A MICROPROCESSOR BASED CONTROLLER FOR SUPERCONDUCTING RESONATORS

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On the basic operating principle of the resonator controller developed as collaboration between the Weizmann Institute of Science and SUNY at Stony Brook [1],[2] and now in operation at the Seattle University LINAC, a new resonator controller has been developed, having in mind, as primary goals, the compactness, the self-test capability and the independence from the host computer architecture.

The controller is intended to operate in a self-excited loop configuration; in other words the controller, an external amplifier and the resonator itself form a closed loop that oscillates at a frequency determined essentially by the cavity parameters. The self oscillation condition is met, provided that the total gain is greater than 1, by changing the phase shift along the loop until a multiple of 360 degrees is reached; a limiter inserted in the RF strip avoids the signal saturation.

Controlling the resonator means to keep the amplitude of the oscillations at a constant level and their phase locked to an external reference; this is done by using a complex phasor modulator, whose inputs are driven by the amplitude and phase error signals. As shown in the figure, the amplitude error is obtained by rectifying the RF signal and comparing it with a constant reference, the phase error is obtained by means of a double balanced mixer, where the input ports are fed with the loop oscillation (through a directional coupler) and an external reference signal. The variable attenuator at the RF input allows to operate at a constant power in the RF strip with different field levels in the resonator.

Even if there are significant modifications in the RF section with respect to the Weizmann/SUNY version, (for example the limiters are now active devices, the loop phase shifter - that had a limited shift range - has been substituted by a full 360 degrees device and a second phase shifter, that was inserted between the reference input and the balanced mixer, has been removed from the board), the major changes in the new controller concern with the computer control philosophy.

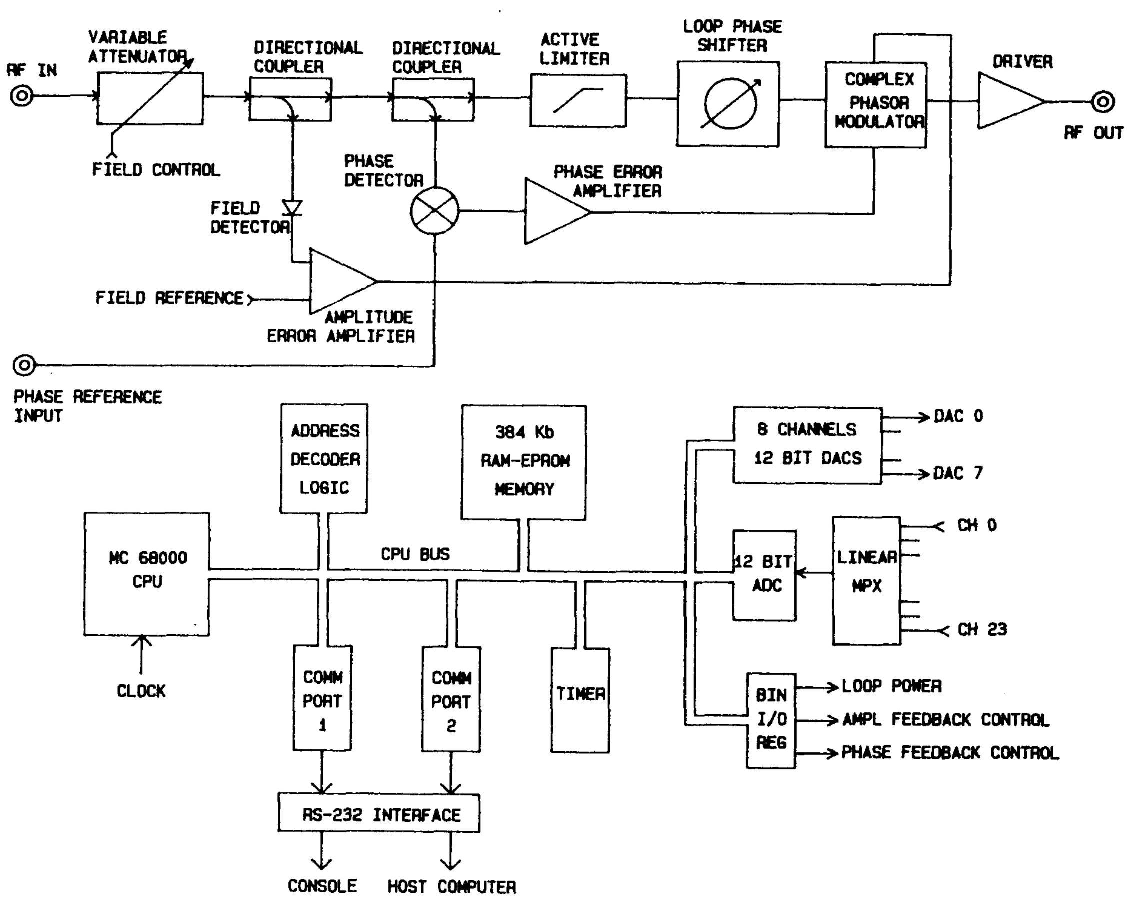
The control of the RF section requires both D/A channels (to setup the loop phase shifter, the input attenuator and the quiescent power level) and A/D channels to monitor the output of the error amplifiers; moreover few digital I/O bits are necessary to enable the loop oscillation and the feedback operation either in the amplitude and phase branch.

In the old control philosophy all these signals were supplied by an external computer through dedicated interfaces and cables; the basic idea of the new controller is to implement a microprocessor on board with all the circuitry (A/D, D/A and digital I/O) necessary to control the RF section . This solution sharply reduces the number of the connections with the external world, improves the reliability and makes the controller independent from the type of host computer. The host communication is accomplished via a general purpose RS232 interface; this isn't a serious bottleneck from the point of view of the response speed because the communication between the controller and the host computer consists essentially in a trasmission of commands and in a read-back of parameters just for monitoring purpose: in fact the phase and amplitude lock is guaranteed by the fast analog section of the controller and all kind of feedback is internal to the board.

The microprocessor is a MC68000 with 384k of RAM/EPROM ; 8 D/A and 24 multiplexed A/D channels with 12 bits of resolution are included on the board. Over the basic settings, the new controller allows the automatic zeroing of the offset of the phase error amplifiers, the monitoring of many test points of the low frequency section for diagnostic purposes and the self test of the analog I/O devices. The control firmware (written in Pascal language) runs under a ROM-based VERSADOS operating system.

[1] I. Ben-Zvi: Superconducting Linacs used with Tandems -N.I.M. 220/1984

[2] I. Ben-Zvi et al.: The control and electronics of a superconducting booster -N.I.M. A245/1986



RESONATOR CONTROLLER BLOCK DIAGRAM