A High Precision Digitiser and Multiplexer for the New Orbit Processing Electronics at Daresbury

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Abstract

The installation of a new precision orbit measurement system for global and local feedback of orbit position has become a basic requirement of the SRS. The first phase in realising this was the development of new distributed Electron Monitor processing units, to provide signal conditioning and down conversion. These units are located adjacent to each BPM in the storage ring tunnel. To reduce induced noise and maintain accuracy, it is necessary to digitise the four position signals locally to each processor unit. Each signal is multiplexed in turn and converted to give a position resolution of < ±5microns. The ADC was designed to interface to the Daresbury standard plant highway. The plant highway interfaces to G64 crates containing Syntel MP302 processor boards. This processes the digitised data to calculate the beam current-independent position. The position information is accessed by the control system over a network file system.

1. INTRODUCTION AND OBJECTIVES

The SRS storage ring is currently undergoing a major upgrade to provide better beam position stability. A new VME based steering system to provide 16 bit DACs and ADCs for the steering magnets was installed and commissioned during 1993. The new electron monitor processing units, providing signal conditioning and down conversion were also installed at the end of 1993. The initial installation utilised the existing co-axial relay multiplexer to read out the beam position in the main control room. The final stage of this project was the high precision digital multiplexing system, providing local digitisation of the detected down-converted BPM signals. This measures beam position signals with an accuracy of ± 5 microns for the steering system. For information on the steering system refer to [1], and on the BPM processing electronics [2].

2. POST HIGH BRIGHTNESS LATTICE BPM SYSTEM

The post HBL BPM system [3] multiplexed the RF output of the button BPM's through coaxial relays connected via an attenuator and filter to a phase sensitive detector. The output was then digitised by a 12 bit ADC in a CAMAC crate which formed part of the SRS control system. The switching time of these relays was around 300 mseconds. As sixteen position signals had to be multiplexed, one complete scan including computer overheads took around 20 seconds. The accuracy of this system was limited by noise in the switching circuits to ± 100 microns.

3. DIGITAL MULTIPLEXED BPM SYSTEM OVERVIEW

The new system is split into two identical halves. Each half contains a G64 [4] processing crate connected to a VME crate in the Steering System. The G64 crate drives two plant highways with each highway covering one quadrant of the SRS and connecting to four crates housing the ADC modules. The local ADC modules interface to the down converter units installed at each BPM position.

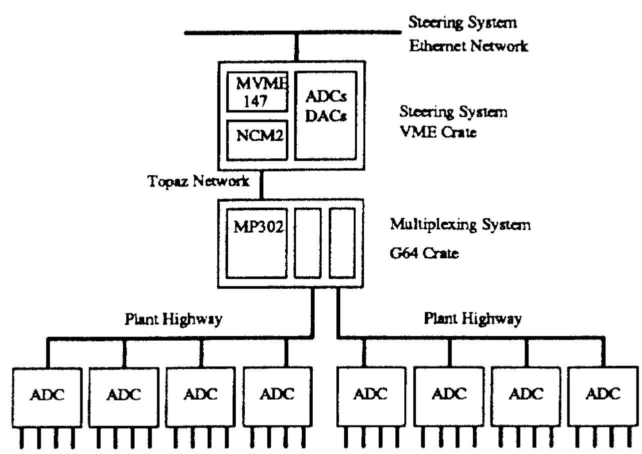

Figure 1. One half of the BPM multiplexing system.

3.1 Processor crate

The processing crates consist of a G64 back plane with processor boards and two plant highway interface boards. The processor board is a commercial unit containing a Motorola MC68302 integrated multi-protocol processor, four Mbit of EPROM, 1Mbyte of DRAM, two RS232/422 serial channels and a token passing network interface. The processor has a 68000 core along with a communications RISC processor, RAM, timers, chip select logic, independent DMA channel and a number of other features all on one integrated circuit.

3.2 Software

The application software was developed in "C" and runs under the OS-9 operating system. A device driver was written to support the Daresbury plant highway interface. A number of processes are started when the system is powered up. These create the RAM disc, manage the network, and run the application programs. The application programs read the sum and difference signals for each of the BPMs on the two highways. From this information and calibration data, the horizontal and vertical position values are calculated. The resultant values are stored in a shared file on the RAM disc that is mounted over the network as a volume on the steering system VME crate. The applications reads a control file for the changes to the gain and the number of averages used, for BPM reads. The update rate for the total system is 2Hz.

3.3 Plant Highway

The processing crates communicate with the ADC modules over the plant highway. This is a Daresbury designed multiplexed highway that operates up to forty metres in electrically noisy environments. To realise this the highway uses 24V logic and signal filtering to improve noise immunity. All modules connect to the highway using opto coupled inputs and high voltage drivers. The highway provides twenty-two decoded address lines, sixteen bi-directional data signals, four control signals and power to the interface modules. A terminator card, fitted to the end of the highway provides resistive termination and highway security.

3.4 Front End processing

The down converter detectors provide four position related DC outputs, consisting of horizontal and vertical sum (Σ) and difference (Δ) signals derived from the BPM buttons. These operate in two modes: in data mode the outputs are the beam positions and in calibration mode the outputs are the multiplier offsets for the processing units low frequency detector stage. Each mode supports a gain of x2 and x20 for multi and single bunch operation. The gain and mode are selected by two signals from the ADC card.

The ADC crate comprises of a small EuroCrate housing two commercial power supplies and a Daresbury designed analogue multiplexer and ADC card. The interface to the sixteen bit ADC card was designed to comply to the Daresbury MKII Status Highway Specification [5], allowing the card to be used for other functions at Daresbury. The four position signals are input to the multiplexer section of the ADC cards. To reduce the effects of RF noise and ground currents these inputs are passed through simple RC low pass filters. The optimum break frequency for these filters was found, by experiment, to be 30 Hz. The output from the multiplexer is then digitised by the ADC to a fifteen bit plus sign representation in seventeen microseconds.

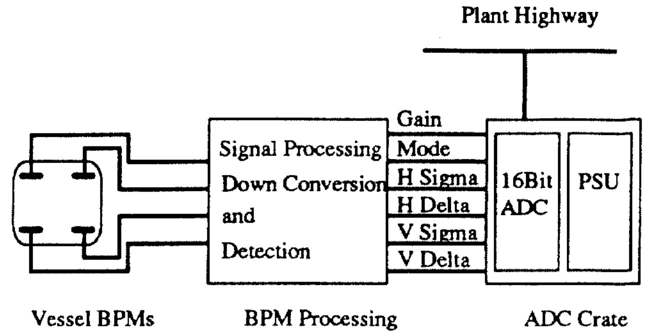

Figure 2. Processing arrangement at each BPM location.

3.5 Interface to VME crate

The interface from the processing G64 crates to the Steering System VME crates uses Topaz [6], a commercial local area network, with a Syntel NCM2 Topaz interface installed in the VME crates. This was designed for industrial process control and uses a token passing bus structure to give a deterministic response. The electrical interface is RS485 on a screened twisted pair. Topaz is used with an OS-9 Network File Manager (NFM) to make the RAM disc on the processor crate available to the VME Steering System.

4. SYSTEM PERFORMANCE

The new system was installed and commissioned during a two week machine shutdown. It shows a ten fold improvement in position measurements, to better than ± 5 microns.

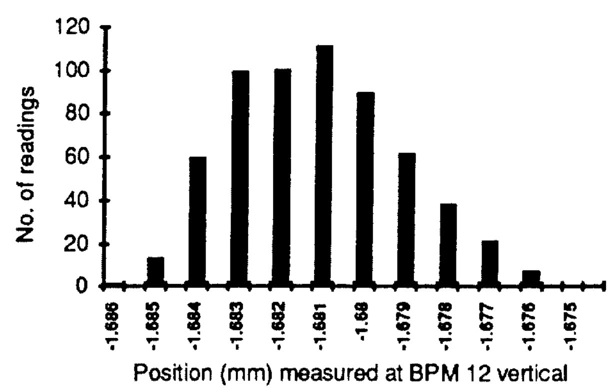

Figure 3. Histogram of 600 readings, one taken every second, with no feedback applied (Ib=220mA)

Analysis of the results using the new ADC system and software shows typical rms noise values to be 2 microns. This should be compared with the vertical electron beam size of ≈0.1mm (sigma)

5. CONCLUSIONS

The MKII system is now ten years old, but as the project has shown it has still proved to be an economically viable method of realising a data acquisition system in a storage ring environment. The improvement in system speed is most noticeable at the control desk level. Applications to check and measure the beam orbit now respond in under two seconds, compared with more than twenty seconds prior to the upgrade. We have now entered the final stages of the upgrade, with trials using global feedback to maintain the beam stability.

6. REFERENCES

[1] P. D. Quinn, et al., "An Advanced Beam Steering System for the SRS at Daresbury", in Proceedings of the 3rd European Accelerator Conference, Berlin, June 1992, PP. 1152-1154.

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[3] T. Ring ,"Beam Position Monitors for the High Brightness Lattice", Daresbury Internal Report DL/SCI/TM42A.

[4] GESPAC-SA, G64 Specification manual, February 1984.

[5] B.G. Martlew, et al "A Microprocessor-Based Status Control and Interlock Protection System for the SRS", Daresbury Internal Report DL/SCI/P545A.

[6] TOPAZ software, Syntel Microsystems.