REMOTE MONITORING SYSTEM FOR CURRENT TRANSFORMERS AND BEAM POSITION MONITORS OF PEFP*

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Abstract

PEFP(Proton Engineering Frontier Project) in Korean proton linear accelerator program has a diagnostic system with current transformers and beam position monitors. Prototype of current transformer (CT) and beam position monitor(BPPM) were made and tested successfully in tools of the beam diagnostic systems. We are preparing to monitor remotely signals from the diagnostic system. Remote monitoring system is based on VME system with EPICS environments. For fast digitizing the analog signals VME ADC Input Output Board (3301) are used to meet the various needs of beam diagnosis device. EPICS channel access and drivers have been programmed in VME CPU to operate the Input output controller(IOC) and interface operators.

INTRODUCTION

PEFP has developed a 100MeV proton linear accelerator and DTL of the 20MeV was already fabricated and installed at KAERI test stand [1][2]. The 20MeV accelerator consists of 50keV proton injector, 3MeV radio frequency quadrupole (RFQ) and 20MeV drift tube linac (DTL) which is divided into four tanks. Various beam diagnostic systems such as some current transformers, faraday cup, and beam position and phase monitors were installed along the linac to measure beam current and position. An AC current transformer (ACCT) was installed in front of the RFQ, a fast current transformer (FCT) and a Faraday cup were installed at the exit of the 20MeV DTL and tuned current transformers (Tuned CTs) were installed between DTL tanks. Two BPPMs were installed at the exit of 20MeV DTL to measure not only the beam position and phase but also the time of flight for the beam energy measurement.

These diagnostic instruments are needed to monitor remotely and acquire its data with fast analog digitizing and reliable control system. We chose VME system with VME CPU and fast ADC boards and adopted EPICS to get them. PEFP proton linear accelerator has pulsed proton beams with 20MeV and 100MeV of the energy. All acquired data should be processed from its wave form and average in the system operated by external triggering and displayed on the operator console in the control room, which can be implemented by using EPICS extension tools.

The overall layout of the beam diagnostics and remote monitoring system for the 20MeV linac is shown in Figure 1.

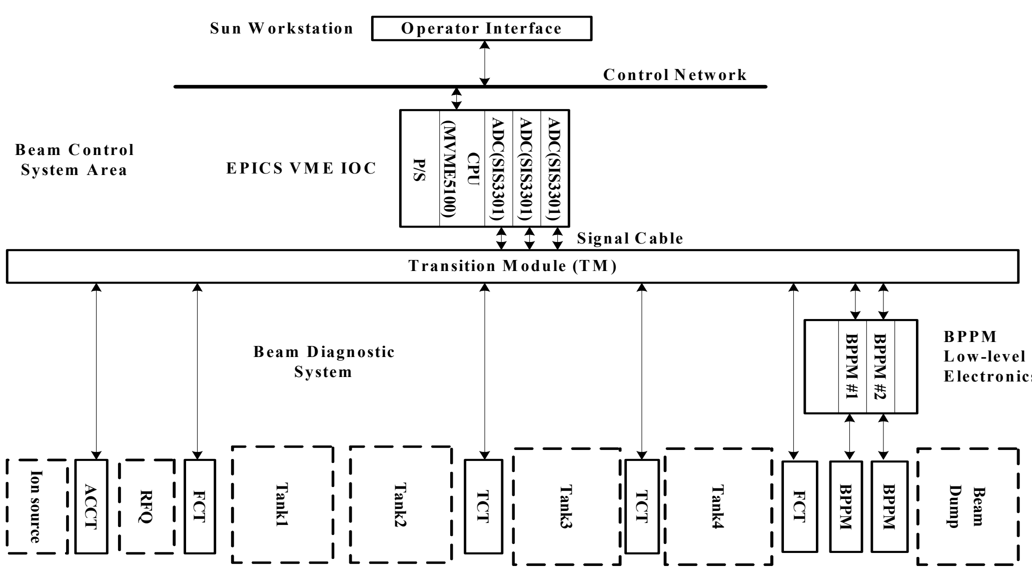

Figure 1: Schematic diagram of the beam diagnostic and monitoring system.

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BEAM DIAGNOSTIC SYSTEM [3]

AC current transformer (ACCT)

To measure the beam current from the proton injector, an ACCT was installed in front of the RFQ. The Bergoz ACCT consists of in-vacuum ACCT sensor with 55mm inner diameter and associated electronics. The electronics has 1V output when 20mA current pass through the ACCT.

Fast current transformer (FCT)

The FCTs were installed at the exit of the 3MeV RFQ and the 20MeV DTL. The FCTs were also fabricated by Bergoz. The droop is less than 1%/us and the minimum L/R time constant is 100us. The turn ratio of the FCT is 20:1 and the measured sensitivity is 1.25V/A. Therefore it can measure the beam bunch signal.

Tuned current transformer (TCT) [4]

The tuned CT is a narrow bandwidth current transformer tuned to fundamental beam bunch frequency. It measured 350MHz beam bunch signal. Because the tuned CT measured the fundamental component of the beam bunch signal, it has no droop in the beam current signal which is a troublesome in FCT. Three tuned CTs were installed after the RFQ, DTL tank2 and tank3 to measure the relative beam transmission through the tanks.

Beam position and phase monitor (BPPM)

Two sets of BPPMs are installed after the 20 MeV DTL to measure not only the beam position and phase but also the beam energy by the time of flight method. The distance between two BPPMs is 250mm, which corresponds to 4.10ns time difference between signals from two BPPMs.

REMOTE MONITORING SYSTEM BASED ON EPICS

IOC

We use a single board computer of Motorola PowerPC and a VxWorks of Real Time Operating System to monitor the beam current and position. It supplies to communicate between VME 64x fast ADC boards and the instruments with the efficient signal processing.

The development environment to implement the application software is installed at the UNIX O/S of SUN(Sparc) W/S. This system supports to develop the VxWorks through Tornado IDE and application software. EPICS base is the main core of EPICS, comprising the build system and tools, common and OS-interface libraries, Channel Access client and server libraries, static and run-time database access routines, the database processing code, and standard record, device and driver support. Figure 2 shows the structure of the EPICS IOC server program. The main core of IOC development includes record support, device support and driver support. A record support module consists of a standard set of routines which are called by database access routines. The purpose of device support is to hide hardware specific details from record processing routines. Driver support is modules that interface directly with the hardware. Drivers can be complicated bus-level access, critical timing, interrupts, semaphores, threads. The development environment to develop the EPICS IOC composes the IOC base and Tornado to create the VxWorks image at the UNIX system of SUN W/S.

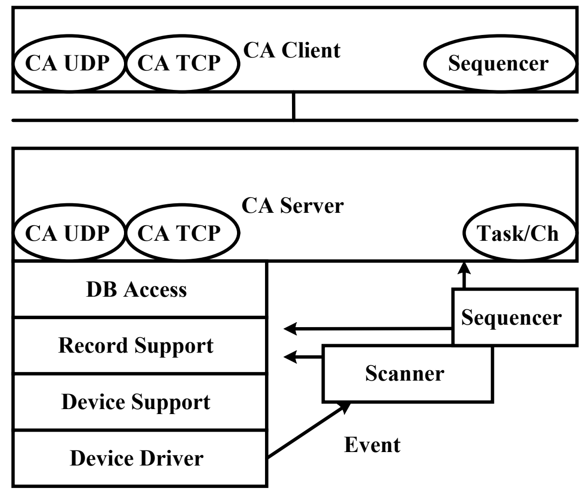

Figure 2: Block diagram of IOC software.

Fast ADC

We chose SIS3301 as a fast ADC for fast data processing of the beam measuring instruments. The SIS3301 is eight channel ADC/digitizer boards with a sampling rate of up to 105 MHz (for the individual channel) and a resolution of 12/14-bit. This specification is enough to require for the beam measurements. The boards are single width 6U VME card. Dual memory bank functionality in conjunction with multi event memory structure and a range of trigger options give the unit the flexibility to cover a variety of applications. Figure 3 shows the picture of the fast ADC board.

Figure 3: Picture of fast ADC (SIS3301).

The individual memory bank(s) can be used either as one contiguous memory or as a subdivided multi event memory. In addition memory depth can be limited in single event operation to match the requirements of the given application. The memory configuration is defined through the memory configuration register, while bank handling (on dual memory bank modules) is under control of the acquisition control register. The full memory of 128 K Samples of the SIS3301 is used as one big circular buffer or as single shot memory in single event mode, unless memory size is limited by the event configuration register. The SIS3301 features pre/post trigger capability as well as start/stop mode acquisition and a gate mode (in which start and stop are derived from the leading and trailing edge of a single control input signal). The trigger behaviour is defined by the acquisition control register. A 1024 x 24 bit Time Stamp Memory is implemented for each memory bank. An internal counter starts with the first Stop trigger condition in multievent mode and it will be incremented with the sample clock or with the pre divided sample clock (factor 1 to 256). Each stop trigger condition (end of event) writes the counter value into Time Stamp Memory.

SUMMARY

Various sets of current transformers and BPPM are used for the test of the PEFP 20MeV proton accelerator. The main instrument to measure the RFQ and DTL beam transmission is FCT at the exit of the RFQ and FCT at exit of the DTL downstream. To measure and process the current signal properly, a monitoring and data acquisition system has been constructed based on EPICS. Fast data processing for measuring beam currents and position can be implemented by using a fast ADC.

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