NEW VME-BASED ELECTRONICS FOR PROSCAN DIAGNOSTICS

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New VME-based electronics are being developed for PROSCAN diagnostics. Their main characteristics and expected performance are presented in this report.

INTRODUCTION

VME-based electronics are being developed for PROSCAN. They shall replace existing CAMAC-based boards used for the initial phase of PROSCAN.

For the development of these electronics, the chosen approach was to take advantage of the general structure of a VME system [1]. By clearly defining the tasks the main VME module and the transition module have to respectively cover, the development of these modules can be performed in parallel.

The transition module electronics will be dedicated to the specific needs of a given diagnostic such as the beam position monitors (BPM) or current measurements (LogIV32) for the profile monitors.

The main VME "generic" board has been designed to be flexible enough to be able to process the data from the various types of transition modules. It also will function as a carrier board for the PMC modules.

VME GENERIC BOARD

The generic board called "VPC-Board" is a VME-64x live insertion compliant carrier board with two slots for PMC mezzanine board plugins. All user pins on the backplane VME connectors P0 and P2 can be redirected by the user to any destination on the VME, to the PMC mezzanines using the 66 MHz PCI bus or to an external location using an optical Gigabit link that is based on the RocketIO™ protocol. Embedded PowerPC™, fast memory and a Sharc™ DSP allows the user to acquire and process data in real-time. PMC slots allow the users to use a wide range of commercially available boards for their specific needs. (Ethernet, ADC/DAC, Digital I/O modules, etc …). The first prototypes will be available by April 2004.

BPM ELECTRONICS

The new electronics (see Fig. 1) will be used for a BPM prototype to be tested on PROSCAN. The same electronics will also replace the obsolete electronics on the proton accelerator.

The electronics is based on the newest digital receiver techniques. The HF beam signals will be directly digitized bypassing the usual analog mixers. Larger dynamic range, true 90 degree I/Q demodulation, increased stability (e.g. no temperature effect on the digital demodulation processes) are among the advantages of the digital receiver over analog systems. Furthermore, the extreme flexibility and power of the digital processing techniques makes the system easily reconfigurable.

Particularities of this new system are the remote control of the preamplifier stage and the online measurement of each individual signal overall gain (amplifier gains and various attenuations). The remote amplification control in combination with the amplifier before digitization maximizes the measurement dynamic range (expected measurement range: 104 dB). The overall gain of each signal is measured using a pilot signal fed at the pre-amplification stage. This will improve the precision and quality of the measurement by taking into account the variations of factors affecting the channel overall gain.

In the HF Front End (HFFE) electronics the signals from the BPM pick-up coils are first filtered around the RF first harmonic i.e. 144 MHz. This frequency is used because the direct RF field contribution is smaller than the one at the fundamental (f_0=72MHz) or at $3 \cdot f_0$ harmonic. The beam and pilot signals are then pre-amplified to minimize the noise effects (typical cable length between HFFEs and the VME electronics: 75 to 100 meters). The remotely controlled pilot signal is set at a slightly different frequency than the RF frequency. This way, pilot and beam signals can be separately filtered and then processed in parallel.

The first block of the VME transition board is again a bank of band-pass filters centered on the RF first harmonic i.e. 144 MHz. The signal is then amplified to use the full dynamic range of the fast 14 bit AD6644 ADCs. The ISL5216 digital down converter (DDC) translates the pilot and beam signals into the baseband.

Digitally filtered base-band signals are then further processed on the carrier board using the Xilinx Virtex2 Pro FPGA. In particular, the beam signals will be normalized using the pilot signals, adaptive filtering will be applied and the beam position (horizontal and vertical component) computed. A built-in-test (BIT) procedure will also be implemented to better localize and identify potential problems or failures.

The expected dynamic range of the input RF signal level is from -120 to -16 dBm, and the resulting sampling rate for position measurement is 10 kHz. The electronic prototype should be built by March 04.

LOGIV-32

As for the BPM system, the chosen philosophy was to design a transition board containing both the analog processing and the signal digitalisation. In the present case, 32 current signals are measured using logarithmic amplifiers. This electronics will be for instance used for the beam width and position measurement of the proton beam [2].

The measurement principle is based on the use of commercially available logarithmic amplifiers (AD8304 from Analog Devices) allowing current from 20 pA to 500 µA to be measured. This sensitive electronics is mounted in a metallic enclosure for shielding from external electromagnetic noise. To avoid ground loop problems, electrical ground of the transition board and that of the enclosure electronics (being at the machine ground) have been separated. The 32 channels are synchronously digitized using Maxim MAX125 14 bit ADCs and then further processed on the generic board.

The performance of this system is expected to be the same as the CAMAC-based version to be used for the initial phase of PROSCAN. Every channel will be separately calibrated with the corresponding calibration parameters (offset and gain correction) stored in an EEPROM of the transition board. The precision is expected to be better than +-2 % for current between 100 pA and 100 µA. Fig. 2 presents the calibration results obtained with a CAMAC-based channel. The response time of the logarithmic amplifier depends on the measured input current. Longer than 1 ms for current below 1 nA, the exact dependence will be the object of near future measurements.

Another development based on this electronics is a VME-based LogIV-4x4 board that is being currently designed. It shall consist of 4 groups of 4 current inputs each. Each group has its own isolated ground.

REFERENCES

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[2] R. Dölling, L. Rezzonico, U. Frei, S. Benz, P.-A. Duperrex, M. Humble, *Profile Measurement of Scanning Proton Beam for LiSoR using Carbon Fibre Harps*, 10th Beam Instrumentation Workshop, Upton, New York, USA, 2002, 361-367.

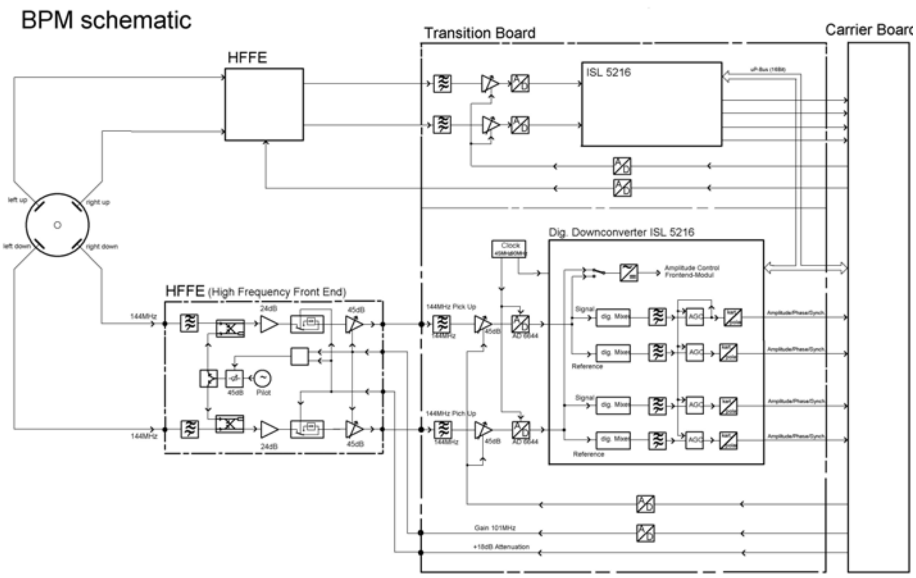

Fig. 1: Schematic of the new BPM electronics showing its different elements: HFFE pre-amplification, transition board with the DDC and the carrier board for the position calculation.

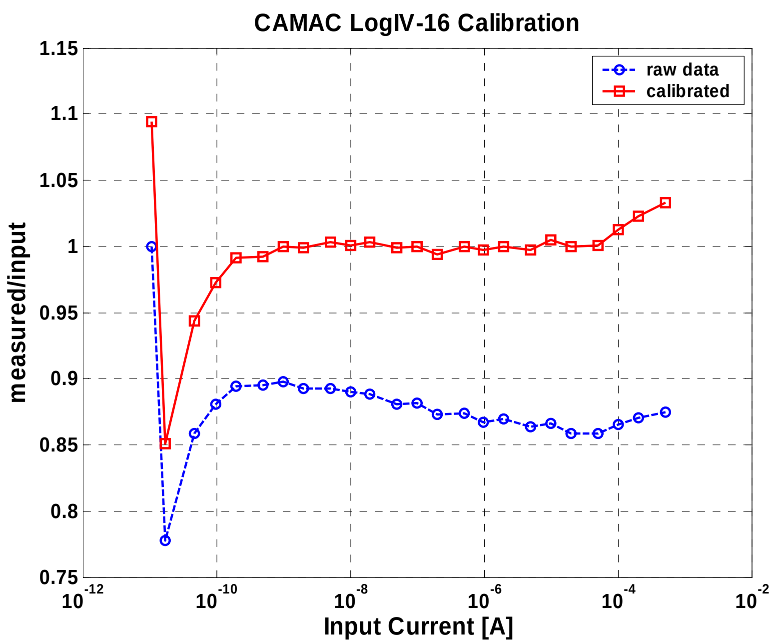

Fig. 2: Current measurement before (broken line) and after calibration (thick line). Precision better than +-2 % is expected between 100 pA and 100 µA.