Motion Control System for the Fermilab Electrostatic Septa

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Abstract

For many years the intensities of the proton beams going to the various experimental areas of the Fermi National Accelerator Laboratory were controlled by moving the beam relative to the wires of the electrostatic septa splitting stations. A change in this basic philosophy was made previous to the last fixed target run at Fermilab. We now have a system that moves the septa relative to the stationary beam. Magnets are no longer adjusted while changing split ratios. This has resulted in less tuning of the beam lines downstream of splitting stations. As many as ten, ten foot long electrostatic septa have been moved simultaneously while maintaining alignment to within a mil.

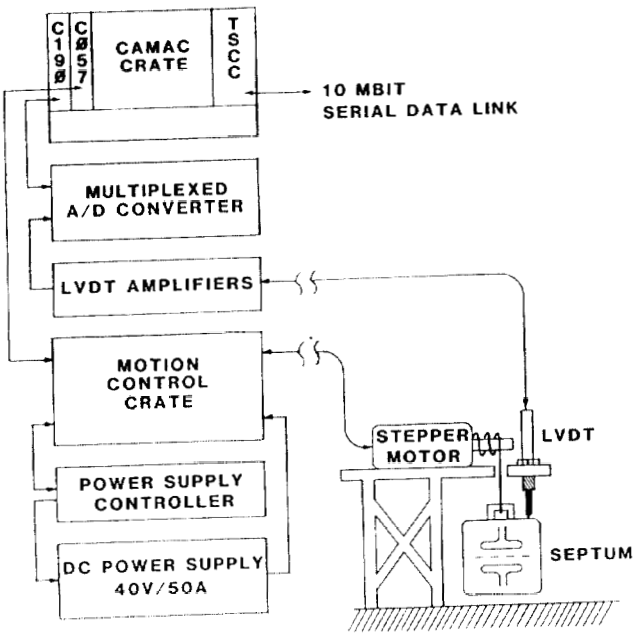

Figure 1
Motion Control System Block Diagram

Motor Drive System

Each ten foot long electrostatic septum moves in a direction perpendicular to the wire plane. In order to do this, one stepper motor with gearing and one linear variable differential transformer (LVDT) is mounted on each end of each septum. All septa in a splitting station are moved simultaneously when changing splits.

Each motor drive system consists of up to sixteen motor drive cards (one for each motor), one interface card, one LVDT conditioning and readback chassis, one d.c. power supply and controller.

For most septa stations the motors and gearing are such that eight steps will move the septa 0.001 inch.

The motor drive cards use switching transistors to produce the required step sequence for the motors from the output of the d.c. supply.

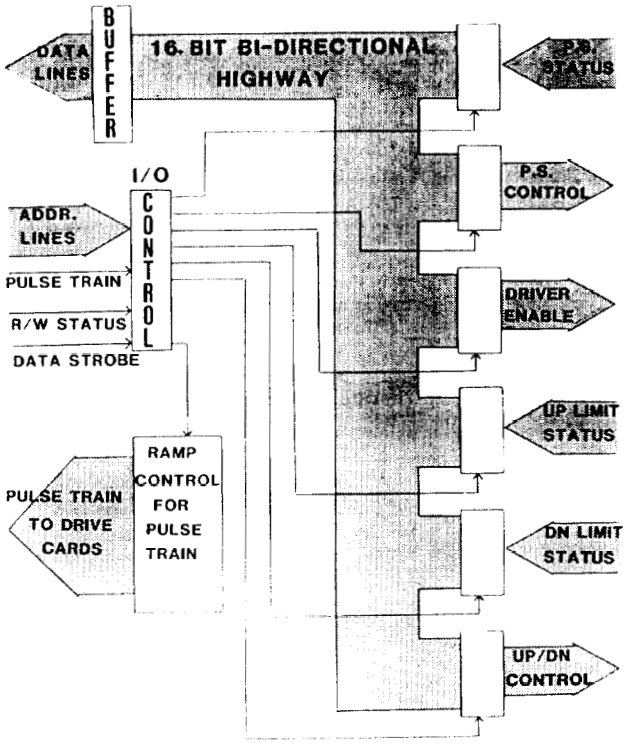

Figure 2
Crate Interface Card Block Diagram

Position Readbacks

The readbacks are Schaevits linear variable differential transformers using the same electronics which were designed for the Tevatron refrigeration control system.[1] They use a single 3 kHz oscillator to drive the primaries of up to sixteen LVDT's. The position outputs are read back through the Tevatron control system multiplexed analog to digital converters.

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Controls Interface

The camac 057 card interfaces to the controls system so that the septa positions are changed in the same manner as any generic Tevatron control system[2] device.

The 057 card uses a Zilog Z8000 microprocesor to interface between the camac system and the motor drive crate. The data is transferred using sixteen bi-directional data lines and six address lines. The step rate may be changed from 1 Hz to 10 kHz and up to 32767 steps can be sent at one time.

There is also a separate applications program for diagnostic purposes. Through this program, the pulse rate can be varied and the number of steps remaining can be monitored as well.

Results

Presently there are eight splitting stations in the Fermilab switchyard. Two of these will be run for the first time during this year's fixed target run. The splits can now be changed easily through the entire two inch range during the time between beam pulses to within a mil of the desired location. The motion control systems have been so successful that the systems have also been used to move the low beta quads for the Tevatron as well as various collimators, targets, and the lenses for the low beta quad alignment system.

References

[1] Zagel, J.R. et.al., Tevatron Satellite Refrigeration Control Subsystem, IEEE Transactions on Nuclear Ssience, Vol. NS-28, P. 2153, 1981.

[2] Bogert, D. et.al, The Tevatron Control System, IEEE Transactions on Nuclear Science, Vol. NS-28, p. 2204, 1981.