Acqiris SA220P
14-bit ADC Card, 2 GS/s, 2 channels with FPGA signal processing
See deeper and sharper than before

Essential features

Accurate and precise measurement
- 14-bit resolution
- 2 GS/s sampling rate on 2 channels
- 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 cards ideal for OEM applications requiring digitizer sampling at wide bandwidth and very high dynamic range, especially at 500 mV full scale range.

The PCIe Gen 3 interface enables high data transfer rate and streaming capabilities to the host computer at up to 6.5 GB/s.

This ADC card occupies a single PCIe slot, offering high performance in a small footprint.

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

New generation of Signal Acquisition cards

The SA2 is Acqiris's high-performance 14-bit ADC card platform, performing fast signal acquisitions from 2 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 SA220P is the entry model of the SA2 product line, enabling 2 GS/s simultaneously on two channels. This unique DC coupled 14-bit digitizer captures waveforms from DC up to 1.2 GHz.

Features depending on your application (options)

Increased recording time:
- Up to 8 GB memory allowing for 4 GSamples
- Streaming capability up to 6.5 GB/s

Real-time processing:
- Very high digitized data throughput thanks to PCI Express Gen 3
- Kintex UltraScale FPGA for on-board signal processing
- Custom real time-processing

Figure 1. SA220P ADC card - Open view.
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 SA220P 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 Card's I/O signals allow for system control.

This PCIe card 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 SA220P enables deeper, faster and more accurate measurement and analysis for final products.

Easy software integration

The ADC cards 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 very fast data interface, the product is compliant with PCI Express 3.0 x8 standard.

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.
Integration

In a host computer or externally, the SA220P signal acquisition card occupies a single half-length PCIe x8 slot, and, additionally, a fan assembly is attached to the rear for effective cooling.

Unique proprietary technology

Our engineering team developed exclusive proprietary integrated circuits enabling excellent signal performances. Indeed, the SA220P 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 SA220P ADC card 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 PCIe connection to the host 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.

Full scale range

The SA220P standard version enables 2 GS/s sampling rate per channel and features selectable full-scale range (FSR) of 500 mV or 2.5 V.

Programmable I/Os

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

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.

<table>
<thead>
<tr>
<th>Software information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported operating systems and host computers</td>
</tr>
<tr>
<td>Standard compliant drivers</td>
</tr>
<tr>
<td>Supported application development environments (ADE)</td>
</tr>
</tbody>
</table>

Software applications

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

This software application can be used to initially explore the ADC card 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.

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.
Application options

Real-time processing matching your system needs

The firmware in the ADC card’s FPGA enables real-time signal processing. Each firmware can 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)

Optional feature:

- Simultaneous acquisition and readout (CST option)

Dedicated application:

- SS-OCT configuration and firmware (SS4 option)

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 2 GS/s, featuring:

- Accumulation from 1 to > 65 000 triggers
- Effective acquisition length up to 1 MSamples
- 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, and 250 MS/s.

Besides, the streaming capabilities of the SA220P allows to readout previously averaged record while performing a new accumulation. The averaging firmware enables multiples and successive averaging sequences without missing any trigger.

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.

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 SA220P 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, and 250 MS/s.
Simultaneous acquisition and readout (CST option)

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. Benefitting from the PCIe Gen 3 interface, the SA220P sustains data transfer to the host at up to 6.5 GB/s.

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, by integrating all SS-OCT processing in the on-board FPGA for real-time computation.

This option supports A-scan rate up to 400 kHz, using a SA220P pre-configured version composed of:
- 2 GS/s sampling rate
- DC to 1.2 GHz bandwidth
- 4 GB acquisition memory

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

\(^1\) 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)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>2</td>
</tr>
<tr>
<td>Impedance</td>
<td>$50 \Omega \pm 2%$ (typical)</td>
</tr>
<tr>
<td>Coupling</td>
<td>DC</td>
</tr>
<tr>
<td>Full scale range (FSR)</td>
<td>500 mV and 2.5 V (selectable)</td>
</tr>
</tbody>
</table>
| Maximum input voltage         | $500 \text{ mV FSR}$  
$2.5 \text{ V FSR}$  
$\pm 600 \text{ mV pk}$  
$\pm 3 \text{ V pk}$         |
| Input voltage offset          | $\pm \text{ FSR/2}$                        |
| Input frequency range (-3 dB bandwidth) | DC to 1.2 GHz (typical)                   |
| Effective numbers of bits (ENOB)$^1$@ 410 MHz | 9 (nominal)                             |
| Signal to noise distortion (SNR)$^1$ @ 410 MHz | 55 dB (typical)                        |
| Spurious free dynamic range (SFDR)$^1$@ 410 MHz | 70 dBc (nominal)                        |
| Total harmonic distortion (THD)$^1$ @ 410 MHz | -70 dBc (typical)                      |

### Digital conversion

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>14 bits</td>
</tr>
<tr>
<td>Acquisition memory -MEA</td>
<td>4 GB (1 GSamples/ch) (default)</td>
</tr>
<tr>
<td>Acquisition memory -MEB</td>
<td>8 GB (2 GSamples/ch) (optional)</td>
</tr>
<tr>
<td>Sample clock source</td>
<td>Internal</td>
</tr>
<tr>
<td>Internal clock source</td>
<td>Internal, external reference</td>
</tr>
<tr>
<td>Real-time sampling rate</td>
<td>2 GS/s per channel</td>
</tr>
<tr>
<td>Clock jitter$^2$</td>
<td>100 fs (nominal)</td>
</tr>
<tr>
<td>Clock accuracy</td>
<td>$\pm 1$ ppm (nominal)</td>
</tr>
<tr>
<td>External reference clock (REF IN MMCX connector)</td>
<td>50 $\Omega$ (nominal)</td>
</tr>
<tr>
<td>Impedance</td>
<td></td>
</tr>
<tr>
<td>Frequency range</td>
<td>10 MHz $\pm$ 1 kHz</td>
</tr>
<tr>
<td>Signal level</td>
<td>-3 dBm to +3 dBm (nominal)</td>
</tr>
<tr>
<td>Coupling</td>
<td>AC</td>
</tr>
<tr>
<td>Acquisition modes</td>
<td>Single record, Multi-record, Streaming</td>
</tr>
</tbody>
</table>

### Calibration

The SA220P is factory calibrated and shipped with a certificate of calibration.

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1. Measured for a $-1$ dBFS input signal in internal clock mode at 2 GS/s.
2. Jitter figure based on phase noise integration from 100 Hz to 100 MHz in internal reference.
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.

System requirements

<table>
<thead>
<tr>
<th>Topic</th>
<th>Windows</th>
<th>Linux</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating systems</td>
<td>Windows 10 (32-bit and 64-bit), All versions</td>
<td>Linux Kernel 2.6 or higher (32 or 64-bit), Debian 8, Ubuntu-16.04, CentOS-7</td>
</tr>
<tr>
<td>Processor speed</td>
<td>1 GHz 32-bit (x86), 1 GHz 64-bit (x64), no support for Itanium 64</td>
<td>As per the minimum requirements of the chosen distribution</td>
</tr>
<tr>
<td>Available memory</td>
<td>1 GB minimum</td>
<td>As per the minimum requirements of the chosen distribution</td>
</tr>
<tr>
<td>Available disk space</td>
<td>1.5 GB available hard disk space; includes: 1 GB for Microsoft .NET Framework</td>
<td>100 MB</td>
</tr>
<tr>
<td>Display</td>
<td>Minimum of 1024 x 768, 96 or 120 DPI</td>
<td>No display required</td>
</tr>
<tr>
<td>Temperature range</td>
<td>Check upon environment requirement. It might not allow to go as high as ADC card allows</td>
<td></td>
</tr>
</tbody>
</table>

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

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**Trigger**

<table>
<thead>
<tr>
<th>Trigger mode</th>
<th>Positive or negative edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger source</td>
<td>External, Channel, Software</td>
</tr>
<tr>
<td>Channel trigger frequency range</td>
<td>DC to 2.5 GHz (nominal)</td>
</tr>
<tr>
<td>Trigger time interpolator resolution</td>
<td>6 ps (nominal)</td>
</tr>
<tr>
<td>Trigger time interpolator precision</td>
<td>15 ps RMS (nominal)</td>
</tr>
<tr>
<td>Rearm time (deadtime)</td>
<td>&lt; 0.5 μs (nominal)</td>
</tr>
</tbody>
</table>

**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

**Programmable IO (I/O 1, 2 and 3 MMCX connectors)**

**Output functions**

- Acquisition active
- Trigger is armed
- Trigger accept resynchronization
- Reference clock out
- Self-trigger
- 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
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

<table>
<thead>
<tr>
<th>Usage</th>
<th>Indoor use recommended (outdoor is possible provided the ADC card is within an environment that guarantee indoor conditions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution degree</td>
<td>2</td>
</tr>
<tr>
<td>Temperature range</td>
<td>Operating(^1,2) 0 to +50 °C (sea-level to 10,000 feet) 0 to +45 °C (10,000 to 15,000 feet)</td>
</tr>
<tr>
<td></td>
<td>Non-operating -40 to +70 °C</td>
</tr>
<tr>
<td>Altitude</td>
<td>Up to 15,000 feet (4 572 meters)</td>
</tr>
<tr>
<td>Relative humidity range</td>
<td>Operating(^3) 10 % to 90 % RH, non-condensing</td>
</tr>
<tr>
<td></td>
<td>Non-operating(^3) 5 % to 95 % RH, non-condensing</td>
</tr>
<tr>
<td>Environmental Directive</td>
<td>2011/65/EU (RoHS) EN 50581 :2012</td>
</tr>
<tr>
<td>Acoustic</td>
<td>Acoustic noise emission LpA &lt; 60 dB (nominal) Operator position, Normal operation mode</td>
</tr>
<tr>
<td>Power dissipation(^4)</td>
<td>+ 3.3 V /+ 12 V Power on PCIe edge connector &lt; 15 W (nominal)</td>
</tr>
<tr>
<td></td>
<td>+ 12 V Power on additional power cable(^5) &lt; 35 W (nominal, firmware dependent)</td>
</tr>
<tr>
<td>Mechanical characteristics</td>
<td>Form factor PCIe x8 standard</td>
</tr>
<tr>
<td>Size</td>
<td>Without fan(^6) 17.6 W x 126.3 H x 169.5 D mm</td>
</tr>
<tr>
<td></td>
<td>With rear fan(^7) 40.6 W x 126.3 H x 244.1 D mm</td>
</tr>
<tr>
<td>Weight</td>
<td>&lt; 1.24 kg (&lt; 2.73 lbs)</td>
</tr>
</tbody>
</table>

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1. Host computer internal ambient temperature at intake of the digitizer’s fan.
2. Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2.
3. Tested in accordance with IEC 60068-2-30 and IEC 60068-2-78.
4. Power measured in digitizer mode.
5. Additional power cable mandatory to ensure adequate power distribution as per PCIe standard.
6. 60 m³/h airflow is required. The unit must be operated with the included fan.
7. Optional rail guide can be ordered to stabilize the PCIe card in the host computer.
### Ordering information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA220P</td>
<td>PCIe 14-bit ADC card with FPGA signal processing includes:</td>
</tr>
<tr>
<td></td>
<td>– Fan assembled on module</td>
</tr>
<tr>
<td></td>
<td>– 5-years standard warranty</td>
</tr>
</tbody>
</table>

#### Configurable options

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
</table>

- Additional Memory
- Firmware and application options
- Card retainer (recommended if the card is assembled horizontally or in harsh environment)

Ordering number format is SA220P-xxxx.

### Accessories

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>U5300A-101</td>
<td>MMCX male to SMA male cable, 1 m</td>
</tr>
<tr>
<td>U5300A-102</td>
<td>MMCX male to BNC male cable, 1 m</td>
</tr>
<tr>
<td>U5300A-001</td>
<td>Card Retainer</td>
</tr>
<tr>
<td>U5300A-003</td>
<td>Short card retainer</td>
</tr>
</tbody>
</table>

This information is subject to change without notice.

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