DRAFT

ACNet Front-end
for
Recycler BPM Project
Technical Overview

Introduction

The Recycler BPM system (BPM) includes a computer that, among other functions, interfaces the BPM to the global accelerator control system commonly referred to as ACNet. From the ACNet perspective this computer is functionally a front-end node. The ACNet front-end computer (front-end) provides the following services:

- communication interface between the BPM and ACNet,
- timing interface between the BPM and ACNet
- mechanical and electrical housing for the BPM digital receiver modules,
- BPM data processing and
- in situ status monitoring and control for BPM diagnostics.

A BPM front-end computer has hardware and software elements that are as far as practicable built from Beams Division or Industry standard technologies.

1.0 Hardware

The front-end hardware consists of a VME crate populated with a number of commercial off-the-shelf VME modules. The ACNet specific timing and machine data requirements are implemented with custom firmware programmed into commercial mezzanine I/O modules. Detailed performance specifications for each hardware element can be found elsewhere.

1.1 VME64x Crate

The VME crate manufactured by Tracewell supports VME64 extensions to provide a 64 bit data path and 3.3 volt power for the digital receiver boards. The crates have 16 slots with adequate power and cooling for up to 12 digital receivers and associated support modules. A crate monitor subsystem provides power supply, fan speed and crate temperature to an RS-232 serial port.

1.2 VME Single Board Computer

The single board computer (SBC) is the Motorola MVME2434-3 containing a 350 MHz MPC750 class microprocessor with 256 Mbytes of RAM and two PMC sites. The SBC supports the front-end software packages described in 2.0 below. The two PMC sites house the following I/O modules.

1.2.1 PMC-UCD Tevatron Clock Decoder Module

The PMC-UCD Tclk decoder module supports timing and data collection triggers for the MOOC/ACNet software package described in 2.2 below.

1.2.2 **TBD** Digital Receiver Clock Generator Module

The clock generator module provides a TBD sine wave output used to clock the digital receiver modules' analog to digital converter and digital down converter stages.

1.3 VME PMC Module Carrier

. PMC module site expansion is provided by a Motorola PMCSPAN-002 primary PCI expansion module containing two 64 bit PMC sites. The two PMC expansion sites house the following I/O modules.

1.3.1 **TBD** Calibration Signal Generator

The calibration signal generator provides a TBD waveform to the BPM calibration system.

1.3.2 Spare PMC Site

1.4 VME Industrial I/O Pack Carrier Board

Industrial I/O Pack (IP) module site expansion is provided by a SBS GreenSpring VIPC616 IndustryPack Carrier module containing four 16 bit IP sites. The four IP sites house the following I/O modules.

1.4.1 IP-TSG #1 Recycler Beam Synchronization Clock Decoder Module

The IP Timing Signal Generator (TSG) decodes the Recycler Bsync clock to provide beam synchronous timing and trigger signals.

1.4.2 IP-TSG #2 Recycler Beam Synchronization Clock Decoder Module.

See above.

1.4.3 IP-UCD Tevatron Clock Decoder Module

The IP Universal Clock Decoder (UCD) decodes the Tevatron Tclk to provide measurement arm events .

1.4.4 IP-UD 24 Line Input/Output Module

The IP input/output module provides 24 bits of buffered input/output for:

- 8 bits preamplifier calibration control
- 16 bits background flash circular buffer trigger control

1.5 VME Timing Signal Generator Break-out Board

The break-out board provides a smooth cabling transition from the TSG modules (1.4.1 & 1.4.2 above) to the digital receiver modules (1.6 below.)

1.6 Digital Receiver Modules

The Echotek ECDR-GC814 digital receiver modules are the heart of the BPM signal processing scheme. From eight to ten receiver modules may be installed depending upon location.

2.0 Software

The front-end software consists of a custom developed BPM software package and the Beams Division Controls Department standard MOOC/ACNet software package. The BPM package is derived from the software developed for the first generation Recycler BPM system and re-uses as much of the older software as possible. The MOOC/ACNet package is an off-the-shelf product used in all VxWorks/VME front-end computers.

2.1 BPM Package

The BPM front-end package is responsible for management of the timing, data acquisition and calibration hardware subsystems of the BPM. Additionally the front-end acts as an interface point to the global accelerator control system accepting commands and returning position data as specified by control system elements. The front-end software package is evolved from the software package written for the first generation Recycler BPM. Software reuse is an important issue in developing the front-end package.

2.1.1 Measurement Control

The front-end software must accept parameters and commands that support five basic measurement types.

- Background Flash (BF)
- Flash (FL)
- Closed Orbit (CO)
- Turn-by-turn (TbT)
- Diagnostic (DIAG)

The first four measurements represent the ‘physics’ measurements for which the system is created. The diagnostic measurement is a ‘technical’ measurement that provides for evaluation of system performance. Each measurement type is described in more detail below. For each of the first four measurement types both position and intensity proportional values are returned. Given two beam pickup plates A and B the calculated position is (A - B) / (A + B) and the intensity proportional value is simply the sum of A and B. Gain and offset scaling factors are applied to provide position and intensity in engineering units. The diagnostic measurement type

returns raw ADC and DDC count values to aid in commissioning and maintenance of the system.

Each measurement type must support bunched and de-bunched beam as follows:

- Bunched (injected/extracted)
  - Whole Batch – BF, FL, CO, TbT & DIAG
  - Individual Bunch - BF, FL, CO, TbT & DIAG
- De-bunched (hot/cold)
  - De-bunched Ensemble – BF, CO & DIAG
  - Head - BF, FL, CO, TbT & DIAG
  - Tail - BF, FL, CO, TbT & DIAG

Each measurement type must support accurate timing for:

- Calibration/Beam
- Proton/Pbar
- Injection/Extraction
- Main Injector/Accumulator

2.1.2 Interactive Command Driven Measurements

Acnet console application programs may instruct the front-end to take any of the measurements outlined above. A measurement request issued by an application program acts as a measurement arm event that prepares the front-end to acquire data on the next specified trigger Bsync clock event. Data collected by command measurements are stored in buffers until over-written by another measurement.

2.1.3 Event Driven Measurements

The front-end contains a list of fifteen acquisition specifications that allow users to attach automated beam measurements to arm/trigger event pairs. The arm events are provided by the Tclk system and the trigger events are provided by the Bsync system. . Data collected by event triggered measurements are stored in buffers tied to the individual acquisition specification until over-written by another measurement of the same type.

2.1.4 Background Flash Measurements

Background Flash measurements are essentially repetitive Flash measurements taken at a programmable frequency and asynchronously to any triggering events. Background Flash data are available for plotting and logging on an individual BPM basis. Background Flash activity may be momentarily interrupted by other measurement activity, but is resumed when the interrupting measurement has completed. Background Flash

may be aborted if required for system diagnostics. The Background Flash data are stored in a 16,384 element triggered circular buffer for post-mortem analysis.

2.1.5 Flash Measurements

Flash measurements are triggered by Bsync clock events and return a single sample from all detectors in the system.

2.1.6 Closed Orbit Measurements

Closed Orbit measurements are triggered by Bsync clock events and are evaluated from a specified number of samples of consecutive turns from all detectors in the system. The Closed Orbit measurement returns the mean and RMS values over the specified number of turns.

2.1.7 Turn-by-turn Measurements

Turn-by-Turn measurements are triggered by Bsync clock events and return a specified number of samples of consecutive turns from all detectors in the system.

2.1.8 Diagnostic Measurements

Diagnostic measurements are flash type measurements triggered by Bsync clock events and return the raw ADC and DDC data used to evaluate the position and intensity proportional values.

2.1.9 Calibration Mode

The calibration mode returns position and intensity proportional data collected from a fixed calibration source connected to the preamplifier test input. The calibration source can simulate both bunched and de-bunched beam at two positions and at two intensities. Calibration measurements are made by switching the front-end into calibration mode and then requesting any of the five basic measurements. In this way calibration data follows the same processing paths as normal flash and turn-by-turn beam data and can be used to verify system timing and electrical connection performance

2.2 MOOC/ACNet Package

The MOOC/ACNet package supports communication between the front-end computer and the global accelerator control system ACNet. The package supports one-shot set commands that are used to transfer parameter and control values from ACNet to the front-end. The package also supports both one-shot and repetitive read requests that are used to transfer parameter values and measurement data from the front-end to ACNet. Repetitive reads take the form of slow (15 Hz and below), fast continuous plot and fast snapshot plot. The three

types of repetitive reads have the ability to return data upon specified Tclk events. All forms of set and read commands are used by the front-end package.

End.