New Magnet Power Converters for the SRS at Daresbury

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Abstract

A programme to replace 25 year old magnet power converters on the SRS at Daresbury is nearing completion. The roller regulator converters recovered from the NINA synchrotron beamlines are being replaced by commercially available switch-mode units for those rated up to 10kW, and by thyristor phase controlled units for those rated from 90kW to 750kW. The latter are designed to the CERN LEP standards, and incorporate the LEP control electronics. Some minor changes to the microprocessor software were made to facilitate interfacing to the SRS control system.

1. INTRODUCTION

When the SRS was designed, all of the large magnet families were powered by roller regulator/transistor trimmer type power converters, which were originally used to power the experimental beam line magnets used with the 5GeV electron synchrotron NINA[1]. A large number of these were available, and they were re-used, sometimes singly, sometimes in series/parallel combinations, in order to save on the capital cost of the SRS. They are now 25 years old, and although the electronics had been modernised when they were adopted for the SRS, they are expensive to maintain and their reliability has reached a figure no longer acceptable for an accelerator required to deliver 6000 scheduled beam hours per year.

2. CONVERTER TYPES

2.1 Units up to 10kW

The chosen solution for magnet circuits rated up to 10kW was to purchase commercial switch-mode converters from the range manufactured by PowerTen in the USA. Five models from this range were able to meet all our power ratings.

Multipole Steering Units	2 off 30V 320A
Storage Ring Octupoles	2 off 30V 320A
Injection Transfer Path Dipoles	2 off 30V 160A
5 Tesla Wiggler	2 off 10V 500A
6 Tesla Wiggler	1 off 10V 1000A
6 Tesla Wiggler Trim	2 off 10v 75A

The rated long term stability of these converters is 1 part in 10^3, which is not adequate for the duty required, so a simple external current stabiliser was designed, providing an additional current control loop, using a DCCT to measure the current, and accepting an analogue control signal from the SRS control system. The PowerTen units thus serve as high power current amplifiers, and the required long term stability of 1 part in 10^4 is easily achieved. Analogue control and monitoring are via ADCs and DACs in CAMAC. The SRS status control system provides interlock protection, and on/off switching makes use of the facility to externally control the 60kHz oscillator which controls the switching circuits. An additional contactor is added in cases where a magnet function forms part of the personnel safety system.

2.2 Units from 90kW to 750kW

There are five converters in this power range, two at 750kW, one at 250kW and two at 90kW. These power the SRS storage ring dipoles, quadrupoles and sextupoles. It was decided to adopt 50Hz line commutated thyristor technology, in particular the designs developed at CERN for the LEP machine [2,3]. The main benefit was the availability of a modular control electronics system with a well defined interface to the power part of the converter. The functions available from the electronics matched our requirements extremely well, being microprocessor controlled and already programmed to do energy ramping[4].

For the 250kW rating, a CERN design, type B9, (providing 720A at 350V or 360A at 700V), was used unmodified. The 90kW units were a modified version of the CERN B10, but providing 450A at 200V (instead of 360A at 250V).

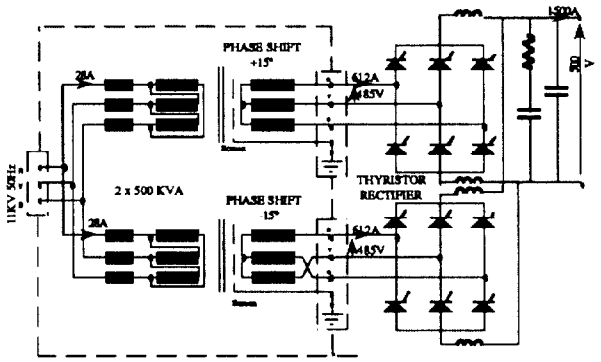

Figure 1 - Electrical Circuit of 750kW Power Converter

The 750kW units are required to deliver 1500A at 500V. A new design was required here, but the specification closely followed the CERN guidelines. The chosen topology was two thyristor bridges connected permanently in parallel with a passive filter resonant at 35Hz, as shown in Figure 1. The rectifier transformer is fed at 11kV and comprises two identical transformers housed in a single oil tank, using an extended delta primary configuration to achieve a 15° phase shift. Reversing the phase rotation of one of them provides a very well balanced supply to the twelve pulse rectifier.

All of this group of converters are naturally air cooled, thus making it possible to dispense completely with the closed circuit demineralised water cooling system used by the old equipment.

3. CONTROLS CONSIDERATIONS.

The five thyristor converters represent the first use of "fully intelligent" items of plant on the accelerator. At CERN, the MIL 1553 interface is used, but it was considered adequate for only five converters to use the optional 20mA current loop port on the master processor board as the main communication link. Also required was a timing signal to synchronise the ramping of all the converters.

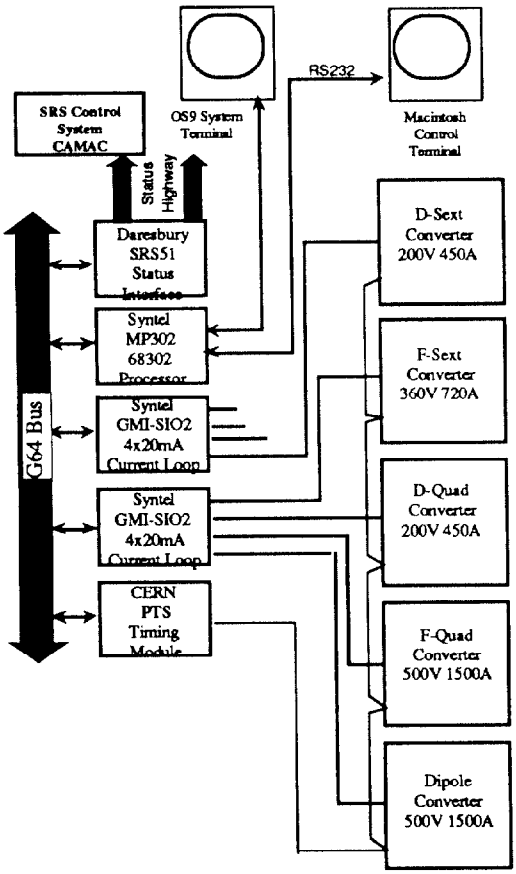

Figure 2. Block Diagram of Power Converter Control System

A sub-control system was designed in G64 using a Syntel MP302 processor running OS9, equipped with a CERN timing simulator, 20mA current loop drivers and also interfaces to the SRS control system standards. Figure 2, which is a block diagram of the complete system, includes this unit with all of its interfaces. In the SRS control system[5][6], analogue calibration from engineering units to digital is performed at high level. CERN provided two additional commands to enable the DAC, ADC, and status information to be passed in digital form, in addition to their normal ASCII strings of text. Thus it was possible to achieve partial integration with the existing control system. To access functions which are not compatible with the SRS system, a serial link to a purpose written application running on a Macintosh computer was provided, which can address commands to individual converters, broadcast commands to all of them and control the timing system. This is used to edit and download files of data for the energy ramp, to set degaussing limits, and to interrogate the comprehensive diagnostics available within the control electronics for troubleshooting in a very user friendly manner. The same application can be used for local control of a single converter, via the RS232 interface on the master processor module.

4. STATUS OF THE PROJECT

All of the new equipment is on site. Two of the converters have been used operationally with the Sextupole magnets since April 1994, and the full system will be operational after a one month shutdown in July 1994

5 ACKNOWLEDGEMENTS

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6. REFERENCES

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