RF Low Power System for the Storage Ring

Yuji OHASHI, Hiroyasu EGO, Masahiro HARA, Naoyasu HOSODA, Yoshitaka KAWASHIMA,
Takashi OHSHIMA, Hiromitsu SUZUKI, Takeo TAKASHIMA and Hiroto YONEHARA

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

A low power RF control of the SPring-8 storage ring is being constructed and tested. It consists of (a)508.58 MHz reference signal line, (b)automatic level control(ALC) and phase lock loop(PLL) of RF power, (c)cavity tuning, (d)anode modulation, (e)interlock, and (f)various monitoring. Final installation is essentially based on the design reported previously except for the phase locking of (a) and a part of (f). System testing is being done simultaneously with cavity aging.

Low power RF control diagram close to the real configuration is shown in Fig. 1. Signals from high power transmission lines and from cavities are sent through phase stabilized coaxial cables. A part (b) surrounded by the dotted line has a function to level klystron-out power and cavity voltage, and to lock klystron-out and cavity phase. (c) is to keep cavity resonating at 508.58MHz by controlling tuner with a stepping motor. (d) makes klystron power handling stable (cathode modulation is applied in one RF station and anode modulation in the other two RF stations). (e) is for protecting equipments from break down, beam abort, and radiation safety (switching off of RF switch is the quickest way to abort stored beam currently). (f) is to check running condition and to respond system malfunction.

Three changes were made in the low power control scheme. 1)RF signal picked-up from a pickup port of

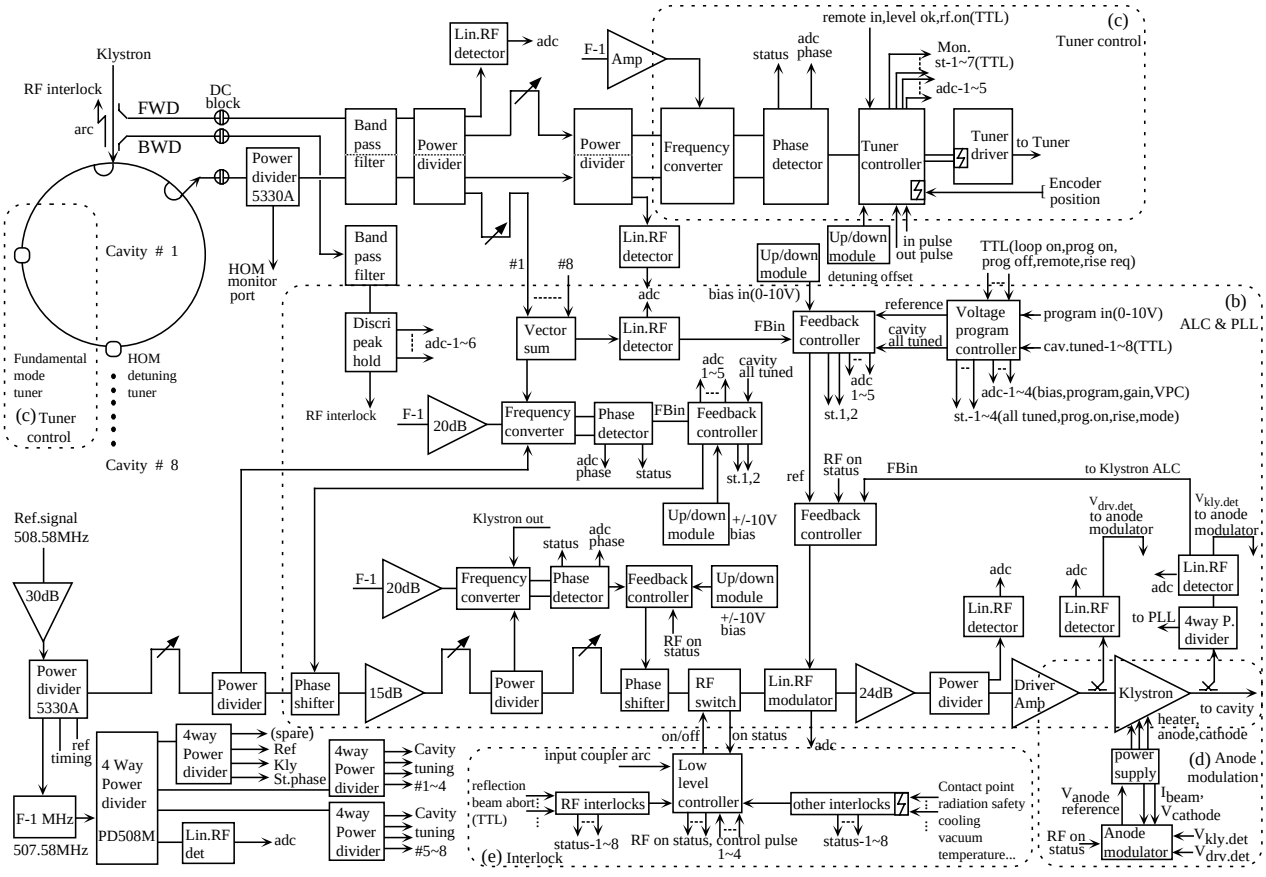

Fig. 1 Low power RF control diagram.

each cavity was split into two ways before entering bandpass filter. This was substituted to measure and handle higher order modes excited in the cavities by the beam. 2)Auto level control was doubled, that is, separated into klystron loop for relatively high frequency control and cavity loop for relatively low frequency control. 3)Phase lock loop was also doubled as 2). Klystron loop was introduced to make feedback control stabler.

Low power RF control system was assembled to do testing each RF station. Fig.2a and 2b show the klystron forward phase and RF voltage with ALC and PLL-off and -on, respectively. Fig.3a and 3b show the RF spectrum of the klystron forward signal with ALC and PLL-off and -on, respectively. Klystron power supply is based on thyristor control. Corresponding ripple extends to several kHz. Since single feedback loop is not effective above ~1kHz, sharp spikes remain even with ALC and PLL-on as seen in Fig.2b.

Feedback control has a range of ~1kHz, higher frequency components are not compensated in proper phase, that is, phase mismatch increases with frequency. 800kW of klystron power was successfully fed into 8 cavities, and the feedback control worked as designed. Meanwhile the cavity aging is kept going as long as time permitted, the long term system stability and reliability is under examined

References

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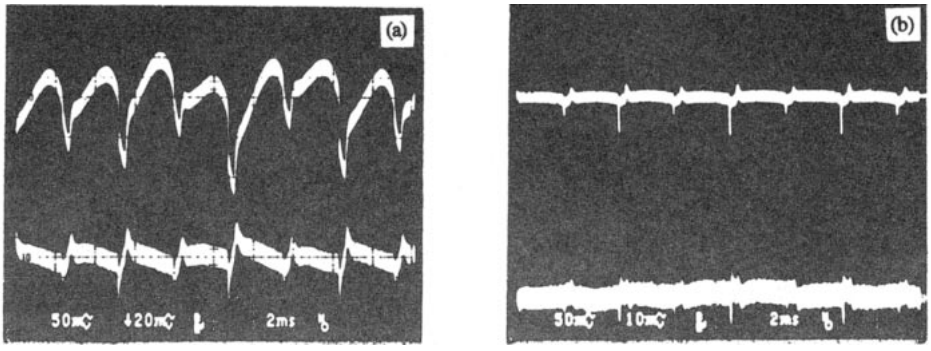

Fig. 2 Raw output signals with ALC and PLL-off(a) and -on(b) of phase detector which detects klystron-out phase relative to reference, and of linear RF detector which detects RF voltage picked from klystron forward power. Upper data for phase(˚/50mV, 50mV/div), lower for linear RF detector voltage(level~2.7V, 10mV/div), and sweep of 2ms/div).

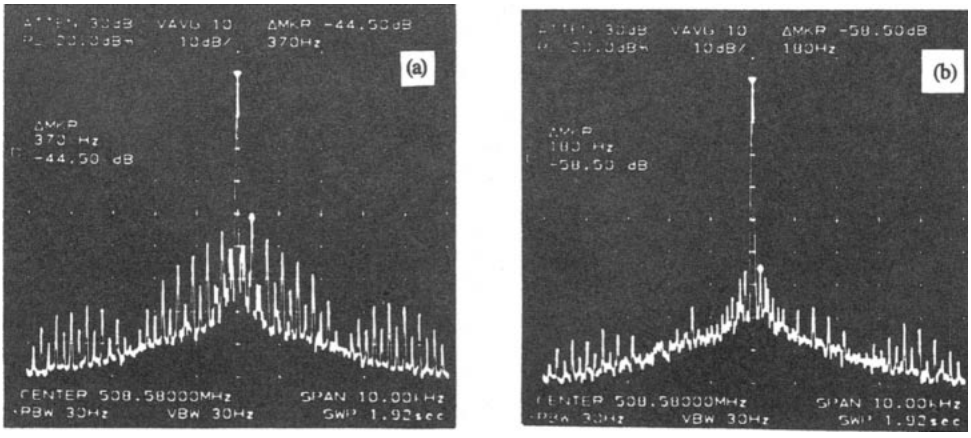

Fig. 3 RF spectrum of the klystron forward signal with ALC and PLL-off(a) and -on(b). Spectrum analyzer parameters(vertical:10dB/div, horizontal:center frequency508.58MHz/span10MHz).