A PXI-based, Multi-channel Ultra-fast Data Acquisition System for Transient Pulsed Signal

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Fig. 1: The photo of one single DAQ board

Mainly for Recording of Transient Pulsed Signals!
• 16 DAQ cards at most
• All-hybrid backplane
• Trigger Distribution

Oscilloscopes in a crate!

Fig.2: A photo of the designed DAS

Fig.3: Control software with LabVIEW
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1. Overview

This work presents a high-speed, high-resolution data acquisition system (DAS) with 1 Gsps sampling rate and 12 bit resolution, mainly applied to nuclear and particle physics experiments. The system consists of one NI PXIe-1085 chassis, containing a PXIe controller card and 16 data acquisition cards at most. For every single card, the signal conditioning module incorporates one high precision Op Amps converting single-ended signals to differential signals (VDS) with low additional noise level, and the data acquisition module combines a 12-bit folding interpolating ADC with a Xilinx Kintex-7 FPGA, implementing controls of A/D conversion and high speed data transmission through SFP interface using Aurora protocol. All these cards in the chassis can be synchronized easily using timing and triggering with PXI resources. Besides, a simple software of our system is designed to display the captured waveform signal and communicate with the host PC for remote controlling.

2. Design and Test

2.1 Hardware Design

- We deploy several orders of input range to cover some hundreds of milli-volts to hundreds of volts.
- To improve SNR, a three-order Butterworth filter as anti-alias filter is used.
- A baseline shift module is designed for unipolar signals to fully display in the virtual oscilloscope.

2.2 Logic and Software Design

- Virtually, oscilloscopes in a chassis.
- After calibration, primary test results show as follows:

Test Results

<table>
<thead>
<tr>
<th></th>
<th>1G samples/s</th>
<th>100M samples/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENOB</td>
<td>9 bits</td>
<td>9 bits</td>
</tr>
<tr>
<td>SNR</td>
<td>50 dB</td>
<td>50 dB</td>
</tr>
<tr>
<td>DR</td>
<td>12 bits</td>
<td>12 bits</td>
</tr>
<tr>
<td>Data Rate</td>
<td>1 Gbps</td>
<td>100 Mps</td>
</tr>
</tbody>
</table>

2.3 Test Results

- The resulting data can be transmitted to remote server through SFP connector with optic fibers using Aurora Protocol.
- After creating the VISA-based driver and developing basic communication and DMA support, our control software is built.

3. Summary

- The DAS can integrate 16 DAQ boards in one chassis. With great scalability, the system can be used for modern big physics experiments. Primary measurements show that each single card in our DAS achieves an analog bandwidth of higher than 200MHz and an ENOB of more than 9 bit at 1Gsps sampling rate.
- Each channel has a memory depth of 65ks and the trigger position can be programmable through software interface.
- The digitized data can be either transferred through PXI 32x10/33MHz bus to the disk of the local controller or through SFP interface to the remote receiver within 1ms.
- Qualitatively speaking, more research work should be done with record and test of single transient pulsed signals.