GaGe

APPLICATION NOTE
Radioactive nuclear decay detection

Challenge

The customer has a requirement for PC-based waveform digitizer cards to digitize shaped pulses derived from nuclear-decay detectors. These pulses vary in their rate (frequency of occurrence) and amplitude. Their shape is approximately Gaussian with a full-width at half the maximum amplitude (FWHM) of 3 to 5 microseconds.

The characterization of each pulse is critical for the accurate and precise determination of the activity of radioactive materials. These materials have very low count-rates (0.02 pulses per minute) to relatively high count-rates (>1,000 pulses per minute).

Important to the measurement process are the speed and reliability of the waveform digitizer cards. The customer wants to digitize pulses continuously with minimal probability of missing a decay event. The re-displaying of digitized pulses during the data acquisition is an important capability and needs to be done in a near real-time fashion.

They need 4 cards, each able to simultaneously digitize two input-voltage signals at a minimum of 50 million samples per second, with a voltage-resolution of at least 1 part 4096. This means that they need at least 12 bits of vertical resolution. The number of points per record is up to 4096 points, with each channel needing a minimum of 256 kiloSamples of acquisition memory.

It is hard to predict what fundamental research will lead to, but past experience has brought about the wealth of modern technologies we now enjoy… Radioactivity, while an accidental discovery, is now a well-known phenomenon, but one that must be monitored

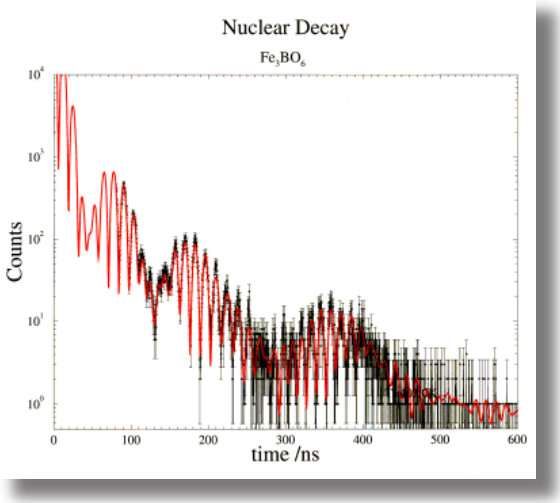
Solution

We recommended the CompuScope 8384, an 8 channel, 14-bit, 50 MS/s PCI digitizer.

With a CS8384 card at the externally-clocked sampling-rate of 50 MS/s, a minimal-sized 256 point acquisition would take 5.12 µs. To then transfer that 512 Bytes (2 Bytes per sample) acquisition to PC-RAM using PCI bus-mastering (at up to 200 MB/s) for displaying and saving, would take less than 3 µs per channel. After that, a nominal 100 µs is required to re-arm for the next trigger.

The customer uses PC-based digitizer cards to digitize shaped pulses derived from nuclear-decay detectors. The speed and reliability of the digitizers are important to the measurement process. The customer has decided that they will need four cards with at least 12 bit resolution, sampling rate of at least 50 million samples per second and minimum acquisition memory of 256 k words.

Gage's CompuScope 8384 is recommended for this project. The CompuScope 8384 can sample analog signals at speeds up to 50 MS/s with 14 bit resolution and up to 2 GigaSample on-board acquisition memory.



Scientific Research

Therefore, for an eight-card system, this gives a total cycle-time (Pulse Repeat Interval) of about

PRI = 8 channels*3µs + 100µs= 124µs

In the best-case scenario, therefore, the repetitive-trigger Pulse Repeat Frequency (PRF) is better than 7 kHz. This is over 500 times better performance than the customer's requirement of >17 Hz (1,000 pulses per minute).

CompuScope 8384

Gage's Octopus™ family of multi-channel digitizers features up to 8 channels, up to 4 GB of on-board acquisition memory, and up to 125 MS/s sampling per channel on a single-slot PCI card.

Starting at less than $1,000 per channel, you save money by paying only for the number of channels that you need. With our Octopus family of digitizers, we offer you many more options than ever before.

Our eXpert™ advanced on-board FPGA technology, such as Filtering and Signal Averaging, is also available.

Features

- 2, 4, or 8 digitizing channels
- 10, 25, 50, 65, 100, or 125 MS/s sampling per channel
- 14 bits vertical resolution
- 128 MS to 2 GS on-board acquisition memory
- More than 100 MHz bandwidth
- 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 Event Out
- Programming-free operation with GageScope® oscilloscope software
- Software Development Kits available for LabVIEW, MATLAB, C/C#

Results

Theoretically, we cannot guarantee to display every pulse nor can we guarantee that there will be no missed triggers. Video refresh is a big bottleneck as it is for any GUI-based software application. In our own Windows-based GageScope software design, we generally target a 30 Hz refresh-rate or better to ensure that it is flicker-free. The customer's own customized software development can also achieve this. We have therefore suggested the CompuScope/C/C# software development kit.

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