Signal Operation System for X-ray Beam Position Monitors

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1.Introduction

The X-ray beam position monitor (XBPM) with high position sensitivity of less than a few microns and with stability under the high heat load condition is required for the SPring-8 beam-lines[1]. Presently, some types of XBPMs are being installed at the front-end of the SPring-8 beam-line. Line-up of the SPring-8 XBPMs are shown in table 1.

Table 1. The SPring-8 XBPMs

Light Source	Monitor Type	Signal Amount
Insertion Device	Diamond Area	1pA～10mA
	Diamond Blade	1pA～(1A)
Bending Magnet	Metal Blade	1pA～10mA

The current signals are sent from the front-end in concrete shield to the experimental hall through low noise coaxial cable(HLN-RG55:Hitachi densen). The detail of the signal processing is as follows.

2. The front-end electronics for the X-ray beam position monitor

The electronics consist of the current-voltage converters and the operational circuits that generate the beam position signal. (Figure 2)

1 Current-Voltage (I/V) converter

The amount of current signal from the XBPMs are estimated as shown in Table1.

According to the driving mode of the SPring-8 Storage Ring and the insertion devices, the estimated amount of currents is variously changed. Then, the I/V converting ratio is designed to be from 1nA/V to 1mA/V. An ultra low-drift and low-off-set type of OP-amp (AD549:Analog Devices) is used in I/V converting[2] for detection of small amount of current signal(nA order).

Because the signal from the XBPM is micro-pulse shaped current, the time constant of the I/V converting of the electronics is designed to be longer enough than the pulse period (~5μs) in single bunch mode, then the signal current is properly averaged. (In the case of SPring-8, the signals are sent with 40m cable. Therefore, the current signals might be also averaged by the inductance of the cable.)

2 Operational Circuit

The monitor has four(two) for ID beam(for BM beam) blades to obtain the information of the two(one)-dimensional beam position. Then, the beam position can be calculated in the following formula:

$$X = Ax \times \frac{(I_{U\text{-}R} + I_{D\text{-}R}) - (I_{U\text{-}L} + I_{D\text{-}L})}{I_{U\text{-}R} + I_{D\text{-}R} + I_{U\text{-}L} + I_{U\text{-}R}} \quad (1)$$

$$Y = Ay \times \frac{(I_{U\text{-}R} + I_{U\text{-}L}) - (I_{D\text{-}R} + I_{D\text{-}L})}{I_{U\text{-}R} + I_{D\text{-}R} + I_{U\text{-}L} + I_{U\text{-}R}} \quad (2)$$

$$Y = Ay \times \frac{I_U - I_D}{I_U + I_D} \quad (3)$$

,where $I_{U\text{-}R}$,$I_{U\text{-}L}$,$I_{D\text{-}R}$,$I_{D\text{-}L}$ (U: upper, D: down, R: right, L: left) are currents from each electrode, and Ax, Ay are coefficients to be calibrated. Formula(1) and (2) are used for the beam from ID, and (3) is used for the beam from BM.

The analog data of the I/V converter is sent to the A/D board in VME work station system of beam line, and calculated. Then, users can utilize the information of the photon beam position.

If the data of the photon beam position is used as a part of the feedback system for the electron orbit correction, it should be quickly enough to obtain the beam position data. Therefore, the analog data from I/V converter are also sent to an analog operation circuit[3].

In the electronics, the analog voltage data from I/V converter are operated as formula (1),(2) and (3).

Addition and subtraction are done with LF356 (National Semiconductor), and division is done with ICL8013(HARRIS). The calculation speed of the circuit is ~20kHz.

Figure 1. XBPM signal processing system

3. System Construction

We have prepared these electronics as NIM modules, and assembled them in the NIM BIN power supply at each beamline. These electronics, high voltage power supplies, and other electronics for interlock X-ray monitor is also assembled in a NIM BIN power supply, and a XBPM signal processing system is constructed. (Figure 1.)

Reference

[1] H. Shiwaku, H. Sakae, H. Kitamura, SPring-8 Annual Report 1, 162 (1994)
[2]manufactured by Clear Pulse Co.
[3]manufactured by Tamaoki Electronics Co.

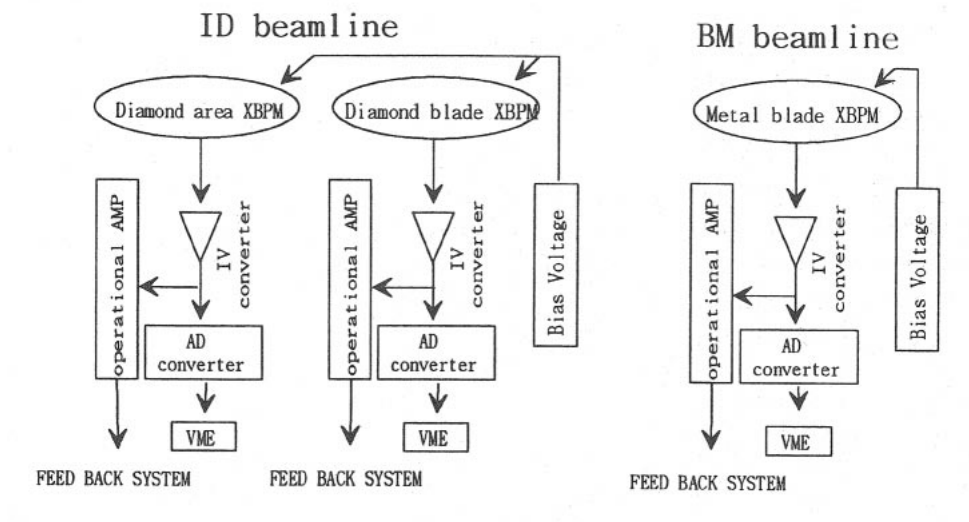

Figure 2. SPring-8 XBPM system