MICROIOC LR-BPM - BEAM POSITION MONITOR SOLUTION

P. Medvescek[1], M.Kobal[1], S. Artinian[2], J. Bergoz[2]

[1]Cosylab, Teslova 30, Ljubljana, Slovenia

[2]Bergoz Instrumentation, Saint Genis Pouilly, France

Abstract

MicroIOC LR-BPM product offers complete beam position monitoring solution to be used on transfer lines or linear accelerators where bunch repetition rate is low (< 50Hz). It consists of Log ratio Beam position monitor (LR-BPM) modules from Bergoz instrumentation and of microIOC analogue to digital acquisition unit (microIOC-ADA) from Cosylab. In this paper we present the detailed operation of the system and the results from testing that was performed at Soleil accelerator in May 2008. In this particular test microIOC LR-BPM proved to be a complete stand alone solution with only signals from the beam pickup detectors as inputs. It is capable of providing up to 8 X-Y beam positions and since its design is based on a single board computer inside the ADA unit it is easily integrated in higher level control system software. Furthermore the position data is available to the control system clients over the external network via Ethernet link. EPICS was used as a control system although the product can accommodate other types of control systems that can run on x86 platform.

INTRODUCTION

Bergoz LR-BPM modules are widely used for the beam position monitoring in accelerator institutions. In most cases the data acquisition system of the position analogue signals is developed in-house. MicroIOC-LR-BPM product was developed as a stand-alone, standardised solution which provides complete integration into the control system software. It meets all the main needs of the BPM users and due to the design offers enough flexibility that users can extend its functionality according to their requirements.

It was tested in Soleil, France and it proved to be a good solution when measuring beam position on Linacs or transfer lines where bunch repetition rates are relatively low(<50 Hz).

SYSTEM OVERVIEW

Housed in a 19" rack it consists of two main parts: LR-BPM modules from Bergoz instrumentation and of microIOC-ADA unit from Cosylab (**Figure 1**). One of the main advantages of the system is that almost all of the BPM components are located in one box.

Orthogonal or rotated pick-up detectors are mounted on the vacuum pipe. Signals from these detectors are fed to the LR-BPM modules which operate in Sample&Hold mode. This means that after they process the signals from the detectors and measure the position of the beam they hold an analogue +/-2V signal which is proportional to the position. There is one signal for each coordinate axis (X and Y) and it is held until the next bunch arrives. LR-BPM module is capable of measuring single-bunch and multi-bunch signals, this can be selected with use of an on-board jumper.

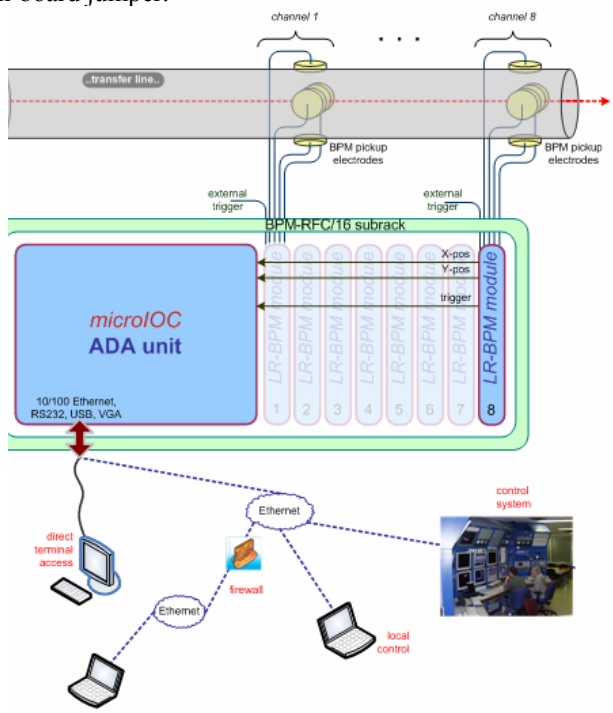

Figure 1: microIOC-LR-BPM schematic.

Analogue position signals are sampled by the ADC cards inside ADA unit. Oversampling is used in order to filter out the mains noise. Start of the sampling and the time window during which sampling is performed is adjustable.

Bunch transition is synchronized with the data acquisition which is performed by the ADA unit. LR-BPM modules can be triggered by an external trigger signal or - if equipped with LR-BPM-TRG option – the Built-In Beam Trigger [1]. ADC cards start sampling when they receive trigger from the LR-BPM module ADC trigger output which ensures that analogue position signals are available for sampling.

Since there is a single board computer (SBC) with x86 platform inside the ADA unit also software part of the control system is residing inside the same box. SBC

communicates with the ADC cards over the PC104, performs the control system tasks and communicates with the outside world (control system clients) over the Ethernet port.

SOFTWARE DESIGN

In this paper a software solution based on EPICS control system that was used for the Soleil testing is described, although SBC card inside the ADA unit means that microIOC-LR-BPM could accommodate also solutions based on other control systems. Software layers and the hierarchy are displayed on the **Figure 2**.

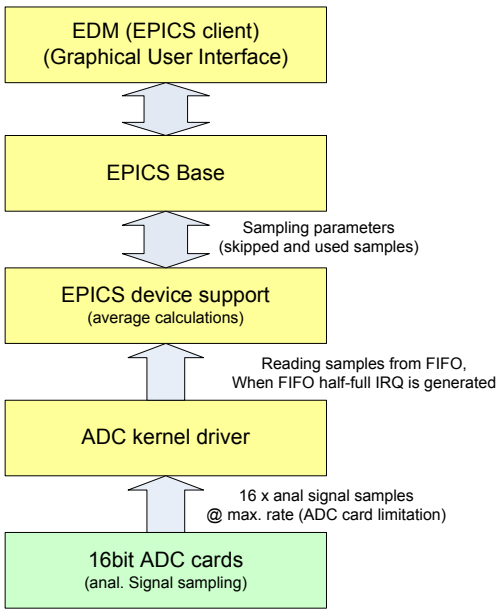

Figure 2: Software hierarchy of the microIOC-LR-BPM solution [2].

Position signals from the LR-BPM modules are sampled by the ADC cards. The sampling rate of the ADC card is 250kSamples/s and since one ADC card has 8 analogue input channels maximum sampling rate for each signal is approx. 30kHz. When ADC cards are triggered samples are being stored into a 2k FIFO buffer which generates an interrupt on the PC104 bus when half full. ADC kernel driver reads the samples from the buffer only when this interrupt is generated which significantly reduces the CPU consumption.

Sampled data is available to EPICS Device support where averaging is performed. On top of the hierarchy there is an EPICS database and EDM Graphical User Interface (GUI). On the **Figure 3** the GUI screens are shown where user can monitor the X and Y position from 8 detectors, see the maximum, minimum, mean average and Standard Deviation value. User can also modify the Skipped and Valid period after the trigger which define when the samples used in averaging are taken.

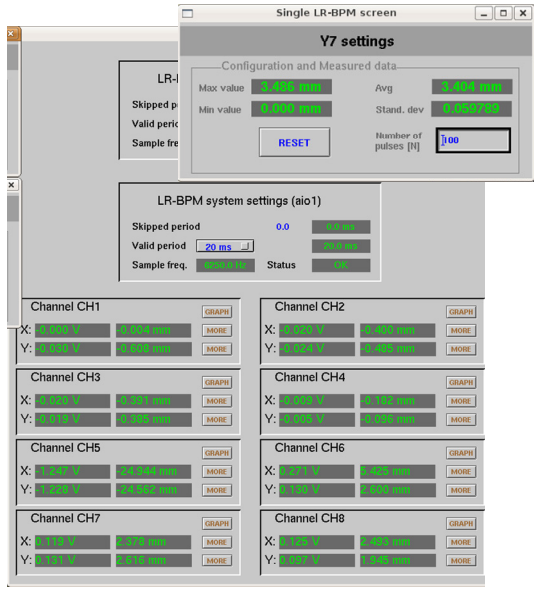

Figure 3: GUI application for 8 BPM systems. On the small screen in front user sees the minimum and the maximum value since the last reset. On the screen in the back user can set the Skipped and Valid period and values of the last bunch position (in V and mm) are displayed.

TESTING IN SOLEIL

In May 2008 microIOC-LR-BPM was tested on the transfer lines LT1 (Linac) and LT2 (Booster -> Storage Ring) in Soleil, France. The cables from the pickup detectors normally used for Soleil BPM system were split and connected in parallel to the microIOC-LR-BPM. The data from both systems cannot be absolutely compared since the calibration of both systems has not been calibrated in the same way.

The data displayed on the **Figure 4** is taken on the LT2 transfer line during an Injection procedure after a beam loss. Storage Ring was ramped from 0mA to 251.44mA, 240 multi-bunches were shot and all of them were detected by the LR-BPM system. Sampling of the position signals with ADC cards started immediately after the trigger signal arrived and finished 20 milliseconds later.

On the graph the last 150 samples are shown and they are all well within 1mm tolerance which is consistent with what they measure at Soleil with their BPM system.

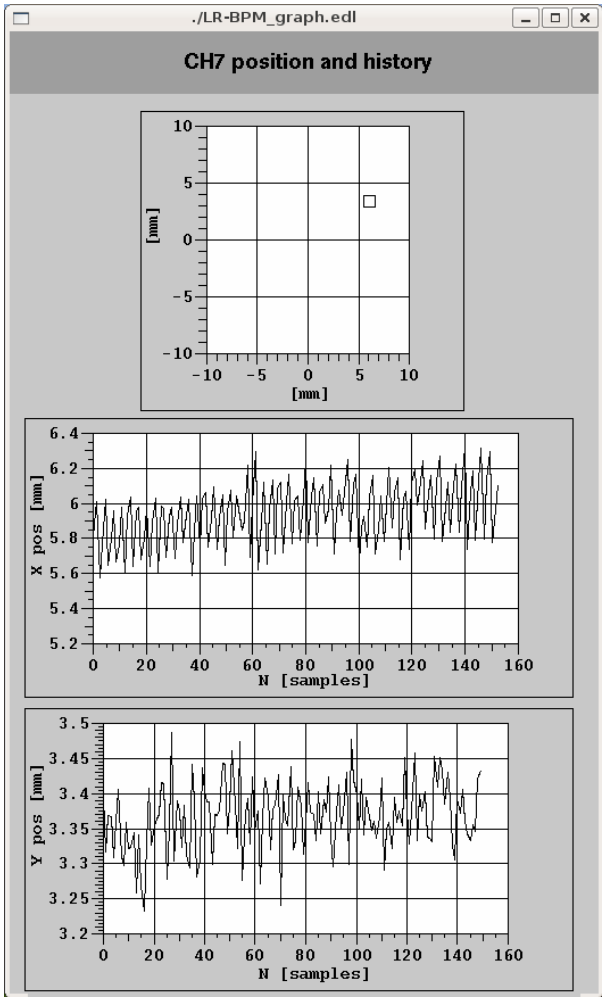

Figure 4: Graphical data taken during the Injection procedure on transfer line LT2.

CONCLUSION AND FUTURE UPGRADES

microIOC-LR-BPM proves to be a compact and very flexible solution which integrates 8 BPM pickup detectors into control system and does not require any additional hardware. As far as software is concerned, its x86 platform can provide integration into various types of control systems and offers user with flexibility to implement solutions which meet his specific requirements.

For the settings of External/Built-In trigger or Single/Multi-bunch mode on the LR-BPM modules jumpers are used. In future it could be possible to operate this settings remotely if jumpers are replaced with electronic switches and digital outputs (that are already present on the ADC cards) are used to operate them. There are also plans to upgrade the existing ADC cards to a new version which would have larger FIFO buffer and with use of settable FIFO interrupt threshold allow greater flexibility when defining the number of samples used in averaging.

REFERENCES

[1] Log-Ratio: Beam Position Monitor, User's Manual, Bergoz Instrumentation

[2] Peter Medvescek, "Technical Documentation for microIOC-LR-BPM"