Adjustable Tuner for S-Band High-Power Waveguide

J. R. Loreman
R. F. Systems Development Section

As part of an effort to reduce the DSN transmitter backpower at DSS 14, an adjustable S-band waveguide tuner for use at 400 kW has been developed. The tuner will be used to improve the match of the transmitter waveguide to the antenna feed system at DSS 14 in an effort to reduce transmitter back power at certain operating frequencies caused by high voltage standing wave ratio (VSWR) in the feed.

Because of various waveguide modifications to the transmitter waveguide run at DSS 14 (Ref. 1), the waveguide match of the run has changed, causing high transmitter back power. Measurements have been conducted in an effort to determine the corrective measures required (Ref. 2). The measurements, as well as reports by operating personnel, indicated that the S-band polarization diversity (SPD) cone configuration in particular requires an effort to reduce back power at certain operating frequencies. Figures 1 and 2 show the voltage standing wave ratio plot of the waveguide from the DSN transmitter through the SPD cone in right circular polarization (RCP) and linear polarization. Calculated back power for each VSWR has been included on the charts.

Further measurements have been made at DSS 14 to determine the effect of a waveguide tuning section on the VSWR. The tuning section used was a low-power broad wall vane type tuner and, though not of a design applicable to high microwave power, its characteristics approximate deflection of the broad waveguide wall, a technique frequently used for tuning of high-power waveguides. Figure 3 shows the match at low power through the SPD cone in linear polarization, with the tuner at the transmitter input to the waveguide. The effect on the VSWR with respect to frequency is apparent when this figure is compared with Fig. 2. From the testing, it was apparent that a simple tuner based on the controlled deflection of the waveguide broad wall would probably have sufficient tuning effect to reduce the VSWR of the SPD cone configuration to approximately 1.12 across the band of 2110 to 2120 MHz. The advantages of such a tuner are simplicity; direct application to the high-power configuration, as the tuner could be easily water-cooled; small size, as no auxiliary cavities would be required; and simple mechanical design. The main disadvantages are felt to be a limited frequency effect and limited retuning capability due to work-hardening of the copper waveguide. Both of these disadvantages may be crucial to the acceptability of such a simple design, as the changing of any one of the major reactive components in the waveguide run or cone will require retuning, and the complex nature of the mismatch may require several tuners of this type. For these reasons, a parallel tuner development based on the coupling of a waveguide section to an adjustable cavity through the narrow wall is being pursued (Ref. 3).

Based on a simple waveguide broad wall deflection scheme, a prototype adjustable tuner has been designed and fabricated (see Fig. 4). The broad walls have been machined to approximately 0.25 cm to minimize work-hardening of the copper wall, and water-cooling ducts are provided on both narrow walls. The mechanism allows bidirectional deflection of both waveguide broad walls. Waveguide structural rigidity is provided by both the water-cooling ducts and the stainless steel deflection bars. Laboratory tests indicate that the tuner can be adjusted from a VSWR of 1.01 to 1.15 up to four times before the copper waveguide walls begin to visually show work-hardening. Thus, it appears more tuning flexibility may exist than was expected. The prototype tuner has been operated at a power level of 400 kW for several hours with no heat buildup on the thinned broad walls of the waveguide. It appears that the tuner at its present level of development may be operationally installed. Several additional tuners have been fabricated, and one tuner will be installed at DSS 14 in the 400-kW radio science transmitter waveguide run to the SPD cone in January 1974. Based on the results of this installation, the tuner may be installed in the DSN high power transmitter waveguide run on an interim basis.

References

1. Leu, R. L., "X-Band Filter," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XVI, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1973.

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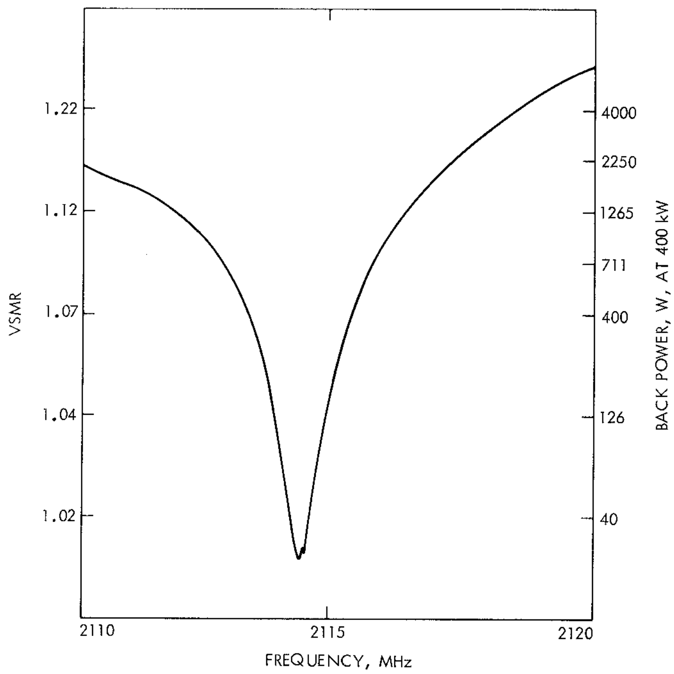

Fig. 1. VSWR 400-kW transmitter through SPD cone (RCP)

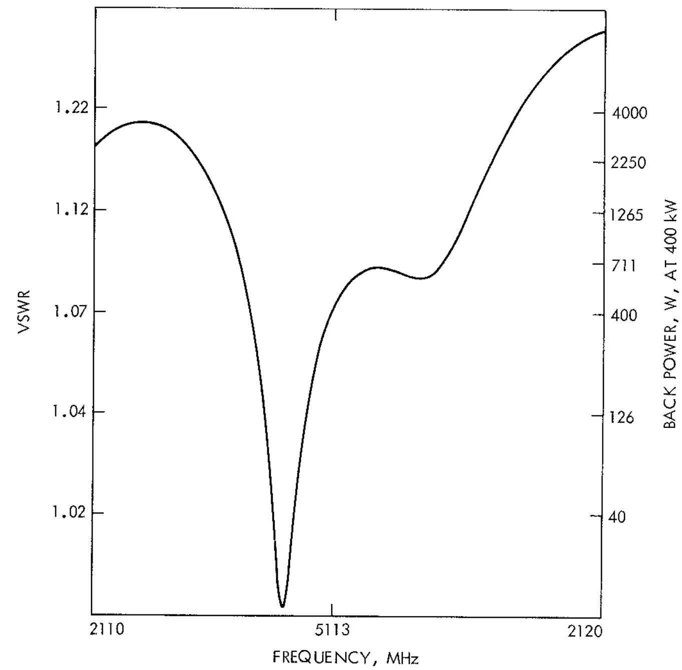

Fig. 2. VSWR 400-kW transmitter through SPD cone (linear polarization, 359 deg)

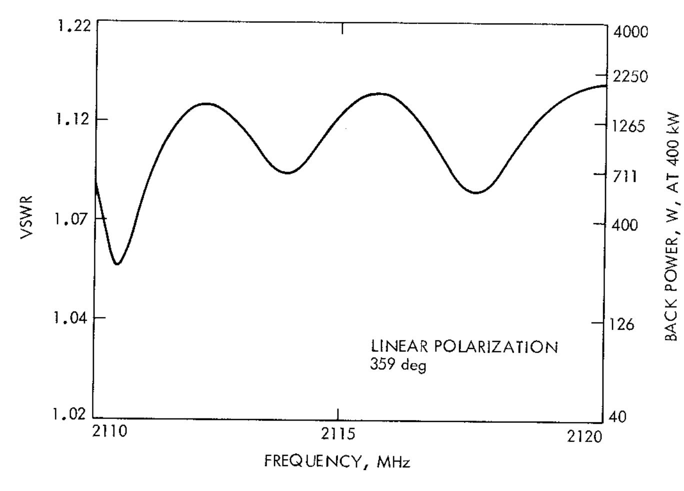

Fig. 3. VSWR 400-kW transmitter through SPD cone, vane-type tuner installed

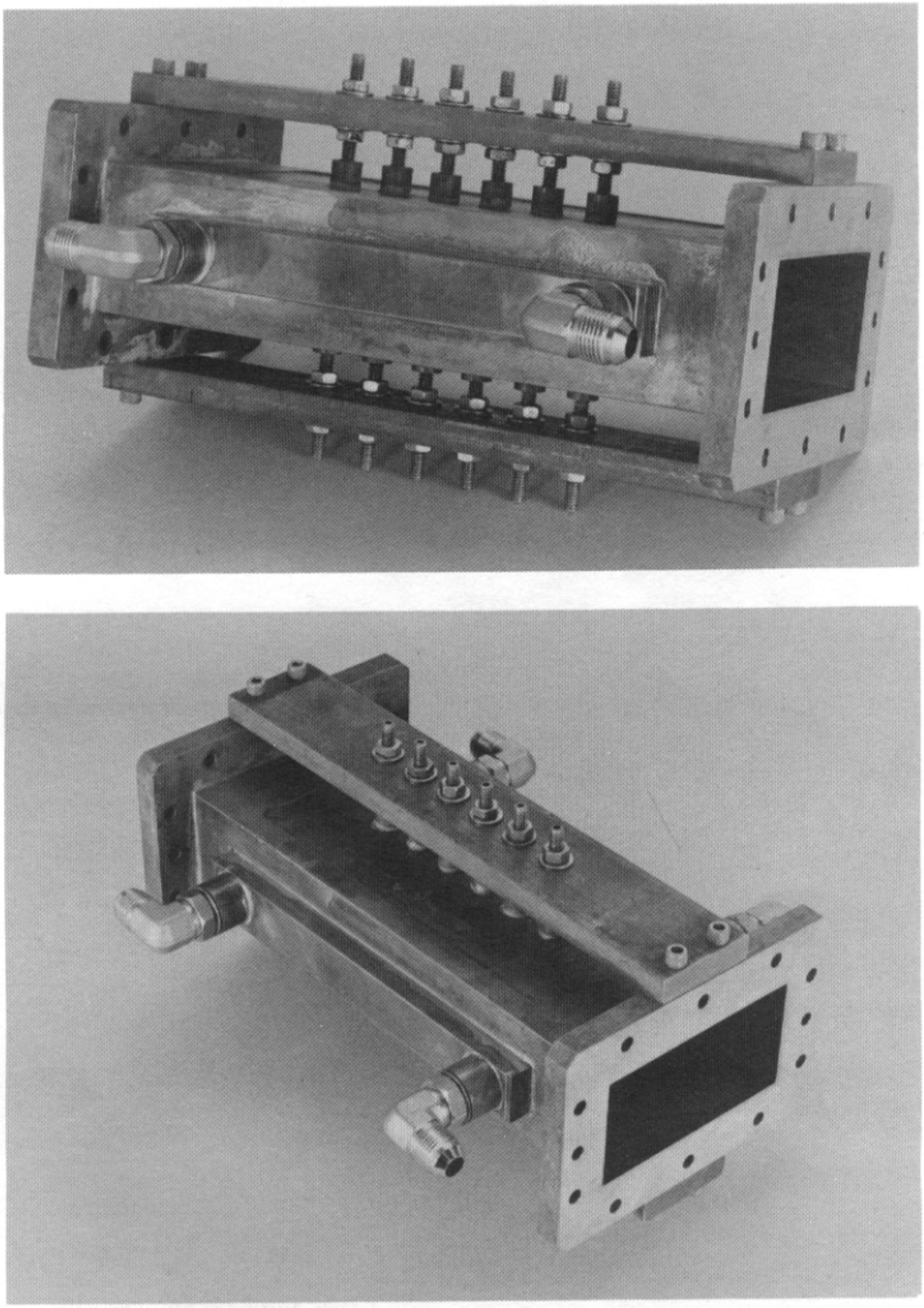

Fig. 4. Two views of prototype adjustable tuner for S-band high-power waveguide