

# RIDER

Time to **Reinvent** advance signal generation

## ARB Rider 4000 Technical Datasheet



Function Generator, Arb Generator and Digital Pattern Generator all in one.

- 2,5 Gs/s 14 Bit Resolution
- 5Vpp into 50 ohm
- Up to 64 Ms/s per Channel
- Rise and fall time less than 350 ps (direct DAC)
- 16-32 Digital Channels in synchronous with analog Generation
- SimpleRider™ Wizard users Interface

### Key performance specifications

- Basic mode (AFG)
  - Two analog channels
  - 600 MHz sine waveforms
  - 2.5 GS/s, 14-bit, 16 kpts arbitrary waveforms
  - Amplitude up to 5 V<sub>p-p</sub> into 50 Ω load
  - +/- 2.5V programmable offset
- Advanced mode (AWG)
  - Two analog channels
  - 16/32-bit digital channels (optional)

- 1/16/32/64 Mpts per channel arbitrary waveform memory (optional)
- Up to 1 GHz bandwidth
- SFDR < -60 dBc
- 

### Features & benefits

- Sample rate can be programmed in from 100 S/s to 2.5 GS/s, with 14-bit vertical resolution, ensures signal integrity
- Optional arbitrary waveform memory up to 64 Mpts for each analog channel and 32 Mbit for each digital channel for long waveforms
- Optional 16-32 channel digital outputs. Purchasing SW option includes the shipment of digital probe accessory.
- Two operation modes – Basic (DDS AFG mode) and advanced (arbitrary AWG mode)
- Dual analog channels and up to 32-bit digital channels, for mixed signal generation
- Dedicated bus to synchronize up to 4 unit and create a real **8 channel waveform generator**
- Digital outputs provide up to 1.25 Gb/s data rate in LVDS format. LVDS to LVTTTL converters are available
- One marker output for each analog channel for triggering and synchronization
- Three software-configurable output paths to cover all applications:
  - Direct DAC mode: > 1 GHz bandwidth with differential output
  - AC coupled mode: > 1 GHz bandwidth with 10dBm output power for RF applications
  - Amplified mode: 5 V<sub>p-p</sub> amplitude 600 MHz bandwidth with differential output
- Full functional sequence with up to 16384 user defined waveforms provides the possibility of generating complex signals with the best memory usage, in the form of loops, jumps, and conditional branches
- Both channels (together with the corresponding digital output channels) can work independently on different sampling clocks and sequences

- Windows based platform with 7in touch screen, front panel buttons and knob
- Compact form factor, convenient for bench top and fully fit with 3U – 19" rackmount standard
- Removable hard disk guarantees the security of confidential data
- LAN interfaces for remote control

## Applications areas

### IoT and Ind 4.0 perfect RF Modulator

Arb and Function Riders will be the iconic instrument for this applications. The possibility to emulate complex RF I/Q modulation for simulation and Test vs wireless devices or working on Internet of things of industry 4.0 applications. Each engineer may use the possibility to import waveform to emulate devices under test, impose distortion on waveform (such noise) to test the ability of devices to be compliant to the standards.

### Research Applications

Research centers and Universities, are key users of have Rider generator's series.

Complex waveform and/or sophisticated Pulses emulation based variable or multilevel edges could be perfectly created. The combination of fast edge generation, excellent dynamic range and easy to use user interface meet perfectly scientists and engineers working on large experiments such Accelerators, Tokamak or synchrotrons to emulate signals without creating specifics test boards. There are several large experiments where Riders can be the perfect solution to combine high-speed transition time with high channels density.

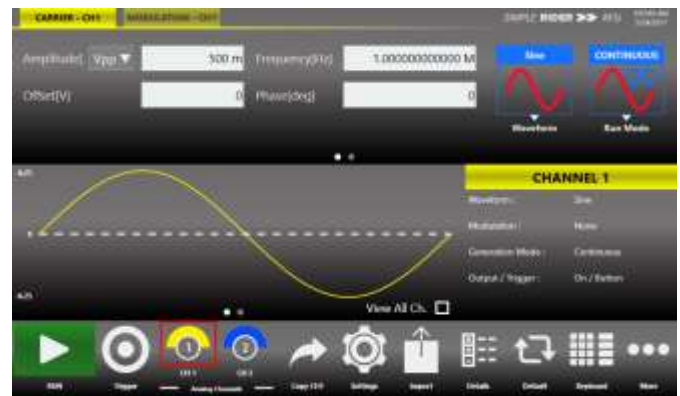
### Army applications

Electronics warfare signals driven by Radar or Sonar systems perfectly match with these generators. Large BW Riders can be used on digital modulation systems for Radio Applications or others I/Q signal modulation. Pulses may be easily generated for applications such Pulse Electron Beam or X Ray Sources, Flash X-ray Radiography, Lighting pulse simulators, high Power Microwave modulators.

### Semiconductors Test

Emulation of complex signals generated with inclusion of noise or distortions may became an excellent way to provide Compliance Components Test to help semiconductors engineers. The fast edges and pulse generation can be used to provide characterization in fast power devices.

### SimpleRider: AFG, AWG and Pulse Wizard Interface



Simple Rider UI is designed for touch and it has been developed to put all the capabilities of modern Waveform Generators right at your fingertips. All instrument controls and parameters are accessed through an intuitive UI that recalls the simplicity of Tablets and modern smart phones: touch features and gestures are available to engineers and scientists to create advanced waveforms or digital patterns in few touches.

- The swipe gesture gives easy access to the output waveform parameters
- A touch-friendly virtual numeric keypad has been designed to improve the user experience on entering the data.
- Time saving shortcuts and intuitive icons simplify the instrument setup.

Arb Rider supports the most common interfaces for remote control (Ethernet) for easy customized instrument programming. **SimpleRider** Touch UI is available on all the instruments of the Rider Series product family.

In Advanced mode, users can define complex waveforms with up to 16,384 entries of analog waveforms and digital patterns in a sequence, in terms of loops, jumps, and conditional branches.



In the Multi-sequence mode, two sequences can be defined to control Channel 1 and Channel 2 (and the corresponding digital channels) separately as two units of generator.

### Best in class performance in its price range

The AWG4000 gives users access to the best-in-class DAC technology at an affordable price. Up to 2.5 GS/s sampling rate and 14-bit vertical resolution help users generate ultra wideband communication signals with 1GHz modulation bandwidth (2GHz in I/Q modulation) and < -60 dBc SFDR across each channel. The analog channels can be configured to output as differential, single ended, or AC

coupled, eliminating the needs of balloons or hybrids in the test path.

### Mixed-signal generation

The AWG4000 has optional 16/32-bit digital outputs, synchronized with the corresponding analog channels in two 16-bit groups. Each group can be configured as 8-bit full speed (bit rate at half the sampling rate) or 16-bit low speed (bit rate at 1/4 of the sampling rate). The mixed signal generation is a great solution for digital designs and validation, system synchronization and DAC/ADC tests.

The digital output pin are native LVDS standard and digital cable to SMA adapter is available



For slower speed application, LVDS to LVTTTL converters are available as well.

### System extension with multi-unit synchronization

Up to four instruments can be synchronized together in order to build a real 8 channel waveform generator system, which is extremely useful in the applications where multiple channels are needed, like MIMO.



## AWG-4022 - Technical Specifications

Document name AWG-4022 - Technical Specifications

Last Date update : 13/12/2017

### Definitions

#### Specification (spec.)

The warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 0 °C to 55 °C and after a 45-minute warm up period. Within  $\pm 10$  °C after autocal. Data published in this document are specifications (spec) only where specifically indicated.

#### Typical (typ.)

The characteristic performance, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement uncertainty, and is valid only at room temperature (approximately 23 °C).

| Specifications                              | AWG-4022                                                                                                                                                                                               |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             |                                                                                                                                                                                                        |
| <b>Number of Channels</b>                   |                                                                                                                                                                                                        |
| Analog                                      | 2                                                                                                                                                                                                      |
| Digital                                     | 0/16/32 – optional                                                                                                                                                                                     |
| Markers                                     | 2                                                                                                                                                                                                      |
| <b>Basic Operation Mode</b>                 | DDS mode                                                                                                                                                                                               |
| Standard Waveforms                          | Sine, Square, Pulse, Ramp, more (Noise, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine)                                                                               |
|                                             | Continuous, modulation, sweep, burst                                                                                                                                                                   |
| Run Modes                                   | Sampling clock: 2.5 GS/s, fixed<br>Vertical resolution: 14-bit                                                                                                                                         |
| Arbitrary Waveforms                         | Waveform length: 16,384 points                                                                                                                                                                         |
| <b>Advanced Operation Mode</b>              |                                                                                                                                                                                                        |
| Run Modes                                   | Continuous, sequencer, triggered, gated                                                                                                                                                                |
| Vertical Resolution                         | 14 bit                                                                                                                                                                                                 |
| Waveform Length                             | 64 to 64 M points (1 M = $2^{20}$ ) in multiple of 64 points for length < 320 points, in multiple of 16 points for length $\geq 320$ points<br>Standard: 1 M points; Optional: 16 M, 32 M, 64 M points |
| <b>General characteristics – Basic mode</b> |                                                                                                                                                                                                        |
| <b>Output Channels</b>                      |                                                                                                                                                                                                        |
| Connectors                                  | SMA's for DC AMP on front panel                                                                                                                                                                        |



|                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Output type<br>Output Impedance                                                                                                                                                                                                                                                                | Single-ended or differential<br>50 $\Omega$ (Single-ended) or 100 $\Omega$ (differential)                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Frequency Range</b><br><br>Sine<br>Square, Pulse<br>Ramp, Exponential Rise, Exponential Decay<br>Sin(x)/X, Gaussian, Lorentz, Haversine<br>Arbitrary                                                                                                                                        | <br><br>1 $\mu$ Hz to 600 MHz<br>1 $\mu$ Hz to 330 MHz<br><br>1 $\mu$ Hz to 30 MHz<br>1 $\mu$ Hz to 60 MHz<br>1 $\mu$ Hz to 400 MHz                                                                                                                                                                                                                                                                                                                                      |
| <b>Frequency Resolution</b><br><br>sine, square, pulse, arbitrary<br>amp, Sin(x)/X, Gaussian,<br>Lorentz, Exponential Rise,<br>Exponential Decay, Haversine                                                                                                                                    | <br><br>1 $\mu$ Hz or 15 digits)<br><br>1 $\mu$ Hz or 14 digits                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Frequency Accuracy</b><br><br>Non-ARB<br>ARB                                                                                                                                                                                                                                                | <br><br>$\pm 10^{-6}$ of setting<br>$\pm 10^{-6}$ of setting $\pm 1$ $\mu$ Hz                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Sine Waves</b><br><br>Flatness (1 V <sub>p-p</sub> , relative to 1 kHz)<br>Harmonic Distortion (1 V <sub>p-p</sub> )<br><br>Total Harmonic Distortion (1 V <sub>p-p</sub> , typical)<br><br>Spurious (1 V <sub>p-p</sub> )<br><br>Phase Noise (1 V <sub>p-p</sub> , 10 kHz offset, typical) | <br><br>DC to 600 MHz : $\pm 0.5$ dB<br>1 $\mu$ Hz to $\leq 10$ MHz: < -60 dBc<br>> 10 MHz to $\leq 50$ MHz: < -55 dBc<br>> 50 MHz to $\leq 200$ MHz: < -40 dBc<br>> 200 MHz to $\leq 600$ MHz: < -28 dBc<br><br>10 Hz to 20 kHz: < 0.1%<br><br>1 $\mu$ Hz to $\leq 10$ MHz: < -65 dBc<br>> 10 MHz to $\leq 330$ MHz: < -55 dBc<br>> 330 MHz to $\leq 500$ MHz: < -50 dBc<br>> 500 MHz to $\leq 600$ MHz: < -40 dBc<br><br>1 MHz: < -115 dBc/Hz<br>10 MHz: < -110 dBc/Hz |



|                                                                                                                                                                                           |                                                                                                                                                                                                               |
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|                                                                                                                                                                                           | 100 MHz: < -105 dBc/Hz<br>600 MHz: < -90 dBc/Hz                                                                                                                                                               |
| <b>Square waves</b><br>Rise/fall time (typical)<br>Overshoot (1 V <sub>p-p</sub> , typical)<br>Jitter (rms, typical)                                                                      | 1 ns<br>< 2%<br><10 ps                                                                                                                                                                                        |
| <b>Pulse waves</b><br>Pulse width<br>Resolution<br>Pulse duty<br>Leading/trailing edge transition time<br>Resolution<br>Overshoot (1 V <sub>p-p</sub> , typical)<br>Jitter (rms, typical) | 1 ns to (Period - 1 ns)<br>10 ps or 15 digits<br>0.1% to 99.9% (limitations of pulse width apply)<br>800 ps to 1000 s<br>1 ps or 15 digits<br>< 2%<br><10 ps with leading/trailing edge transition time ≥1 ns |
| <b>Ramp waves</b><br>Linearity (< 10 kHz, 1 V <sub>p-p</sub> , 100% Symmetry, typical)<br>Symmetry                                                                                        | ≤ 0.1%<br>0% to 100%                                                                                                                                                                                          |
| <b>Other waves</b><br>Noise bandwidth (-3 dB, typical)<br>Noise add<br>Level<br>Resolution                                                                                                | 400 MHz<br>When activated, output signal amplitude is reduced to 50%<br>0.0% to 50% of amplitude (V <sub>p-p</sub> ) setting<br>0.1%                                                                          |
| <b>Arbitrary</b><br>Number of Samples<br>Analog Bandwidth (-3 dB, typical)<br>Rise/fall time (typical)<br>jitter (rms, typical)                                                           | 2 to 16,384<br>400 MHz<br>≤800ps<br>400 ps                                                                                                                                                                    |
| <b>DC</b><br>Range (50 Ω, single-ended)<br>Accuracy                                                                                                                                       | -2.5 V to 2.5 V<br>±(1% of  setting  + 5 mV)                                                                                                                                                                  |
| <b>Amplitude</b><br>Range (50 Ω, single-ended)                                                                                                                                            | 1μHz ~ 350 MHz: 5 mV <sub>p-p</sub> to 5 V <sub>p-p</sub><br>350 MHz ~ 550 MHz: 5 mV <sub>p-p</sub> to 3 V <sub>p-p</sub>                                                                                     |





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| Range (100 $\Omega$ , differential)                                                                                                                                                | 550 MHz ~ 600 MHz: 5 mV <sub>p-p</sub> to 2 V <sub>p-p</sub><br><br>1 $\mu$ Hz ~ 350 MHz: 10 mV <sub>p-p</sub> to 10 V <sub>p-p</sub><br>350 MHz ~ 550 MHz: 10 mV <sub>p-p</sub> to 6 V <sub>p-p</sub><br>550 MHz ~ 600 MHz: 10 mV <sub>p-p</sub> to 4 V <sub>p-p</sub>                                                                                          |
| <b>Amplitude Accuracy</b> (1 kHz sine wave, 0 V offset, > 5 mV <sub>p-p</sub> amplitude, 50 $\Omega$ load)<br><br>Resolution<br><br>Output impedance                               | $\pm(1\%$ of setting + 5 mV)<br><br>1 mV <sub>p-p</sub> or 4 digits<br><br>Single-ended: 50 $\Omega$ , Differential: 100 $\Omega$                                                                                                                                                                                                                                |
| <b>Vocm</b><br><br>Range (50 $\Omega$ load, single-ended)<br>Range (High Z load, single-ended)<br>Accuracy (50 $\Omega$ load, single-ended)<br>Resolution                          | -2.5 V to +2.5 V<br><br>-5 V to +5 V<br><br>$\pm(1\%$ of  setting  $\pm$ 5 mV)<br><br>1 mV or 4 digits                                                                                                                                                                                                                                                           |
| <b>Offset</b><br><br>Range (50 $\Omega$ load, singleended)<br>Range (High Z load, singleended)<br>Accuracy (50 $\Omega$ load, singleended)<br>Resolution                           | $\pm(2.5$ Vpk - Amplitude $\div$ 2)<br><br>$\pm(5$ Vpk - Amplitude $\div$ 2)<br><br>$\pm(1\%$ of  setting  + 5 mV)<br><br>1 mV or 4 digits                                                                                                                                                                                                                       |
| <b>Window</b><br><br>Range (50 $\Omega$ load, single-ended)<br><br><br><br><br><br>Range (100 $\Omega$ , differential)<br><br><br><br><br><br><br><br>Range (High Z, single-ended) | 1 $\mu$ Hz ~ 350 MHz: -5 V to +5 V<br>350 MHz ~ 550 MHz: -4 V to +4 V<br>550 MHz ~ 600 MHz: -3.5 V to +3.5 V<br><br><br><br>1 $\mu$ Hz ~ 350 MHz: -10 V to +10 V<br>350 MHz ~ 550 MHz: -8 V to +8 V<br>550 MHz ~ 600 MHz: -7 V to +7 V<br><br><br><br>1 $\mu$ Hz ~ 350 MHz: -10 V to +10 V<br>350 MHz ~ 550 MHz: -8 V to +8 V<br>550 MHz ~ 600 MHz: -7 V to +7 V |
| <b>Amplitude Modulation (AM)</b><br><br>Carrier waveforms                                                                                                                          | Standard waveforms (except Pulse, DC and Noise), ARB                                                                                                                                                                                                                                                                                                             |



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| Modulation source<br>Internal modulating waveforms<br>Modulating frequency<br>Depth                                                                          | Internal or external<br>Sine, Square, Ramp, Noise, ARB<br>Internal: 500 $\mu$ Hz to 50 MHz, External: 10 MHz maximum<br>0.00% to 120.00%                                                      |
| <b>Frequency Modulation (FM)</b><br>Carrier waveforms<br>Modulation source<br>Internal modulating waveforms<br>Modulating frequency<br>Peak deviation        | Standard waveforms (except Pulse, DC and Noise), ARB<br>Internal or external<br>Sine, Square, Ramp, Noise, ARB<br>Internal: 500 $\mu$ Hz to 50 MHz, External: 10 MHz maximum<br>DC to 300 MHz |
| <b>Phase Modulation (PM)</b><br>Carrier waveforms<br>Modulation source<br>Internal modulating waveforms<br>Modulating frequency<br>Phase deviation range     | Standard waveforms (except Pulse, DC and Noise), ARB<br>Internal or external<br>Sine, Square, Ramp, Noise, ARB<br>Internal: 500 $\mu$ Hz to 50 MHz, External: 10 MHz maximum<br>0° to 360°    |
| <b>Frequency Shift Keying (FSK)</b><br>Carrier waveforms<br>Modulation source<br>Internal modulating waveforms<br>Key rate<br>Hop frequency<br>Numer of keys | Standard waveforms (except Pulse, DC and Noise), ARB<br>Internal or external<br>Square<br>Internal: 500 $\mu$ Hz to 50 MHz, External: 10 MHz maximum<br>1 $\mu$ Hz to 600 MHz<br>2            |
| <b>Phase Shift Keying (PSK)</b><br>Carrier waveforms<br>Modulation source<br>Internal modulating waveforms<br>Key rate<br>Hop phase<br>Numer of keys         | Standard waveforms (except Pulse, DC and Noise), ARB<br>Internal or external<br>Square<br>Internal: 500 $\mu$ Hz to 50 MHz, External: 10 MHz maximum<br>0° to +360°<br>2                      |
| <b>Pulse Width Modulation (PWM)</b><br>Carrier waveforms<br>Modulation source<br>Internal modulating waveforms                                               | Pulse<br>Internal or external<br>Sine, Square, Ramp, Noise, ARB                                                                                                                               |





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| Modulating frequency<br>Deviation range                                                                                                                                                                            | Internal: 500 $\mu$ Hz to 50 MHz, External: 10 MHz maximum<br>0% to 50% of pulse period                                                                                                                                                                                                        |
| <b>Sweep</b><br>Type<br>Waveforms<br>Sweep time<br>Hold/return times<br>Sweep/hold/return time resolution<br>Total sweep time accuracy (typical)<br>Start/stop frequency range<br>Trigger source                   | Linear, Logarithmic, staircase, and user defined<br>Standard waveforms (except Pulse, DC and Noise), ARB<br>50 $\mu$ s to 2000 s<br>0 to (2000 s - 50 $\mu$ s)<br>20 ns or 12 digits<br>$\leq 0.4\%$<br>Sine: 1 $\mu$ Hz to 600 MHz, Square: 1 $\mu$ Hz to 300 MHz<br>Internal/External/Manual |
| <b>Burst</b><br>Waveforms<br>Type<br>Burst count<br>Internal trigger delay<br>Internal trigger delay accuracy (typical)<br>Internal trigger rate<br>Internal trigger interval range<br>Internal trigger resolution | Standard waveforms (except DC and Noise), ARB<br>Trigger or gated<br>1 to 1,000,000 cycles or Infinite<br>0 to 100 s<br>$\pm(0.1\% \text{ setting} + 5 \text{ ps})$<br>0 to 500 s<br>1 $\mu$ s to 500 s<br>2 ns or 12 digits                                                                   |
| <b>General characteristics – Advanced mode</b>                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                |
| <b>Output Channels</b><br>Connectors<br>Output type<br>Output Impedance                                                                                                                                            | SMA's for AMP, DAC, and AC modes on front panel<br>AMP and DAC modes: single-ended or differential, AC mode: single-ended<br>50 $\Omega$ single-ended, 100 $\Omega$ differential                                                                                                               |
| <b>Channels skew</b><br>Skew between positive and negative outputs (typical)<br>Skew control (between channels) – Range<br>Skew control (between channels) – Resolution                                            | $\leq 20 \text{ ps}$<br>0 to 240,000 ps<br>10 ps                                                                                                                                                                                                                                               |



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| Skew control (between channels) – Accuracy<br>Initial skew                                                | $\pm(10\% \text{ of setting} + 20 \text{ ps})$<br>< 200 ps from 1.25 GS/s to 2.5 GS/s, < 1 ns below 1.25 GS/s                                                                                                      |
| <b>Marker skew</b><br>Range<br>Resolution<br>Accuracy (typical)<br>Initial skew                           | 0 to 101,790 ps<br>78 ps<br>$\pm(10\% \text{ of setting} + 140 \text{ ps})$<br>< 1.4 ns from 1.25 GS/s to 2.5 GS/s<br>< 2 ns from 100 MS/s to 1.25 GS/s<br>< 4.5 ns below 100 MS/s                                 |
| <b>Calculated bandwidth (0.35 / rise or fall time, typical)</b><br>AMP<br>DAC<br>AC                       | 460 MHz<br>1 GHz<br>1 GHz                                                                                                                                                                                          |
| <b>Amplitude Range</b> (single-ended, 50 $\Omega$ load)<br>AMP<br>DAC<br>AC                               | 0 to 5 V <sub>p-p</sub> (doubled in case of differential or High Z load)<br>0 to 0.8 V <sub>p-p</sub> (doubled in case of differential or High Z load)<br>0 to 2 V <sub>p-p</sub> (doubled in case of High Z load) |
| <b>Amplitude accuracy</b><br>AMP DAC (1 kHz sine, offset 0 V )<br>AC (100 MHz sine, offset 0 V, typical ) | $\pm(1\% \text{ of setting} + 5 \text{ mV}_{p-p})$<br>$\pm(2\% \text{ of setting} + 5 \text{ mV}_{p-p}) - 0.1\% \text{ of }  \text{setting}  \times \text{temperature deviation}$                                  |
| <b>Amplitude resolution</b><br>AMP, DAC, and AC                                                           | 0.1 mV or 5 digits                                                                                                                                                                                                 |
| <b>Offset range</b> (single-ended, 50 $\Omega$ load)<br>AMP<br>DAC                                        | -2.5 V to +2.5 V (doubled in case of differential or High Z load)<br>-0.35 V to +0.35 V (doubled in case of differential or High Z load)                                                                           |
| <b>Offset accuracy</b><br>AMP, DAC                                                                        | $\pm(1\% \text{ of }  \text{setting}  + 5 \text{ mV})$                                                                                                                                                             |
| <b>Offset resolution</b><br>AMP, DAC                                                                      | 10 mV or 3 digits                                                                                                                                                                                                  |
| <b>Vocm range</b> (single-ended, 50 $\Omega$ load)                                                        |                                                                                                                                                                                                                    |



|                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| AMP<br>DAC                                                                                                                                                                                                    | -2.5 V to +2.5 V (doubled in case of differential or High Z load)<br>-0.35 V to +0.35 V (doubled in case of differential or High Z load)                                                                                                                                                                                                                                                                                                                |
| <b>Vocm accuracy</b><br>AMP<br>DAC                                                                                                                                                                            | $\pm(1\% \text{ of setting} + 5 \text{ mV})$<br>$\pm(6\% \text{ of Vocm range} + 5 \text{ mV})$                                                                                                                                                                                                                                                                                                                                                         |
| <b>Vocm resolution</b><br>AMP, DAC                                                                                                                                                                            | 10 mV or 3 digits                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Voltage window</b> Range (single-ended, 50 $\Omega$ load)<br>AMP<br><br><br>DAC<br><br><br>AC                                                                                                              | $1 \mu\text{Hz to } 300 \text{ MHz: } -5 \text{ V to } 5 \text{ V}$<br>$> 300 \text{ MHz to } 550 \text{ MHz: } -4 \text{ V to } 4 \text{ V}$<br>$> 550 \text{ MHz to } 600 \text{ MHz: } -3.5 \text{ V to } 3.5 \text{ V}$<br>(doubled in case of differential or High Z load)<br><br>$-0.4 \text{ V to } 0.4 \text{ V}$<br>(doubled in case of differential or High Z load)<br><br>$-1 \text{ V to } 1 \text{ V}$<br>(doubled in case of High Z load) |
| <b>Harmonic distortion</b> (Sine wave 32 points at 2.5 GS/s, 78.125 MHz, typical)<br>AMP (1 V <sub>p-p</sub> single-ended)<br>DAC (0.5 V <sub>p-p</sub> single-ended)<br>AC (1 V <sub>p-p</sub> single-ended) | $< -56 \text{ dBc}$ (single-ended or differential)<br>$< -60 \text{ dBc}$ (single-ended or differential)<br>$< -56 \text{ dBc}$                                                                                                                                                                                                                                                                                                                         |
| <b>Spurious</b> (Sine wave 32 points at 2.5 GS/s, 78.125 MHz, typical)<br>AMP (1 V <sub>p-p</sub> single-ended)<br>DAC (0.5 V <sub>p-p</sub> single-ended)<br>AC (1 V <sub>p-p</sub> single-ended)            | $< -62 \text{ dBc}$ (single-ended or differential)<br>$< -62 \text{ dBc}$ (single-ended or differential)<br>$< -55 \text{ dBc}$                                                                                                                                                                                                                                                                                                                         |
| <b>SFDR</b> (Sine wave 32 points at 2.5 GS/s, 78.125 MHz, typical)<br>AMP (1 V <sub>p-p</sub> single-ended)<br>DAC (0.5 V <sub>p-p</sub> single-ended)                                                        | $< -56 \text{ dBc}$ (single-ended or differential)<br>$< -60 \text{ dBc}$ (single-ended or differential)                                                                                                                                                                                                                                                                                                                                                |



|                                             |           |      |        |
|---------------------------------------------|-----------|------|--------|
| AC (1 V <sub>p-p</sub> single-ended)        | < -55 dBc |      |        |
| <b>Rise/fall time (10% to 90%, typical)</b> |           |      |        |
| AMP (1 V <sub>p-p</sub> single-ended)       | < 800 ps  |      |        |
| DAC (0.5 V <sub>p-p</sub> single-ended)     | < 350 ps  |      |        |
| AC (1 V <sub>p-p</sub> single-ended)        | < 350 ps  |      |        |
| <b>Overshoot (typical)</b>                  |           |      |        |
| AMP (1 V <sub>p-p</sub> single-ended)       |           | < 2% | 800 ps |
| DAC (0.5 V <sub>p-p</sub> single-ended)     |           | < 1% | 450 ps |
| AC (1 V <sub>p-p</sub> single-ended)        |           | < 2% | 450 ps |



| Timing and Clock                                                                                     |                                                                                                         |
|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Random jitter on clock pattern (rms, typical)<br>AMP, DAC                                            | < 5 ps                                                                                                  |
| Total jitter on random pattern (peak-to-peak at 625 Mb/s, PRBS 15 data pattern, typical)<br>AMP, DAC | < 150 ps                                                                                                |
| Digital outputs (Optional)                                                                           |                                                                                                         |
| Output Channels                                                                                      | Mini-SAS HD connector on front panel                                                                    |
| Connectors                                                                                           | 2                                                                                                       |
| Number of connectors                                                                                 | 32-bits (16-bits x 2 groups)                                                                            |
| Number of outputs                                                                                    |                                                                                                         |
| Output impedance                                                                                     | 100 $\Omega$ differential                                                                               |
| Output type                                                                                          | LVDS                                                                                                    |
| Rise/fall time (10% to 90%, typical)                                                                 | 600 ps                                                                                                  |
| Initial skew between digital outputs (typical)                                                       | < 500 ps between group A and B                                                                          |
| Jitter (peak-to-peak, 2.5 GS/s, 1.25 Gb/s, PN15 pattern, BER = 1e-12)                                | 150 ps                                                                                                  |
| Maximum update rate                                                                                  | 1.25 Gbps (full speed mode, maximum 16-bit) 625 Mbps (low speed mode, maximum 32-bit)                   |
| Memory depth (optional)                                                                              | Half of analog waveform length (full speed mode), One fourth of analog waveform length (low speed mode) |
| Auxiliary input and output characteristics (Marker out)                                              |                                                                                                         |
| Connector type                                                                                       | SMA on front panel                                                                                      |
| Number of connectors                                                                                 | two, one for each analog output                                                                         |
| Output impedance                                                                                     | 50 $\Omega$                                                                                             |
| Output level (into 50 $\Omega$ )                                                                     | 1 V to 2.5 V                                                                                            |
| Resolution                                                                                           | 10 mV                                                                                                   |
| Accuracy (typical)                                                                                   | $\pm(2\% \text{ setting} + 10 \text{ mV})$                                                              |
| Variable delay control                                                                               | 0 to 60606 ps                                                                                           |
| Resolution                                                                                           | 78 ps                                                                                                   |



|                                                                                                                      |                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Accuracy (typical)                                                                                                   | $\pm(10\% \text{ of setting} + 140 \text{ ps})$                                                                    |
| Rise/fall time (10% to 90%,<br>2.5 V, typical)                                                                       | 800 ps                                                                                                             |
| Total jitter on random pattern (peak-to-peak, 2.5 GS/s, 1.25 Gb/s, PN15 pattern, output level 2.5 V, BER = $1e-12$ ) | 155 ps                                                                                                             |
| Trigger/Gate input                                                                                                   |                                                                                                                    |
| Connector                                                                                                            | SMA on the Front Panel                                                                                             |
| Input impedance                                                                                                      | 1.1 k $\Omega$                                                                                                     |
| Slope/Polarity                                                                                                       | Positive or negative selectable                                                                                    |
| Input damage level                                                                                                   | < -15 V or > +15 V                                                                                                 |
| Threshold control level                                                                                              | -10 V to 10 V                                                                                                      |
| Resolution                                                                                                           | 50 mv                                                                                                              |
| Threshold control accuracy (typical)                                                                                 | $\pm(10\% \text{ of }  \text{setting}  + 0.2 \text{ V})$                                                           |
| Input voltage swing                                                                                                  | 0.5 V <sub>p-p</sub> minimum                                                                                       |
| Minimum pulse width                                                                                                  | 12 ns                                                                                                              |
| Initial trigger/gate delay to Analog Output                                                                          | Basic mode: 384.6 ns $\pm$ 50 ps<br>Advanced mode: 20 ns + 2288 sampling clock cycles $\pm$ 1 sampling clock cycle |
| Trigger In to output jitter (typical)                                                                                | < 50 ps                                                                                                            |
| Auxiliary input and output characteristics                                                                           |                                                                                                                    |
| Sync in/out                                                                                                          |                                                                                                                    |
| Connector type                                                                                                       | Infiniband 4X connector on rear panel                                                                              |
| Master to Slave delay (typical)                                                                                      | 48.6 ns                                                                                                            |
| Reference clock input                                                                                                |                                                                                                                    |
| Connector type                                                                                                       | SMA on rear panel                                                                                                  |
| Input impedance                                                                                                      | 50 $\Omega$ , AC coupled                                                                                           |
| input voltage range                                                                                                  | -5 dBm to 4 dBm sine or square wave                                                                                |
| Damage level                                                                                                         | +8 dBm or $\pm 15 \text{ V}_{DC}$ Max                                                                              |
| Variable Input Frequency range                                                                                       | 10 MHz to 80 MHz                                                                                                   |
| Reference clock output                                                                                               |                                                                                                                    |
| Connector type                                                                                                       | SMA on rear panel                                                                                                  |
| Output impedance                                                                                                     | 50 $\Omega$ , AC coupled                                                                                           |
| Frequency                                                                                                            | 10 MHz                                                                                                             |



|                                      |                                                                                                                                                                        |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accuracy                             | $\pm 1.0 \times 10^{-6}$                                                                                                                                               |
| Aging                                | $\pm 1.0 \times 10^{-6}/\text{year}$                                                                                                                                   |
| Amplitude (typical)                  | 1.6 V <sub>p-p</sub> into 50 $\Omega$ , 3.2 V <sub>p-p</sub> into High Z                                                                                               |
| Jitter (rms, typical)                | 11.5 ps                                                                                                                                                                |
| <b>External Sampling Clock input</b> |                                                                                                                                                                        |
| Connector type                       | SMA on rear panel                                                                                                                                                      |
| Input impedance                      | 50 $\Omega$ , AC coupled                                                                                                                                               |
| Number of inputs                     | Two, one for each channel                                                                                                                                              |
| Frequency range                      | 1.25 GHz to 2.5 GHz                                                                                                                                                    |
| Input voltage range                  | -5 dBm to 4 dBm                                                                                                                                                        |
| Damage level                         | +8 dBm or $\pm 15$ V <sub>DC</sub> Max                                                                                                                                 |
| <b>External Modulation input</b>     |                                                                                                                                                                        |
| Connector type                       | SMA on rear panel                                                                                                                                                      |
| Input impedance                      | 10 K $\Omega$                                                                                                                                                          |
| Number of inputs                     | Two, one for each channel                                                                                                                                              |
| Bandwidth (typical)                  | 10 MHz with 50 MS/s sampling rate                                                                                                                                      |
| Input voltage range                  | -1 V to +1 V (except FSK, PSK) FSK, PSK: 3.3 V                                                                                                                         |
| Vertical resolution                  | 14-bit                                                                                                                                                                 |
| <b>Power</b>                         |                                                                                                                                                                        |
| Voltage range                        | 100-240 VAC $\pm 10\%$                                                                                                                                                 |
| Frequency range                      | 47-63 Hz                                                                                                                                                               |
| Max. power consumption               | 120 W                                                                                                                                                                  |
| <b>Environmental characteristics</b> |                                                                                                                                                                        |
| Temperature (operating)              | +0 °C to +50 °C (+32 °F to 122 °F)                                                                                                                                     |
| Temperature (non-operating)          | -20 °C to +85 °C (-4 °F to 185 °F)                                                                                                                                     |
| Humidity (operating)                 | 8% to 90% relative humidity with a maximum wet bulb temperature of 29°C at or below +50°C, (upper limit de-rates to 20.6% relative humidity at +50°C). Non-condensing. |
| Humidity (non-operating)             | 5% to 98% relative humidity with a maximum wet bulb temperature of 40°C at or below +60°C, upper limit de-rates to 29.8% relative humidity at +60°C. Non-condensing.   |
| Altitude (operating)                 | 3,048 meters (10,000 feet) maximum                                                                                                                                     |
| Altitude (non-operating)             | 12,000 meters (39,370 feet) maximum                                                                                                                                    |





| EMC and safety          |                                                                                                                                                |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Safety                  | UL61010-1, CAN/CSA C22.2 No.61010-1,<br>EN61010-1, IEC61010-1                                                                                  |
| Emissions               | CISPR 11, Class A, EN61000-3-2:2006, EN 61000-3-3:1995                                                                                         |
| Immunity                | EN 61326-1:2006, IEC 61000-4-2:2001, IEC 61000-4-3:2002,<br>IEC 61000-4-4:2004, IEC 61000-4-5:2001, IEC 61000-4-6:2003,<br>IEC 61000-4-11:2004 |
| Regional certifications |                                                                                                                                                |
| European union          | EN61326-1                                                                                                                                      |
| Australia/New Zealand   | CISPR 11:2003                                                                                                                                  |

| General characteristics |                                                                                                                                                                                                                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Display                 | 7 inch, 1024x600, capacitive touch LCD                                                                                                                                                                                                                                                                  |
| Operative System        | Windows 10                                                                                                                                                                                                                                                                                              |
| External Dimensions     | W 445 mm – H 135 mm – D 320 mm<br>(3U 19" rackmount)                                                                                                                                                                                                                                                    |
| Weight                  | 21.4 lbs (9.7 Kg)                                                                                                                                                                                                                                                                                       |
| Front panel connectors  | CH1 OUTPUT+ (SMA)<br>CH1 OUTPUT- (SMA)<br>CH1 AC (SMA)<br><br>CH2 OUTPUT+ (SMA)<br>CH2 OUTPUT- (SMA)<br>CH2 AC (SMA)<br><br>MARKER OUT 1 (SMA)<br>MARKER OUT 2 (SMA)<br>TRG.IN (SMA)<br><br>DIGITAL POD A[7..0]<br>DIGITAL POD B[7..0]<br>DIGITAL POD C[7..0]<br>DIGITAL POD D[7..0]<br>2 USB 3.0 ports |



|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rear panel connectors | Ref. Clk. IN (SMA)<br>Ext.Clk.In Ch1 (SMA)<br>Ext.Clk.In Ch2 (SMA)<br>Ext.Mod.In Ch1 (SMA)<br>Ext.Mod.In Ch2 (SMA)<br>Ref.Clk.Out (SMA)<br>Sync. Out (Infiniband 4X)<br>Sync. In (Infiniband 4X)<br>Pattern Jump In (DSUB-15)<br><br>External Monitor ports (DVI, VGA)<br><br>4 USB 2.0 ports<br>2 USB 3.0 ports<br><br>Ethernet port (10/100/1000BaseT Ethernet, RJ45 port)<br><br>Audio In/Out ports<br><br>2 PS/2 keyboard and mouse ports |
| Hard Disk             | 256 GB SSD                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Processor             | Intel® I3-4170, 3.7 Ghz (or better)                                                                                                                                                                                                                                                                                                                                                                                                           |
| Processor Memory      | 8 GB                                                                                                                                                                                                                                                                                                                                                                                                                                          |