GaGe

The GaGe Razor™ family of multi-channel digitizers features up to 4 channels in a single-slot PCI card with up to 200 MS/s sampling per channel, and up to 2 GS of on-board acquisition memory.

Combine several Razor cards for up to 32 channels in a single system.

APPLICATIONS

Radar Design and Test
Disk Drive Testing
Manufacturing Test
Signal Intelligence
Lidar Systems
Communications
Non-Destructive Testing
Spectroscopy
High-Performance Imaging
Ultrasound Test

Razor CompuScope 16XX

16-Bit Family of Multi-channel Digitizers for the PCI Bus

The Razor family of 16-bit digitizers represents a new generation of high-speed, high-resolution data acquisition cards from GaGe. Razor digitizers offer many powerful advanced features including:

FEATURES

- 2 or 4 digitizing channels
- 100 or 200 MS/s maximum sampling per channel
- 16 bits vertical resolution
- 128 MS to 2 GS on-board acquisition memory
- 65 or 125 MHz bandwidth
- Ultralow distortion (THD < -80 dB)
- Full-size, single-slot PCI card
- Full-featured front-end, with software control over input ranges, coupling and impedances
- 32 bits, 66 MHz PCI standard for 200 MB/s transfer to PC memory
- Ease of integration with External or Reference Clock In and Clock Out, External Trigger In and Trigger Out
- Programming-free operation with GageScope® oscilloscope software
- Software Development Kits available for LabVIEW, MATLAB, C/C#

MAIN RAZOR SPECIFICATIONS

Razor Model	Number of Input Channels	Maximum Sampling Rate	Input Bandwidth (-3 dB Point)
CS1621	2 Simultaneous	100 MS/s	65 MHz
CS1641	4 Simultaneous	100 MS/s	65 MHz
CS1622	2 Simultaneous	200 MS/s	125 MHz
CS1642	4 Simultaneous	200 MS/s	125 MHz

Verticle Resolution: 16-bits
Basic Acquisition Memory[1]: 128 MegaSamples
Available Acquisition Memory Options: 256 MS, 512 MS, 1 GS, 2 GS

CHANNEL SPECIFICATIONS

Channel Input Voltage Ranges: (software-selectable)
1 MΩ: ±100 mV, ±200 mV, ±500 mV, ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, ±50 V
50 Ω: ±100 mV, ±200 mV, ±500 mV, ±1 V, ±2 V, ±5 V

Channel Impedance: 1 MΩ or 50 Ω (software-selectable)

Channel Impedance Accuracy: 0.5% for 1 MΩ. 1.5% for 50 Ω (typical)

Channel Capacitance (1 MΩ): 65 pF on ±100 mV, ±200 mV

45 pF on ±500 mV, ±1 V, ±2 V, ±5 V

35 pF on ±10 V, ±20 V, ±30V

Channel Coupling: AC or DC (software-selectable)

Channel DC User Offset[2]: Spans Full Scale Input Range (FSIR) (software-selectable)

Channel Low-Pass Filter: 3-Pole with -3dB point at 25 MHz

(May be independently software-selected for each input channel)

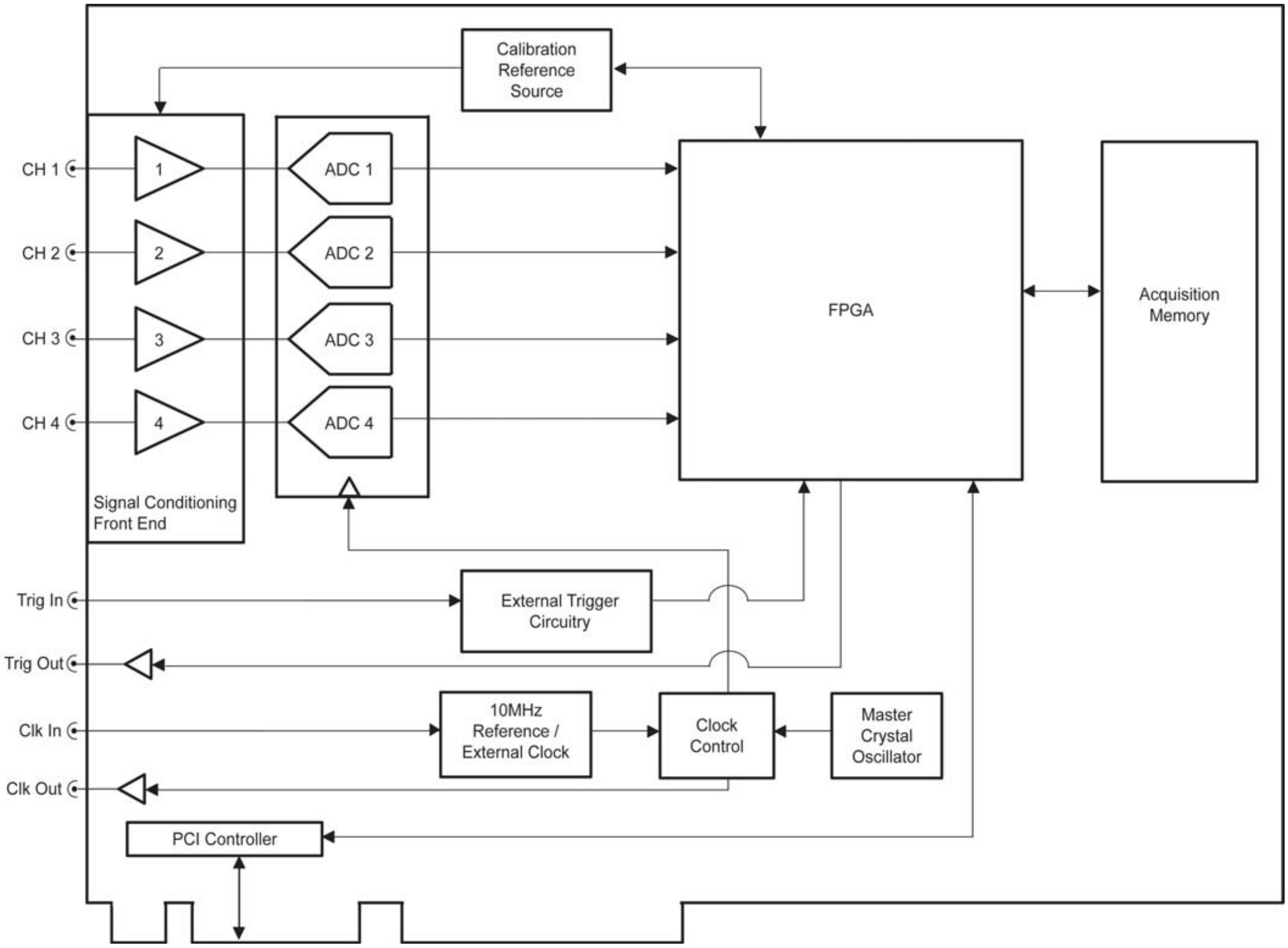
Channel-to-Channel Isolation: TBA

Channel Absolute Max Input: 50 Ω: ±15 V

1 MΩ: ±75 V (except on ±100 mV and ±200 mV range, where Max is +/- 25V)

1 Memory is divided among the all active Razor channels (1, 2 or 4)
2 Adjustable in 1/2 % steps. Above ±5 V is limited to ±2.4 V

Razor CompuScope 16XX Simplified Block Diagram



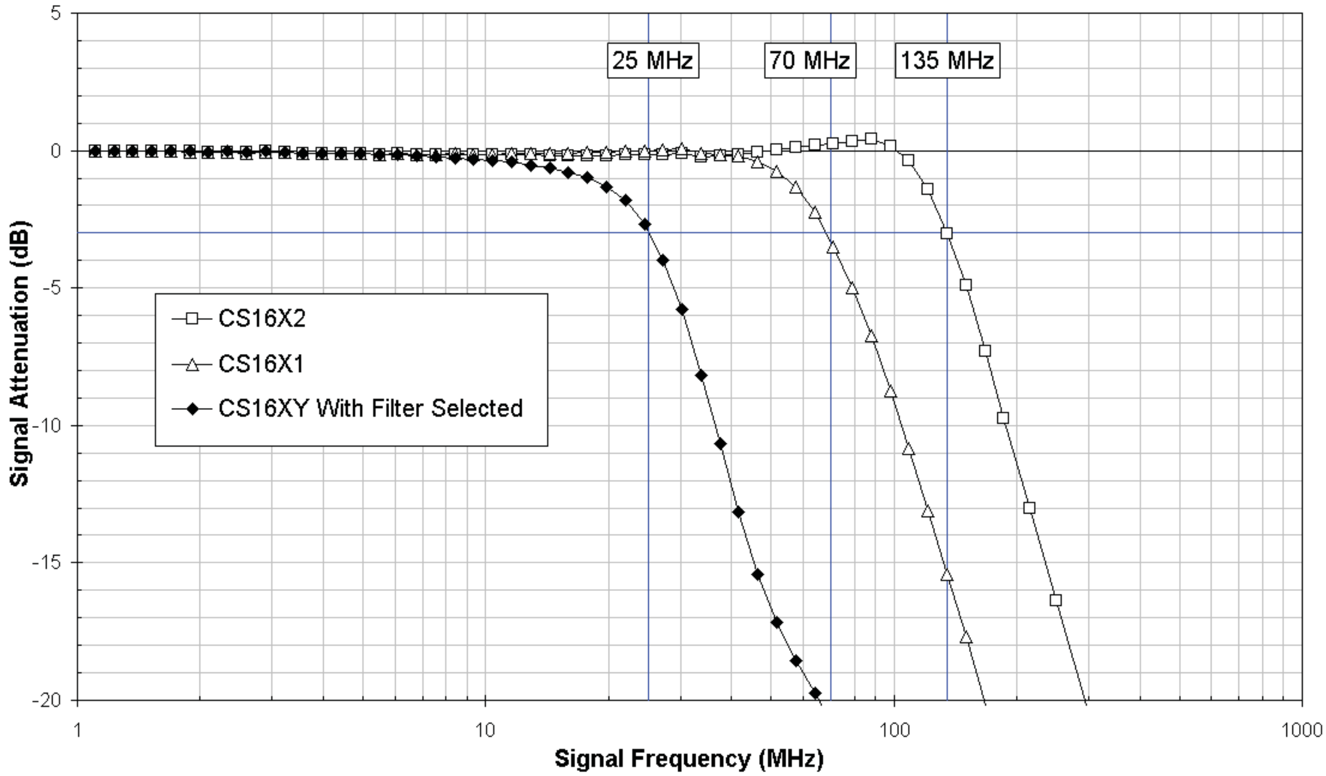
PHYSICAL/MECHANICAL

Length:	312.00 mm / 12.283"
Width:	< 12.5 mm/0.5" (neighboring PCI slots are accessible)
Height:	106.68 mm / 4.200"
Weight:	< 0.45 Kg / 1 lbs
Connectors:	SMA

PCI INTERFACE

PCI Speed:	32-bit PCI – 33 or 66 MHz
PCI Power:	Universal - 3.3 Volt or 5 Volt

CHANNEL FREQUENCY RESPONSE



Note: Typical Frequency Response curves above taken on ±500 mV input range with on with 50 Ω termination with DC coupling. In AC Coupled mode, the lower -3 dB cutoff frequency is 200 kHz.

Input Range	CS16X1				CS16X2			
	Bandwidth (MHz)		Flatness (MHz)		Bandwidth (MHz)		Flatness (MHz)	
	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ
±2 V	70.1	69.4	56.7	59.2	133.8	69.3	110.0	59.3
±500 mV	70.6	68.2	57.4	58.2	135.2	68.2	111.6	58.2
±100 mV	69.5	62.0	55.9	46.2	132.0	62.0	107.6	46.2

Note[1]: The *Bandwidth* is defined as frequency at which the signal attenuation falls below -3 dB of its value at DC. The *Flatness* is the frequency below which the signal attenuation is constant within ± 1 dB of its value at a 1 MHz signal frequency.

Rise Time[2]: 5.0 nanoseconds for CS16X1 (Typical on 50 Ω)
2.6 nanoseconds for CS16X2 (Typical on 50 Ω)

1 In AC coupling mode with 1 MΩ termination, lower -3dB roll-off is at 10 Hz
2 The Rise Time is calculated as 0.35/Bandwidth

CHANNEL ABSOLUTE ACCURACY

DC Gain and Offset Error are presented as a function of the Full-Scale Input Range (FSIR). For example, on the ±1 Volt Input Range, the FSIR is 2 Volts.

Absolute DC Gain Error (Volts): < ±0.3% x (FSIR) (50Ω)
< ±0.1% x (FSIR) (1MΩ)
e.g. Gain Error< 0.3% X 2V = 6 mV on ±1 V Input Range (50Ω)

Absolute DC Offset Error (Volts): < ±(0.2 % x (FSIR) (50Ω)
< ±(0.2 % x (FSIR) (1MΩ)
e.g. < 0.2% x 2V = 4 mV on ±1 V Input Range (50Ω)

Notes:

The Maximum Absolute DC Error may be calculated by summing the Absolute DC Gain Error and the Absolute DC Offset Error in quadrature

Maximum Absolute DC Error= $\sqrt{(\text{Absolute DC Gain Error})^2 + (\text{Absolute DC Offset Error})^2}$

For example, on the ±1 Input Range (50Ω)

Maximum Absolute DC Error= $\sqrt{(0.3\% \times 2V)^2 + (0.2\% \times 2V)^2}$

Maximum Absolute DC Error < 7.2 mV

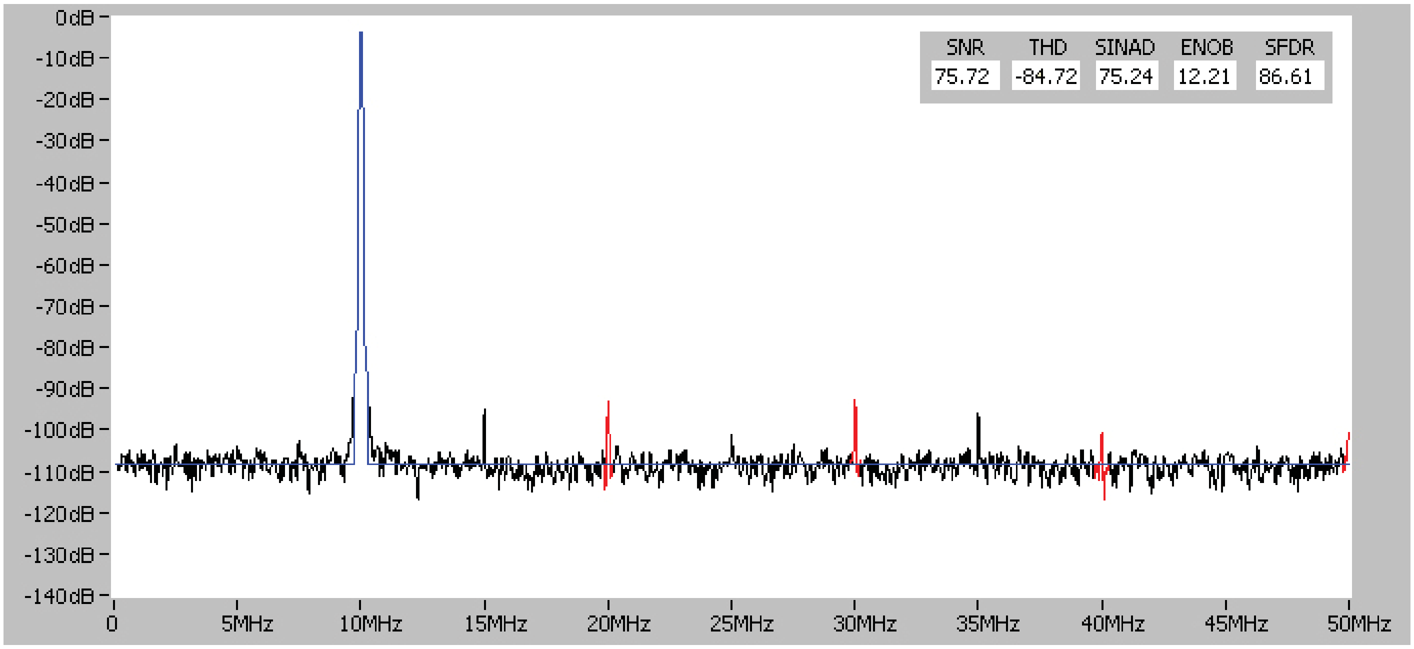
Maximum Absolute DC Error < 0.36% of FSIR

These values relate only to the Absolute accuracy of the Razor CompuScope and say nothing about the relative accuracy. Relative accuracy performance is superior and is provided by the Dynamic Performance Parameters.

Each time that a new input configuration (e.g. Input range, termination, coupling) is selected, the Razor undergoes an on-board auto-calibration sequence, which corrects for component value changes due to aging or thermal drift.

Before shipment, all Razor CompuScopes are tested at the factory using the Gage Performance Verification System. This system introduces DC voltages from a NIST-traceable calibrator source to the card in all input configurations and confirms that no measured errors are worse than the errors listed above.

RAZOR DYNAMIC PERFORMANCE



Frequency spectrum above taken on a Razor CS1641 on its ±500 mV input range with 50 Ω termination and DC coupling.

Dynamic Parameters are measured by acquiring a high-purity 10 MHz sine wave signal, deriving an associated Fourier Spectrum and identifying the Fundamental Power (F), the Noise Power (N) and the Harmonic Power (H). These Powers are measured as the areas under the frequency bins respectively indicated in blue, red and black in the frequency spectrum above.

DYNAMIC PARAMETERS DEFINITIONS

Signal-to-Noise Ratio (SNR) Ξ 10 x log (F/N)

Total Harmonic Distortion (THD) Ξ 10 x log (H/F)

Signal-to-Noise-and-Distortion Ratio (SINAD) Ξ 10 x log (F/(H+N))

Effective Number Of Bits (ENOB) Ξ (SINAD – 1.76 dB)/6.02 dB

Spurious Free Dynamic Range (SFDR) Ξ Amplitude of highest spurious spectral peak

RMS Noise Ξ Standard Deviation of acquired signal with CompuScope input loaded with external 50 Ω terminater. No filters are applied.

Razor Dynamic Parameters with 10 MHz Signal Frequency[1]

Product	Input Range	SNR		THD		SINAD		ENOB		SFDR	
		50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ
CS16X1	±500 mV	75.72 dB	62.31 dB	-84.72 dB	-66.65 dB	75.24 dB	61.03 dB	12.21	9.85	86.61 dB	67.55 dB
	±100 mV	70.99 dB	62.45 dB	-82.78 dB	-65.70 dB	70.74 dB	60.90 dB	11.50	9.82	85.02 dB	66.44 dB
CS16X2	±500 mV	73.03 dB	62.22 dB	-80.96 dB	-66.69 dB	72.43 dB	60.99 dB	11.74	9.84	86.61 dB	68.64 dB
	±100 mV	69.04 dB	62.06 dB	-78.31 dB	-66.20 dB	68.60 dB	60.75 dB	11.18	9.80	83.65 dB	67.77 dB

Razor Dynamic Parameters with 70 MHz Signal Frequency[1]

Product	Input Range	SNR		THD		SINAD		ENOB		SFDR	
		50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ
CS16X1	±500 mV	69.78 dB	56.82 dB	-60.21 dB	-52.39 dB	60.09 dB	51.35 dB	11.30	7.15	61.91 dB	52.22 dB
	±100 mV	62.86 dB	56.36 dB	-60.10 dB	-52.54 dB	58.50 dB	51.33 dB	10.15	8.23	61.54 dB	52.67 dB
CS16X2	±500 mV	68.84 dB	53.93 dB	-68.20 dB	-47.45 dB	65.71 dB	46.91 dB	10.62	7.50	71.47 dB	47.77 dB
	±100 mV	57.83 dB	53.21 dB	58.79 dB	-48.30 dB	35.44 dB	47.99 dB	8.92	7.68	60.54 dB	48.53 dB

RMS Noise on Select Input Ranges

Input Range	±100 mV		±500 mV		±2 V		±10 V		±50 V	
Razor Model	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω	1 MΩ
CS16X1	30 µV	100 µV	60 µV	500 µV	310 µV	600 µV	-	5.3 mV	-	7.3 mV
CS16X2	50 µV	130 µV	90 µV	660 µV	440 µV	830 µV	-	7.3 mV	-	10.5 mV

1 Dynamic Parameters for 10 MHz frequency acquired with 25 MHz low-pass filters activated. For 70 MHz frequency, no filters activated.

TIME-DOMAIN SAMPLING

Internal Sampling Rates: (Maximum is model dependent)	200 MS/s, 100 MS/s, 50 MS/s, 25 MS/s, 10 MS/s, 5 MS/s, 2 MS/s, 1 MS/s, 500 kS/s, 200 kS/s, 100 kS/s, 50 kS/s, 20 kS/s, 10 kS/s, 5 kS/s, 2 kS/s, 1 kS/s
Internal Sampling Rate Accuracy/Stability[1]:	1 part-per-million
Channel-to-Channel Skew[2]:	<400 picoseconds

CLOCK IN

Clock In Signal Level:	Minimum 0.3 V RMS
	Maximum 1.5 V RMS
Clock In Signal Input Termination:	50 Ω
Clock In Signal Input Coupling:	AC
Clock In Signal Duty Cycle:	50% ± 5%
Clock In Modes:	

1. External Clock – Input signal is used as a sampling clock signal and directly clocks Razor ADC chips
2. 10 MHz Reference – High accuracy 10 MHz input signal disciplines the internal sampling oscillator so that, for example, a 200 MS/s sampling rate is at exactly 20X the 10 MHz reference frequency

Maximum External Clock Frequency:	Maximum Razor sample rate
Minimum External Clock Frequency:	10 MHz
10 MHz Reference Mode Frequency:	10 MHz ±10 kHz

CLOCK OUT

Clock Out Modes:	Sampling Clock Out and 10 MHz Reference Clock Out
Clock Out Signal Level:	0-1.8 V
Clock Out Signal Output Termination:	50 Ω compatible
Maximum Clock Out Signal Frequency:	Maximum Razor model sample rate
Minimum Clock Out Signal Frequency:	10 MHz (Using External Clock)
	1 kHz (Using Internal Sampling)
Clock Out Signal Duty Cycle:	50%

1 Master Sampling Oscillator is disciplined by an on-board temperature-compensated 10 MHz reference signal with 1 part-per-million accuracy and stability.

2 Channels use same input settings

TRIGGERING

Trigger Source:	Any Input Channel, External Trigger or Software
Trigger Level:	Software controllable analog Trigger level with span of the Full Scale Input Range (FSIR) of the Trigger Source. Adjustable in ½ % steps
Trigger Slope:	Positive or Negative (software-selectable)
Trigger Engines:	2 per Input Channel, 1 for External Trigger -results logically ORed to create trigger event
Trigger Jitter[1]:	1 Sample
Trigger Hold-off:	Allows triggers to be ignored in order to ensure acquisition of any pre-set amount of pre-trigger data.
Trigger Delay:	Allows suppression of the acquisition of any amount of post-trigger data in order to conserve memory for the acquisition of only later waveform data.

INTERNAL TRIGGERING

Trigger Sensitivity:[2]	±2% of Full Scale Input Range of Trigger Source
Trigger Level Accuracy:	Better than ±2% of Full Scale

EXTERNAL TRIGGERING

External Trigger Input Voltage Ranges:	±1 V, ±5 V (software-selectable)
External Trigger Coupling:	AC or DC (software-selectable)
External Trigger Input Impedance:	2 kΩ
External Trigger Input Bandwidth:	>100 MHz
External Trigger Absolute Max Input:	±15 V
External Trigger Sensitivity:	±5% of Full Scale External Trigger Range
External Trigger Level Accuracy:	±10% of Full Scale External Trigger Range

1 This jitter applies for an asynchronous trigger and sampling clock. Sub-nanosecond jitter may be achieved using synchronous trigger and sampling clock

2 Signal amplitude must be at least 4% of Full Scale Input Range of Trigger Source to cause a trigger event. Smaller signals are rejected as noise.

COMPUSCOPE ACQUISITION

ACQUISITION MODES:

1. Single Record Mode – In Single Record Mode, each waveform is downloaded to PC RAM, where it is accessible to the user, prior to the next waveform acquisition.

2. Multiple Record Mode – In Multiple Record Mode, acquired waveforms are stacked in on-board Compscope memory for later download. Between successively triggers, the acquisition circuitry is rapidly re-armed in hardware with no software communication required.

Segment Memory is the amount of memory available to hold waveform data, which may include both pre- and post-trigger data

Post-Trigger Data: 32 Sample minimum up to full Segment Memory. Post-trigger Depth may be increased in steps of 32 Samples.

Pre-Trigger Data: Up to full Segment Memory.

MAXIMUM SEGMENT MEMORY

Single Record Mode[1,2]:

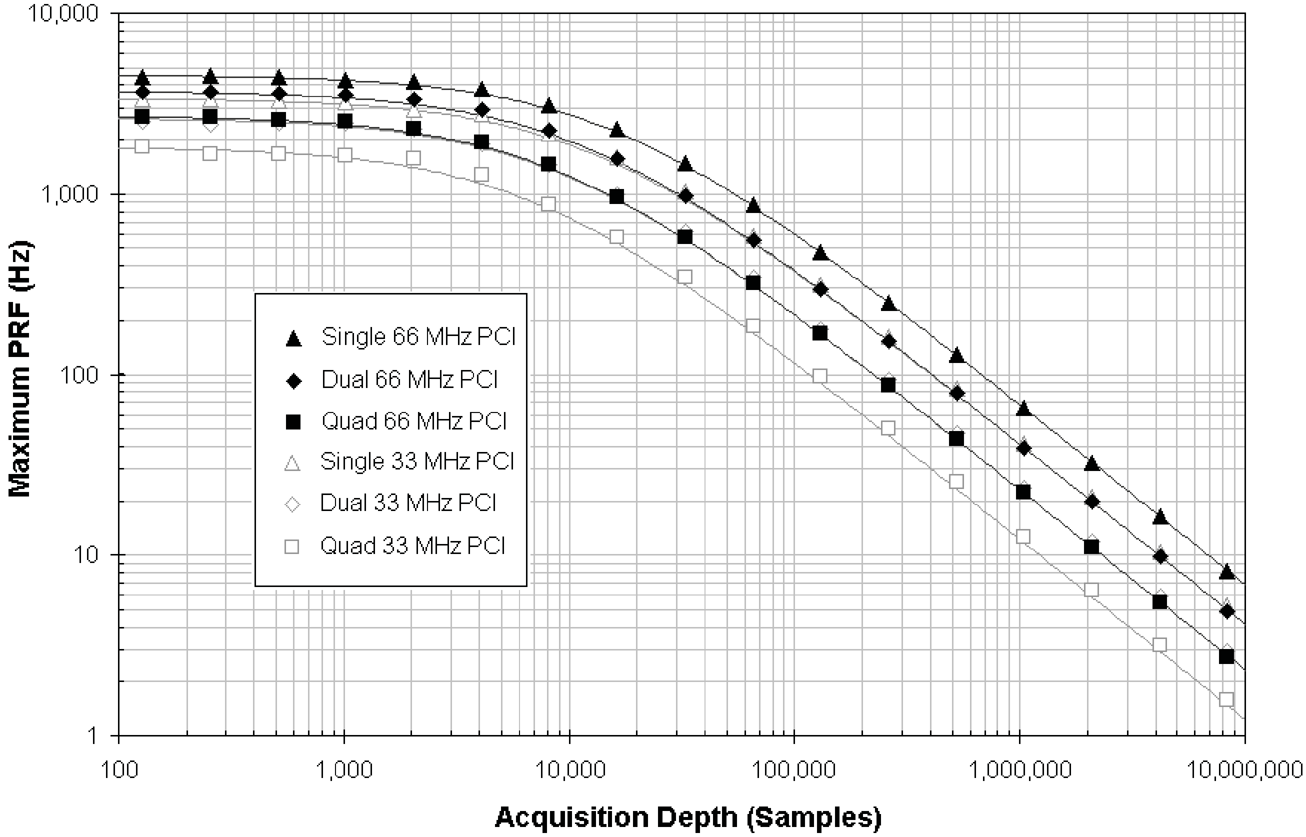
Max Segment Memory ≈ Total on-board memory / Number of Active Channels

Multiple Record Mode[2]:

Segment Memory ≈ Total on-board memory / Number of Active Channels / Number of Segments

1 Number of Active Channels may be 1, 2 or 4.
2 The equation is not exact due to storage of a small amount of inter-record data, such as Time-Stamping Information.

SINGLE RECORD MODE ACQUISITION



Razor's Repetitive Waveform Acquisition Performance

The plot above shows the Razor's maximum Pulse Repeat Frequency (PRF) which is the maximum trigger rate without trigger loss. Curves are shown with a sampling rate of 200 MS/s for acquisition of 1, 2 and 4 channels (Single, Dual and Quad) and for PCI clock speeds of 33 MHz and 66 MHz. (In practice, 66 MHz PCI usually implies PCI-X). Straight line portions of the curves at high Depths provide measurement of PCI bus-mastering transfer speeds of over 100 Megabytes/second and 200 Megabytes/second respectively for 33 MHz and 66 MHz PCI.

No data processing or storage to hard drive were performed for the PRF measurements and performance may vary slightly with system configuration.

MULTIPLE RECORD MODE ACQUISITION

Multiple Record Inter-Trigger Re-arm time: Less than 2 microseconds

Note: Because the no software communication is required during a Multiple Record acquisition, the Re-arm time is completely deterministic or invariant. For example, an acquisition of duration 6 microseconds could be triggered at a rate of up to 1/(6 μs + 2 μs) = 125 kHz with a guarantee of no loss of triggers.

TRIGGER TIME-STAMPING

The Trigger Time –Stamping functionality tags the occurrence time of trigger events using a wide high–speed on-board counter that has high accuracy and is independent of any Host PC timing.

Time–Stamping Counter Clock source:	Fixed 133 MHz on-board oscillator or Sampling Clock (software-selectable)
Time–Stamping Counter Resolution:	One clock cycle
Time–Stamping Counter Width:	44-bits
Time–Stamping Counter Rollover time[1]:	24 hours or more

MULTI-COMPUSCOPE SYSTEMS

Master/Slave CompuScope Mode

Number of Master/Slave CompuScopes:	2-8 cards
Board-to-Board Timing Skew:	<500 picoseconds

Note: In a Master/Slave CompuScope system, identical CompuScopes are configured to behave from a hardware and software perspective as a single multi-channel digitizer system. All CompuScopes within a Master/Slave system will sample, trigger and re-arm simultaneously. CompuScopes self-configure as a Master/Slave system upon detection of the internal Master/Slave inter-CompuScope bridge-board connector. This system may be broken up into independent CompuScopes simply by not installing the bridge-board.

Independent CompuScope Mode

Number of Independent CompuScopes: Number limited only by number of PCI slots in backplane and available DC power.

Note: Users may install independent CompuScopes, which may be different models, within a single host PC. Independent CompuScopes may trigger and sample asynchronously. Independent asynchronous Compscope operation is fully supported by GageScope and all Compscope Software Development Kits (SDKs).

POWER CONSUMPTION

PCI DC SUPPLY	CS1621	CS1641	CS1622	CS1642
+5 V	12.7 W	22.3 W	12.7 W	22.3 W
+3.3 V	8.3 W	8.9 W	9.4 W	10.1 W
+12 V	0.3 W	0.2 W	0.2 W	0.2 W
-12 V	0	0	0	0
-5 V	0	0	0	0
Total	21.3 W	31.4 W	22.3 W	32.6 W

Note: The consumption values above are for Razor CompuScopes with the base acquisitions memory of 128 MegaSamples. For a 2 GigaSample Razor Compscope, the extra power consumption is 3 Watts. For intermediate memory options, the extra consumption increases in proportion to the amount of memory.

1 At the top Razor Time-Stamping Counter clocking rate of 200 MHz, the counter rollover time is 2^{44}/200 MHz = 87961 seconds > 1 day.

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HOST PC SYSTEM REQUIREMENTS

PCI-based computer, minimum Pentium II 500 MHz, with at least one free full-length PCI slot, 128 MB RAM, 100 MB hard disk.

Operating System:

Windows 7:	All Versions (32/64-bit)
Windows Vista:	All Versions (32/64-bit)
Windows XP:	SP1 or higher (32/64-bit)
Windows Server:	2003, 2008
Linux Version:	Debian 5

SOFTWARE SUPPORT

Application Software:

GageScope is a Windows-based software for programming-free CompuScope operation

GageScope LITE Edition: Included with purchase, provides basic functionality
GageScope Standard Edition: Provides limited functionality of advanced analysis tools, except for Extended Math
GageScope Professional Edition: Provides full functionality of all advanced analysis tools

Software Development Kits:

CompuScope SDKs for C/C# for Windows
Includes: CompuScope C SDK for Windows[1]
CompuScope .NET SDK for Windows[2]

CompuScope SDK for MATLAB for Windows

CompuScope SDK for LabVIEW for Windows

Contact your GaGe Sales Agent for information on Linux support.

FIRMWARE SUPPORT

eXpert Signal Averaging Firmware Option
Call factory for custom eXpert Signal Processing Firmware

OPERATING TEMPERATURE

Internal PC Temperature Range: 0 °C to +50 °C

1 C SDK is compatible with LabWindows/CVI 7.0 +
2 .NET SDK is CLR compliant and includes support for Visual Basic .NET and Delphi

GaGe

WARRANTY

One year parts and labor

Certificate of NIST Traceable Calibration is included.

*All specifications subject to change without notice.

ORDERING INFORMATION

Hardware & Upgrades

Razor 16-bit Family	2 Channel	4 Channel
100 MS/s	CS1621: RAZ-002-100	CS1641: RAZ-004-100
200 MS/s	CS1622: RAZ-002-200	CS1642: RAZ-004-200

Memory Upgrade: 128 MS to 256 MS	RAZ-181-001
Memory Upgrade: 128 MS to 512 MS	RAZ-181-003
Memory Upgrade: 128 MS to 1 GS	RAZ-181-005
Memory Upgrade: 128 MS to 2 GS	RAZ-181-007
Set 1 Cable SMA to BNC	ACC-001-031
Set 4 Cable SMA to BNC	ACC-001-033
Master Multi-Card Upgrade	RAZ-181-002
Slave Multi-Card Upgrade	RAZ-181-003
eXpert™ Firmware Options	
eXpert Signal Averaging Firmware Option	250-181-001
GageScope® Software	
GageScope: Lite Edition	Included
GageScope: Standard Edition (with Purchase of CompuScope Hardware)	300-100-351
GageScope: Professional Edition (with Purchase of CompuScope Hardware)	300-100-354
Software Development Kits (SDKs)	
GaGe SDK Pack on CD	200-113-000
CompuScope SDK for C/C#	200-200-101
CompuScope SDK for MATLAB	200-200-102
CompuScope SDK for LabVIEW	200-200-103

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