Transactions of the Korean Nuclear Society Autumn Meeting
Pyeongchang, Korea, October 30-31, 2014

Development of KOMAC Beam Monitoring System Using EPICS

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1. Introduction

The data acquisition system for the beam signal monitors is required to measure the output beam signals conditioned in analog front-end circuitry from beam position monitor and beam loss monitors. The beam loss signals must be digitized and the sampling has to be synchronized to a reference signal which is an external trigger for beam operation. The digitized data must be accessible by the Experimental Physics and Industrial Control System (EPICS)-based control system, which manages the whole accelerator control. In order to satisfy the requirement, an Input /Output Controller (IOC), which runs Linux on a CPU module with PCI express based Analog to Digital Converter (ADC) modules, has been adopted. An associated linux driver and EPICS device support module also have been developed. The IOC meets the requirements and the development and maintenance of the software for the IOC is considerably efficient. The data acquisition system running EPICS will be used in increasing phase of KOrea Multi-purpose Accelerator Complex (KOMAC) beam power.

2. Beam Diagnostics System

The KOMAC consists of low-energy components including a 50-keV ion source, a low-energy beam transport (LEBT), a 3-MeV radio-frequency quadrupole (RFQ), and a 20-MeV drift tube linac (DTL), as well as high-energy components, including seven DTL tanks for the 100-MeV proton beam. The KOMAC includes 10 beam lines, 5 for 20-MeV beams and 5 for 100-MeV beams [1]. The KOMAC comprises beam diagnostics systems including Beam Position Monitor (BPM), Beam Loss Monitor (BLM), and Beam Current Monitor (BCM). For beam position / phase measurement, a strip line type BPM 14 set was designed and fabricated for increasing sensitivity. 5 FC and 13 CT are prepared for beam current monitoring. The beam current has been monitored by Oscilloscope and EPICS SoftIOC via VICP protocol [2]. For beam loss monitoring, BLM 20 set including 4 proportional type and 16 scintillation types are installed with 20 pre-amp for beam loss monitoring.

3. System Configuration

Signals from these beam detectors are fed to data acquisition systems which operate in sampling mode. They sample the signals from the detectors and measure the beam loss via pre-amp and position of X-Y +/- 2 V signal. The schematic view of a monitoring system is shown in Fig. 1.

A data acquisition system of beam monitor is dual high speed CPUs are installed for parallel processing of multiple threads in EPICS/IOC. We adopted CentOS6.3 which supports dual CPU hardware. Figure 2 shows a beam monitoring system which consists of Linux OS, PCIe ADC card, and terminal board.

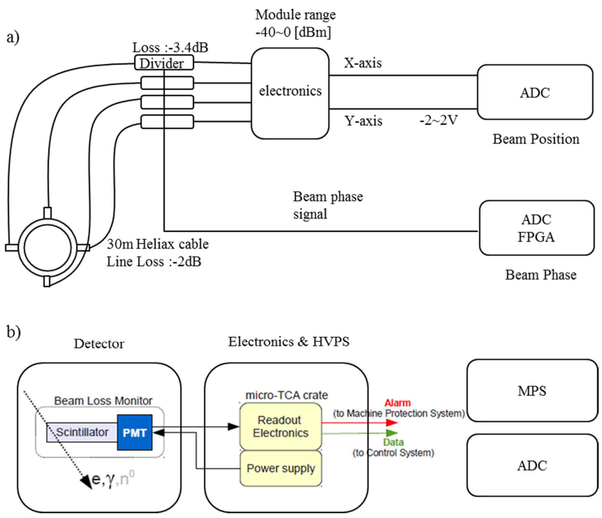

Fig. 1. Block diagram for data acquisition of beam signals from detectors for a) beam position monitor and b) beam loss monitor.

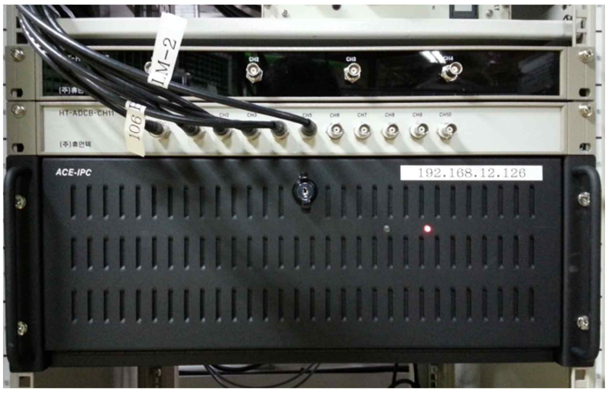

Fig. 2. Data acquisition system for beam monitors installed to klystron galley room.

4. Software Design

The EPICS is a distributed architecture that provides several solutions such as independent programming tools for operating system, operator interface tools, and archiving tools. Software layers are displayed on the Fig. 2. The beam signals are sampled with 3 MHz sampling rate. The AD data FIFO is 1024 samples and one ADC card has 10 analog input channels. Analog input resolution is 12 bit. Once ADC card operation stars by external trigger, control returns to IOC. The ADC temporarily stores the acquired data in the onboard AD data FIFO and then transfers the data to a user defined DMA buffer memory in the IOC.

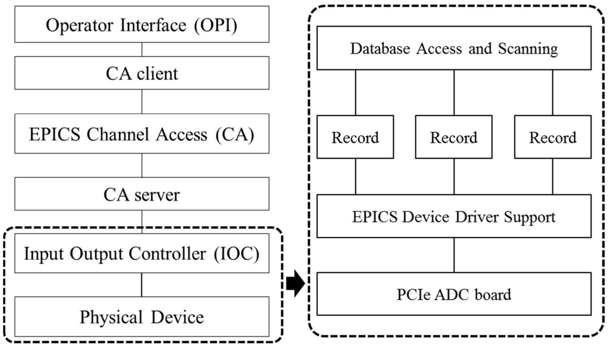

Fig. 3: Software layer of the beam monitoring system using EPICS [2].

Sampled data is available to EPICS device/driver contains dedicated equipment controllers, which in turn interface to PCI ADC card through PCI bus and also support that averaging value and waveform data are produced. We can define the number of samples of average length through OPI. There is a Control System Studio (CSS) Operator Interface (OPI). Fig. 4 shows the main OPI displays average values of BLM and BPM. Operators can check more detail signal by browsing sub OPIs. The sub OPI displays waveform data of BPM and BLM as shown in Fig. 5 and 6.

Fig. 4: Main screen for user interface of BPM and BLM of linac and beam lines.

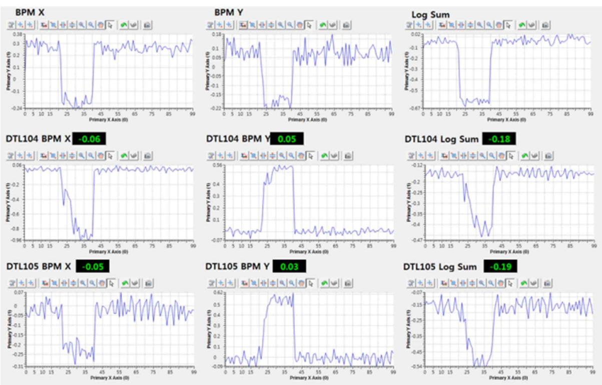

Fig. 5. OPI for BPM via EPICS CA connection to IOC.

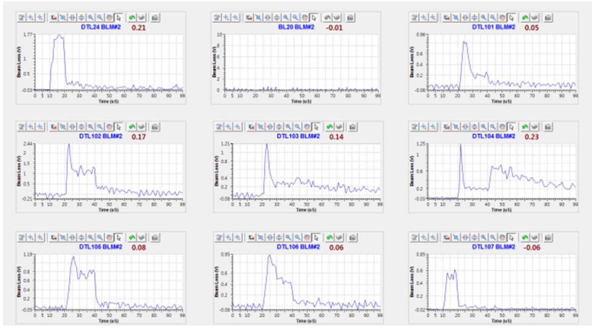

Fig. 6. FOPI for BLM via EPICS CA connection to IOC.

5. Conclusions

The beam monitoring system integrates BLM and BPM signals into control system and offers real-time data to operators. The IOC, which is implemented with Linux and PCI driver, has supported data acquisition as a very flexible solution.

ACKNOWLEDGMENT

This work was supported by the Ministry of Science, ICT & Future Planning of the Korean Government.

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