Design of Beam Position Monitoring System for a Local Bump Feedback at Variably Polarizing Undulator Section

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1. Introduction

A local bump feedback system is under construction to correct the orbit distortion at the section of a double array undulator to generate linear and circular polarization of light for a soft X-ray beamline. This feedback system is composed of a beam position monitoring system (BPM system) and a magnet system. The BPM system measures the beam position and calculates the local bump orbit to decrease the COD and stabilize the photon beam from the undulator. The magnet system which is composed of four steering magnets and a long coil create this bump orbit.

2. Design of BPM system

The schematic diagram of the BPM system is shown in Fig.1. The beam position monitors (BPMs) are placed next to the steering magnet, and each monitor is composed of four button pickup electrodes which mounted on the vacuum chamber. By the passage of the electron beam a pulse shape current is induced on the surface of the vacuum chamber inner wall. When a pulse passes one of the button pickups, a pulsed signal is induced [1] [2]. The button signal intensity is estimated as several watt in a single bunch mode. These button signals are provided for the Chebyshev type band-pass filters through a 30m length coaxial cable. The bandwidth of these filters is 25MHz around 508.58MHz. The maximum input signal intensity for the BPM signal processor board (BPM board) is decreased to about 120 μ W by the coaxial cable and the filter. The schematic diagram of the BPM board supported by BERGOZ company is shown in Fig.2 [3]. The BPM board is

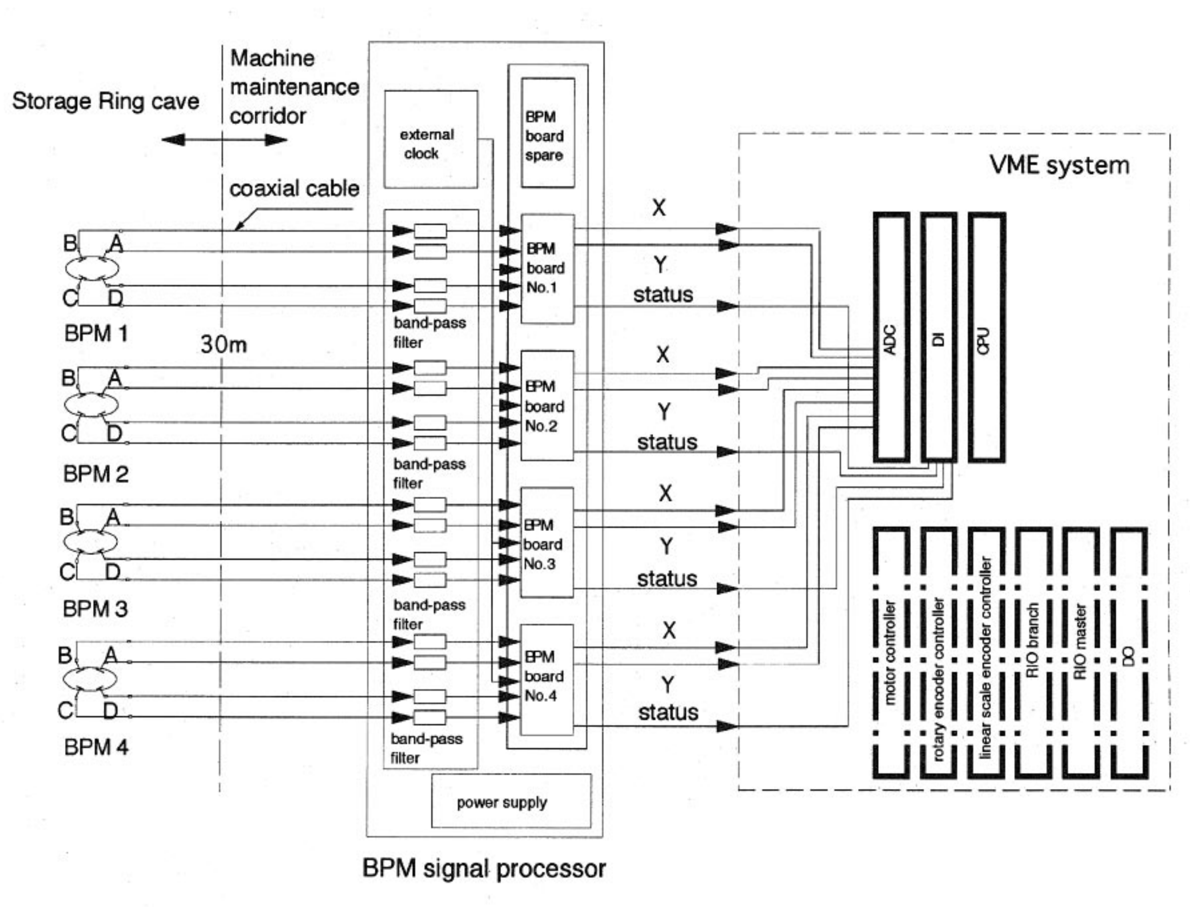

Fig.1.Schematic diagram of the BPM system

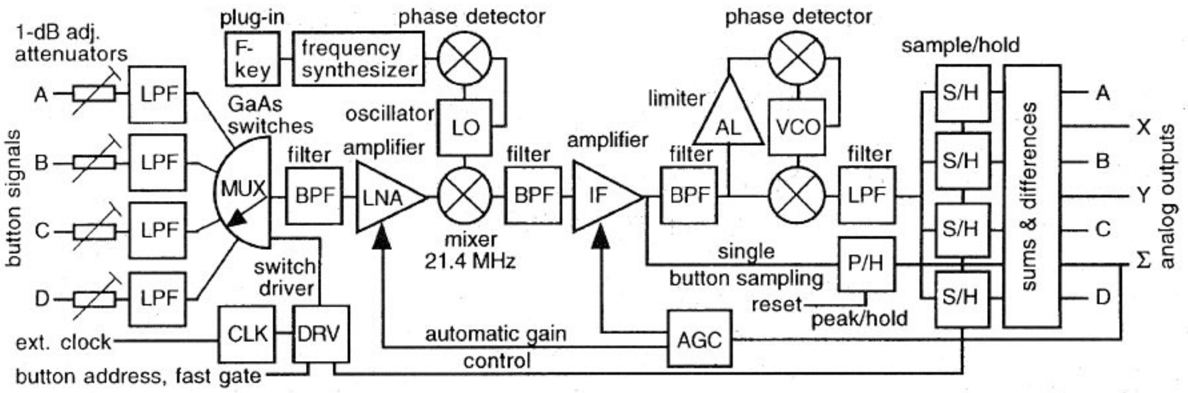

Fig.2 Schematic diagram of BPM signal processor board

composed of variable attenuators for input signals, low-pass filters, GaAs scanning switches, band-pass filters at the chosen harmonic of the beam, front-end amplifier with automatic gain control, synthesized local oscillator, down-converter, intermediate frequency amplifier with automatic gain control, phase-locked synchronous demodulation, and beam position output buffers. The signals from four buttons of a BPM is processed in a single set of BPM board. Four button signals are time-multiplexed into a single signal and supplied to a superheterodyne receiver. The detection frequency is chosen to be 508.58MHz which is the same frequency as RF acceleration frequency. The demodulated signal is demultiplexed into four signals described as A, B, C and D. To obtain position information, four signals are analog processed. The horizontal position X is obtained by A-B-C+D and the vertical position Y by A+B-C-D under constant sum of four signals Σ. These positions are obtained as sequential analog output. The output range is ±10V and the resolution is chosen as 1V/mm. Same sampling frequency is supplied for four sets of BPM boards from the external clock.The frequency is chosen in the range of 40kHz to eliminate the aliasing ofcertain beam motion. Four buttons can be sampled up to a frequency of 10kHz. The beam position output signals from the four sets of BPM board are converted into 16bits digital signal by an 8 channels analog-to-digital converter (ADC) in the VME system. The minimum through put rate of one channel is 10 μ sec, so the horizontal and vertical beam position outputs from the four sets of BPM board are sampled up to 5kHz frequency. The several times sampling of four beam positions are stored on the ADC memory and then fed into the VME-bus CPU (HP9000-743rt/64) at once. The CPU takes an average of the beam positions and calculates kick angles of the steering magnet to create the local bump orbit. In this feedback, relative beam position is used for calculation to reject constant or slow drift of the beam position caused by the difference of the insertion loss of cables and the temperature fluctuation effect for a circuit. This feedback is performed at a rate of 100Hz.

References

[1] S.Takano, “Analysis of Signals of Beam Position Monitor Pickups on the Spring-8 Storage Ring”, Spring-8 Annual Report, p134 (1994)

[2] S.Sasaki, “Beam Diagnostics”, Spring-8 Annual Report, p32 (1994)

[3] BERGOZ Precision Beam Instrumentation, catalog of Beam Position Monitor