X-Band Waveguide Switches

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To accommodate the X-band frequency requirements of the Deep Space Network, new microwave components, including high-performance waveguide switches, are being developed. Waveguide switches in the new WR-125 waveguide size are presently being evaluated. Progress to date in prototype and pre-production model development is described in this article.

I. Introduction

To accommodate the X-band frequency requirements of the DSN, new microwave components are being developed. One of the critical components is a high-performance waveguide switch. Because of its size, the highly reliable drive system used at S-band, consisting of a DC motor driving a worm cam and follower plate, cannot readily be used for the much smaller and lighter X-band switch.

During the development of the S-band switch, many drive mechanisms were tested and discarded as unreliable, including solenoids and ordinary geneva drive mechanisms. Since that time, several new switch drives have evolved, including the DC stepping motor developed at JPL, the so-called Sector Motor drive developed by Logus Corp. of New York, and the Transactor drive developed by Transco Products, Inc., of California. Each of these drives has been examined for its relative merits and limitations.

The JPL stepping motor may be the most precise and reliable, but it is complex and expensive. Though the designs are fundamentally distinct, the Logus and Transco drives are similar to each other in the sense that each is very simple and uses minimal linkage between the motor and switch rotor.

As a result of a competitive procurement, Logus was awarded a contract to develop a copper waveguide switch in the WR-137 waveguide. This prototype switch pioneered the use of a water-cooled rotor with stationary input and output connectors without the possibility of an internal leak due to a rotary joint.

II. Production Switches

As a result of favorable testing of the WR-137 waveguide switch, another contract was placed with Logus to deliver three pre-production WR-125 waveguide switches using the same drive motor and water-cooling system. These switches have now been delivered, and one is shown in Fig. 1.

The motor drive has a manual override, seen as a black knob on the top of the motor (the part with the identifying label). This allows the switch to be activated by hand if

AC power is not present. Markings on the knob also provide visual evidence of the switch position, a very useful feature in the field. The entire drive motor, microswitch plate, and actuator linkage can be removed from the switch in one piece and replaced with a spare drive without affecting waveguide pressurization.

The water connections for the rotor can be seen at the bottom of the switch. The water is fed through a stationary tube into a cylindrical coaxial passage in the rotor. The water flows out of the open end of the tube back up the rotor passage, cooling the rotor in the process. The rotor has an extension that brings the water outside the waveguide area through the center of the bearing. A seal keeps the water within the auxiliary housing on the bottom of the switch, where it is removed by the off-center connector. Should the seal develop a leak, the water will exit the slots between the auxiliary housing and the switch stator, preventing the water pressure from forcing water into the waveguide past a second seal that maintains gas pressure within the waveguide.

The voltage standing-wave ratio (VSWR) of the switches over a wide band is shown in Fig. 2. The effect of manufacturing and assembly tolerances can be seen in the variation between the two units. It has been learned that a very small dimensional change in the rotor will flatten the VSWR to under 1.03, and this change will be incorporated in the production models.

The isolation of the switch is shown in Fig. 3. Some adjustment may be made in the production models to shift the maximum isolation area over to 8.5 GHz, a principal operating frequency. However, the isolation even at its lowest point exceeds 95 dB.

Acknowledgment

The assistance of G. S. Palecki in providing the measurement data is gratefully acknowledged.

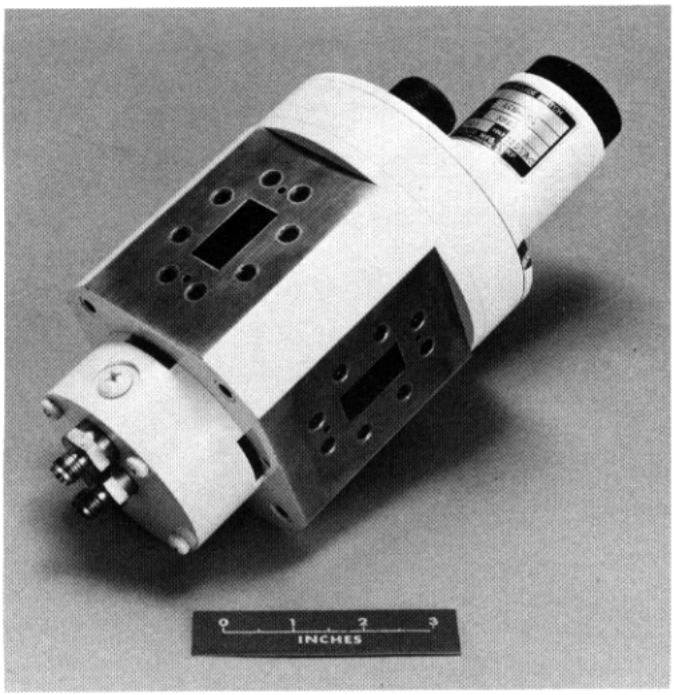

Fig. 1. Waveguide switch

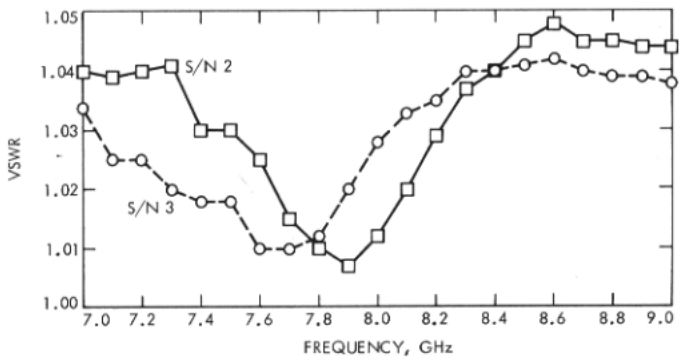

Fig. 2. VSWR vs frequency for prototype WR-125 waveguide switches

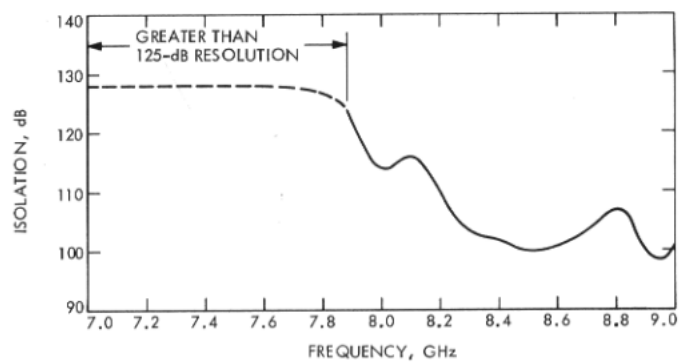

Fig. 3. Isolation vs frequency for WR-125 waveguide switch S/N 3