FEEDBACK SYSTEM FOR DUMPING OF LONGITUDINAL BUNCH OSCILLATIONS IN VEPP-4M COLLIDER

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Abstract

In order to luminosity increase in VEPP-4M collider at BINP, it was accepted to increase the current in four-bunch mode ($2e^-2e^+$) from 5мА up to 40мА in each bunch [1]. One of the problems on the way to current increase is instability associated with longitudinal bunch oscillations. A feedback system is being developed for bunch oscillations control.

FEEDBACK SYSTEM

There are two e^- bunches and two e^+ bunches in the VEPP-4 ring. Two bunches of the same sort of particles are placed diametrically opposite.

The System consists of two identical channels, each influences on a specified sort of particles. Each channel contains two sub channels for damping in-phase and anti-phase mode of oscillations of two bunches (see Figure 1).

All bunches produce a series of short voltage pulses in a pickup electrode. These pulses come to a pulse phase detector and impact relaxation oscillations in a band pass filter (BPF). The central frequency of the BPF is 181 MHz. The phase of these oscillations is compared with a phase of a master oscillator and filtered in a low pass filter (LPF).

The series of pulses with amplitude proportional to the phase of bunches comes to two independent sub channels corresponding to the sort of particles.

The bunch selector consists of an analog to digital converter (ADC), two registers (RAM), two digital to analog converters (DAC1 and DAC2) and a synchronization unit. The synchronization unit starts the ADC at the time when the chosen sort of particles influences the pickup electrode and the voltage from pulse phase detector is settled (taking into account time delays in the BPF and LPF). The output voltage of the DAC№1 and DAC№2 corresponds to the phase shifts of bunches #1 and #2. The refresh rate is equal to the revolution frequency (818.9 KHz).

An in-phase and anti-phase calculator is simple analog summation (Σ) and subtraction (Δ) units which correspond to inphase and antiphase mode of oscillations respectively. The constant phase shift is excluded from processing.

A phase and amplitude control unit, consisting of phase shifters (Ph.Sh.) and variable gain amplifiers (VGA), is intended to control the main parameters of the feed back loop.

An up-converter unit contains two phase looking loop oscillators (G1 and G2) that generate even and odd harmonics of the revolution frequency. The even (398) harmonic oscillator acts on the in-phase mode of oscillation of diametrically opposite bunches. The odd (397) harmonic oscillator act on anti-phase mode.

KICKER

There are two kickers in feedback system. Each of kikers interacts with only one type of particles. The kicker consists of two cavities (see Figure 2) working from one generator. RF power is divided by 3dB directional coupler and supply to cavities. Length of cables is selected such that the phase of one cavity differs from another by $\pm\pi/2$. The distance between cavities is $\lambda/4$(230мм). Electrons and positrons move in opposite directions. Therefore, for one RF voltage on cavities is inphase for others antiphase. One particles have double kick, others nothing. Thus selectivity of the kiker is provided. The kiker for electrons differs from the kicker for positrons a by sign of shift of a RF phase only.The Higher Oder Modes (HOM) of the cavity are above critical frequency of the vacuum chamber (2500MHz). Thus, the problem with the HOM induced voltage disappears. Circulators are used for protection generators from a voltage induced at the main frequency.

Table 1: Main parameters kicker cavity

RF Frequency	325 MHz
Characteristic impedance	15 Ohm
Quality	1000
Shunt impedance	15000 Ohm
RF Voltage	1000 V

Decrement due to the feedback system is about 500 1/s, that exceeds the decrement due to radiation losses approximately by 30 times.

At present the system is in a stage of manufacture. Installation and start of system is planned to 2007.

REFERENCES

[1] V.Smaluk for VEPP-4M Team (BINP, Russia) "VEPP-4M Status Report", this conference.

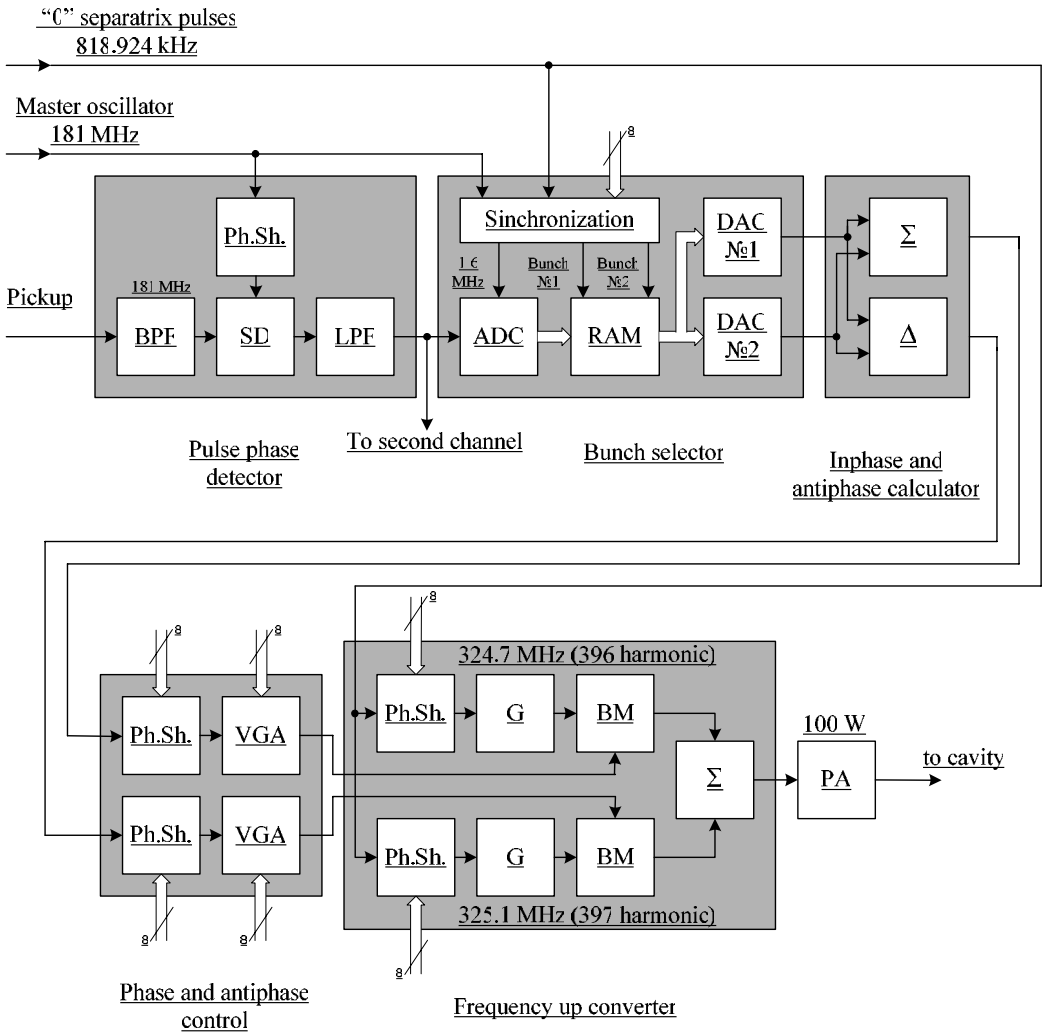

Figure 1: The block diagram of feedback system.

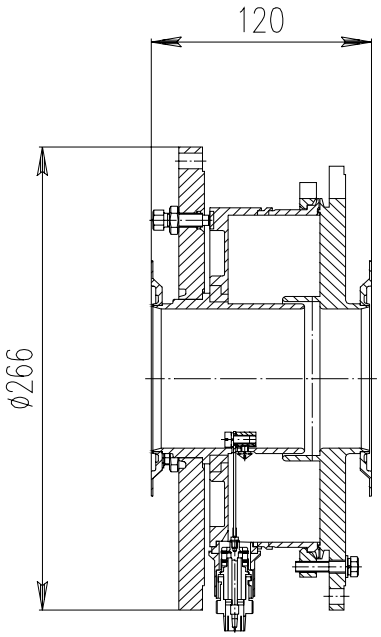

Figure 2: Kicker cavity.