

GaGe is a worldwide industry leader in high-speed data acquisition solutions featuring a portfolio of the highest performance Digitizers, PC oscilloscope software, powerful SDKs for custom application development, and turnkey integrated PC-based measurement systems. GaGe is a product brand of Vitrek, LLC, a USA ISO 9001:2015 Certified Company.



# APPLICATIONS

- Wideband Signal Analysis RADAR Design and Test Signals Intelligence Ultrasonic Non-Destructive Testing LIDAR Systems Communications Optical Coherence Tomography Mass Spectroscopy Ultrasound Imaging Time of Flight Life Sciences
- **Particle Physics**

# **GaGe Product Overview**

# World Leader in High-Speed Digitizers



# FEATURES

- High-Speed Software Selectable A/D Sampling Rates up to 6 GS/s
- Analog Input Bandwidth up to 1.75 GHz with ±0.5 dB Flatness to 1.25 GHz
- Best ENOB, SNR, SFDR Dynamic Performance Over Wide Frequency Ranges:
  - True ENOBs of over 11-Bits for 14-Bit and 16-Bit Digitizers
  - True ENOBs of over 10-Bits for 12-Bit Digitizers
  - True ENOBs of over 7-Bits for 8-Bit Digitizers
- Up to 16 GB of Deep Onboard Digitizer Sample Memory
- Advanced Real-Time eXpert FPGA DSP Routines:
  - Signal Averaging, OCT, Ultrasonic NDT Position Encoder, FFT, DDC
- Up to 6 GB/s Gap-Free Real-Time Sustained PCIe Data Streaming Rates
- Stream Acquired Signal Data to GPU for In-Line Processing in Real-Time
- Stream Acquired Signal Data to Storage for Real-Time Recordings
- Ease of Integration with External or Reference Clock In & Clock Out
- External Trigger In & Trigger Out with Advanced Triggering Operations
- Large Channel Counts with Synchronized Sampling
- Programming-Free Operation with GaGeScope PC Oscilloscope Software
- Programming-Free Recording & Playback with DsScope & DsScopeView
- Software Development Kits Available for C/C#, LabVIEW and MATLAB
- Windows and Linux Operating Systems Supported



## Digitizer Dynamic Parameter Performance that is Best-in-Class!

GaGe high-performance Digitizers are renowned for sustaining the maximum effective number of bits (ENOB) over a wide signal frequency range with quality signal conditioning and signal fidelity features.

Most engineers and scientists focus on sample rate and resolution when selecting high-speed Digitizer products. Those "banner specs" will usually narrow the pool of candidates in the final selection. To really understand the true overall Digitizer performance, the best specification to use is ENOB, or Effective Number of Bits.

The most widely used definition for ENOB is:

ENOB = (SINAD - 1.76) / 6.02

Where all values above are given in dB. SINAD is the signal to noise and distortion ratio, again in dB.

The use of ENOB allows one to evaluate the entire performance of the Digitizer under consideration. It includes errors and non-linearity in the data converter chip, the front end analog amplifier, sample clock jitter, and interleave function if used to extend the sample rate. To be used effectively in comparing Digitizer products, one should look at ENOB versus frequency - ENOB is usually much better at lower frequencies.

Drawing on experience from the development of many generations of Digitizer product, the engineers designing GaGe products have created proprietary methods and tests to maximize ENOB. Today GaGe Digitizer products consistently have best in class ENOB specifications for a given resolution and sample rate.

Figure 1 is a good example, comparing GaGe Digitizers to similar competitive products from other suppliers. Note the ENOB specifications for the GaGe Digitizer models remains almost flat at higher frequencies, versus the trend of other products to dramatically decrease as frequency increases. The GaGe 12-bit Digitizers have much better ENOB than competitor "Z's" 16-bit product at test frequencies above 30 MHz!

Figure 2 shows another case of the ENOB comparisons between the GaGe 8-bit Cobra Digitizer and competitive products. Again, the GaGe ENOB remains fairly flat across frequency, and easily beats a competitor's 10-bit design.

Customers have acknowledged the GaGe difference in Digitizer ENOB performance as well. Recently an engineer told us about ENOB tests they performed on many new 12-bit, 1 to 2 GS/s Digitizer products. Their results showed the GaGe CS121G2 CompuScope 2 GS/s Digitizer had 1.5 more effective bits than the other new models. This meant their system dynamic range was increased by about 9 dB by selecting GaGe.

If your company is pushing the limits, and wants the best measurement technology available today, look carefully at specifications beyond resolution and speed, and include ENOB in your final decision. Look to GaGe for the leading products in high-speed Digitizer technology.







ENOB vs. Frequency for 8-bit to 10-bit Digitizers



# Deep Digitizer Memory to Enhance Digitizer System Performance

Digitizer memory can be used in many ways to greatly enhance the Digitizer system's performance. The size of onboard Digitizer memory is one of the most important specifications for users interested in real-time data capture, streaming, or triggered event capture.

In general, onboard Digitizer memory can be used in 3 ways:

- For real-time storage of continuous gap-free waveforms (see Table 1 for data recording times versus sample rates for various Digitizer memory sizes).
- The Digitizer memory is segmented, and then used to store waveforms acquired at extremely fast trigger rates, (i.e. say, 500 kHz trigger rates).
- 3. The Digitizer memory is used as a large first in, first out (FIFO) buffer for streaming data in real-time to the PC. In this case, the large Digitizer memory allows for asynchronous data collection by the Digitizer, and post processing by the PC. The large Digitizer memory allows for PC OS interruptions, so that the PC does not need to synchronize actions with the Digitizer. The multi-GS (GigaSample) buffer allows for intense PC post processing delays by graphics, LAN, storage drives, and other operations.

Most importantly, deep Digitizer memory provides *real-time, multi-channel synchronized data recording* capability, in a way that can't be done by other means, due to high-speed multi-GS/s sample rates. In all 3 cases above, the more Digitizer memory, the better.

GaGe PCI Express (PCIe) Digitizers lead the data acquisition industry for onboard Digitizer memory capacity. GaGe PCIe Digitizers have both the largest standard size onboard Digitizer memory – **1** GS or **2** GS – and the greatest optional onboard Digitizer memory upgrade capacities – up to 4 GS, 8GS and 16 GS –available from any Digitizer supplier.

16 GS of onboard Digitizer memory for 8-bit resolution sampling, and 8 GS of onboard Digitizer memory for 12-bit / 14-bit / 16-bit resolution sampling leads the world today in total memory depth for PCIe Digitizers.

Using the GaGe Cobra Express PCIe Digitizer for example, this would allow for 16 seconds of single channel 8-bit real-time recording at 1 GS/s (Table 1), without using large disk arrays, or transferring any data in real-time to the computer.

This large amount of Digitizer onboard recording memory can now be used effectively with Windows 64-bit OS that allow complimentary large memory in the PC for data offloading, post processing, and storage.

Plus GaGe turnkey PC oscilloscope software, GaGeScope, fully supports post processing from the maximum optional Digitizer memory configurations. This allows turnkey, multi-channel scope like systems to be built with no programming required.

Table 1:									
	Sample Rate								
	4 GS/s	2 GS/s	1 GS/s	1 GS/s 500 MS/s		100 MS/s			
Digitizer Memory	Memory Recording Times (seconds)								
16 GS	4	8	16	32	80	160			
8 GS	2	4	8	16	40	80			
4 GS	1	2	4	8	20	40			
2 GS	0.5	1	2	4	10	20			
256 MS	0.062	0.125	0.25	0.5	1.25	2.5			
16 MS	0.004	0.008	0.015	0.031	0.08	0.15			

Recording Time vs Digitizer Memory	y Capacity for	Various Sample Rates
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So, how does GaGe onboard Digitizer memory stack up to the competition? We recently surveyed and summarized an onboard memory comparison of GaGe PCIe Digitizers to other Digitizer suppliers, for models in the same approximate sample rate and performance ranges:



Standard Digitizer Base Model Memory Capacity of 6 Competitive Models Figure 2:



Maximum Digitizer Model Memory Capacity of 6 Competitive Models

For maximum optional Digitizer memory, the 16 GS provided by the GaGe 8-bit PCIe Digitizer is again 4 times larger than any other Digitizer supplier's capability. It is currently the largest high speed Digitizer memory available from any scope or Digitizer supplier; and it is surprisingly low priced as compared to the price charged for additional memory on other competing Digitizer products.



# Powerful and Programming-Free Software

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GaGeScope

PC Oscilloscope Software

GaGeScope is a solutions oriented PC oscilloscope software package that allows users to quickly and easily control GaGe's advanced CompuScope Digitizers without having to write a single line of code. Data can be displayed, analyzed, printed and saved with an easy-touse Windows-based user interface.

GaGeScope Lite Edition is included and provided free of charge with any CompuScope Digitizer model. Optional upgrades to the Standard or Professional Editions of GaGeScope provide access to more advanced features and functionalities.

Features Include:

- Capture, Display & Analyze Waveforms from up to 60 Channels
- Acquisition, Display, and Analysis of Data Sets up to 4 GS
- Quick Data Transfer to Analysis Packages such as MATLAB,
- Powerful FFT Analysis with up to 4 Million Point FFTs Possible
- Automatically Measure and Display Rise Time, Fall Time,
- Pulse Width, Frequency, Amplitude
- Save Transient Signals to Disk with Date and Time Stamp
- AutoSave Feature Saves both Pre- and Post-Trigger Data
- Average Virtually Unlimited Captures to Cancel Random Noise
- Co-Adding (Averaging without Dividing the Result) Available
- Allows Numerical Differentiation, Integration, Auto-Correlation and Cross-Correlation
- Creation of Sub-Channels based on Signal Features and Trigger

# DsScope & DsScopeView Signal Recording & Playback Viewer Software



DsScope is a Windows based PC oscilloscope application that allows the operator to view/edit all Digitizer hardware settings, display acquired signal data, and conduct real-time signal recording monitored operations to drive storage.

DsScope queries the system for available supported Digitizer models upon startup for selected operation and provides the ability to save established settings to a configuration file that can later be opened and applied, thus saving time from manually re-applying settings for repetitive configurations.

Analysis displays include Time Domain, Frequency Domain, and Spectrogram. Multiple display type windows can be opened and shown simultaneously with auto tile and cascade options or manually sized and placed as desired.

Display windows include support for scope cursors to navigate through the display and obtain measurements. Cursor Track Mode can be enabled to lock the position of the two placed cursors. When locked, the spacing between cursors remains constant as they are moved through the display of data.

The primary advantage of DsScope is the ability to conduct real-time streaming signal recordings to drive storage with provided monitoring capability to ensure the recording process is operating with expected signal data and without errors.

DsScopeView is a Windows based application that allows an operator to open/view and playback to display previously recorded signal data files for analysis, with additional display capabilities that include persistence and histogram modes.

Playback operations utilize familiar navigation toolbar buttons for starting playback, stopping playback, stepping backwards and forwards, and moving back to start. When the Enable Playback Looping option is enabled, the time domain data will loop from the end of the file back to the beginning when the end of file is reached. If the option is disabled the playback ceases once the end of the file has been reached.



#### Software Development Kits

GaGe provides extensive software for custom application development with optional Software Development Kits (SDKs) for C/C#, MATLAB, and LabVIEW. All SDKs provide several powerful programming examples illustrating the use of the Digitizer hardware in different operating modes. These sample programs serve as a starting point for users to develop customized software applications optimized for their specific application requirements.

#### eXpert FPGA Processing Firmware Options

The default Digitizer configuration can store raw acquired waveform data and transfer them quickly to the user for analysis, display and/or storage.

The addition of optional eXpert FPGA processing firmware features allow for some signal processing analysis to be performed on the Digitizer hardware itself within its onboard Field Programmable Gate Array (FPGA).

There are three primary advantages to the processing of waveform data using an eXpert firmware option. First, data can be processed at full sampling rate speeds, where data rates may exceed what can be sustained for streaming over the PCIe bus to other targeted processing devices. Second, processing data onboard the Digitizer hardware reduces the data processing load on the host computer. Third, onboard processing may provide data reduction that reduces the data transfer traffic on the host bus and allow for a greater raw data acquisition rate.

eXpert FPGA feature packages are loaded from an onboard flash memory module and are designed to be transparent to the standard Digitizer drivers for Windows/Linux. Only one eXpert FPGA feature can be utilized at a time.

eXpert FPGA feature packages can be purchased at any time and can be implemented on Digitizers already in use in the field by existing customers without requiring the Digitizer to be returned to GaGe for reprogramming.

GaGe can also develop customized firmware to meet specific customer application requirements. Please contact us with a summarized listing of application requirements to evaluate for design feasibility. Pricing for customized FPGA development is highly dependent on the scope of the project work and on expected product volume. Current eXpert FPGA features available for the RazorPlus Express include:

eXpert FPGA Feature	Feature Description					
PCIe Data Streaming	Allows for data streaming mode of acquired data directly through the PCIe interface to the host PC RAM and on to targeted host based CPU or dedicated processing cards for analysis and/or to high-speed storage systems for real-time signal recordings.					
Signal Averaging	Allows for detection of very small repetitive signals in a noisy environment. Using rapid signal averaging, small signals can be extracted from a background of high amplitude noise, which may even be larger than the actual signal itself.					
Optical Coherence Tomography (OCT)	Supports variable rate k-clocking or inactive external clock by simultaneously digitizing the interferometer signal with the returned optical signal for use with OCT applications.					
Fast Fourier Transform (FFT)	Performs 8192 point FFT calculation analysis directly on the Digitizer and transfer of multiple Fourier Spectra to the host PC in a single PCIe transfer.					

#### CompuScope GPU CUDA Processing

Optionally stream acquired data from the Digitizer to highperformance Graphic Processing Units (GPUs) for signal processing and data recording in real-time!



Utilize high-performance GPU cards to take advantage of the familiar C programming development environment with powerful multi-core parallelized vector processing for real-time signal processing routines on the streamed signal data.

Gage CompuScope C SDK ready-made compiled sample programs illustrate PCIe data streaming to GPU and effective exploitation of GPU parallelized vector processing to attain 10X ~ 100X faster analysis rates than host CPU.

This enables end users to quickly and easily begin working with GPU cards, focusing on the development of their custom in-line processing routines that is unique to their application. Projects can be developed rapidly and are more transportable working in a C programming environment with the GPU CUDA library.



#### **Multi-Card Systems**

Multiple Digitizer cards can work together either within a single system or across multiple systems in three possible configurations: Independent, Synchronized Cascade, or Synchronized Split.

In an Independent configuration, each card simply operates independently within the system.

In a Synchronized Cascade configuration, each card operates together as a group by cascading the trigger signal via the Trigger Out. The Clock Out can be similarly cascaded if synchronous clocking is required. This mode has a small constant delay between each channel but requires no external clocking source or RF splitters.

In a Synchronized Split configuration, each card operates together as a group by splitting the trigger signal to each card's Trigger In using an RF power splitter (not a BNC Tee) and same equal length cables. This can also be done with the External Clock input if synchronous clocking is required. This mode requires more external hardware but provides the best simultaneity between multiple cards.

# **Thunderbolt 3 Options**



In Thunderbolt 3 mode, up to four lanes of PCIe Gen3 is supported for a maximum rate of 32 Gbps (4 GB/s); making it an ideal match for optimal data transfer performance of our PCIe Gen3 Digitizers to connected PC devices.

# Sig-Station System Options



Optional Sig-Stations are available for providing complete turn-key systems for our Digitizers. Sig-Stations are highperformance PC workstations that are designed specifically for integrating GaGe advanced instruments and maximizing their operational performance.

For real-time operations, it is critical that the underlying host platform is fully capable of sustaining high-speed PCIe data streaming rates to and from multiple instruments. Traditional lower cost desktop based platforms often restrict performance capabilities by placing multiple PCIe slots behind shared PCIe switches. Sig-Station systems utilize dedicated bandwidth PCIe slot architecture for maximum sustained PCIe streaming rates for multiple instruments operating together simultaneously.

Sig-Stations come with all GaGe cards, features, and software fully tested and installed so that the user can be up and running with their system solution right out of the box; thus saving time and minimizing risks of self-integrated systems. Custom system configurations can be defined to meet specific customer application requirements.

These systems incorporate the latest in PC-based technology and utilize workstation class motherboards with multiple dedicated bandwidth PCIe slots, high multi-core count Xeon CPUs, and large system memory capacity. Integrated highspeed data storage systems for real-time signal recording applications requiring a guaranteed continuous sustained data streaming rate with no missing data can be included.

Contact us to configure a system tailored for your application.



# CompuScope Digitizer PCI Express (PCIe) Card Specification Matrix



	8-1	Bit	12-	-Bit		14-Bit					16-Bit		
Spec	COBRAMAX	COBRA	EON	RAZOR	RAZOR	OCTOPUS	OCTAVE	RAZORMAX	RAZORPLUS	RAZOR	OSCAR	OCTOPUS	
US Starting \$	\$7,725	\$6,560	\$13,915	\$5,300	\$6,455	\$5,710	\$4,125	\$9,080	\$8,660	\$8,030	\$4,940	\$6,560	
			•		F	Performance			•				
A/D Resolution	8-Bit	8-Bit	12-Bit	12-Bit	14-Bit	14-Bit	14-Bit	16-Bit	16-Bit	16-Bit	16-Bit	16-Bit	
# of Channels (CH) per Card	1 or 2	1 or 2	1 or 2	2 or 4	2 or 4	8	2 or 4	2 or 4	2	2 or 4	2 or 4	8	
Maximum Sampling Rate Per Channel	4 GS/s: 1 CH 2 GS/s: 2 CH	2 GS/s: 1 CH 1 GS/s: 2 CH	6 GS/s: 1 CH 3 GS/s: 2 CH	200 MS/s	200 MS/s	125 MS/s	125 MS/s	1 GS/s or 500 MS/s	500 MS/s or 250 MS/s	200 MS/s	100 MS/s	25 MS/s	
Minimum Sampling Rate	5 kS/s	2 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	1 kS/s	
# of Software Selectable A/D Rates	19	20	27	17	17	20	20	31	30	17	16	15	
Onboard Sample Memory	2 GS (2 GB) to 16 GS (16 GB)	2 GS (2 GB) to 16 GS (16 GB)	2 GS (4 GB) to 4 GS (8 GB)	4 GS (8 GB) to 8 GS (16 GB)	4 GS (8 GB) to 8 GS (16 GB)	2 GS (4 GB) to 8 GS (16 GB)	2 GS (4 GB) to 8 GS (16 GB)	4 GS (8 GB)	4 GS (8 GB)	4 GS (8 GB) to 8 GS (16 GB)	2 GS (4 GB) to 8 GS (16 GB)	2 GS (4 GB) to 8 GS (16 GB)	
					In	put Channels							
Connectors	SMA	SMA	SMA	SMA	SMA	SMB	SMA	SMA	SMA	SMA	SMA	SMB	
Impedance	50 Ω	50 Ω	50 Ω	50 Ω & 1M Ω	50 Ω & 1M Ω	50 Ω & 1M Ω	50 Ω & 1M Ω	50 Ω	50 Ω & 1M Ω	50 Ω & 1M Ω	50 Ω & 1M Ω	50 Ω & 1M Ω	
Coupling	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	DC or AC	
Bandwidth	1.5 GHz	500 MHz	1.75 GHz	125 MHz	125 MHz	100 MHz	100 MHz	700 MHz or 350 MHz	300 MHz or 150 MHz	125 MHz	65 MHz	20 MHz	
Voltage Ranges	±50 mV to ±5 V	±50 mV to ±5 V	±100 mV to ±5 V	±100 mV to ±50 V	±100 mV to ±50 V	±100 mV to ±10 V	±100 mV to ±10 V	±200 mV to ±1 V	±100 mV to ±5 V	±100 mV to ±50 V	±100 mV to ±50 V	±100 mV to ±10 V	
						Triggering							
# of Trigger Engines	Up to 5 Independent	Up to 5 Independent	Up to 5 Independent	Up to 9 Independent	Up to 9 Independent	Up to 17 Independent	Up to 9 Independent	Up to 9 Independent	Up to 5 Independent	Up to 9 Independent	Up to 9 Independent	Up to 17 Independent	
Trigger Slope	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	
Trigger Source	CH1 or CH2, EXT, Software	CH1 or CH2, EXT, Software	CH1 or CH2, EXT, Software	CH1 to CH4, EXT, Software	CH1 to CH4, EXT, Software	CH1 to CH8, EXT, Software	CH1 to CH4, EXT, Software	CH1 to CH4, EXT, Software	CH1 or CH2, EXT, Software	CH1 to CH4, EXT, Software	CH1 to CH4, EXT, Software	CH1 to CH8, EXT, Software	
PCI Express													
Card Interface	Gen2 x8	Gen2 x8	Gen3 x8	Gen2 x8	Gen2 x8	Gen2 x8	Gen2 x8	Gen3 x8	Gen3 x8	Gen2 x8	Gen2 x8	Gen2 x8	
Max. Sustained PCIe Streaming Rate	2 GB/s	2 GB/s	6 GB/s	1.6 GB/s	1.6 GB/s	2 GB/s	1 GB/s	5 GB/s	2 GB/s	1.6 GB/s	800 MB/s	400 MB/s	
Single Slot Card Size	Full Height, Full Length	Full Height, Full Length	Full Height, ¾ Length	Full Height, Full Length	Full Height, Full Length	Full Height, Full Length	Full Height, Full Length	Full Height, ¾ Length	Full Height, ¾ Length	Full Height, Full Length	Full Height, Full Length	Full Height, Full Length	
Max. # of Cards per PC	8 Cards 16 Channels	8 Cards 16 Channels	8 Cards 16 Channels	8 Cards 32 Channels	8 Cards 32 Channels	8 Cards 64 Channels	8 Cards 32 Channels	8 Cards 32 Channels	8 Cards 16 Channels	8 Cards 32 Channels	8 Cards 32 Channels	8 Cards 64 Channels	

Please refer to product model data sheets at www.gage-applied.com for more detailed specifications. Information above is provided as a summary and is subject to change.



## GaGe Volume Embedded OEM Program

GaGe values our embedded OEM customers and understands their needs to complete projects on time and within budget. With our reliable, high-quality products and support, our OEM customers gain valuable time-to-market and save tens of thousands of development dollars. Our knowledgeable support staff assists OEM customers through all product lifecycle stages from development to production. This OEM-friendly philosophy is why we have so many satisfied OEM customers around the world.

The GaGe OEM Program consists of two tier levels: Gold and Platinum

#### Gold Tier Level

All established and identified GaGe OEMs enter the program at the Gold Tier Level where GaGe can help the OEM "focus on their added value" while we provide our expertise of integrating GaGe instrumentation products into customized PC solutions, including hardware, software and firmware. The Gold Tier Level includes the following feature benefits:

- No charge supplied product evaluation unit(s) and Software Development Kits (SDKs) for qualification and initial development.
- No charge telephone support through the evaluation.
- Negotiated factory and/or on-site technical support including custom hardware/software development.

#### • Platinum Tier Level

Once the OEM has specified a GaGe product ready for full production integration and release, they then move to the Platinum Tier Level that includes the following feature benefits:

- Volume discount pricing is established.
- OEM specification is established and corresponding product is given a unique part number to ensure quality tracking and Engineering Change Order (ECO) control.
- All software tools are provided on a site-license basis.
- A Smart Spares Pool (safety stock) program is established if the OEM application requires one. This ensures that a specified quantity of product is always kept on stock on a ready-to-ship basis.

We encourage you to contact GaGe and discuss your potential volume embedded OEM application in more detail with our engineering team.

#### About GaGe and Vitrek

GaGe is a product brand of Vitrek, LLC, a USA ISO 9001:2015 certified company; and GaGe branded manufactured instruments are provided with a standard 2 year product warranty.

We are a customer oriented industry leader in high-performance, accurate, and reliable data acquisition solutions. Our core competencies include engineering, manufacturing and integration of data acquisition cards, Digitizers, signal conditioners, and waveform generators into continuous signal data recording, processing and arbitrary signal generation systems. Distributed By:



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