Remote Waveform Access Supports with EPICS for TPS and TLS Control System

Y. S. Cheng#, C. Y. Liao, C. Y. Wu, K. H. Hu, K. T. Hsu
National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan

Abstract

To eliminate long distance cabling for improving signal quality, the remote waveform access supports have been developed and applied on the TPS (Taiwan Photon Source) and TLS (Taiwan Light Source) control systems. Waveforms include pulse magnets power supplies waveforms, AC waveforms of main power supplies, LLRF waveforms, beam signals, etc., and these are necessary to be monitored during routine beam operation. One is that use the EPICS-embedded data acquisition systems which are formed by the Zynq System-on-Chip architecture to capture the waveform signals; the other is that a dedicated EPICS IOC is used to communicate with the present Ethernet-based oscilloscopes to acquire each waveform data. According to specific purposes use, the different graphical applications have been developed and integrated into the existing operation interfaces. These are convenient to observe waveform status and to analyze the acquired data on the control consoles. The efforts are described at this paper.

System Architecture of Waveform Supports with EPICS

- Remote waveforms access supports with EPICS mechanism have been developed and applied on both TPS and TLS control systems, and the system architecture is illustrated as Fig. 1.
- Fan-less PC-based platform was set up as the dedicated soft-IOC to connect with oscilloscopes via an Ethernet interface. An IOC uses the VXI-11 or TCP/IP protocol to communicate.
- A commercial standalone data acquisition system with embedded EPICS IOC is suitable to use at the routine operation phase.
- Some waveforms date have been calculated and translated to specific data formats to be easily monitored and archived into database server.
- Consoles apply toolkits to show trends of observed signals and to retrieve the archived data for long term analysis.

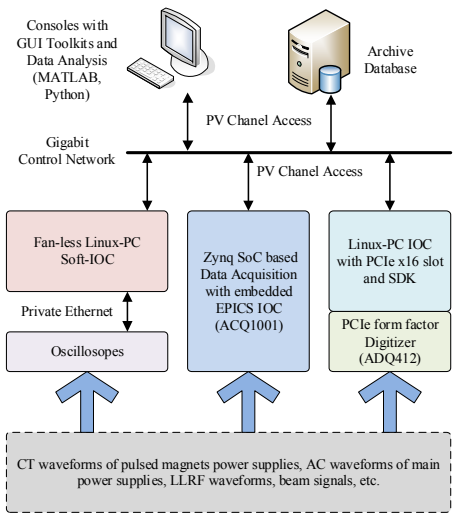

Figure 1: System architecture of waveform support with EPICS for TPS and TLS control systems.

Waveform Support of Ethernet-based Oscilloscopes

- Device supports were built to communicate oscilloscopes with the device driver.
- Related record supports were created with a link to the device supports. The software block diagram of establishing EPICS support for oscilloscopes is shown as Fig. 2.
- A user can easily analyse the acquired waveform data using specific toolkits (Python, C/C++, MATLAB, etc.) with the EPICS channel access library.
- To monitor bunch current, the waveform acquired from oscilloscope are processed online by the MATLAB and formed to one dedicated waveform PV. The GUI has been created to show the calculated fill pattern as Fig. 3.

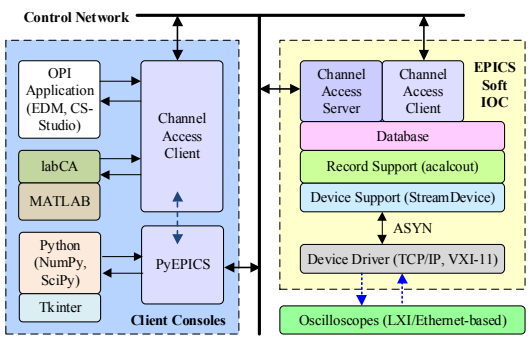

Figure 2: Software block diagram of building EPICS support for acquiring waveforms from LXI/Ethernet-based oscilloscopes.

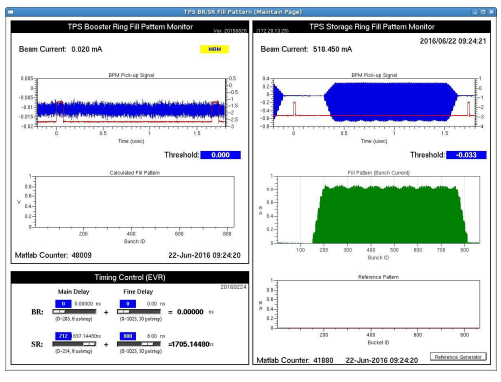

Figure 3: GUI created for monitoring fill pattern of TPS storage ring.

Zynq SoC Based Data Acquisition with Embedded EPICS IOC

- ACQ1001 data acquisition is suitable for continuously observing variations without higher sample rate acquisition and it is also with low power consumption.
- It is a smaller size appliance (shown as Fig. 4) with external 12V DC power, and supports both provided FMC and ELF modules.
- The Zynq System-on-Chip architecture is carried with featuring low power and integral FPGA device.
- It supports external clock and trig options, and can be synchronized between units using HDMI cable bus.
- Its software environment equips the Linux operation system, and an EPICS IOC is embedded as standard.
- ACQ1001 with ACQ430FMC module supports eight simultaneous channels with 24-bit 128 kSPS.
- EPICS GUI of monitoring essential waveforms which integrated with new ACQ1001 and existed oscilloscopes for TLS booster ring as shown in Fig. 5, and waveforms observation integrates with new ACQ1001 system and EPICS support of existed oscilloscopes.
- The EPICS applications have been gradually supported and operated on the consoles environment of TLS control system.

Figure 4: Outward of ACQ1001 with FMC module.

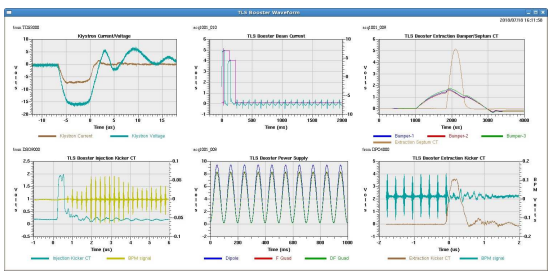

Figure 5: EPICS GUI of monitoring essential waveforms which integrated with new ACQ1001 and existed oscilloscopes for TLS booster ring.

PCI-express Form Factor Digitizer

- ADQ412 digitizer is equipped up to 4 GSPS sampling rate per channel, up to 2 GHz analog bandwidth and 12-bit vertical resolution.
- It also supports four input channels, and external clock reference and external trigger input.
- ADQ412 digitizer is available in the PCI-Express form factors as shown in Fig. 6, and PCIe for integration in a PC platform.
- PC with installing ADQ412 is as an EPICS IOC to be developed the waveform access support with provided SDK.
- Software framework of EPICS support is under construction and test, and can be verified with actual signals on-site in the future.

Figure 6: Outward of ADQ412 with PCIe form factor.

Summary

- To eliminate long distance cabling for improving signal quality, remote waveform access supports are necessary to be implemented.
- A dedicated EPICS IOC is used to acquire waveform data from Ethernet-based oscilloscopes.
- In addition, the EPICS IOC embedded data acquisition system which formed by the Zynq System-on-Chip architecture has been also used to monitor waveform during route operation.
- The EPICS support of PCIe digitizer with high sample rate and high bandwidth under construction and test.
- GUIs of waveform supports for specific purposes have been created and applied on the TPS and TLS control systems, and enhanced continually.

#E-mail: cheng.ys@nsrrc.org.tw