High-Voltage Control for 400-kW Transmitter

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This article describes a high-voltage control unit, whose function is to bring the high voltage to a required level, provide voltage regulation, and reduce beam modulation.

I. Introduction

A second-generation high-voltage control panel has been installed in the 400-kW transmitter subsystem at DSS 14 and DSS 13, replacing the original control panel. The primary reason for replacing the original control panel is that it required extensive troubleshooting, and replacement of parts required that the operator unsolder the component to be replaced.

The second-generation control panel utilizes current solid-state devices with electronics parts either mounted on printed circuit boards or plug-in modules so that repairs and/or troubleshooting are reduced to substitution of boards or modules by the operator.

II. Design Requirements

Requirements for high-voltage control of the 400-kW klystrons used at DSSs 13 and 14 call for a stable reference voltage to drive the generator field power supply, closed-loop regulation, and the ability to compensate for low-frequency modulation caused by the rotating machinery used in the beam voltage system for power generation.

III. Description of Control Unit

The high voltage control panel achieves a stable reference voltage with a motorized potentiometer and a +70 Vdc power supply whose regulation is ±0.5%. The motorized potentiometer is connected across the +70 Vdc power supply, with the wiper connected to a solid-state error amplifier which consists of a voltage follower and a variable-gain single-ended amplifier. Control of the motorized potentiometer is achieved by switching the phases of the 400-Hz power to the driving motor with +28 Vdc-controlled relays. These relays enable the operator to position the potentiometer by the use of push buttons located on another panel in either the local or remote control console.

The voltage follower of the error amplifier portion of the beam control unit has two inputs; one is from the motorized potentiometer discussed above, and the other is from a high-voltage divider located in the crowbar cabinet of the 400-kW transmitter subsystem. This voltage divider is connected directly to the beam voltage applied to the klystron, and has a ratio of 1000:1. The feedback voltage from the divider is opposite in polarity to the voltage from the motorized potentiometer. The two voltages are applied to the voltage follower, whose inputs form a summing point. The difference in inputs is then applied to the variable-gain amplifier. This stage amplifies the difference voltage and sends this error voltage to the generator field supply. Voltage regulation is achieved by the difference in the two input voltages; that is, any change in beam voltage is opposed by the error amplifier. The tightness of regulation is controlled by the gain of the error amplifier, and is adjustable.

The high-voltage control has two modes of operation. One is the normal mode in which the magnitude of beam voltage is controlled by the motorized potentiometer, and to decrease the beam voltage to zero the motorized potentiometer must be activated. The second mode, which is called the programmed mode, allows the operator to set the operating point of the beam voltage and then, by either manual or computer operation, raise or lower the beam voltage from zero to the operating point. In this mode the motorized potentiometer, once it has been set, does not move.

Compensation for modulation introduced by the rotating machinery poses a particular problem. The normal frequency response of the beam voltage system is approximately 1.5 Hz with maximum modulation present at 5 to 25 Hz. To compensate for this, a lead circuit is installed in the feedback path so that at the modulating frequencies, the error voltage is greater than normal. This increase in error voltages forces the system, with a much greater output variation of the error amplifier, to correct for the modulation. With the use of the lead circuit a nominal decrease in modulation of 65 to 75% is achieved over the noncompensated loop.

IV. Summary

The high-voltage control utilizes all solid-state devices, mounted on printed circuit boards. The motorized potentiometer is modulized for ease of replacement. This along with the printed circuit board replacement capability, requires a minimum of maintenance by the operators, and repairs are made by module replacement at the field level.

V. Future Plans

Another unit is to be installed in the operational time sync (OTS) transmitter subsystem at DSS 13. The unit will also be installed in the overseas 100-kW transmitter subsystem used in the 64-m subnet.

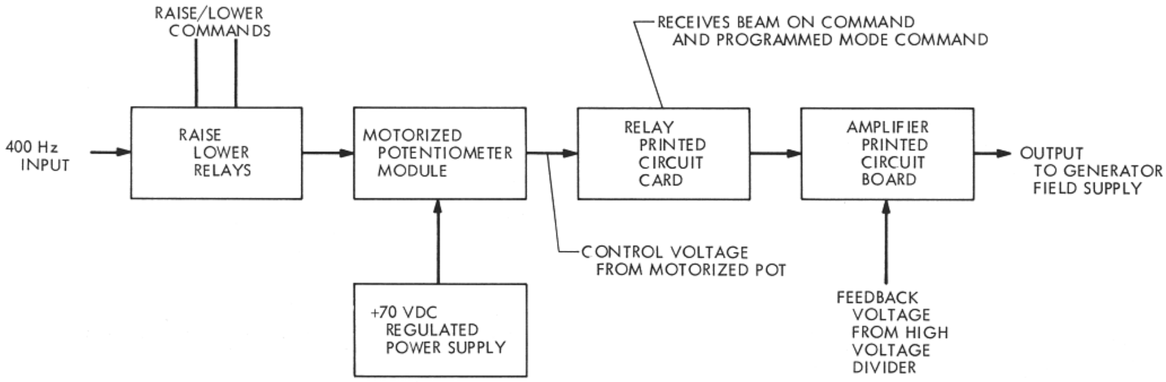

Fig. 1. Block diagram of high-voltage control panel

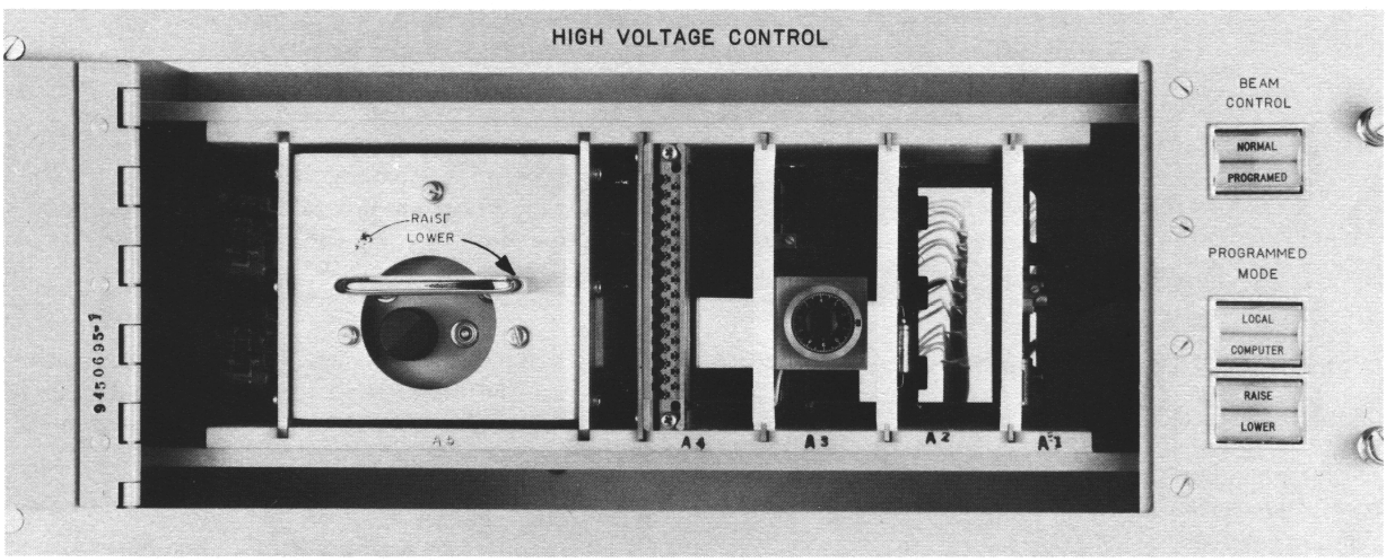

Fig. 2. High-voltage control panel installed at DSSs 13 and 14