The Low Level System for the ELETTRA RF Plants

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Abstract

The four RF plants of the ELETTRA storage ring are driven by the reference RF signal derived from the machine master oscillator. Each RF plant will operate with three active loops controlling the tuning of the cavity and the phase and amplitude of the gap voltage. The complete feedback loops are described here and the results of bench tests are given.

1. INTRODUCTION

A mechanical tuning loop, a fast phase loop and an amplitude loop will ensure the required stability condition for the ELETTRA cavities operation. In the following sketch a general layout of the logical allocation of the control loops is given

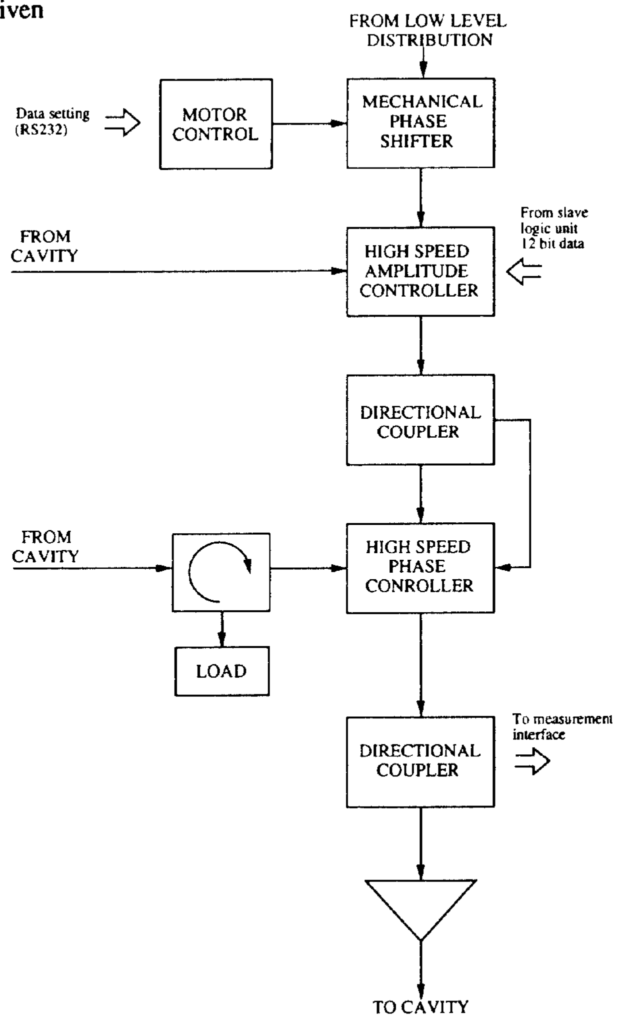


Fig. 1 Block diagram of the RF plant control loops

The complete set of these control loops has been built and each one has been deeply tested. The final tests of the fast phase feedback loop and the detailed study of cross talk interaction among the different loops will be performed in the very next months.

We give here a list of typical response times and regulation accuracies.

2. MECHANICAL TUNING LOOP

The structural description of the loop is shown in fig. 2 and its operational behavior has been described [1].

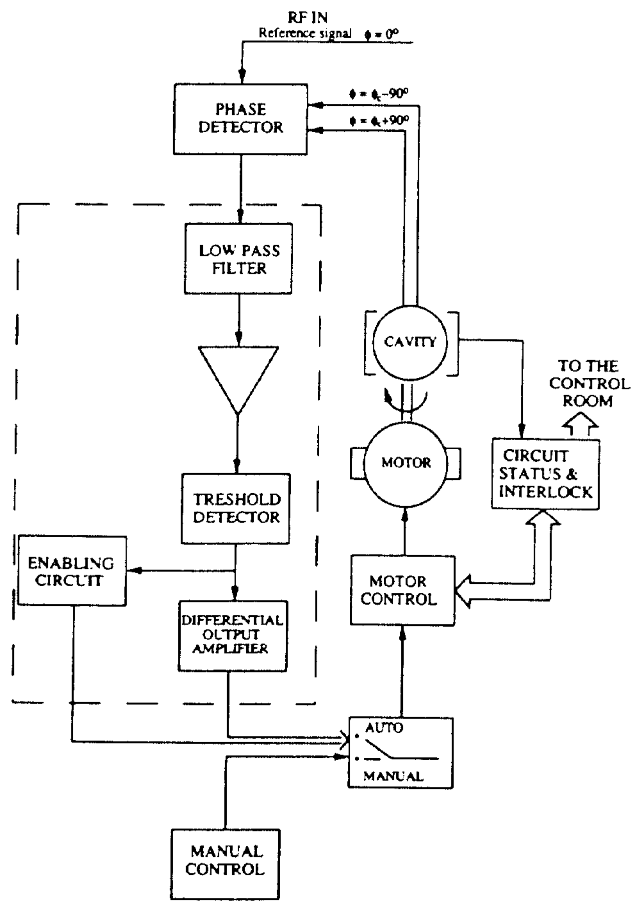


Fig. 2 Block diagram of the mechanical tuning loop

The cavity tuning, which is obtained changing the axial length of the cavity [2], can be controlled both manually and automatically. The working conditions of the loop are remotely transferred to the control room.

The velocity of the loop has been raised to a correction speed of 500 Hz/sec with respect to the previous design (200 Hz/sec), in order to ensure a proper tuning control during the RF plant start up procedure and to avoid interaction with the temperature control loop.

3. Fast Phase Loop

A block diagram of the fast phase loop is shown in fig. 3.

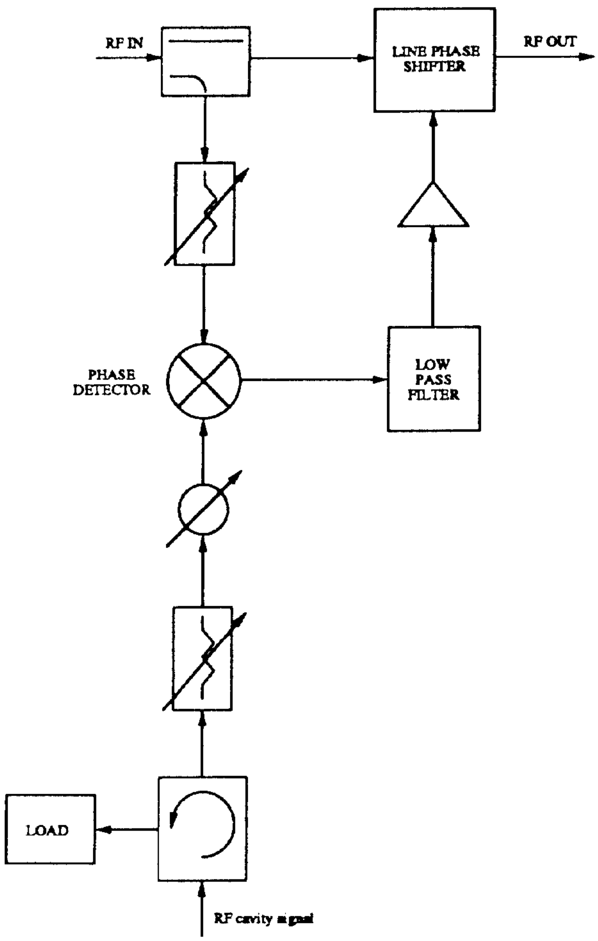


Fig. 3 Block diagram of the fast phase loop

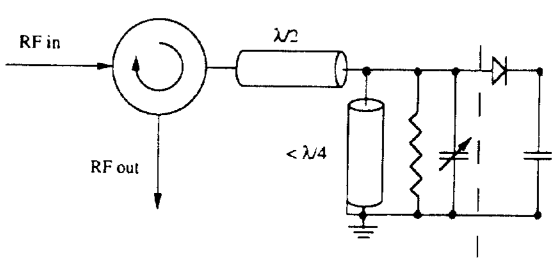


Fig. 4 Schematic drawing of line type phase shifter

After some unsatisfactory tests on avaiable commercial phase shifter it has been decided to develope a line type phase shifter. According to this, a phase shifter based on a quarter wavelength resonant coaxial line properly connected to a circulator has been selected (see fig. 4).

This configuration has shown a satisfactory constant RF attenuation in the range of operation, which is ±20 degree, as it can be seen from the table 1. Moreover the phase variation speed has been improved and the amplitude modulation of the radiofrequency signal has been prevented .

Table 1
Phase shifter characteristics

Dephasing (degrees)	Attenuation (dB)
21.3	- 1.40
15.5	- 1.44
8.9	- 1.48
4.5	- 1.51
0	- 1.53
- 3.1	- 1.54
- 7.5	- 1.57
- 12.1	- 1.59
- 16.8	- 1.61
- 22.1	- 1.63

The preliminary bench measurements have reported an open loop gain of about 30 dB with a phase margin of more than 50 degrees.

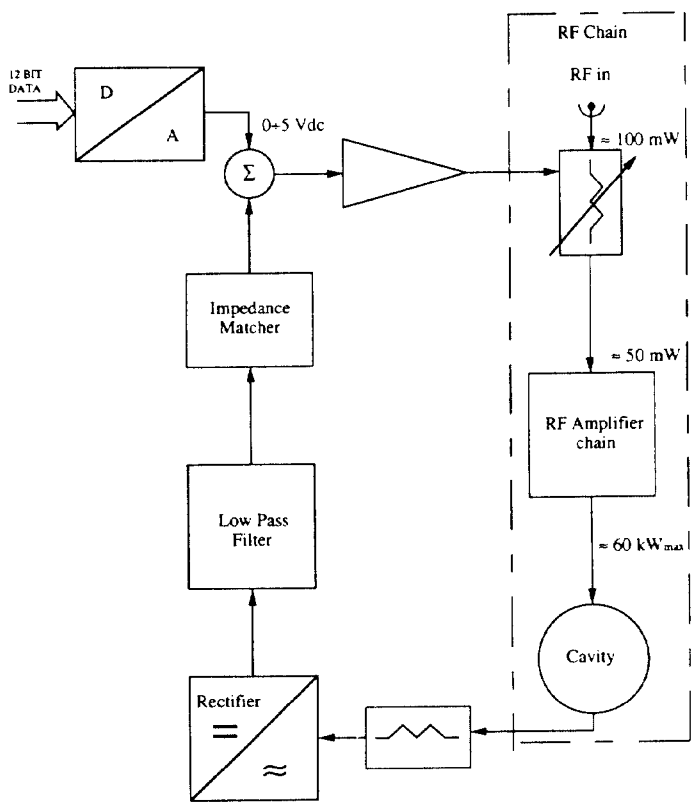


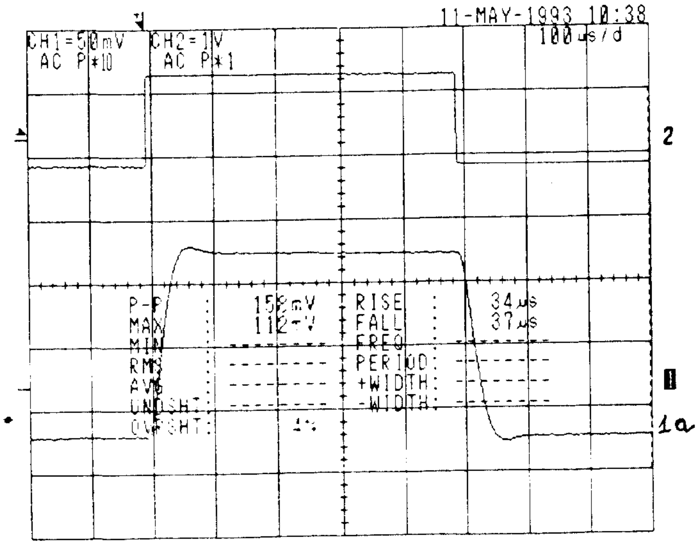
Fig.5 Block diagram of the amplitude loop

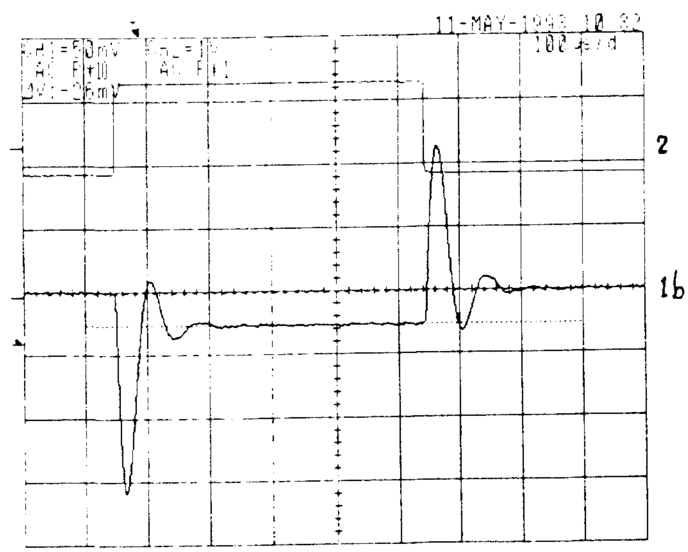
4. AMPLITUDE LOOP

In fig. 5 a definitive sketch of the cavity voltage amplitude loop is shown.

The rectified signal from the cavity should be connected through a long distance cable to the regulating chain. To overcome this problem, an impedance matching circuit driving a 100 Ω low attenuation cable has been used. The signal error between the cavity voltage and the reference analog input drives a commercial variable attenuator to set the RF attenuation to the proper value by means of an amplifier with voltage gain of 50.

The variable attenuator provides the fine regulation of the signal amplitude. This device has been tested. The attenuation resolution of this device at 20 dBm of RF input power is 0.05 dB in the range of 30 dB. Its phase variation in the full range of attenuation is better than ±1.5 degree.





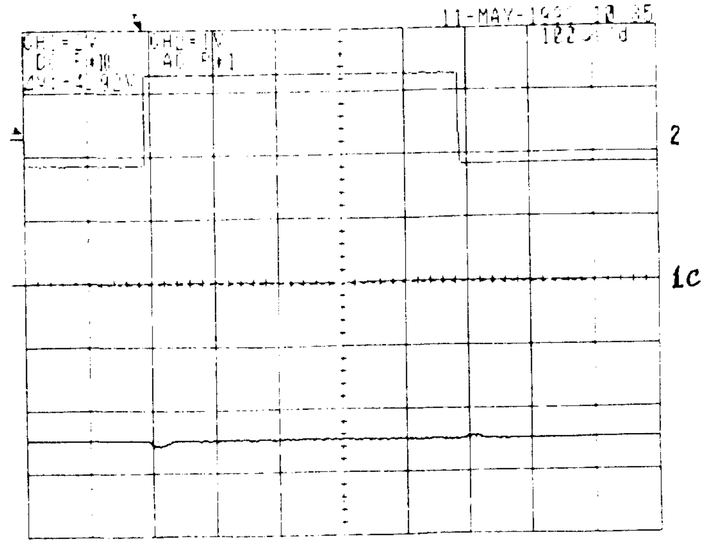


Fig. 6 Waveform 2: modulating signal
waveform 1a: feedback signal- imp. matcher input
waveform 1b: error signal - RF rectifier output
waveform 1c: DC level of the modulated signal RF rectifier output

In the scope plots (fig. 6) the response of the feedback loop to 20 % amplitude modulated signal by a square wave modulation is shown. Similar results can be obtained in the presence of a phase modulation.

As can be seen the typical response time is about 50 µsec with a precision of the regulated value better than 0.6 %.

5. CONCLUSION

The reliable and efficient operation of the different loops, which we consider satisfactory, cannot be separated from the complete RF plant characteristics, in order to have an efficient control of the whole RF cavity parameters. For this reason the definitive parameter configuration of the ELETTRA RF low level system will be set after the tests on the whole system will be performed.

6. REFERENCES

[1] A. Massarotti et al., "Status Report on the ELETTRA R.F. System", in Proceedings of the 4th EUROPEAN PART. ACC. CONF., Berlin, Germany, March 1992.

[2] A. Massarotti et al., "500 MHz Cavities for the Trieste Synchrotron Light Source Elettra", in Proceedings of the 2nd EUROPEAN PART. ACC. CONF., Nice, France, June 1990, pp. 919-921.