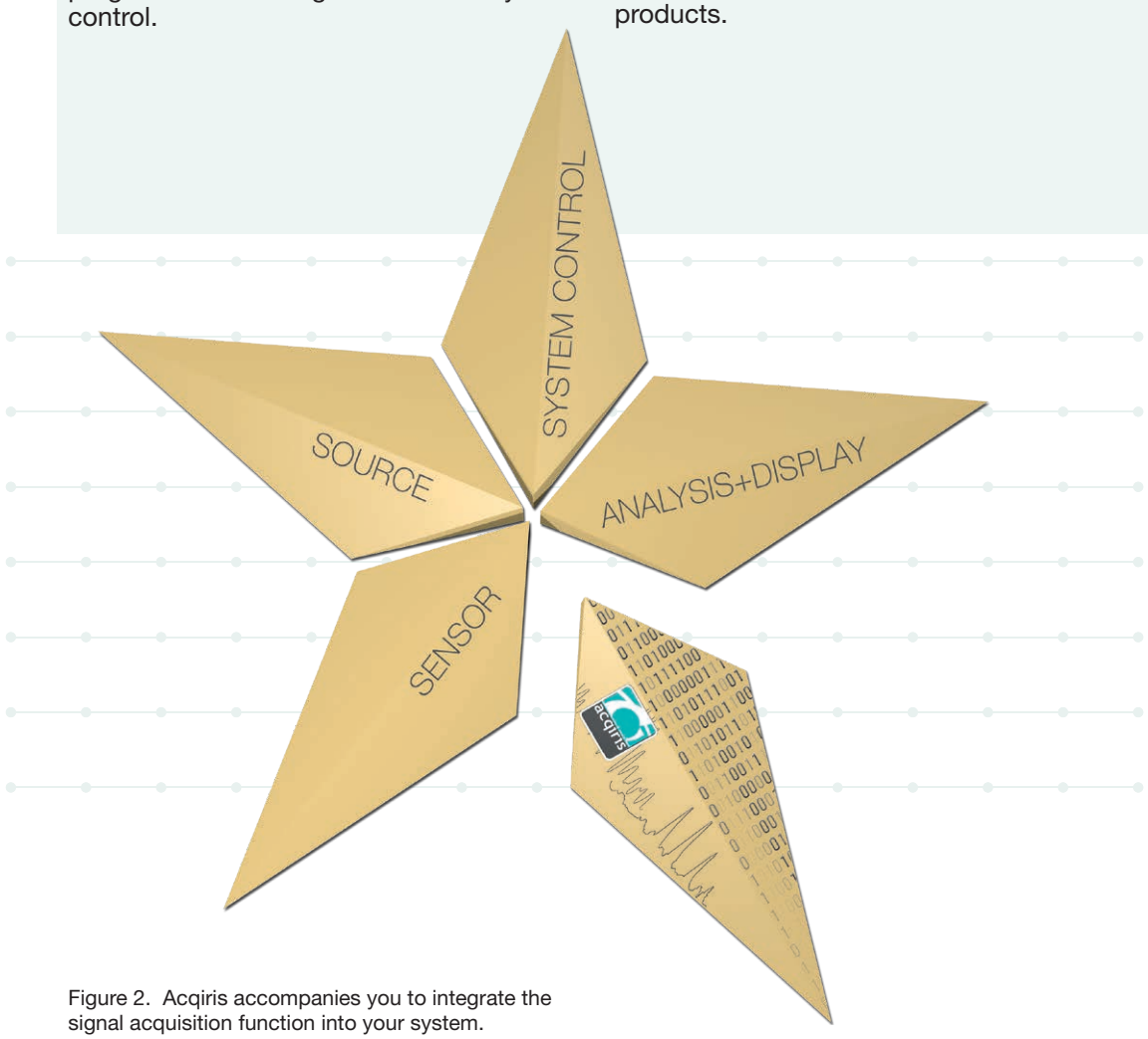

Figure 2. Acqiris accompanies you to integrate the signal acquisition function into your system. Our data acquisition solutions aim at improving the overall performances of your end-product.

Easy software integration

The ADC cards and modules of the SA2 family are supplied with a comprehensive portfolio of module drivers, documentation, examples, and software tools to assist you to quickly develop your system with your software platform of choice.

Additionally, our integration experts are there to help you.

Compliance

Designed to benefit from fast data interface, the product uses a Thunderbolt 3 link.

Hardware platform

Figure 3. SA220E signal connectors, with analog inputs and multiple programmable I/O signals.

Integration

Connected to a Thunderbolt 3 compatible laptop, embedded host, mini PC or workstation, the SA220E signal acquisition module enables a compact system and can be easily recombined with different remote computers.

Unique proprietary technology

Our engineering team developed exclusive proprietary integrated circuits enabling excellent signal performances.

Indeed, the SA220E incorporates:

- a low noise and low distortion signal conditioning amplifier to drive interleaved ADCs
- a specific clock distribution, minimizing the clock jitter and spurious.

On-board real-time processing

At the heart of the SA220E ADC module is a data processing unit (DPU) based on the Xilinx Kintex UltraScale FPGA. This DPU controls the digitizer functionality by implementing digitization of the signal, data storage in the DDR4 SDRAM memory and transfer through the Thunderbolt 3 connection to the computer.

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

Sampling rate

The SA220E is proposed with two sampling rate versions:

- 2 channels at 2 GS/s (default)
- 2 channels at 1 GS/s.

Trigger

The trigger source can be a signal level acquired on any of the two input channels (IN 1 or IN 2), or an external signal applied on TRG IN, or a software trigger.

Trigger resolution

The trigger time interpolator technology achieves a unique trigger resolution of 15 ps.

Programmable I/Os

Three programmable I/Os are available for your system control and optimization.

Block diagram

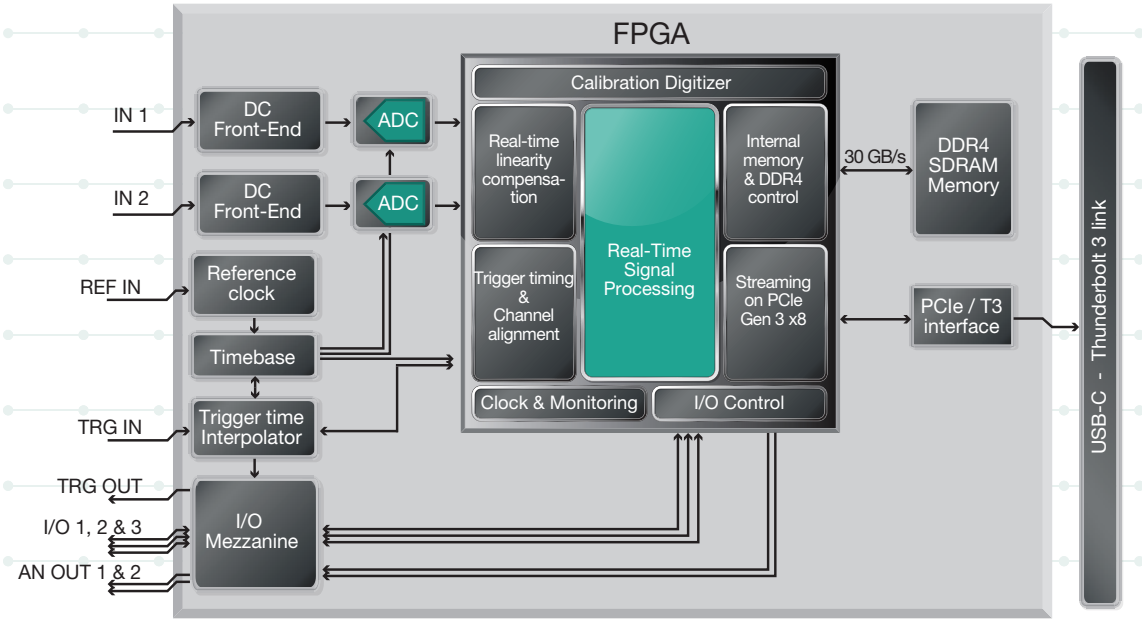

Figure 4. Top level block diagram of the SA220E ADC module with USB-C interface, with on-board real-time processing.

Software platform

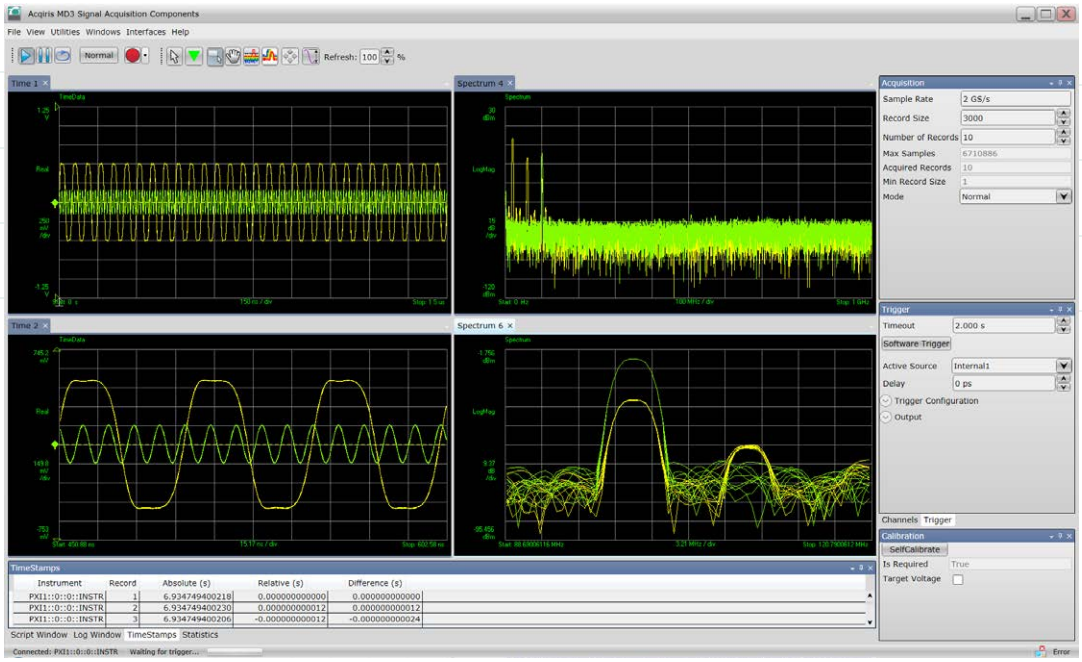

Figure 5. The software front panel (SFP) interface can display acquired data in time domain, frequency domain and provide additional useful information, such as the list of trigger time-stamps.

Drivers

The module comes with Windows or Linux drivers that work in the most popular development environments, to make easier the integration in your system.

Software information

Supported operating systems and remote computers	See system requirements on page 11.
Standard compliant drivers	Standard compliant drivers IVI-C, IVI.NET, LabVIEW
Supported application development environments (ADE)	VisualStudio (VB.NET, C#, C/C++)

Software applications

In addition, all the SA2 family products include the soft front panel (SFP) graphical user interface.

This software application can be used to initially explore the ADC module main capabilities and as a debugging tool during the development phase.

It serves as a friendly and convenient tool for capturing and displaying the acquired data in time or frequency domain.

For further integration in your application, our experts can help by providing code snippet.

Application options

Figure 6. The SA220E is a fully shielded module, maximizing both ESD and EMI protection.

Firmware features

Accurate trigger timing

When using an external trigger, the digitizer accurately measures and stores the time of each trigger. This information is essential to determine the precise relation between the trigger and the signal digitized samples. The trigger time interpolator (TTI) is a high-precision integrated time-to-digital converter that guarantees trigger time-stamp measurement accuracy.

Easy mode switch

A simple call to the configuration function allows to automatically switch from the digitizer to the average mode.

Real-time processing matching your system needs

The firmware in the ADC card's FPGA enables real-time signal processing. Each firmware an have different acquisition modes themselves having various features, including data compression or noise reduction. This results in fine-tuned FPGA firmware allowing the on-board processing to be optimized for your specific applications.

Main ADC card modes:
- Digitizer (DGT)
- Real-time averaging (AVG option)

Additional features:
- Simultaneous acquisition and readout - Streaming records (CST)
- Zero suppress - Thresholding (ZS1 option)

Dedicated application:
- SS-OCT configuration and firmware (SS4 option)

Digitizer mode (DGT)

The digitizer firmware allows standard data acquisition, including:

- Digitizer initialization
- Setting of the acquisition
- Management of channel triggering for best synchronization
- Distortion reduction
- Baseline stabilization and digital offset
- Storing data in the internal memory
- Transferring data to the host computer

The multi-record functionality allows to capture successive triggered events occurring within a very short time. The very fast trigger rearm time of the SA220E is a crucial feature to achieve low dead time. To increase trigger flexibility, a pre- or post-trigger delay can also be applied to the trigger position at picoseconds resolution.

Furthermore, the binary decimation can be used to reduce the amount of data, lowering the sample rate by a factor of 2, 4, or 8 – enabling decimated sampling rates at 1 GS/s, 500 MS/s, or 250 MS/s.

Real-time averaging mode (AVG option)

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

This mode enables synchronous real-time sampling and accumulation at up to 2 GS/s, featuring:

- Accumulation from 1 to > 65 000 triggers
- Effective acquisition length up to 1M samples
- Noise suppressed accumulation (NSA)
- Self-trigger mode for minimal synchronous noise
- Baseline stabilization and digital offset
- Decimation factors of 2, 4, or 8 with associated low pass filters, enabling decimated sampling rates at 1 GS/s, 500 MS/s, or 250 MS/s.

Besides, the streaming capabilities of the SA220E allows to readout previously averaged record while performing a new accumulation. The averaging firmware enables multiples and successive averaging sequences without missing any trigger.

Dedicated application options

Simultaneous acquisition and readout - Streaming records (CST)

Combined either with the digitizer or the averager mode, this function enables continuous simultaneous acquisition and readout. Compared with standard mode, it allows longer acquisition duration, and is especially dedicated to applications requiring no trigger loss.

In a standard digitizer mode, acquisition and readout are sequential, i.e. the readout of the data is performed after the acquisition has stopped; whereas, with simultaneous acquisition and readout, the acquired records are streamed to the host computer while the next records are acquired and processed. Supporting triggered acquisitions and multiple records of same length, this feature allows gaps between the records.

The firmware manages the streaming of 14-bit raw output data. Using raw data output, the trigger position is known with the accuracy of a sample. For applications requiring trigger position at sub-sample, the information is available on a separated marker stream providing absolute trigger position.

There is no maximum duration of the acquisition: the continuous acquisition and streaming can be sustained endlessly without overflow. The maximum trigger rate and record size depend on the readout data throughput.

This feature in included by default.

Zero suppress - Thresholding (ZS1 option)

The zero-suppress is a data reduction mode allowing to select data above a user-defined threshold, as depicted on figure below.

The threshold allows to identify the signal of interest. Data not complying with user selected criteria are suppressed and only the relevant data are stored and transferred to computer.

Particularly efficient when combined with the streaming records feature (CST) the zero-suppress feature performs data compression and allows a larger time window to be captured, assuming a regular occurrence of the trigger condition which periodically segments the continuous data acquisition.

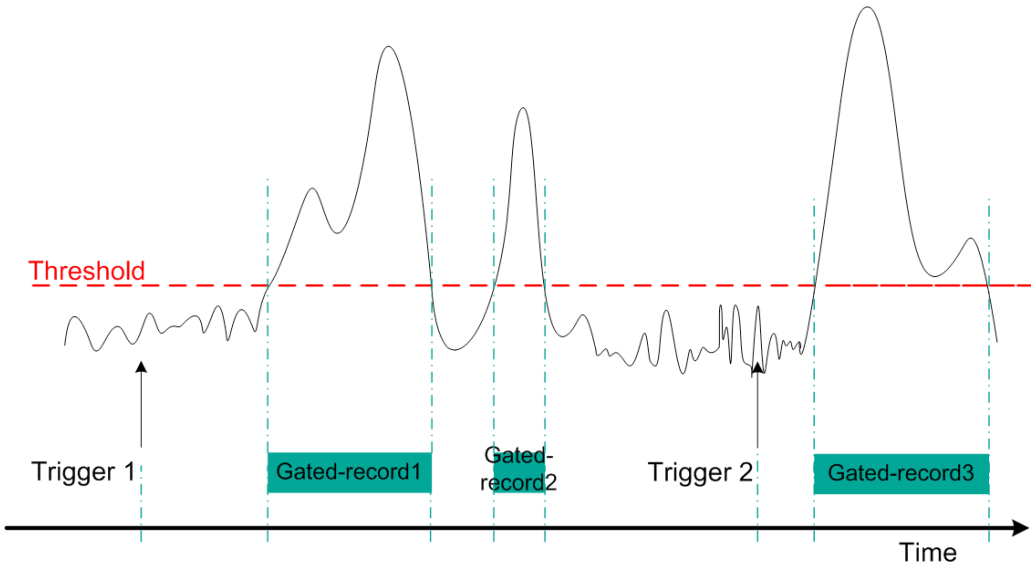

Figure 7. Zero-Suppress compression concept. A gated-record designates the waveform samples selected based on the user-defined threshold criteria.

Dedicated application options

Swept source OCT applications[1] (SS4 option)

The swept source optical coherence tomography (SS-OCT) option is a bundle designed for customers who want best-in-class swept source OCT performance and increase image resolution.

Our SS-OCT solution is light-source independent and allows flexible processing by either providing raw data in output or integrating all SS-OCT processing in the on-board FPGA for real-time computation.

The SA220E-SS4 pre-configured version features:

- A-scan rate from 100 kHz to 400 kHz
- up to 2 GS/s sampling rate
- DC to 1.2 GHz bandwidth
- 4 GB acquisition memory
- FFT up to 8K points

SS-OCT dedicated firmware and API are included in this bundle.

Contact us at SA2@acqiris.com to receive the SA220-SS4 datasheet dedicated to our solution for SS-OCT.

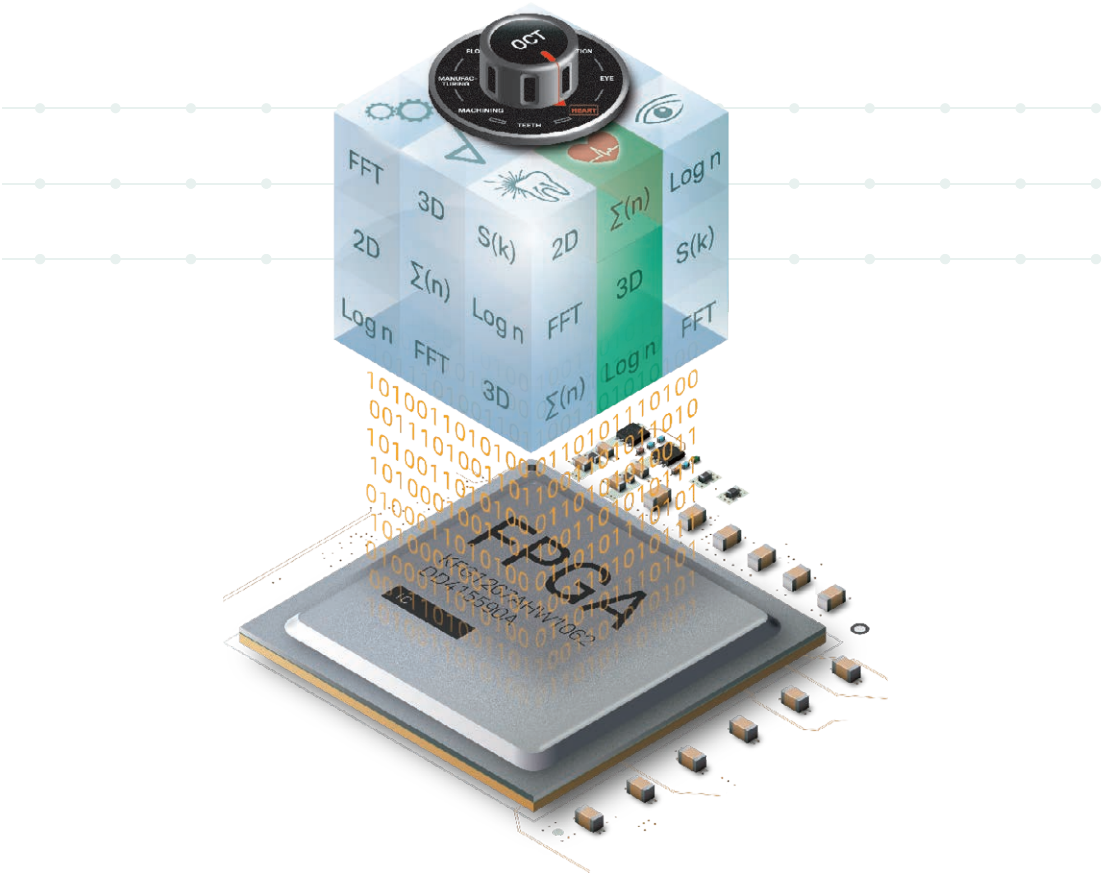

Figure 8. The FPGA allows dedicated real-time processing including FFT and K-clock re-sampling.

1 The SS-OCT application firmware is a dedicated configuration and cannot be mixed with other functions or options, note it includes the basic capabilities of the standard digitizer mode.

Technical specifications and characteristics

Analog input (IN 1 and IN 2 - SMA connectors)		
Number of channels		2
Impedance		50 Ω ± 2 % *(typical)*
Coupling		DC
Full scale range (FSR)		500 mV and 2.5 V (selectable by software)
Maximum input voltage	500 mV FSR 2.5 V FSR	± 600 mVpk ± 3 Vpk
Input voltage offset		± FSR/2
Input frequency range (-3 dB bandwidth)	@ 2 GS/s	DC to 1.2 GHz *(typical)*
	@ 1 GS/s	DC to 475 MHz *(typical)*
Bandwidth limit filters (BWL)		20 MHz, 200 MHz, 700 MHz *(nominal)*
Effective numbers of bits (ENOB)[1]	@ 410 MHz	9 *(nominal)*
Signal to noise distortion (SNR)	@ 410 MHz	55 dB *(typical)*
Spurious free dynamic range (SFDR)	@ 410 MHz	70 dBc *(nominal)*
Total harmonic distortion (THD)	@ 410 MHz	-70 dBc *(typical)*

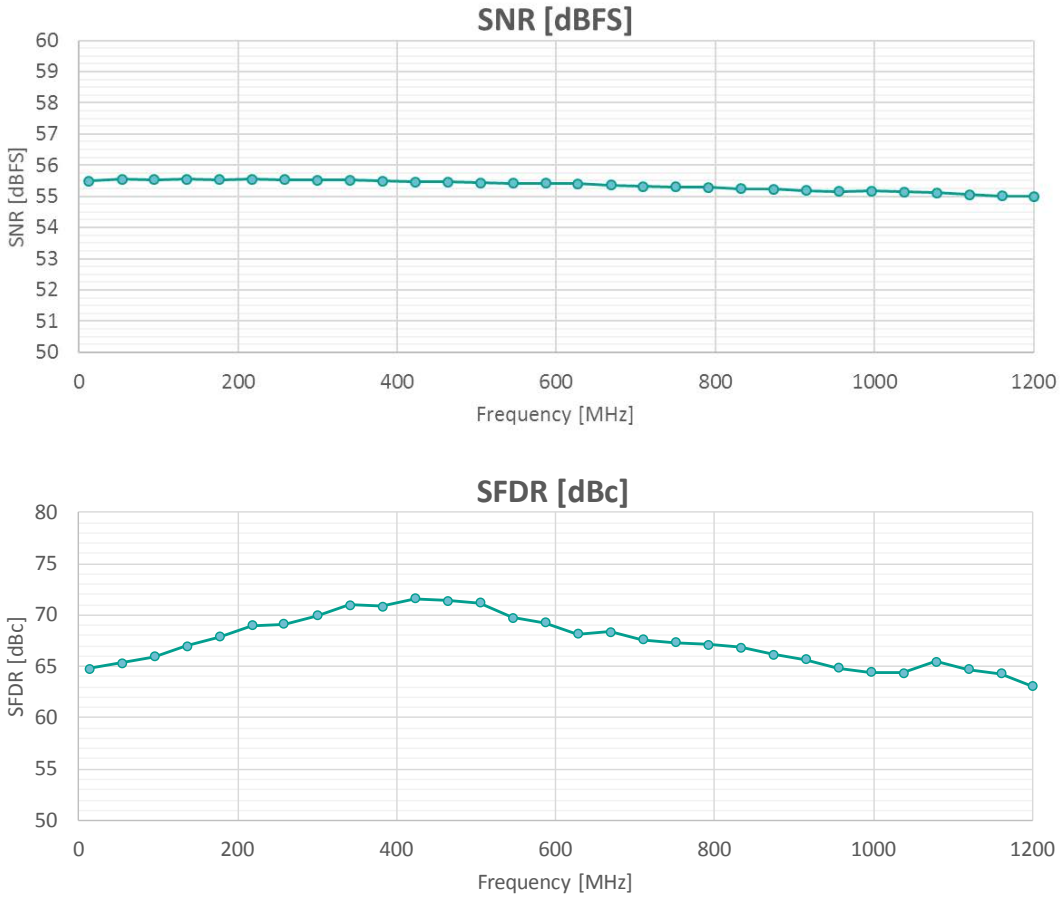

Figure 9. The SA220E offers stable signal performance across the overall bandwidth. Above figure corresponds to the SNR and SFDR measured on 16 channels, at 25°C, 0.5 V FSR, -1 dBFS.

Calibration

The SA220E is factory calibrated and delivered with a certificate of calibration.

1. Measured for a –1 dBFS input signal in internal clock mode at 2 GS/s.

Technical specifications and characteristics

Digital conversion		
Resolution		14 bits
Acquisition memory	-MEA *(default)* -MEB *(optional)*	4 GB (1 GSamples/ch) 8 GB (2 GSamples/ch)
Sample clock source		Internal
Internal clock source		Internal, external reference
Real-time sampling rate	*(default)*	2 GS/s per channel
	-LSR *(optional)*	1 GS/s per channel
Sampling Clock jitter[1]		100 fs *(nominal)*
Clock accuracy		± 1 ppm *(nominal)*
External reference clock (REF IN - MMCX connector)		
Impedance		50 Ω *(nominal)*
Frequency range		10 MHz ± 1 kHz 100 MHz ± 1 kHz
Signal level		-3 dBm to +3 dBm *(nominal)*
Coupling		AC
Acquisition modes		Single record, Multi-record, Streaming
Trigger		
Trigger mode		Positive or negative edge
Trigger source		External, Channel, Software
Channel trigger frequency range		DC to 2.5 GHz *(nominal)*
Trigger time interpolator resolution		6 ps *(nominal)*
Trigger time interpolator precision		15 ps RMS *(nominal)*
Rearm time (deadtime)		< 0.5 µs *(nominal)*
External trigger (TRG IN - MMCX connector)		
Coupling		DC
Impedance		50 Ω
Level range		± 5 V
Minimum amplitude		0.5 V pk-pk
Frequency range		DC to 3 GHz
Trigger out (TRG OUT - MMCX connector)		1 (programmable), 50 Ω source, LVCMOS 3.3 V

1. Jitter figure based on phase noise integration from 100 Hz to 100 MHz in internal reference.

Programmable IO (I/O 1, 2 and 3 - MMCX connectors)		
Output functions		Acquisition active
		Trigger is armed
		Trigger accept re-synchronization
		Reference clock out
	-AVG	Self-trigger
	-AVG	Accumulation active
Output level range		DC coupling, 50 Ω source, LVCMOS 3.3 V
Input function	-AVG	Accumulation enable
Input level range		DC coupling, LVCMOS 3.3 V, max. voltage +5 V

Analog Output (AN OUT 1 and 2 - MMCX connectors)	
Output functions	Application dependent analog signal from a 16-bit DAC, controlled by the internal FPGA
Output level range	DC coupling, 300 Ω source, programmable output up to ± 10 V

System requirements[1]		
Topic	Windows	Linux
Operating systems	Windows 10 (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 9, Ubuntu-16.04, Ubuntu-18.04, 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	As per the minimum requirements of the chosen distribution
Available disk space	1.5 GB available hard disk space, includes 1 GB for Microsoft .NET Framework	100 MB
Display	Minimum of 1024 x 768, 96 or 120 DPI	No display required
Temperature range	Check upon environment requirement. It might not allow to go as high as ADC card allows.	

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 usual 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.

1. Contact support@acqiris.com for a list of recommended host computers.

Technical specifications and characteristics

Quality

Samples of this product have been type tested 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.

Environmental and physical		
Usage		Indoor use recommended (outdoor use is possible, provided the ADC module is within an environment that guarantees indoor conditions)
Pollution degree		2
Temperature range	Operating[1]	0 to +50 °C (sea-level to 6,562 feet)
	Non-operating	-40 to +70 °C
Altitude		Up to 6,562 feet (2 000 meters)
Relative humidity range	Operating[2]	10 % to 90 % RH, non-condensing
	Non-operating[2]	5 % to 95 % RH, non-condensing
Electro-magnetic compliance		Complies with European EMC Directive 2014/30/EU EN 61326-1:2013 (industrial) EN 55011:2016 Group 1, Class A And with international standards : IEC 61326-1:2012 CISPR 11:2015 / AMD1:2016 USA: CFR 47 Part 15, Subpart B, Class A Australia/New Zealand: AS/NZS CISPR 11:2011 Canada: ICES/NMB-001:2006
Safety		The product was tested and found to be in conformity with: IEC 61010-1:2010 IEC 61010-1:2010 / AMD1:2016 And National differences: - EU Group Differences - EU Special National Conditions - EU A-Deviations - AU, CA, KR, US Complies with European LVD Directive 2014/35/EU EN 61010-1:2010
Environmental		Directive 2015/863/EU (RoHS 3) EN 50581 :2012
Acoustic		Acoustic noise emission LpA < 60 dB (nominal) Operator position, Normal operation mode
Power dissipation[3, 4]		
+ 12 V		Power at SA220E DC input connector < 5 A (60 W)
Power supply		
Voltage Range		100-240 VAC +/-10%
Frequency Range		50/60 Hz
AC Current (typ.)		1.3 A
Mechanical characteristics		
Size		15.3 x 27.4 x 5.8 cm (6.02 x 10.8 x 2.3 in.)
Weight		< 2.5 kg (< 5.5 lbs)

1. Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2.
2. Tested in accordance with IEC 60068-2-30 and IEC 60068-2-78.
3. Power measured in digitizer mode.
4. When operated, the airflow input and output of the unit should not be obstructed, and a 60 m^3/h minimum airflow is required.

Configuration and ordering information

Ordering information

Model	Description
SA220E	14-bit ADC module with USB-C, Thunderbolt 3 interface and FPGA signal processing includes: – Power supply – Thunderbolt 3 cable, 50 cm – Thunderbolt lock – 5-year warranty
Configurable options	
Sampling rate version: 2 GS/s (default) or 1 GS/s	
Additional Memory	
Firmware and application options	

Accessories

Model	Description
U5300A-101	MMCX male to SMA male cable, 1 m
U5300A-102	MMCX male to BNC male cable, 1 m
U5300A-117	Mounting brackets for ADC module, 4 pieces

This information is subject to change without notice.

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