

Multichannel Data Acquisition Systems in Big Physics Experiments

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Abstract

Expanding knowledge on phenomena at galactic or nanometer scale, confidence in results is strengthened by dependable measurement solutions that provide exceptional speed and measurement fidelity.

Simplifying the data acquisition system within these experiments can be a non-negligible task. Multichannel digitizers that contain all the timing and synchronization technologies can create synchronous sampling across 10's or 100's of channels at a time. Using AXIe-based instrumentation, you can achieve complex multichannel big physics experiments, including plasma and inertial confinement fusion, particle acceleration, microwave and RF astrophysics, and x-ray imaging in hydrodynamics.

Introduction

Big Physics experiments form the backbone for some of the world's most crucial projects. Be that fusion research for the development of clean sustainable energy, the research into the origins of the universe, through to investigation and discovery of sub-atomic particles. The instrumentation of these experiments often relies upon the use of multiple transducers and arrays of devices that must be integrated into the lab environment. High-speed digitizers provide the crucial data capture component in these systems, and the quality of the measurement often relies on the performance of these devices.

Application Overview

As a scientist, you must define cost effective solutions for complex measurement tasks. Typically you want to model an event or a process, obtaining as much information as possible. This often includes an array of fast detectors of differing characteristics. Be they photomultiplier tubes (PMT), beam current transformers, spectrometers, fast diodes, or other detectors.

To correctly recreate the event or process from captured data, you need confidence in the triggering and synchronization of 10's or 100's of channels used in the experimental setup. Often, the challenge for the scientist is the integration of the various transducer and digitizer components into the complex environment of the experiment.

Triggering and timing data of Multichannel systems must be known across all of the channels, to allow faithful data reconstruction. The data acquisition system must be integrated not only into the hardware environment of the experimental machine, but also into the software environment.

Traditional solutions can be power hungry and bulky, leading to further requirements in lab space, and even additional power and climate control, to house the instrumentation system.

Solution

The Agilent AXIe based 12-bit high-speed-digitizer, for use in two major areas that require high-speed measurements: real-time applications and single-shot or event-based applications. The AXIe-based solution provides the extreme speed and precision needed for system monitoring and control, and for capturing data from the interactions and events in the experiments themselves.

The AXIe-based M9703A is an 8 channel, DC-coupled, 12-bit digitizer for the capture of fast signals. The hardware is supported with a range of API's in Windows and LINUX environments. It integrates state of the art ADC technology in a standard modular form factor (AXIe), to simplify system development.

Solution details

The Agilent AXIe digitizer integrates 8 high-speed, high-resolution digitizer channels into a single card allowing the capture of fast transient signals from PMTs, spectrometers and other fast detectors. The low noise and high dynamic range of the analog-to-digital conversion enables the observation of the finest details in the signals. On-board FPGA processing, in the form of four Virtex-6 FPGA provides real-time processing capability for data reduction.

Multiple AXIe digitizer modules can be integrated into a single AXIe chassis, like Agilent's M9505A chassis which can hold 5 units, providing 40 channels of data acquisition in a desktop system.

Synchronization of the system can be achieved using a choice of external or system reference clock inputs. Timing and triggering signals available from the AXIe backplane include: a system 100 MHz clock, the 100 MHz PCIe clock, point-to-point star trigger from the embedded system module ESM, bi-directional point-to-point star trigger, and a 12 lane parallel trigger bus.

The flexibility in the AXIe infrastructure enables complex triggering from one device to the others. The embedded system module then allows the breakout of the synchronization signals through additional external clock and trigger in/out connections.

Connection to a controlling PC can be made via a cabled PCIe connection to the ESM, or alternatively an embedded controller can be added to the AXIe chassis and be used to control the acquisition system.

The solution is complemented by turnkey software for the capture and control of data across 10's or 100's of channels when using Agilent's U1092A-S01 AcqirisMAQS software. This powerful software was designed and developed specifically for control and monitoring of advanced data acquisition systems. It allows remote Ethernet operation of multiple systems at various networked locations.

The user-friendly interface provides drag & drop functions and a familiar multiple-window workspace, for multiple waveform display, and cursors for simple and rapid measurement.

Conclusion

Using the AXIe-based digitizer will help you to get more synchronized channels on your desktop. A single 5-slot AXIe chassis can integrate 5 AXIe digitizer modules, providing 40 channels of high-speed data acquisition, with 1.6 GS/s, or 20 channels at 3.2 GS/s. The unit provides DC to 1 GHz analog bandwidth, for capture of fast transients, and fast measurement throughput, with 4 GB onboard memory, four lane PCIe Gen 2 backplane link, and four onboard Xilinx Virtex-6 FPGAs providing real-time processing capabilities.

Agilent's AXIe digitizer provides the extreme speed and precision needed for system monitoring and control, and for capturing data from the interactions and events in the experiments themselves.

Image: Five Agilent (M9703A) AXIe 12-bit digitizers installed in the Agilent 5-slot AXIe chassis to form a 40-channel 12-bit acquisition system.



More information: www.agilent.com/find/axie-digitizer