Electronics of XBPMs for the SPring8 Beamlines

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1. Abstract

We previously designed a current-voltage converter (I/V) capable of measuring current value of 10pA to 10mA, and constructed a signal processing system of XBPM using I/V [1][4]. This system had been used in beam line commissioning. The standard deviations of the beam position data of σ =～3 μm in the bending magnet (BM) beamline, and σx=～3 μm, σy=～1 μm in the Insertion Device (ID) beamline were obtained [2].

We have constructed an automatic I/V ratio optimizing system using the DIO interface board of VME. We have already tested a prototype of this system, and have confirmed that the system works well.

2. Design of XBPM data-acquisition system

Based on the estimated amount of current signals, according to the driving mode of the SPring-8 Storage Ring and the insertion devices, the I/V converting ratio is produced to accommodates gains of 1nA/V to 1mA/V. For this, an ultra low-drift and low-offset type OP-amp (AD549: Analog Devices) [3] is used for the I/V converting to detect small nA currents.

The analog data of the I/V converter is sent to the 16-bit A/D board in the VME workstation of each beam line, and calculated.

3. Evaluation of the electronics and the system

The system characteristics of I/V are:

Input current range:	10pA～10mA
I/V conversion ranges:	
	10nA/10V, 1 μA/10V,
	100 μA/10V, 10mA/10V
Temperature drift:	< 100ppm/℃
Out put noise:	each channel < 2mVp-p,
Linearity:	< 0.1%, full-scale
Out put voltage:	0V~+10V

The S/N ratio is limited by the output noise (<2mVp-p: white noise), which is generated from the OP amp itself and is hard to remove by any filtering. The output voltage should be kept at > 1V in which case the S/N ratio is approximately 1000. Actually, by the commissioning of the Spring-8 beamline, it was found that XBPM in the ID beamline can easily demonstrate ～μm resolution when the output voltage from the I/V is > 1V. If, however, the output signal is smaller than 0.1V, then the I/V range of all blades should be manually changed to improve the S/N.

The voltage data from I/V is taken by the A/D board in the VME system every few seconds, and after that, the data is calculated to give the position data. Therefore, the position data is rewritten every few seconds.

The data sampling time is limited by the software of the workstation which is responsible for controlling many of the other beam line components.

This system had been used in the beam-line commissioning , and the standard deviations of σ =3 μ m in the BM beam line and σ x=3 μ m, σ y=1 μ m in the ID beam line were obtained.

4. Automatic I/V ratio optimization

By the commissioning of the SPring-8 beamlines, the XBPM data recording and electronics system have worked well. However, there are some points that can be improved, especially concerning the proper control of the I/V conversion ratio.

In the system, the I/V conversion ratio is manually optimized. Unfortunately, this manual operation is troublesome for users. Therefore, we are considering ways to automatically optimize the I/V ratio.

A simple way for resolving the problem is to adjust the I/V ratio of the I/V converter remotely through the DIO interface board of VME (Fig. 2). The hardware for this change is simple, and a linearity of 0.1% can be easily attained, though the continuity of the analog data is lost when the I/V ratio is remotely changed. However, the problem is not too severe in the present case. We have produced another I/V module for this purpose (Fig. 1) [4].

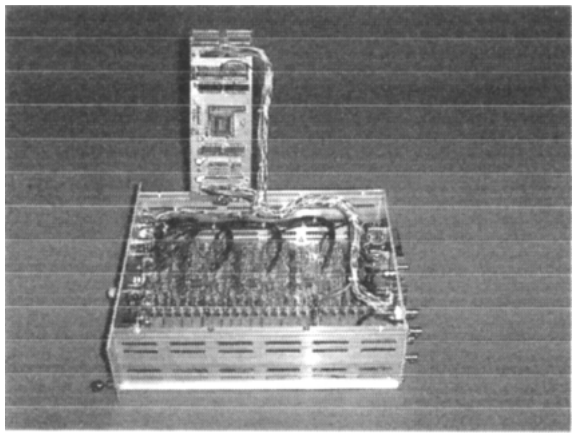

Figure 1 I/V converter with automatic I/V ratio optimizing interface.

In the automatic I/V ratio optimizing system, the four output signals of the I/V converter are usually monitored by the software. When one of the four output signals comes to be less than 0.96V, then all four I/V ratios are changed to be one order larger. Contrarily, if one of the signals is larger than 9.8V, then all of the ratios are changed to be one order smaller. We have already tested this system, and have confirmed that the system works well. In the system, we also improved the time constant for I/V converting to be longer. As a result, the standard deviations of the beam position data of σ x=$\sim$2 μ m and σ y=$\sim$0.03 μ m in the ID beamline were obtained.

5 Future Plans

Although the beam position data taking speed is not so high in the present system, it is hoped that faster data acquisition will be achieved for advanced control of the ID and Storage Ring. Then, we will consider some ways for improving the XBPM data acquisition speed.

Reference

[1] T. Kudo et al, Spring-8 Annual Report 3, 200 (1996)

[2] T. Kudo et al, Journal of Synchrotron Radiation, 1998, Volume 5, pages 630-631.

[3] Analog Devices, Linear DATA book," 755N, 755P", 1994/1995

[4] Manufactured by Clear Pulse Co.

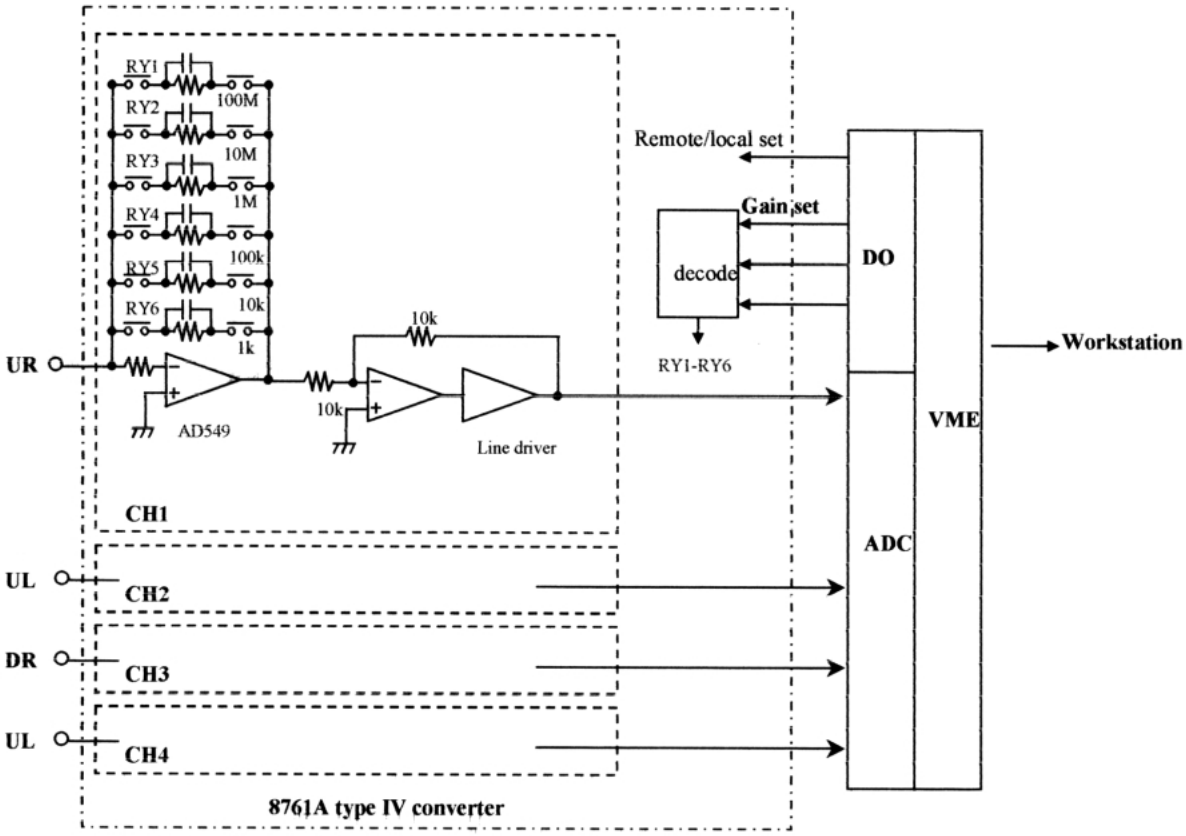

Figure 2 Automatic I/V ratio optimizing system using the DIO interface board.