Design of RF Low Power System for the SPring-8 Storage Ring

Y. Ohashi, H. Ego, M. Hara, Y. Kawashima, H. Suzuki, I. Takeshita, N. Tani,

and H. Yonehara

SPring-8, Kamigori, Ako-gun, Hyogo 678-12, Japan

A low power RF control of the SPring-8 storage ring includes a)508.58 MHz reference signal distribution to the RF stations, b)RF phase and amplitude stabilization of klystron-out signal, c)cavity tuning, and d)various monitoring. A control system design has been completed basically.

A stable signal generator, which is installed in the RF "E" station , supplies the reference RF signal of 508.58MHz. The signal is distributed in succession to the nearby stations (A,B,C,D) and to the synchrotron as shown in Fig.1. A special single-mode fiber-optic cable[1], which compensates the effect of temperature changes, is used for the signal transmission. About 500m long fiber-optic cable is strung between RF stations. Phase stability of the signal transmission over such a cable is about 1° from 20°C to 30°C[2]. Although surrounding temperature along the cable rute varies from 21°C to 28°C, it is expected that transmission cable itself is not a dominant source of drifts. Optic transmitter and receiver(EO/OE) have temperature dependence of 0.1°/°C[2]. EO/OE are located in the low power control room of which temperature is controlled within a few degrees, so these do not contribute much in drifts. In order to secure stability of the reference signal phase within 1°, a phase lock loop(PLL) is introduced to compensate the temperature drifts of the system. As shown in Fig.2 transmitted light is reflected by a mirror, and reflected light is extracted through a photo-coupler for phase locking. By using optic reflection system, performance of the system can be monitored at the transmitting side as well. RF modules are inserted symmetrically in both lines to cancel out the temperature drifts in those modules roughly. As in Fig.3 RF signals picked-up from a pickup port of each cavity and directional coupler imediately before cavity are sent to the low power control room through phase stable coaxial cables. Signals from 8 cavities are linearly summed by vector sum modules after each signal level is adjusted by an attenuator with 0.1dB step. A summed signal is split into two ways. The one is utilized for the phase control to lock RF phase of the klystron-out signal. The other sum-signal is linearly detected and utilized for the amplitude control to suppress ripple and drift of a klystron power supply. Since cavity voltage is used for the klystron power control, a beam loading effect is automatically compensated[3].

The signal phase picked up from each cavity is compared with the phase of incoming signal to cavity. A phase drift, which is caused by the thermal detuning or reactive beam loading effect appeared in each cavity, is compensated by driving a stepping motor of the tuner. Another movable tuner, which is controlled manually, is installed to manipulate higher order mode frequencies.

Monitoring of RF signal levels at various points, RF phases, control voltages, etc. enables us to take a quick responce in the case of malfunction of the system.

References

1) J.Urakawa: Particle Accelerators, 29,251 (1990).

2) H.Suzuki, Y.Kawashima, Y.Ohashi, H.Yonehara, H.Ego, N.Tani, T.Nagafuchi, T.Hori, T.Oshima, and M.Hara: "Characteristics of RF Reference and Timing Signal Distribution for SPring-8" in Procedings of the 9th Symposium on Accelerator Science and Technology (KEK, Tsukuba, 1993)

3) E.Ezura, K.Akai, H.Hayano, M.Ono, M.Suetake and T.Takashima: "The low level RF system for TRISTAN main ring" in Procedings of 1987 Particle Accelerator Conference (Washington, D.C., USA, 1987)

Fig.1 Reference 508.58MHz signal distribution

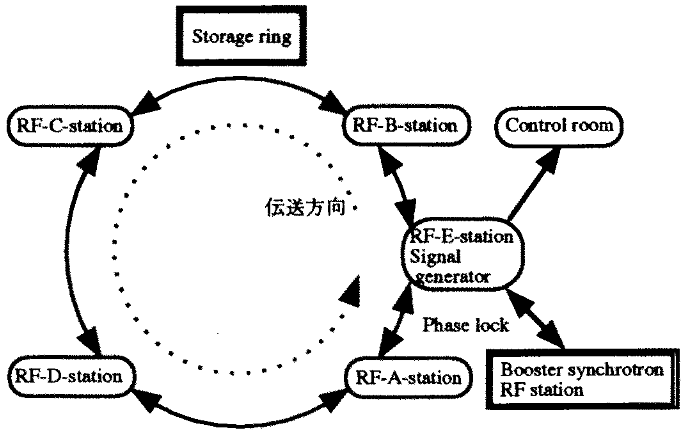

Fig.2 Reference 508.58MHz transmission

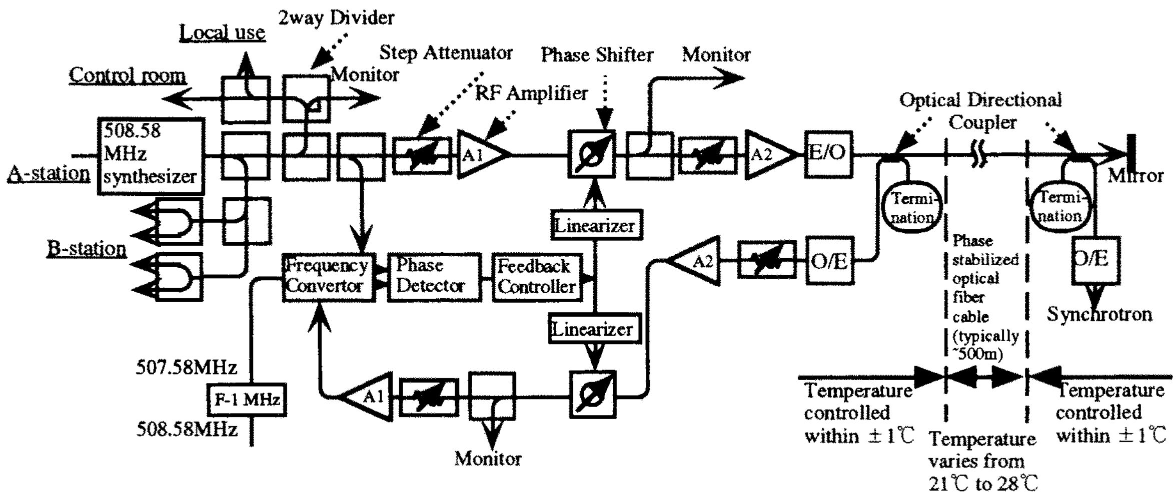

Fig.3 Block diagram of low level RF system