A High-Speed Current Amplifier for PSIC

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1. Introduction

As a beam monitor detector at SPring-8, although PSIC [1] is used, two or more current measuring instruments are required. Moreover, the noise characteristics are very important because an accuracy of 1 micrometer in beam position measurements requires a voltage-reading accuracy of about 1 millivolt in the case of a PSIC position-voltage coefficient of 5000. Therefore, in order to reduce the noise from electric and acoustic disturbances, the current amplifier and the detector need to be connected as close as possible to each other. Since the PSIC, as an I0 monitor, needs to measure the beam intensity to normalize the experimental data from the downstream detectors, the amplifier must be as fast as other detectors to avoid timing errors in normalizing. Since there is no current measurement system capable of satisfying these three conditions currently in existence, we developed a high-speed two channel current amplifier which is directly attached to the PSIC.

2. Design Detail

So far, although a low-noise cable has been used, the most effective method of noise reduction is to avoid the use of a cable. Therefore, the best method to achieve a low noise level is to directly connect the current amplifier to the detector. Since the contact resistance changes depending on the stress building up between the detector and the amplifier, it is not good idea to adopt BNC connectors or similar bayonet coupling connectors. Thus an SMA connector with the smallest outline among all standardized screw lock connectors was adopted.

When a very small current, smaller than 100 nA level is measured, the resistance of the feedback resister must by necessity be very huge, eg. 1 Gohm. Since it combines with the flowing capacity around the circuit and forms a long time constant (millisecond to 1 second) [3][4], such big gain current amplifiers are very slow. In the case of I0 monitors however, they have to synchronize accurately with other detectors, and so the amplifier must be sufficiently fast. In this case, auxiliary feedback circuits enable a frequency of 2 kHz(-3dB). And finally a low noise level of 0.5 or less mVrms can be achieved conserving high-speed responce [5].

3. Conclusion

The current amplifier developed can be used for ionization chambers, Lytle detectors, photoelectron emission type detectors and photodiodes, and it is especially effective when current measuring with two channels is necessary. The method of making the preamplifier simple, small and directly attached to the detector, transmitting the amplified signal from the detector site to the site of the user, and installing advanced signal processing equipment is optimum in respect of S/N and cost performance. We can achieve this method by using a Beam Position Calculator which is an advanced and cost-effective digital signal processing device with a shape like a standard NIM module for general beam monitors. This module is under development at the time of December, 1999. Now, the amplifier reported here is available as type 8868 from Clear Pulse Co.

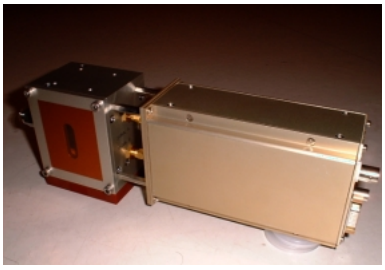

Fig. 1. A photo of the PSIC and the amplifier combination.

References

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