PRELIMINARY TEST OF EPICS WAVEFORM SUPPORTS FOR TPS

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Abstract

The TPS (Taiwan Photon Source) is newly proposed the 3 GeV synchrotron light source project. The control system of TPS is based upon EPICS framework. Waveform displays on control console and data acquisition are essential for the commissioning and operation of TPS. The EPICS IOCs, scope IOCs, digitizers and oscilloscopes can support to acquire waveform through EPICS channel access. The EDM is used to implement the operation interface of control console and will provide waveform display from EPICS scope IOC, digitizers and oscilloscopes with various sampling rate and vertical scale. The environment is implemented and tested at the existed 1.5 GeV Taiwan Light Source (TLS). The efforts will be summarized at this report.

INTRODUCTION

The TPS [1] is a latest generation of high brightness synchrotron light source proposed to build at the National Synchrotron Radiation Research Center (NSRRC) in Taiwan. It consists of a 150 MeV electron Linac, a 3 GeV booster synchrotron, and a 3 GeV storage ring.

The EPICS (Experimental Physics and Industrial Control System) is a set of open source software tools, libraries and applications developed collaboratively and used to create distributed soft real-time control systems for scientific instruments such as the particle accelerators, telescopes and other large scientific experiments [2]. In the field of accelerators, many facilities particularly have good experiences for EPICS and adopt it as the accelerator control systems. Many resources and supports are available as well as numerous applications for accelerator have been developed.

As a result, the EPICS framework was also selected as control system infrastructure for the TPS project. The EPICS platform has been gradually built and tested to control and monitor the subsystems of TPS. Utilizing the EPICS platform can create various database records to access I/O data and setting parameters. One of EPICS database records is the waveform record to store data array acquired from the device.

There are many waveforms alike signals which should be observed in synchrotron light sources including current waveform variation of booster, beam current measured by the fast current transformer, and filling pattern, RF pulse, pulse magnet current and etc. Acquiring waveform data should be based upon EPICS waveform supports. Through PV (Process Variable) channel access the client console can monitor the waveform by using various toolkits (EDM, MEDM, MATLAB and etc). In addition, Ethernet interface LXI instrumentations will be adopted extensively therefore building EPICS modules which can be communicated with these instrumentations would be necessary.

One of the advantages on EPICS waveform support is the remote control and monitor of various oscilloscope instrumentations. Client users can observe the waveform by using display toolkit on the control consoles. Efforts of implementation of EPICS waveform support for the TPS project are summarized in the following paragraphs.

EPICS WAVEFORM SUPPORTS

An EPICS support IOC can interface various instrumentation devices anytime and anywhere. By the EPICS channel access the clients can use the specific toolkits to access IOCs which communicate with instrumentation devices. The usable toolkit is EDM (Extensible Display Manager), MEDM (Motif Editor and Display Manager) or MATLAB (channel access via the labCA module), etc. as OPI (Operation Interface). Using these graphical toolkits can construct the specific pages for different purposes. The basic functions include monitor and control pages that show channel status, select display input channel, save and load configuration, save waveform to file, waveform hardcopy, show timestamp and etc. The various implemented interfaces of waveform support would be described as followed.

LXI Oscilloscope

One solution of building EPICS IOC which has waveform support is adopting computers to interface LXI (LAN eXtensions for Instrumentation) based instrumentations of oscilloscopes. LXI is an instrumentation platform based on industry standard Ethernet technology designed to provide modularity, flexibility and performance to small- and medium-sized system [3]. One key advantage of LXI is its ability to leverage ongoing innovations in LANs that satisfy the requirement for speed, and LXI enhances performance by enabling faster system throughput. The LXI-compliant instruments support the VXI-11 protocol based on remote procedure calls for communicating.

Hence the Tektronix DPO7254 as the EPICS waveform support test-bench of LXI based oscilloscope is launched. The DPO7254 consists of 1 Gbps Ethernet, 2.5 GHz bandwidth, and 40 Gsa/sec sample rate, etc [4]. One workstation as the IOC is setup upon the EPICS environment. The StreamDevice and ASYN modules are needed, and employed to communicate with LXI based oscilloscope through Ethernet interface. At the StreamDevice module, the protocol file is used to describe the communication of various devices, and contains each function of the device type and variables which affect how the commands in a protocol work [5]. The output function in protocol files can send the ASCIIbased SCPI (Standard Commands for Programmable Instruments) command to the instrument devices for communicating. The ASYN module can set the communication protocol (TCP or VXI-11) to connect various instrument devices. The diagram of system architecture is shown as Fig. 1.

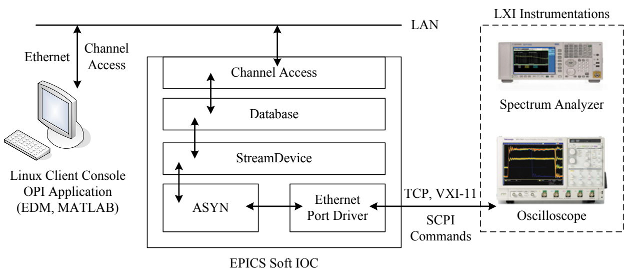

Figure 1: System architecture of building EPICS waveform support of LXI based instrument devices.

In the IOC, the various records can access data and parameters with specific protocol files of StreamDevice to communicate with LXI based oscilloscope. At the client, console utilizes the EDM toolkit as the graphical OPI. The EDM control page is used to gain data from IOC through PV channel access mechanism. The EDM toolkit has built into X-Y graph function to display the waveform array for observed signals measured from LXI based oscilloscope. Using the implemented EPICS waveform support of LXI based oscilloscope to acquire the simulated TPS filling pattern waveform is as shown in Fig. 2.

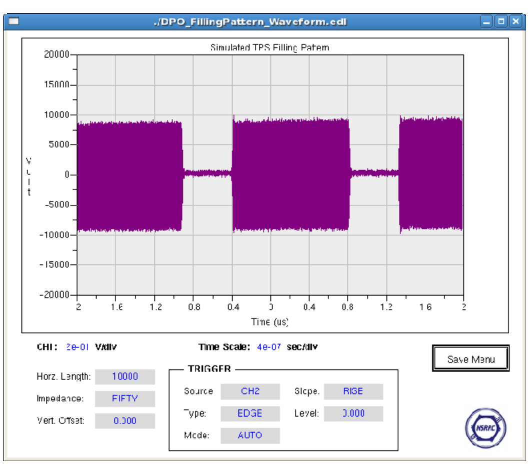

Figure2: EDM monitor page of simulated TPS filling pattern waveform which is channel access from IOC communicated with LXI based oscilloscope.

LXI Spectrum Analyzer

Agilent N9010A EXA [6] is also used as the EPICS waveform support test-bench of LXI based spectrum analyzer. The StreamDevice and ASYN modules are applied to communicate with the spectrum analyzer through TCP network protocol. The system architecture is the same as the Fig. 1. According to the SCPI commands of spectrum analyzer, the specific protocol file with the StreamDevice modules is established. In the IOC host, the specific records store the measurement waveform array data from spectrum analyzer. The console host with EDM toolkit can observe the waveform acquired from IOC through PV channel access. The clients also use the MATLAB software for PV channel access with adopting the labCA module. The display pages are shown as Fig. 3.

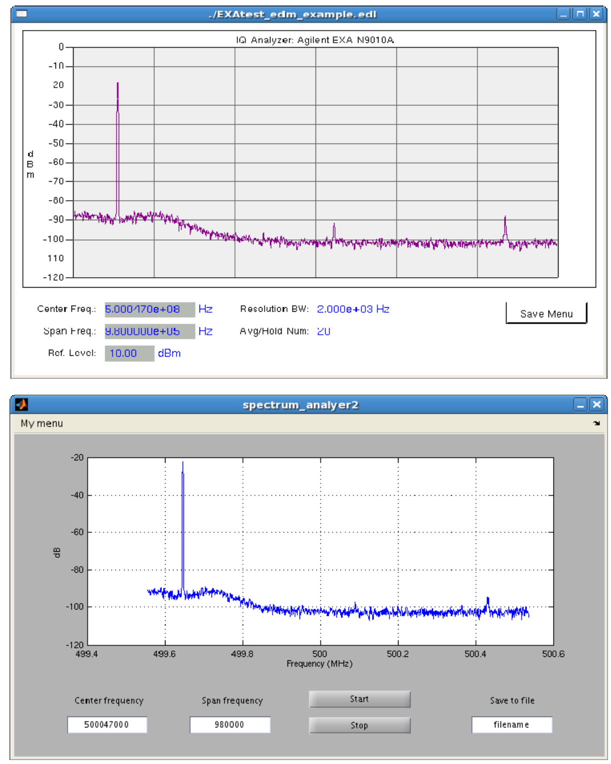

Figure 3: EDM and MATLAB display pages of LXI based spectrum analyzer.

EPICS Oscilloscope

Another solution of the EPICS waveform support adopts the ZTEC EPICS oscilloscope [7]. The ZT4612 scope has built into EPICS framework as an IOC. The ZT4612 consists of 8-bit resolution, 4GS/s maximum sample rate, 1 GHz bandwidth and 4 channels, etc. The PVs can support complete oscilloscope control attached the EPICS mechanism. Relying on channel access the console can set parameters or read data via Ethernet interface. The client host can utilize the EDM toolkit to observe and control the oscilloscope without building another IOC to communicate. It is convenient to observe the waveform data over the EPICS framework. In addition, according to different purpose the different EDM control display page would be designed.

In order to learn the effect of EPICS waveform support, the preliminary test of EPICS waveform support are applied on the actual signals of TLS to observe the measurement waveform. Using an EPICS based oscilloscope acquires the waveform of TLS Linac current transformer, and the EDM control page is as shown in Fig. 4.

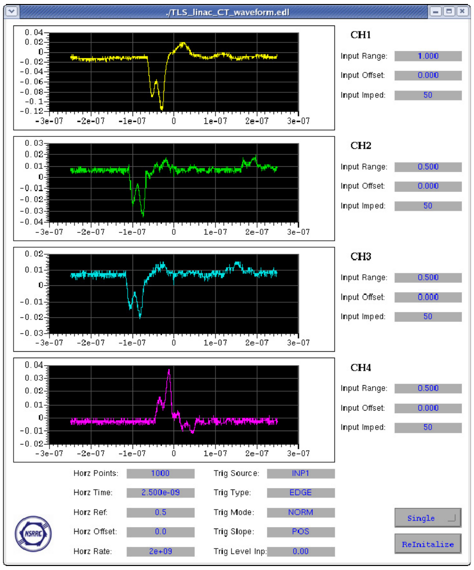

Figure 4: EDM OPI of TLS Linac current transformer with using EPICS based oscilloscope.

cPCI Digitizer

The cPCI digitizer will be used to capture waveform up to 128 kHz rate with 24 bits or 500 kHz rate with 16 bits ADC resolution. D-tAcq ACQ196CPCI digitizer [8] which is a networked Linux system and embedded with EPICS IOC is adopted. Through the channel access mechanism the digitizer participates and publishes data in EPICS control system. Using ACQ196CPCI to record the beam trip signals of the TLS, utilize the plot function of MEDM to monitor waveforms as shown in Fig. 5.

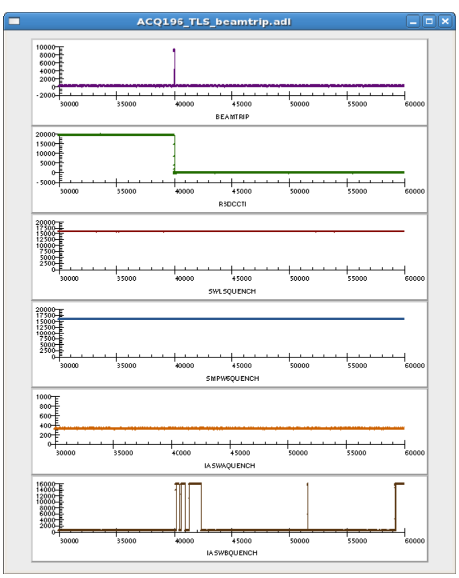

Figure 5: MEDM monitor page for observing the beam trip waveform.

Power Supply Built-in Data Buffer

Intermediate current power supply for the TPS quadrupoles and sextupoles will be built with waveform capture buffer. The sampling rate is planed at 10 KHz with up to 10 sec data buffer. It will be useful for power supply short-term performance analysis, and post-mortem data capture.

MISCELLANEOUS DEVICES

By the above mentioned implemented method of LXI based instrumentations, the EPICS support for TEMPpoint/VOLTpoint/MEASpoint [9] to measure temperature, voltage, or both is also established. One workstation host built with StreamDevice and ASYN modules as a soft IOC will communicate with TEMPpoint. The records built in the IOC store the acquired measurement temperature. The console can monitor the temperature variation from PV channel access. The monitor display page is shown as Fig. 6.

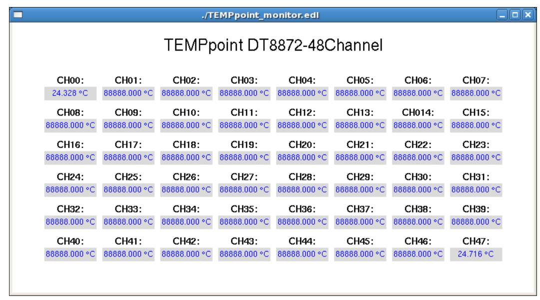

Figure 6: EDM monitor page of TEMPpoint to acquire temperature via channel access.

SUMMARY

Remote operations of all waveform acquisition instrumentations for the TPS are planned to eliminate long distance cabling and improves signal quality. Preliminary tests of various possible EPICS waveform supports have been performed recently. The EPICS waveform support evaluation consists of the embedded EPICS oscilloscope and several different kinds of LXI based instruments. The prototype IOCs modules to communicate with the specific LXI based instrumentations are built and the different display control pages with PV channel access under Ethernet interface are also depicted. These solutions will be improved continually and will be applied for the TPS project in the future.

REFERENCES

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