Magnet Power Supply Controls of the SPring-8 Storage Ring

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Abstract

SPring-8 Storage Ring (SR) magnet power supplies (PS) were installed in the PS-rooms in March and October of 1995. High output current cables for the large DC PSs were put on the trays above the machine tunnel. A large number of small size power supplies are now under construction. A fiber distributed remote I/O (RIO) slave card was installed into the PS unit and connected to the RIO master card in VME. A test program for the power supply system using an RIO device-driver was developed on an HP-RT workstation [1]. Magnet PS control programs are now in being written.

1. Introduction

The SPring-8 storage ring consists of 48 Chasman-Green type cells. Each cell has two Bending magnets (B), ten Quadrupole magnets (Q), seven Sextupole magnets (S) and twelve Steering magnets (St). Forty auxiliary PSs (QA) for the long straight section cells are adapted for the Quadrupole magnets [2]. This number will come to 480 in the future [3]. Thirty-eight sets of Skew Q and eight injection magnets are to be installed. The total number of Steering magnet PSs (St-PS) is 576. Thus the total number of the SR magnet power supplies is 1120. The 480 QA supplies must electrically float several hundred volts above ground level. Due to considerations of isolation, noise rejection and reliability, an optical fiber linked Remote I/O system was chosen. A large number of beam position monitoring circuits plus vacuum control also use this RIO system, which consists of the following devices: 1) VME master with a dual port memory, 2) RIO (slave card), of which there are seven different types, 3) star branch for optical fiber cables from the master module to the slave cards [4][5].

2. Magnet Power Supplies

The total numbers of large PSs for B, Q and Sx is 18. They were installed in PS Room-A in March 1995, and all St-PSs on 6 October 1995. They are thyrister controlled (B: 24th Q: 12th, S: 6th phase) DC supplies [6].

The steering magnets have independent power supplies (St-PS). One hundred ninety-two sets of St-PS and 10 sets of QA are located in four PS rooms. Q magnets, which are connected in series, are adjusted by QA to correct the modulation of the beta function and phase advance [2][7]. St-PS and QA are switching regulator type. Forty sets of QAs and 576 sets of St-PS were also completed and installed.

A Four Bump, one DC-septum and one Pulse-septum magnet PSs (SR injection devices) are designed and under construction. The Bump and Pulse-septum PSs use RIO type-A control circuits (see figure 1). These also use a timing system connected to the 508.58 MHz master oscillator. The DC-septum PS takes RIO type-B.

3. PS Control System

Each reference voltage for the large (B, Q, S) PSs is given by a 16 bit DAC controlled by the digital output of an RIO type-B. These DACs for the B, Q, and S PSs are installed in a temperature controlled box of the PS cubicle. This RIO card has 32 bit DI and DO. Figure 1 shows the BP, QP and SP in PS Room-A.

The St-PS, QA and QB are controlled by the analog output (-10 ~+10 V) of an RIO type-A. The RIO type-A is attached to that PS chassis with the same guard level. The RIO operational power source (5V, ±15V) is supplied by the floated PSs. The RIO type-A also has a double integration ADC, which monitors an actual current using a shunt resistor output (-1 ~ +1V). These PS units have 8 bits of status (power on/off, DC-bus on/off, remote/local, fault, over-current, temperature, ext-interlocks, etc.) to be read.

The currents of the multiple PSs must be changed simultaneously for an orbit correction. Therefore the orbit correction program requires any combination of four or more St-PSs in any PS rooms. Also a slow (rough) timing system (~ 50 ms) is needed. The computer network is used for such rough timing.

4. VME-RIO Network and PS Interlock System

All the RIO slave cards for all the magnet PSs are controlled by only four VME crates by using optical branch cards. The SPring-8 control system adopted FDDI and Ethernet to communicate between WSs and VME crates. The SR magnet PS setup and tuning will also be done through this FDDI.

For a closed orbit correction, multiple sets of steering magnet PSs must be set simultaneously (local bump orbit). Thus a rough timing system (~50 ms) must be installed for magnet control. The RIO's master to master [8] communication (data transfer time is less than 0.8 ms) system can be used if the optical fiber cables are distributed between the four PS rooms as an RIO network [4]. Furthermore if RPC response time is less than 50 ms the FDDI network can be used. (In cases using TCP/IP or UDP the mean response time of RPCs with the HP-RT was measured to be a few ms).

A programmable logic controller (PLC) is used for the PS interlock system. The water flow switches and thermostat switches of all magnets are connected as distributed input units of the PLC.

Figure 1 shows the VME and RIO network and an interlock system for the magnet PSs. The water flow switches and coil thermostat switches are connected to the PLC (Sequencer) remote units, which are located beside the magnet bases, using twisted pair cables. A normal relay close signal from the PLC output card is connected to the PS's interlock input. Primary alarm information goes to a VME from a PLC's Ethernet port. Five PLC controllers are connected through an optical fiber cable in the maintenance corridor.

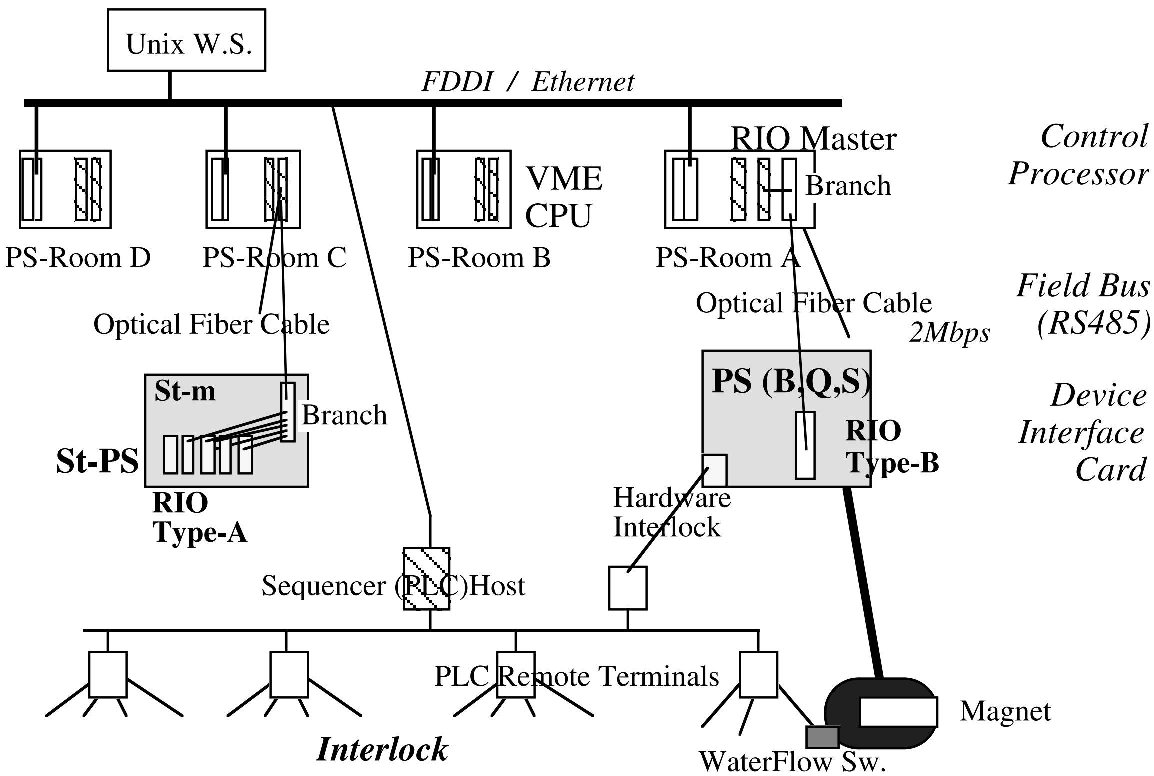
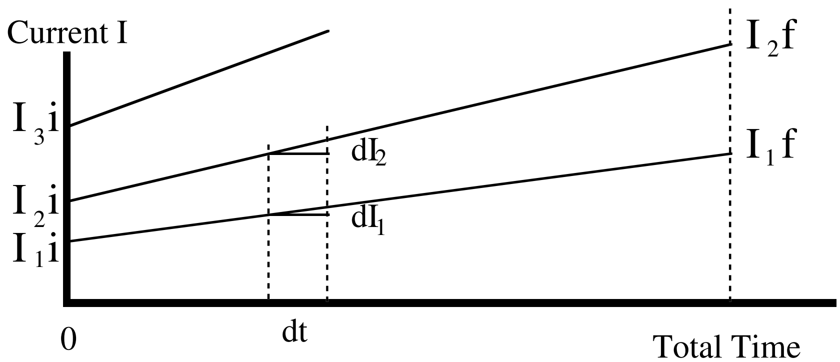


Figure 1. VME-RIO network and PLC (Sequencer) interlock system for magnet PSs.

5. Software

A test program of the VME computer was written for the HP-RT, and a test operation was made with an St-PS for on/off, reset and current up/down control. For the multiple current set sequence of the St-PS, messages from a Message Server (MS) to an Equipment Manager (EM) have been designed [9]. Magnet name, final currents and set times are sent to the EM from an upper layer program. Then the EM gets initial currents from the database table and calculates the step currents and step times (dI and dt), using the current value limitations (see figure 2).

The database structure and the rough timing system of the magnet PS are now being studied. A GUI program and man-machine interface programs will be completed by summer 1996. All installation of the optical fibers into the 576 PSs will be done in December 1995. High power operation for the Q PSs will be done with the 48 Q-magnets connected in series after the SR ring vacuum test in April 1996.



MS --> EM Send Data: Magnet Name, I final, Total Time

EM: $dI/dt < (dI/dt)$ max

Figure 2. Multiple current setings must be made simultaneously. The Equipment Manager (EM) calculates the step currents (dI) and step times (dt) and checks the maximum dI/dt .

6. References

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