대형 초전도자석 테스트설비의 Data Acquisition&Control 시스템

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Data Acquisition and Control System for a Large-scale Superconducting Test Facility

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Abstract - SSTF(Samsung Superconducting Test Facility) has been constructed at Samsung Advanced Institute of Technology to test the KSTAR(Korea Superconducting Tokamak Advanced Research) superconducting magnets and conductors. The SSTF DAC(Data Acquisition and Control) system basically consists of VME I/O modules, host PCs, and Ethernet links. VxWorks is used for the real-time OS of the VME IOC(Input/Output Controller). EPICS (Experimental Physics and Industrial Control System) provides a software architecture for the communication between IOCs and host PCs. For the efficient management of measured data, the database management programs through NFS(Network File System) have been developed and successfully operated. In this paper, the current status of the SSTF DAC system, DBMS(DataBase Management System), recent test results, and future plans are presented.

1. Introduction

SSTF is constructed in order to test superconducting strands, conductors, and magnets. It consists of a vacuum cryostat system, a cryogenic cooling system, a background magnetic field generation system, a power supply system and a data acquisition and control system. The operation scenario of KSTAR device requires a steady state operation of TF(Toroidal Field) coils and a fast ramping of PF(Poloidal Field) coils. Thus, the test of KSTAR superconducting magnet and CICC also need to be performed under the condition of the fast varying magnetic field. The background magnetic field generation system is designed to provide a changing magnetic field of a 3 Tesla/second for 5 seconds and a 20 Tesla/second for 0.05 seconds. Therefore, there must exist two-mode DAC system in our facility, a high-speed data logging and a low-speed monitoring, respectively. The low-speed monitoring system is used to control slow-varying parameters such as Helium flow rate, temperature, and pressure, etc. However, a quench protection system, which is linked with the power supply system, and a magnetic measurement system require a high-speed data acquisition.

The computer system for SSTF DAC is based on UNIX and Linux system and VxWorks and RTEMS are used for the real-time OS of the VME system. The EPICS is the basic communication software for the monitoring of slow- varying parameters and RT-Linux system with a PCI-VME interface is also used for the high-speed data acquisition system. A Linux workstation with PENTIUM 4 CPU is the database server for the in-house developed database system. In this paper, the current status of SSTF DAC system, DBMS and recent test results are presented.

2. SSTF DAC SYSTEM

2.1 SYSTEM OVERVIEW

Figure 1 shows a schematic diagram of SSTF DAC system. The basic configuration consists of operator interfaces, I/O controllers and Ethernet link. The operator interfaces are both UNIX workstations and Linux-based PCs. VME controller boards are based on Motorola 68040 CPU. VxWorks and RTEMS are used

for the real-time OS of VME controllers. RT-Linux is the OS for the host computer of the high-speed data acquisition system, where SBS Model 620 is used for the PCI-VME interface and PENTEK 4275 is the main A/D converter. The data from 64 channels can be handled with 100 kHz sampling rate. Some independent devices such as strain gauge controllers, GPIB devices, vacuum furnaces and Helium liquefiers do not have an Ethernet interface. The data from such devices are collected to PCs and stored to an in-house developed database system using a NFS (network file system). Then, the data can be monitored using an in-house developed quasi-real-time monitoring system.

Most of signals from various sensors are conditioned using isolation amplifiers. Isolation amplifiers have low pass filters and selectable gain controls by resistor change. A voltage tap signal could have a high voltage and high voltage isolation amplifiers are used to protect the data

Helium refrigerator, vacuum furnace and etc. The National Instrument GPIB-ENET is also used for the control of GPIB devices such as a signal analyzer, a digital oscilloscope, voltage source, and etc.

2.2 EPICS

The main purpose of EPICS are to provide a fast, easy interface to data acquisition and control, and to provide an operator interface to all control system parameters.

The EPICS IOC database with respect to these I/O modules has been made using Capfast, which is a commercial schematic editor and compiled to be loaded into IOC via VxWorks startup script file. Each I/O controller provides a channel access server and both operator interfaces and I/O controllers are

available as channel access clients. Using the client/server model and TCP/IP, channel access provides network- transparent access to the IOC database.

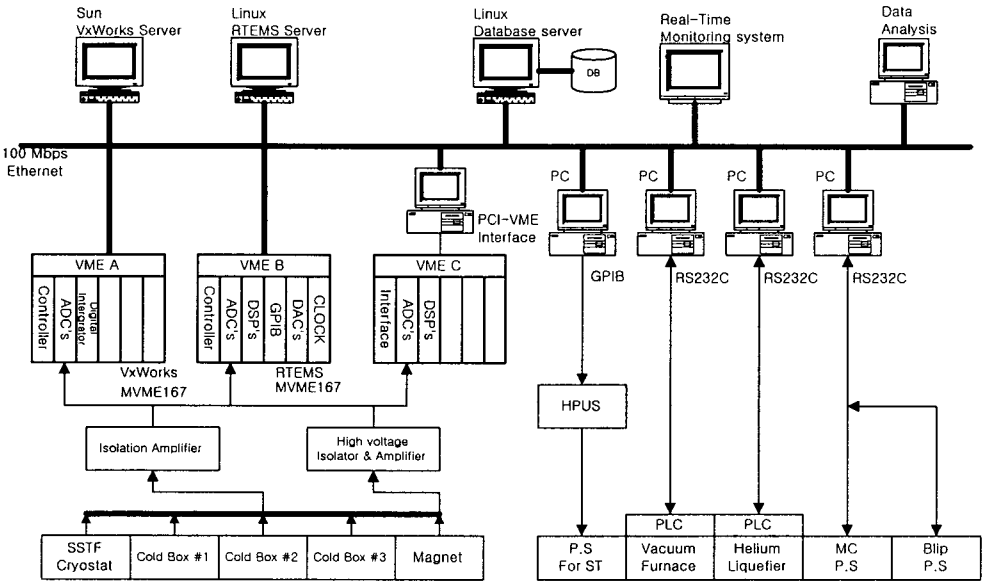

Fig. 1. Current status of SSTF DAC system

acquisition system with the maximum isolation voltage of 20 kV. PENTEK 4270 DSP boards and PENTEK 4275 A/D converters with 4202 MIX baseboards are used for the quench detection and protection of superconducting magnet. Slow-varying parameters such as temperature, pressure, and Helium flow rate are monitored using VMIC VMIVME3122 A/D scanners. Various I/O modules such as VMIVME 4100 D/A Converter, PENTEK 1420 clock, and NIGPIB 1014 board are also installed in VME crates. Sets of PLC systems are used for the control of pneumatic valves,

2.3 Quench Detection & Protection

In order to protect a magnet during quench, the data that is required for the quench detection is sampled with high speed during the operation of the magnet.

For example, the sampling rate of voltage tap signals is 100 kHz, and the data is transmitted via local bus to the DSP board. According to the quench detection algorithm provided, DSP board analyzes the status of the superconducting magnet. In case of quench, DSP board generates a trigger signal for the quench protection system and the magnetic

energy stored in the magnet is dissipated to the energy dump circuit.

2.4 Database Management

The Linux OS with PENTIUM 4 CPU with 800 MHz Rambus DRAM is adopted as a database server because of its faster memory access time. The data from various sensors, GPIB instruments, vacuum gauge and power supply is stored with a given database format. Therefore, all the data during experiment can be easily accessed without modifying the application software for data retrieval and archival. Users merely have to know the data name and recorded date/time to retrieve the favorite data from the database. Besides, in order for users to monitor their equipment data more easily, two GUI programs are developed through x-window libraries. The application program, XY_MON, is a real-time data monitoring software using EPICS CA library and another is XYP which shows a graph after obtaining data through the database server access. XYP can also used for the quasi-real-time monitoring of the data through the continuous access of the database.

3. Test & Results

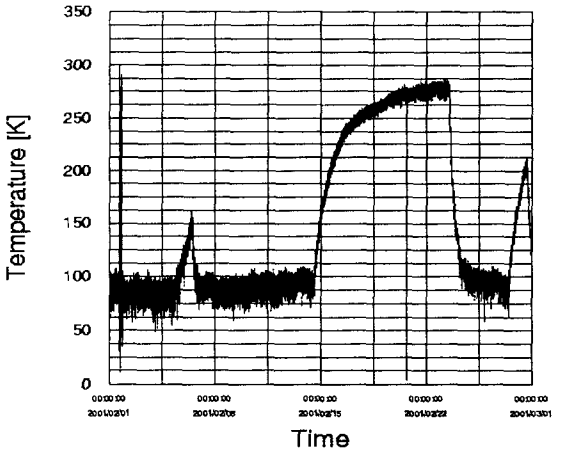

Fig. 2. Thermal Shield Temperature of LVC

Figure 2 shows the SSTF thermal shield cool-down history. XYP and XY_MON also generate the graphics output in postscript format. The raw voltage data from the thermal shield of SSTF LVC is converted to the physical temperature data by built-in calibration routines in the database software, which also accesses the calibration data of various sensors.

4. Conclusion

The database system with EPICS, which plays an essential role in the control system of SSTF, proved its reliability and scalability. For the full test of superconducting magnets under various conditions, the quench detection and protection system using DSP is still under development for more reliable quench detection algorithm. The data from the high-speed data logging system is also stored to the database server with the same file format through DMA access between PCI adapter and VME adapter.

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