

# PCI/cPCI INTERFACE FOR PSI POWER SUPPLY CONTROLLER

D. Beltran, F. Becheri, D. Fernandez-Carreiras, J.V. Gigante, J. Klorá, L. Krause, M. Lipinsky, CELLS, Bellaterra, Spain

## Abstract

CELLS has developed a PCI/cPCI interface for the PSI controller for Power Supplies. The power supplies are used for the Storage Ring corrector magnets (for slow and fast orbit feedback) and the corrector magnets of the Insertion Devices. The hardware interface has a commercial IP carrier (either PCI or cPCI), the PSI PSCIP2 Power supply control module, and a in-house rackable transition module (conversion between the electrical signal of the PSI PSCIP2 module and the optical signal). On the software side, an existing driver for Linux 2.4 VME has been adapted and upgraded to 2.6 PCI. A Tango device server is also available for both Fiber optic links and serial Line.

## INTRODUCTION

ALBA is the first Spanish Light Source which is intended to provide Spain with a powerful source of X-rays. The project is funded by the Spanish and Catalan Governments at equal parts. The first phase includes the construction and commissioning a linear accelerator, a booster accelerator, a storage ring and 7 beamlines, with the start of operation planned for 2010.

ALBA is a 3rd generation 3 GeV light source, with a perimeter of 268 m, With such an energy the brilliance at 20 keV reaches  $10^{19}$  Ph/s/mm<sup>2</sup>/mrad<sup>2</sup>/0.1%BW for vacuum undulators with 5 mm gap.



Figure 1: Aerial view of ALBA synchrotron.

The lattice has 16 cells with a 4-fold symmetry in order to increase the number of available straight sections for experiments, providing 16 medium straight sections of 4.2 m, 4 long ones of 8 m and 12 short ones of 2.2. For more information see reference [1].

In order to provide a stable beam for the experiments, the electron beam has to be stable to values smaller than 10% of the beam size. The electron beam stability in these accelerators is achieved with a fast orbit feedback system. The actuators in this system are the power supplies feeding the corrector magnets in the storage ring [2].

Hardware Technology

Those power supplies require a control bandwidth of more than 1 kHz, and an interface with a small latency (in the order of hundreds of microseconds) in order to provide a global orbit correction bandwidth of 100 Hz.

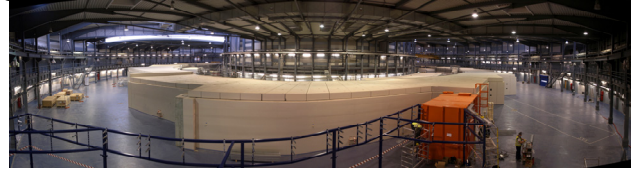


Figure 2: View of the Experimental hall and ALBA tunnel.

The PSI (Paul Scherrer Institute) has developed a digital controller for Power supplies [3] which meets the requirements, and it is used for the Storage Ring Corrector Power Supplies.

## VME CONTROL INTERFACE

This PSI controller has a fibre optics interface and it is used in many synchrotron (SLS, Diamond, Elettra, etc), but everywhere the control interface was based in VME. A commercial VME carrier hosts up to 4 PSI PSCIP2 Power supply control module, and a PSI VME transition module. The following shows the layout based on VME.

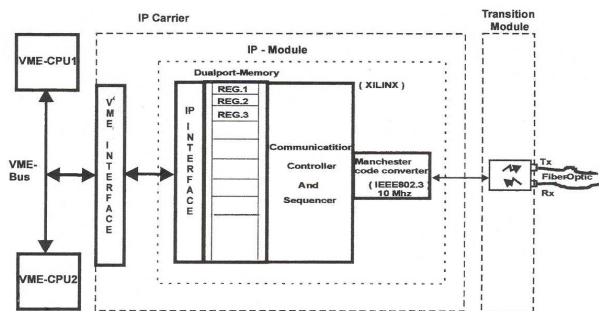


Figure 3: Interface to PSI controller based on VME.

## PCI/cPCI HARDWARE INTERFACE

ALBA standards are PCI and cPCI form factors, so the VME products could not be used.

### IP Carrier

The PCI/cPCI IP carrier is an off-the-shelf product. It was required a carrier with same I/O access on both form factors, because the same transition board could be used for both platforms. ALBA has chosen the TCP211 and TPCI100 from TEWS [4]. The I/O access is a 50 pin 0.1 inch flat ribbon cable connector per IP module, mounted on the front panel.

### PSCIP2 Module

The PSCIP2 module was designed at the SLS. This controller is based on a Xilinx Spartan I FPGA, and two

versions could be mounted: XCS40 working at 5 V and XCS40XL working at 3.3 V.

The IndustryPack standard has two connection slots:

- J1 is defined by the standard, both signals and supply voltages (+5 VDC,  $\pm 12$  VDC)
- J2 is user defined. This port is connected to the transition board. There are 4 pins for an external supply, but there is no return line for this supply.

With the current layout, the FPGA on the IP module is not fed, and the system can not work.

A possible solution was to connect the cPCI/PCI chassis ground directly, but this solution was discarded because it was not reliable and a large ground loop is created.

Our solution was a 5 VDC to 3.3 VDC DC/DC converter has been added to the PSCIP2 modules, to feed the FPGA. This converter is fixed onto the IP module.

This solution has been prototyped and it's working well.

### Transition Board

The transition board module was an in-house development based on the PSI PSC-TM design. It is a stand-alone module able to connect up to eight corrector power supplies with their PSCIP2 controller. The communication between the transition board and the power supplies is done through a Versatile Link optic fibre. This technology allows data rates up to 10MBd and distances up to 50 meters with 1mm Plastic Optical Fibre (POF) or 500 meters with 200 $\mu$ m Hard Clad Silica (HCS) fibbers. We are going to use the POF solution, since our maximal distance is well below 50m. After a prototyping phase, the module was tested in a 40m communication link showing a very reliable behaviour. Recently we have started the production of 45 units)

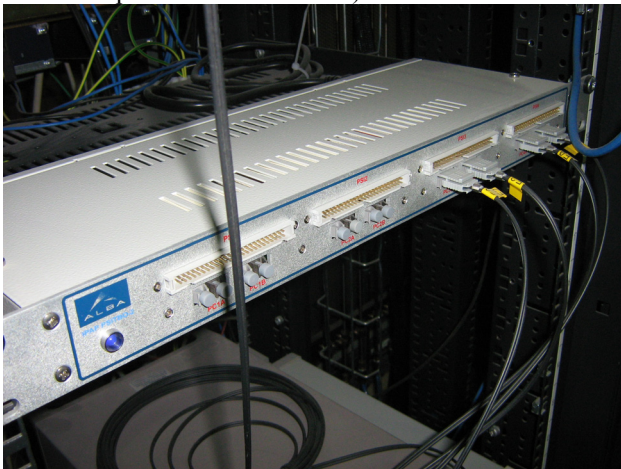


Figure 4: Transition board between IP modules and the PSI controller.

The following figure shows the hardware for the whole interface.

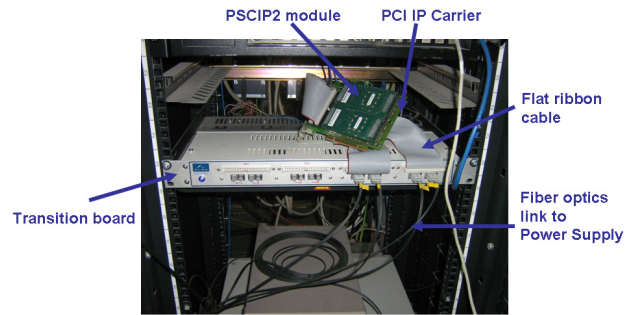


Figure 5: Hardware devices for the PSI Power Supply controller.

## LINUX SOFTWARE

A Linux driver 2.4 was developed at Elettra synchrotron [5] by Giulio Gaio. This driver has been adapted to PCI and upgraded to 2.6. It is a character device driver based on IOCTLs calls and not supporting DMA, although the bandwidth is enough for the fast orbit feedback.

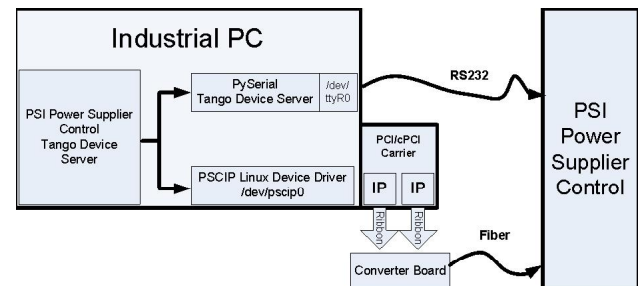


Figure 6: Communication between Tango DS and the PSI PC.

A Tango [6] Device Server has been written in C++. It provides communication and slow control and data acquisition. Specific features, like downloading waveforms are not yet implemented, since they are not needed for the correctors of the Storage Ring. The server supports both Serial links (RS232) and Fibre Optics Manchester encoded 5MHz. Both can be used at the same time for reading. However for writing, the Serial Link takes priority in case it is connected which will rarely be the case. Besides the read and write currents, voltages and set-points, the Server can activate and deactivate the power supply itself, as well as error conditions and even interlocks.

This server is used by the control system, providing an interface for the operators interface. On the other hand, the Fast Orbit Feedback does not use this server. It uses dedicated software not passing by Tango. Communication at 10 kHz can not be guarantee neither by a regular Ethernet network nor by Tango.

## CONCLUSION

A new interface to the PSI Power Supply controllers has been developed in ALBA. This system is based on PCI/cPCI and runs Linux. The porting from a VME was done at the ALBA synchrotron.

The system has been tested successfully and it is currently in production.

## REFERENCES

- [1] D. Einfeld, "Status of the ALBA Project", Proceedings of EPAC-06, Edinburgh 2006.
- [2] D. Beltran, M. Munoz, "Initial Design for a Fast Orbit Feedback system for the ALBA synchrotron", Proceeding of ICALEPCS-07, Knoxville 2007.
- [3] L. Tanner, F. Jenni, "Digital control for highest precision accelerator power supplies", Proceeding of PAC-01, Chicago 2001.
- [4] <http://www.tews.com>.
- [5] <http://www.elettra.trieste.it/>.
- [6] <http://www.tango-controls.org/>.