POWER SUPPLY CONTROL AND APPLICATIONS DEVELOPMENT FOR THE TPS STORAGE RING QUADRUPOLE AND SEXTUPOLE MAGNET

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Abstract

The TPS intermediate power supply for storage ring quadrupole and sextupole magnets with current rating 250 Amp will be equipped with Ethernet interface. The quadrupole power supply is 18 bits with higher stability than sextupole with 16 bits, and have internal data buffer for post-mortem capability. The dedicated IOCs are built individually at the 24 cPCI platforms to manipulate the devices of the 24 cells of storage ring respectively. Each IOC is used to control 10 quadrupole magnet power supplies and 7 sextupole magnet power supplies. The GUIs of storage ring quadrupole and sextupole power supplies controls were implemented by the EDM toolkit. The client console can use the specific EDM pages to access power supplies via PVs channel access. The measured currents of quadrupole and sextupole power supplies were read back for observing performance. Some applications, like the degauss process, boot function and etc, are also developed with the specific toolkit. The efforts will be summarized at this report.

INTRODUCTION

The TPS [1] is a latest generation of high brightness synchrotron light source which is in installation phase at the National Synchrotron Radiation Research Center (NSRRC) in Taiwan, and its commissioning is estimated in 2014. 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 [2]. Many facilities have good practical experiences for the 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 the TPS. The various database records can be created for accessing the I/O data and setting parameters at the IOC (Input Output Controller) layer. Utilizing the EPICS channel access mechanism with the specific toolkits, the data can be accessed between the IOCs and the clients.

At the TPS, the dedicated IOCs are established individually at the 24 cPCI platforms to manipulate the devices of the 24 cells of storage ring respectively. Each IOC is used to control 10 quadrupole magnet power supplies and 7 sextupole magnet power supplies. The GUIs of storage ring quadrupole and sextupole power supplies controls were implemented by the EDM toolkit. The operation applications include the operation interface, power on/off setting and checking, degauss process and etc. The setup of building the power supply control environment is described as followings.

CONTROL INTERFACES FOR THE TPS STORAGE RING POWER SUPPLIES

The power supplies control interfaces of TPS storage ring are divided into five categories rather than a unified solution. [3][4] The intermediate power supply for storage ring quadrupole and sextupole magnet with current rating 250 Amp will be equipped with Ethernet interface as well. The quadrupole magnet power supply is 18 bits with higher stability than sextupole magnet with 16 bits. The two kinds of power supplies are both contracted to a local company Chroma ATE Inc. [5] and would have internal data buffer for transient recording capability.

At each cell, controls of dipole, quadrupole and sextupole power supplies with Ethernet interface will be implemented on one cPCI IOCs crate running EPICS as shown in Fig. 1. The cPCI EPICS IOC equipped with the latest generation CPU board will be standardized as ADLINK cPCI-6510 CPU module [6]. The 6U cPCI platform was chosen for the EPICS IOC platform. Local company manufactured crate and CPU module that could provide an economic solution is the major reason.

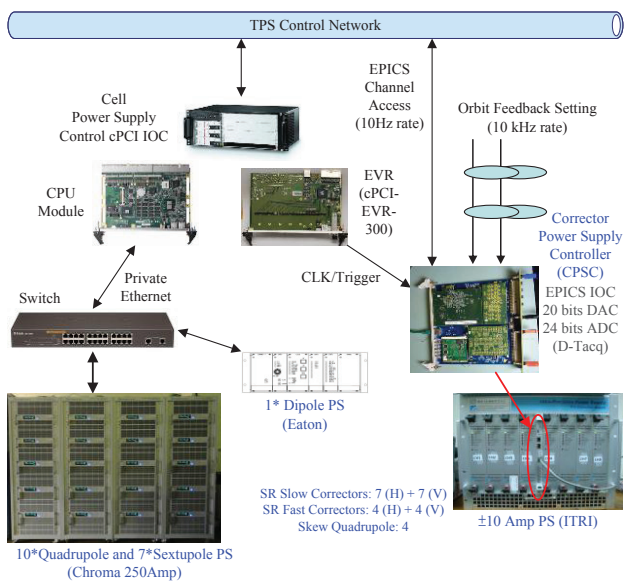

Figure 1: Control infrastructure in one cell of the TPS storage ring power supplies.

SOFTWARE ENVIRONMENT OF THE TPS INTERMEDIATE POWER SUPPLY CONTROL

The quadrupole and sextupole power supplies control environment is established to develop the operation progress of TPS magnet power supply. The dedicated soft-IOCs are built individually at the 24 cPCI platforms to operate the devices of the 24 cells of storage ring respectively. Each soft-IOC is used to control 10 quadrupole magnet power supplies and 7 sextupole magnet power supplies in the storage ring.

Fig. 2 shows the control software environment for the TPS storage ring quadrupole and sextupole power supplies. To control and monitor power supplies based on EPICS environment via Ethernet, the clients should be installed the specific EPICS base and the graphical OPI (Operation Interface) toolkits, such as EDM (Extensible Display Manager) [7] and MATLAB (channel access via the labCA module [8]) for EPICS channel access.

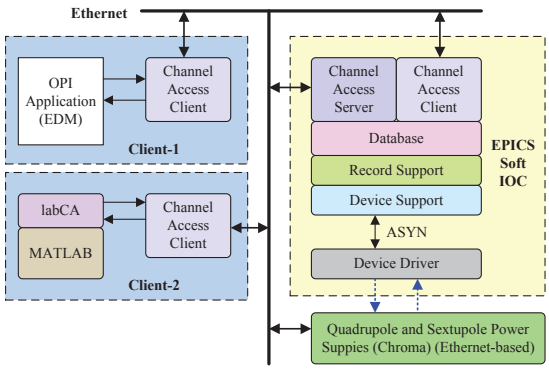

Figure 2: Control software environment of the TPS storage ring quadrupole and sextupole power supplies.

OPERATION INTERFACES OF TPS STORAGE RING POWER SUPPLIES

The EDM toolkit was chosen to develop the operation interface. The client console can use the specific EDM page to access the data via PV channel access. The quadrupole and sextupole magnet power supplies are built into the UDP protocol for automatically sending the power supply status to dedicated IOC as shown in Fig. 3.

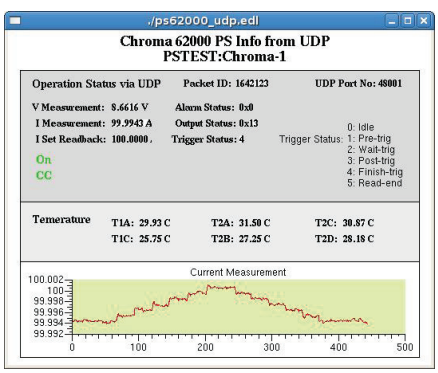

Figure 3: Chroma power supply is built the UDP protocol to send status automatically.

The detail GUI page for individual quadrupole power supply control as shown in Fig. 4. The detail control page of power supplies has the trend plot for observing.

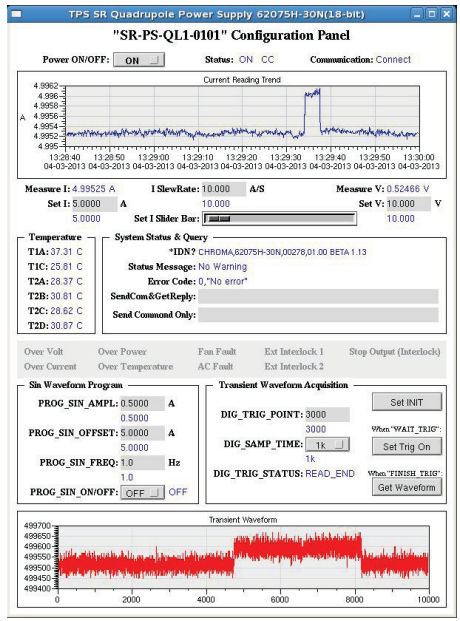

Figure 4: GUI of quadrupole power supplies control.

The sine waveform output function is built into the quadrupole magnet power supply for beam-based alignment used, and the frequency is supported from 0.1 Hz to 20 Hz. The transient waveform is acquired at the operation interface as shown in Fig. 5.

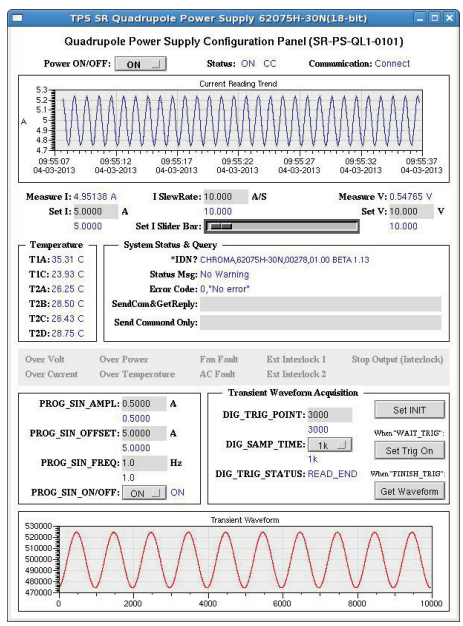

Figure 5: OPI of transient waveform acquisition during the sine waveform output of the quadrupole power supply.

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The MATLAB toolkit with labCA is adopted to develop the high level application program for commissioning and diverse operational procedures. The application includes the specific overall power on/off control, degauss process, checking power supply status, operation performance analysis, operation statistics and etc. The various operation processes is in development and testing according to the various operation modes. Fig. 6 shows the current variation during the degauss process executed.

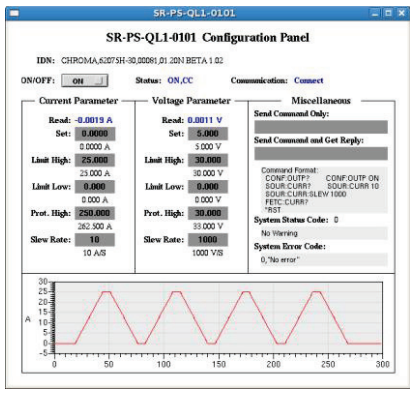

Figure 6: Current trend GUI shows during the degauss process executed.

PERFORMANCE MEASUREMENT FOR INTERMEDIATE POWER SUPPLIES

The quadrupole magnet power supply is 18 bits with higher stability than sextupole with 16 bits. According the transient waveform acquisition as shown in Fig. 7, the stability of quadrupole power supply is about ±1 mA, and is good than specifications (±2.5 mA). At the quadrupole magnet power supply, the overshot of current changed is about 7%. Fig. 8 displays transient waveform acquisition with 1 kHz sample rate and 10k-points, and presents that the overshot is about 70 mA during the 1 A current changed with magnet loaded. Fig. 9 shows the difference between the setting and reading current when the setting current is from 1 A to 250 A with 1 mA step, and the difference is less than 10 mA.

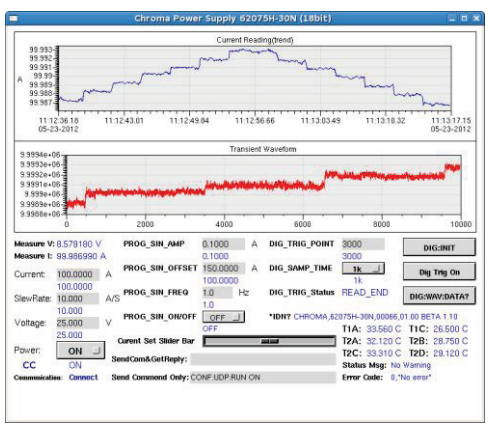

Figure 7: Transient waveform acquisition shows the current stability of quadrupole power supply is about ±1 mA.

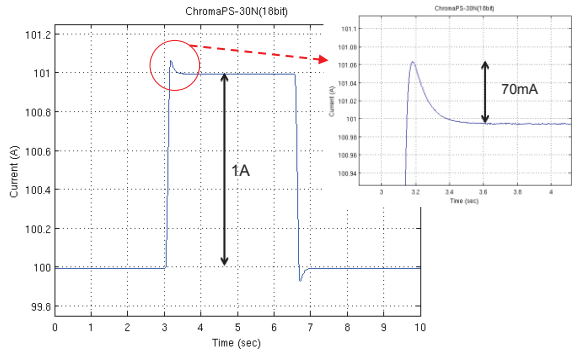

Figure 8: Transient waveform acquisition shows the overshot variation when quadrupole power supply current changed.

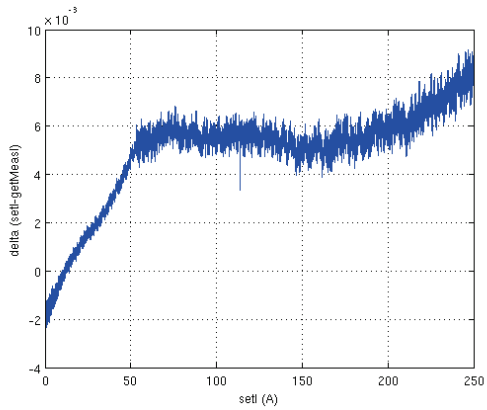

Figure 9: Difference between setting and reading current when setting current is from 1 A to 250 A with 1 mA step.

CURRENT STATUS

The quadrupole and sextupole power supplies have arrived in August 2012. The loading test of an IOC with connection to 17 power supplies is in proceeding and doing long time test. The operation interfaces and the high level operation applications included the specific overall power on/off control, degauss process, checking power supply status and etc. are in development and tested.

REFERENCES

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