

16-Channel 100 MHz CompactPCI/PXI Digital Spectrometer

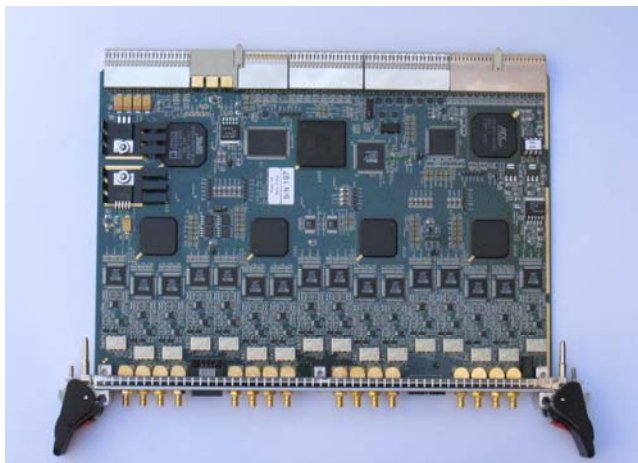
GENERAL DESCRIPTION

The DGF PIXIE-16 is a 16-channel all digital spectrometer on a single 6U CompactPCI/PXI card. Designed for fast coincidence γ -ray spectroscopy with segmented detectors or detector arrays, it offers both high speed waveform acquisition and MCA analysis at a low per-channel cost.

Each channel of the Pixie-16 accepts signals from virtually any radiation detector, with exponential decay times from 150ns to 10ms. Incoming signals are digitized at a rate of 100MSPS with a 12-bit ADC. The digital data stream is used for triggering, pile-up in-spection and filtering in real time. Waveforms with 10ns sampling intervals, up to 40 μ s in length, can be stored in a FIFO. Pulse height reconstruction, incrementing a 32K spectrum for each channel and optional pulse shape analysis is performed on an event-by event basis by a 32-bit floating point digital signal processor (DSP). Waveforms and spectra can be read out at up to 109Mbyte/s.

Multiple Pixie-16 modules can be synchronized and share basic triggers through the PXI section of the backplane. More than 160 additional backplane connections can be configured to distribute triggers, share multiplicity or coincidence information, or link the DSPs of different modules.

The DGF Pixie-16 is operated through a simple graphical user interface running on Windows. A C driver library, compatible with Linux, is provided for users who plan to integrate Pixie modules into a custom data acquisition system. Users can also add their own functions to the DSP event processing code.



FEATURES

- Compatible with HPGe detectors or scintillator/PMT combinations (NaI, CsI, etc.)
- Accepts input signals with exponential decay times from 150ns to 10ms
- Input signals digitized with 100MSPS, 12-bit ADC.
- Waveforms up to 40 μ s length acquired synchronously for each channel.
- Spectrum length from 1K to 32K bins, up to 4.3 billion counts per bin
- List mode data stored in output FIFO to allow acquisition to continue during readout
- Trigger distribution and run synchronization through PXI backplane, no external electronics required.
- Full speed 32-bit, 33MHz PCI interface to host computer, up to 109 MByte/s readout sustained

SPECIFICATIONS

Front Panel I/O

16 analog signal inputs, input impedance 50 Ω or 10k Ω .

28 digital inputs/outputs, including 4 high speed LVDS input/output connections, 16 LVDS inputs for channel specific gating, LVTTTL inputs and outputs for general purpose.

Backplane I/O

Low skew system clock distributed to all modules.

Trigger, run synchronization, and global veto lines.

Over 168 configurable connections for multiplicity information, complex trigger logic, or data transfers between modules.

CompactPCI/PXI System:

6U form factor with

Standard 3U cPCI/PXI 32-bit, 33MHz interface.

Customized power supplies and backplane I/O.

Digital Controls

Input: Choice of two termination/attenuation options

Gain: Fixed analog voltage gain; digital adjustment +/-10%.

Offset: -1.5V to 1.5V in 65536 steps.

Filter: Rise time and flat top: 0.02 - 80 μ s in small steps.

Data Reported

Energy spectra and list mode data (hit patterns, energies, timestamps and waveforms).

APPLICATIONS

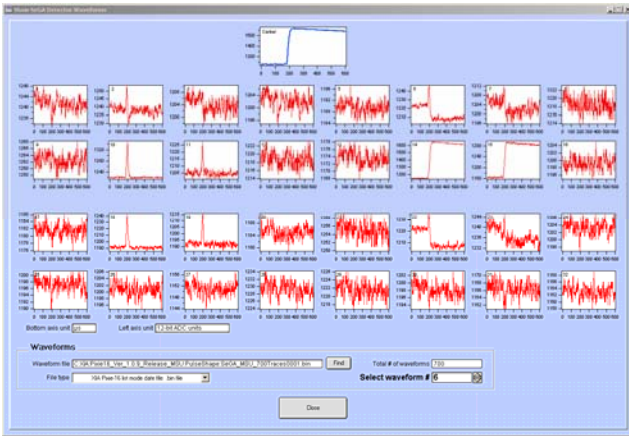


Figure 1: Waveforms from segmented HPGe detector.

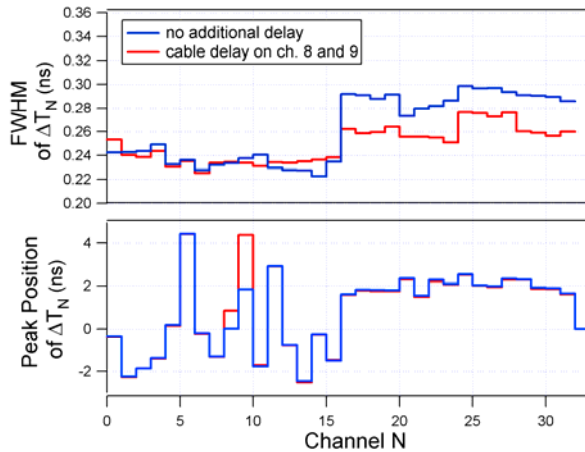


Figure 2: Timing resolution (using 33-channel pulser).

The Pixie-16 can be used in a variety of applications, including **segmented germanium detectors**, **silicon strip detectors**, and arrays of **scintillator detectors**. With firmware adapted for very slow pulses, it can instrument cryogenic **microcalorimeters** achieving resolutions of 0.06-0.10%. Application examples include:

Synchronous Waveform Capture for Gamma Ray Tracking

Figure 1 shows waveforms acquired with a Pixie16 from a highly segmented HPGe detector (blue: central contact, red: segments). The central contact and two segments collect charge, several neighboring segments show induced signals lasting only for the charge collection time. (Waveforms courtesy of National Superconducting Cyclotron Laboratory)

Timing Measurements

Using constant fraction timing algorithms with interpolation between sample points, the Pixie-16 can achieve subnanosecond timing resolution. Figure 2 shows the peak position and FWHM of the time of arrival difference ΔT_N between channel N and the triggering channel from a 33-channel pulser. With additional cable delay, the peak position shifts because the pulse arrives later, but the time resolution remains below 300ps.

Multi-Chassis Systems

For systems with more than 200 channels, clock and trigger signals can be distributed between chassis using high speed, low skew LVDS signals via Pixie-16 front panel connections and/or dedicated CompactPCI read I/O modules.

SAMPLE PERFORMANCE

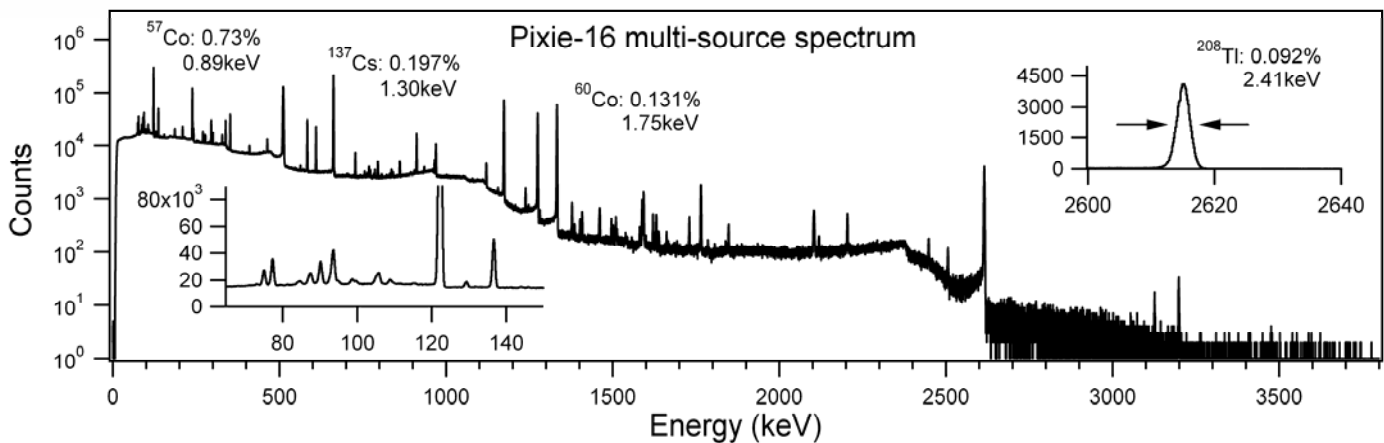


Figure 3: Multi-source spectrum acquired with Pixie-16 and a 40% Aptec HPGe detector.