COMPUTER CONTROL FOR AVF CYCLOTRON OF RESEARCH CENTER FOR NUCLEAR PHYSICS

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INTRODUCTION: The AVF cyclotron of Research Center for Nuclear Physics (RCNP) is controlled either by manual operator console with digital settings of operation parameters or by a computer. Initially controls of many devices are performed manually, but computer is partly used to monitor and display cyclotron status, log and display operational history and preset operational parameters.

DIGITAL CONTROL SYSTEM: Stepping motor actuated potentiometers are used for setting of all power supplies. Stepping motors are also used to drive ion source, puller, phase slits, deflectors and beam probes. There is a 128-word core memory in a digital control system, and previous values of setting parameters are stored in the memory. This system consists of eight blocks and each block has 16 devices driven by stepping motors. If one device in a block is selected, the content of the corresponding memory address is loaded to a counter which is used to count number of pulses for stepping motor. After setting the number of pulses to the register by computer, the stepping motor is driven until the content of the counter gets equal to that of the register. Each block has a register and a counter for stepping motor drive, and can drive each stepping motor independently. Eight stepping motors are driven simultaneously, and 128 devices are controlled by this system. In the case of manual operator console thumbwheel switches are used instead of registers. When an operator selects one device by pushbutton, the counter is connected to the thumbwheel switch and the device can be controlled manually.

COMPUTERS: The control computer is PDP 11/40. It consists of 32 k words of core memory, a typewriter, three 2.4 M byte cartridge disk units, a high speed paper tape reader and puncher, a 17-in. refresh type graphic display with a light pen, and a 19-in. storage-tube type graphic display with a hard copy unit. PDP 11/40 is connected to a host computer TOSBAC 5600/120. It has 128 k word memory, a card reader, a line printer, two 100 M byte disk units and two magnetic tape units.

CYCLOTRON INTERFACE: The linkage from the computer PDP 11/40 to the cyclotron control system is through two general device interfaces (DR11-C) and subsequent decoders, registers, multiplexers and ADC's. The interface DR11-C has a control status register, an output buffer register, and an input buffer register. The computer writes 4-bit command, which specifies the type of operation, and 12-bit output data or address of devices in cyclotron to the output buffer register, and controls the device or reads corresponding data and status from the input buffer register. Contact closure output signals (up to 256) are used for the operations of power supplies. They are used to select power supply polarities and to switch on them. Contact sensor input signals (up to 768) are used to monitor the operational status of the devices. High resolution analog data (up to 16) are ADC readings acquired from the main field of cyclotron magnet, dee voltage and deflector voltages. Medium resolution analog data (up to 128) are also ADC readings from coil currents, power supply voltages and currents, and beam currents. For the setting of the frequency synthesizer which drives the RF system a 32-bit output register is used.

SOFTWARE: A disk-oriented foreground-background monitor of RT-11 (a Real Time monitor) is used for the cyclotron control. The FORTRAN language is used for the initial program development, but it is desirable to use assembler language to save memory and execution time. By using an 8 by 2 pushbutton matrix in console box any one of 64 programs may be selected after some modifications of monitor. A library of operation parameters for various ions and energies will be kept on the disk. Before start-up the operator will select a set of parameters from the library, or the operator may enter parameters such as ion and energy. The logging program will write the data on a disk file and send them to TOSBAC 5600/120. For detailed beam orbit analysis TOSBAC 5600/120 will be used on line from PDP 11/40.

STATUS OF THE CONTROL SYSTEM: The computer and accelerator interface have been installed before this spring. Trim coils are operated using the computer control. Many devices are now under manual control, and they are in the stage of program development and operational tests of computer controls.

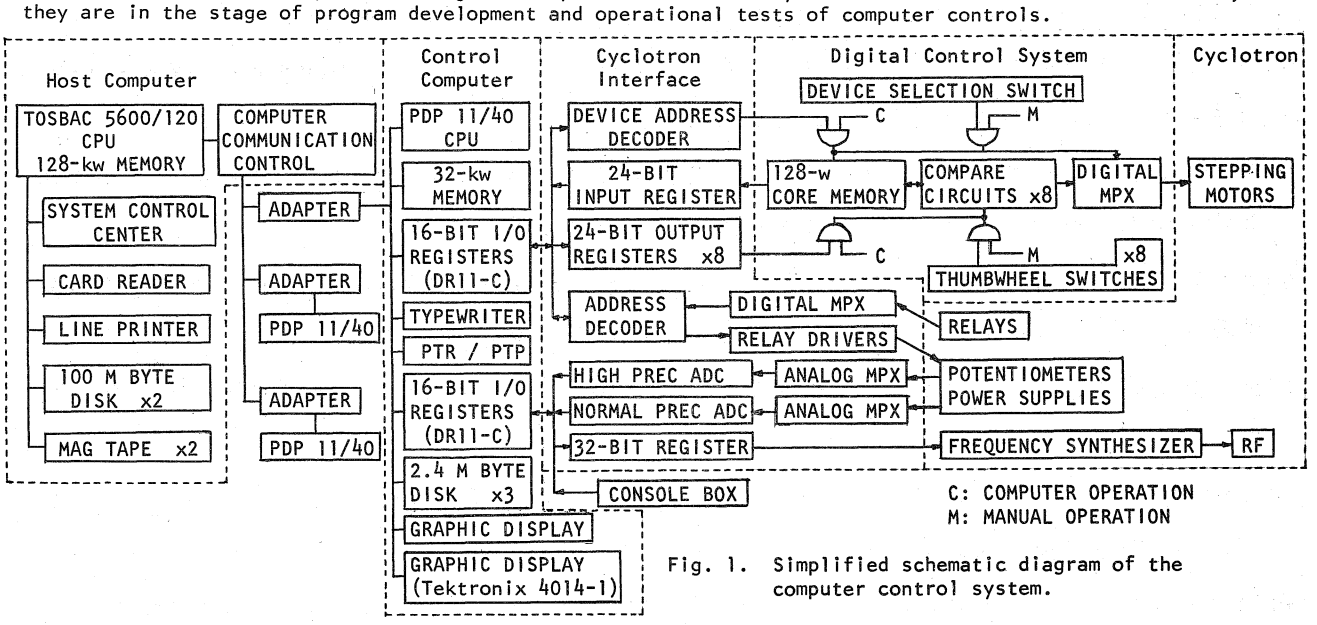

Fig. 1. Simplified schematic diagram of the computer control system.