Performance Evaluation of EPICS Oscilloscopes for Real-Time Waveform Monitoring

Boyd L. Shaw, Johnny Y. Tang

Abstract:

ZTEC’s EPICS Oscilloscopes have been evaluated to perform simultaneous real-time pass-fail monitoring of two or four waveforms. The EPICS oscilloscopes are remotely controlled and monitored via LAN. Operators can control and query all instrument functions and settings, and monitor captured waveforms via EPICS PVs, an EDM panel, or a "virtual front panel" application running in Linux or Windows. Upper and lower waveform masks used for pass-fail testing are automatically generated by the oscilloscope from a captured ideal waveform. A variable-width output pulse is generated upon every captured waveform that passes (falls within the masks) or fails (falls outside the masks), depending on the operator’s requirements. Real-time pass/fail monitoring has been demonstrated on the test stand for the Spallation Neutron Source (SNS) injection and extraction kicker waveforms occurring both at 60Hz and 120Hz. We believe that the same instruments will also support SNS’s future requirements for real-time monitoring of waveforms at 120Hz.

Introduction:

The waveform monitoring system for the SNS extractor and injection kicker is not currently sufficient or easy to integrate. Ideally, the waveform monitoring system would:

- Monitor pulses occurring at 60Hz for proper duration and shape
  - Trigger protection measures if a pulse does not fall within specified tolerances, before the next pulse occurs in 16.67ms (60Hz)
  - No missed pulses
- Allow easy remote control and configuration for technicians using EPICS
- Allow simultaneous instrument monitoring from multiple locations using EPICS

Proposed Solution:

ZTEC has designed LAN-based oscilloscopes specifically for these particle accelerator applications. ZTEC’s EPICS oscilloscopes offer:

- Embedded XScale processor with Linux (core/base??)
  - Runs EPICS 3.14 and Channel Access Client version 4.11.
  - Stores EPICS process variables (PVs) in onboard memory
    - PVs exist for all scope functions
  - Manages LAN services
  - Faster processing than Windows-based oscilloscopes
- Onboard DSP
  - Automatically generate upper and lower masks based on a captured ideal waveform
  - Compare acquired waveforms to upper/lower masks
- Timing FPGA
  - Generate an output pulse if acquired waveform falls within allowed range
- Two models, each with two and four input channel versions:
  - 1 GHz analog bandwidth, 4 GS/s sampling rate (ZT4610)
  - 300 MHz analog bandwidth, 1 GS/s sampling rate (ZT4210)
- Four reference waveforms
  - Store upper and lower waveform masks for mast testing
- Four waveform calculation channels
- Compares captured waveform to upper and lower waveform masks
- Stores last failed waveform

Results:

- ZTEC’s EPICS oscilloscopes support 60 Hz injection and extraction kicker pulses with no missed pulses during continuous operation
- Segmented acquisition memory saves the failed waveform(s) and pre-failure waveforms for later review
- Oscilloscopes can be configured to stop acquiring data upon failure
- The measurement can be gated so that the mask is only applied to a portion of the waveform (e.g., only the rising edge and the top of the pulse)
- Output pulse width is user-defined to optimize interaction with SNS [xxxxxxx] circuitry
- Oscilloscopes can boot up into a predefined state for hands-off remote deployment
- ZTEC’s EPICS oscilloscopes require less rack space than benchtop oscilloscopes
- The embedded EPICS IOC enables easy integration

**Test System Set Up**

![Waveform Monitoring Oscilloscope](image)

**Future Plans:**

- [ ]