

## eXpert Signal Averaging Firmware

Signal averaging is a powerful method of improving the fidelity of noisy repetitive signals. As shown in Figure 1 below, the process consists of making multiple acquisitions of a repetitive waveform and averaging all acquisitions together. Any random noise is subsequently averaged to near zero, while the amplitude of the underlying repetitive signal remains unchanged. Using signal averaging, small signals can be extracted from a background of high-amplitude noise, which may even be larger than the actual signal itself.

Utilizing the eXpert Signal Averaging Firmware on a GaGe CompuScope Digitizer allows users to detect a small repetitive signal in a noisy environment by conducting rapid signal averaging completely on the digitizer's onboard FPGA with absolutely no host system CPU loading.

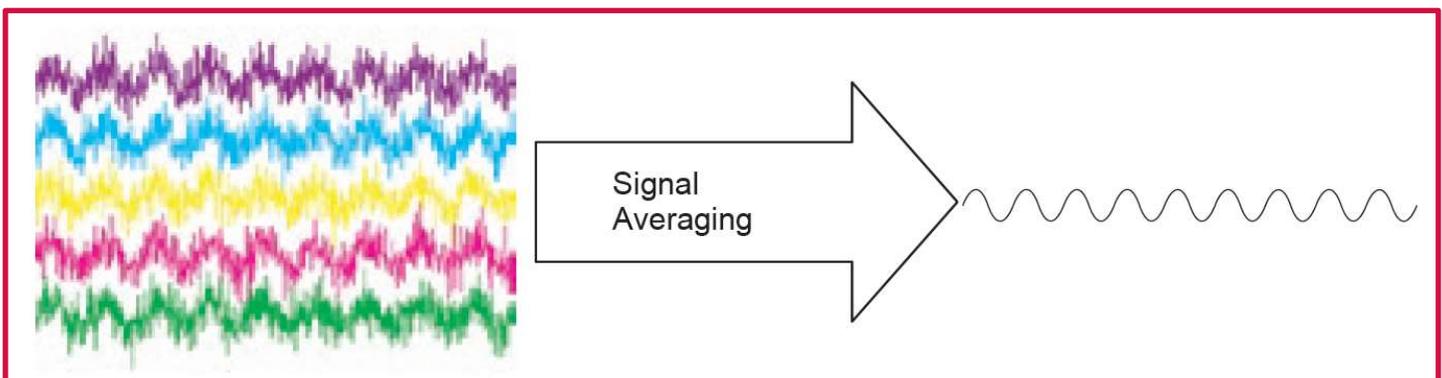
Using eXpert Averaging, waveforms may be signal averaged at a rate of greater than 100,000 waveforms per second – far faster than on the host PC. Conducting signal averaging onboard the digitizer's FPGA also provides the important benefit of reducing the amount of data to be transferred to the host PC system by a factor of more than 1,000 while at the same time allowing the host PC to handle other tasks in parallel.

As with any averaging, the eXpert Signal Averaging Firmware reduces random noise on a signal by the square root of the number of averages. For example, 16 signal averages will reduce the noise on a signal by a factor of 4, while 100 signal averages will reduce the noise by factor of 10.

Strictly speaking, waveforms are not averaged onboard but are summed, since the costly operation of division by the number of averages operation is not performed on-board. The summing conserves the resolution increase gained by averaging.

Averaging is performed within the FPGA, whose memory resource capacity limits the averaging. The resulting maximum number of averages and the maximum averaging depth (waveform length) are shown in the table below for current CompuScope models. The maximum waveform depth must be shared amongst the number of active channels. For example, a CompuScope model with a maximum averaging depth of 8 kiloSamples would be able to acquire a maximum depth of 2 kiloSamples when operated in 4-channel Quad Mode.

CompuScope Digitizer Model	Maximum Depth	Maximum # of Averages
Cobra Express	65,344	1,024
CobraMax Express	65,344	1,024
CS1250X	131,072	124
EON	131,072	124
EON Express	131,072	1,000,000
Octave Express	65,048	1,024
Octopus Express	65,048	1,024
Oscar Express	65,472	1,024
Razor Express	65,472	1,024
RazorMax Express	131,072	1,000,000



**Figure 1: Result of Signal Averaging Multiple Acquisitions to Remove Noise**



eXpert Averaging may be operated in Multiple Record mode so that successive averaged waveforms may be stacked in onboard memory, where each Samples occupies 4 Bytes. For example, a CompuScope with 2 GigaSamples = 4 GB of memory would be able to stack 1,048,576 (1M) averaged waveforms of 512 Samples each in Dual Mode, since:

$$4 \text{ Bytes/Samples} \times 1\text{M Waveforms} \times 2 \text{ Channels} \times 512 \text{ Samples/Waveform} = 4 \text{ GB}$$

Each averaged waveform might result from summing 1,024 waveforms together so that in order to the complete of the acquisition the user would have to issue  $1,024 \times 1\text{M} = 1,073,741,824$  (1G) triggers, which result in only 1M averaged waveforms because of the 1,024X reduction factor afforded by the averaging. These 1M averaged waveforms might represent signals averaged at 1M different locations in a scanning system. Alternately, these 1M waveform might be “super-averaged” in software to create a waveform that has been averaged 1G times.

The eXpert Signal Averaging Firmware is compatible with and requires one of the available GaGe Software SDKs for C/C#, MATLAB, or LabVIEW that provide a ready-made compiled sample program illustrating how to configure and use the signal averaging feature with documentation for its use in custom user developed software applications.



## ORDERING INFORMATION

eXpert Signal Averaging Firmware	Order Part Number
<p>eXpert Signal Averaging</p> <p><b>NOTE:</b> The eXpert Signal Averaging Firmware requires one of the available GaGe Software SDKs for C/C#, MATLAB, or LabVIEW and is compatible for use with the following GaGe Digitizer Model Series sold separately:</p> <ul style="list-style-type: none"><li>• Cobra Express</li><li>• CobraMax Express</li><li>• CS1250X</li><li>• EON</li><li>• EON Express</li><li>• Octave Express</li><li>• Octopus Express</li><li>• Oscar Express</li><li>• Razor Express</li><li>• RazorMax Express</li></ul> <p>Please refer to the separate GaGe product datasheets for these digitizer models for their full specification details and ordering information.</p>	250-181-001

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