UPGRADE OF BEAM STEERING SYSTEM COMPONENTS AND CONTROLS FOR THE NSLS STORAGE RINGS*

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Abstract

The installation of the new insertion devices and new experiments on the NSLS storage rings has increased the demand for better stability of the electron orbit.[1] This, in turn, increased the demand for better stability and resolution as well as larger bandwidth of the orbit correction system. All of the orbit correcting dipoles now have new low-hysteresis laminated steel cores. The magnets are excited by commercial wide-band (1 kHz) current regulated power supplies. The input circuits of the new power supplies permit a summation of analog inputs from orbit stabilization systems with set-point inputs digitally controlled by the operator. This paper describes the design of the new system and summarizes its present performance.

Introduction

The beam steering system components and controls at the NSLS storage rings are in the process of being upgraded. Some of the goals to achieve with this upgrade were: 1) repeatable magnetic steering field, 2) low current ripple in the power supply, 3) good short and long term current stability, 4) wider bandwidth, 5) better set point resolution and 6) improved reliability and maintainability. To achieve all the above mentioned goals, all steering components and controls, such as magnets, power supplies and computer controls have been upgraded with state of the art equipment.

Trim Magnets

While using old trim coil packs, the new cores of these magnets have been designed with laminated low-hysteresis steel having a window frame cross section. A 0.030 inch thick fully insulated M-36 electrical grade silicon steel has been employed for this purpose. The trim magnets, as compared to old solid core steel magnets, have resulted in providing consistent and repeatable magnetic steering field.

Power Supplies

The new power supplies for this upgrade are rated at ± 10A, ± 20 V and are commercially available. These supplies are linear, programmable, wideband current regulated power supplies. These linear power supplies employ a dissipative bank of power transistorswhich is installed between a rectifier-filtered source of "raw dc" and the stabilized output. The transistor bank regulator provides a low ripple to the order of 1 mA rms in the frequency domain of 10 Hz to 10 kHz as well as low current drift with stability of better than 1 mA in 8 hrs. These power supplies, also, have a wide bandwidth of about 6 KHz with the typical magnet load of R=1 ohm and L=27 MH. For stability reasons, an RC network of R=330 ohm and C=0.47 microfarad is required across the output terminals.

Controls

A significant performance improvement has been achieved by increasing the system resolution from ± 11 bits to ± 13 bits. On a full scale of ± 10 amperes of current, it provides a current setability to 1.22 mA. Besides the power supply current readback, several other key signals are monitored from each power supply to keep up with the regulation status. When a fault occurs, these diagnostic readbacks help to locate the source of the fault without probing into the hardware.

Present Status/Improvement Summary

All of the beam steering system components in the NSLS X-Ray storage ring have been upgraded and are fully operational. There are 120 steering magnets at the present time. In the NSLS UV storage ring, all vertical steering system components (20 steering magnets) have been upgraded and are in operation. The upgrade of the remaining steering components will be accomplished in the near future.

The following table provides the summary of the improvements:

Table 1.

Parameter	Old System	New System
Current stability	± 4.88 mA	1 mA
Ripple/noise	± 4.88 mA	1 mA
Resolution	4.88 mA	1.22 mA
Bandwidth	30 Hz	6000 Hz
Magnet	solid core	laminated core

Description

A detailed description of the NSLS X-Ray storage ring hardware is now provided along with block diagrams and some pictures showing installed power supplies and controls. The software description can be found in NSLS Tech Note 308.[2]

X-Ray Trim System

The X-Ray trim system consists of one master VME crate, five slave VME crates and five power supply subsystems shown in Dia. 1. At present, the master crate performs three main functions; communication link to the main computer, communication link to the slave crates via bus interface and several application oriented tasks such as ramping and diagnostic functions. Two "Bit 3" VME-VME adaptor boards provide the bus interface to one slave crate with one board configured as master and other board configured as slave. So, there are five master bus interface boards in master crate and one bus interface board in each slave crate. Each slave crate controls up to 24 power supplies. The three digital to analog converter (DAC's) boards provide 24 reference signals to the power supply circuits with resolution of 14 bits and twelve analog to digital converter (ADC's) boards provide readbacks of 24x8 (192) analog signals with the resolution of 14 bits.

Trim Subsystem Description

There are five X-Ray trim subsystems for the NSLS X-Ray storage ring beam steering system. Each subsystem consists of one slave VME crate and three racks of power supply modules shown in Dia. 2. The slave crate receives its commands from master crate via bus interface board and passes these commands to its VME bus. There are three DAC boards; each board has eight output channels with 14 bits resolution. These analog channels provide stable reference

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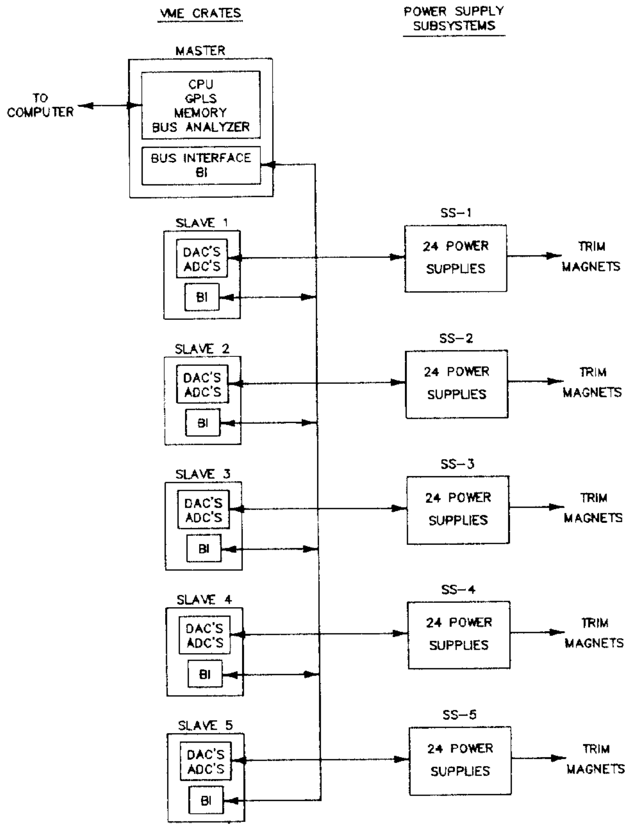
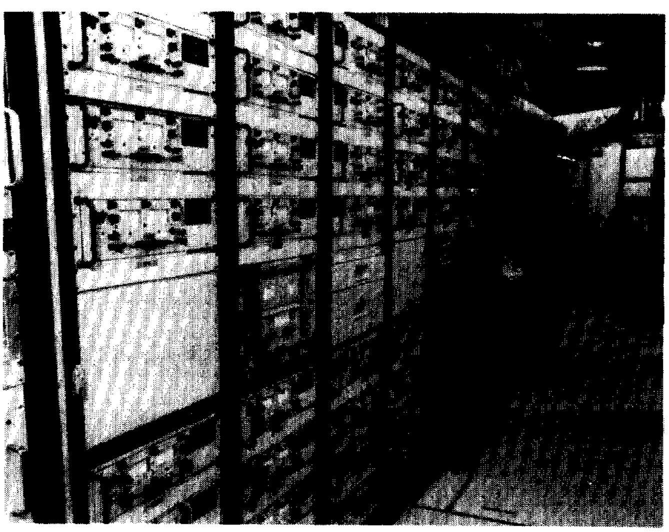
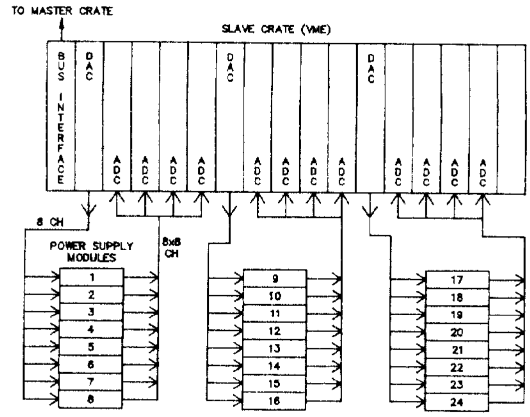


X-RAY TRIM SYSTEM LAYOUT
DIA. 1



X-Ray Trim System

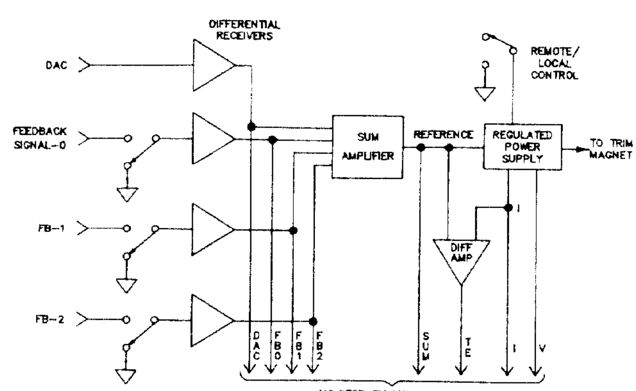
signals to the power supply circuits, with nominal calibration of one ampere for reference input of one volt. There are 12 analog to digital converter boards, each with 16 differential signal inputs. Each board reads signals from two power supplies providing monitoring signals which are useful to diagnose the regulation status of the power supply.



X-RAY TRIM SUBSYSTEM
DIA. 2

Power Supply Module

Each power supply module consists of one Kepco power supply and one analog processor board as shown in Dia. 3. The power supply is a current regulated supply and requires a reference signal of -10 volts to + 10 volts to provide a current of -10 amperes to +10 amperes. The analog processor board receives four signals; one from the DAC board and up to three signals from the orbit stabilization feedback circuits. These signals are summed together to provide the reference signal for the power supply. An error amplifier subtracts the reference signal from the current signal and the output of this amplifier (called tracking error) is monitored by the computer. This signal is a measure of how well the power supply is regulating. In addition, there are seven other signals which are monitored by the computer. These are DAC, feedback 0, feedback 1, feedback 2, sum I (current) and V (voltage of the magnet). The magnet voltage provides a means to measure the trim winding impedance and is used to assess the integrity of the trim system wiring. The nominal values of the impedances are stored into a calibration table, which, then, will be used as a reference in the future.



INDIVIDUAL POWER SUPPLY CIRCUIT
DIA. 3

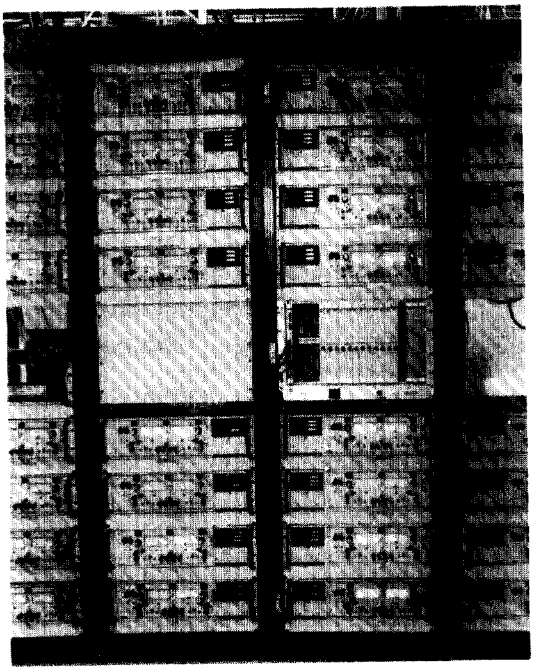
Acknowledgement

W. Rambo was involved in the development and construction of all VME crates and modules. P. Singh and I. Fabien were involved in the development and construction of the power supply subsystem, power supply module and all the cabling associated with interconnecting various magnets.

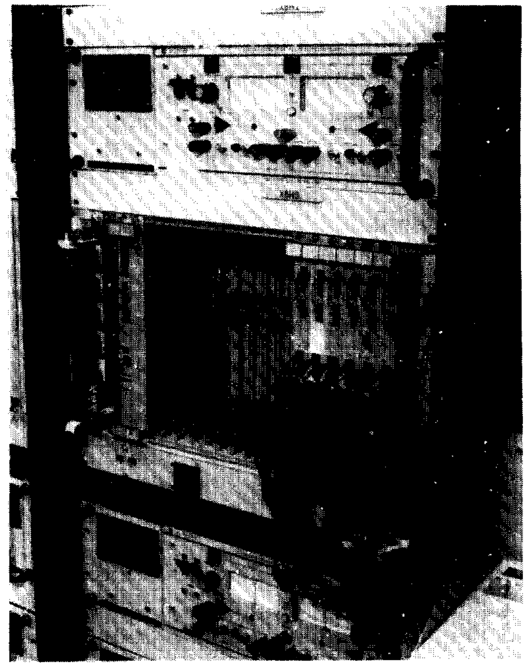
References

1. R.J. Nawrocky et al, "Automatic Steering of X-Ray Beams from NSLS Insertion Devices Using Closed Orbit Feedback", these proceedings.

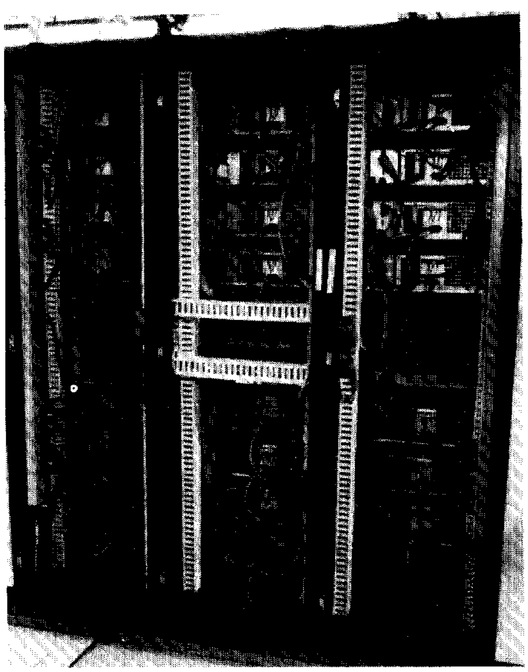
2. J.D. Smith et al, "X-Ray Trim Micro Program Overview", BNL NSLS Tech Note #308.



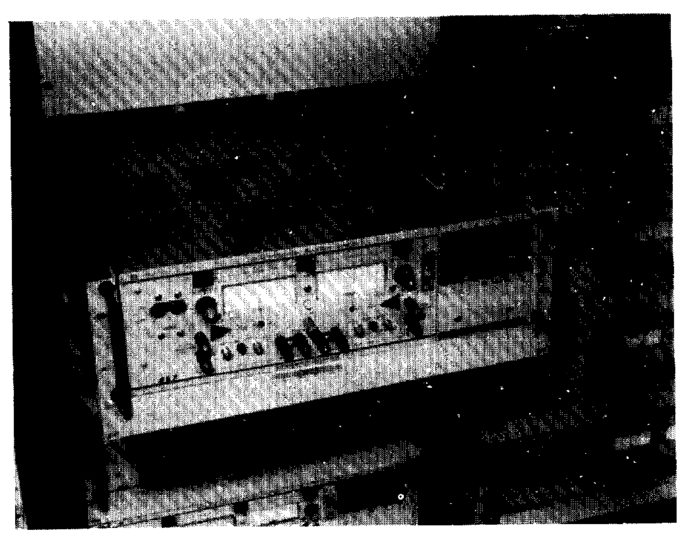
Trim Subsystem (24 ps) Front View



VME Crate - Master



Trim Subsystem (24 ps) Rear View



Power Supply Module