New X-Band Antenna Feeds for the DSN 64-Meter Stations

R. Hartop
Radio Frequency and Microwave Subsystems Section

New X-band antenna feed assemblies with dual-polarization capability are being implemented in the DSN 64-meter stations. Together with dual X-band travelling wave masers, they permit the simultaneous reception of right- and left-hand circular polarization from the Voyager spacecraft. The new feed also includes a dual hybrid mode feedhorn which increases the antenna gain by 0.36 dB over the present feedhorn.

I. Introduction

The X-band feed cone assembly (Ref. 1) on the DSN 64-meter antennas provides the capability for selectable right-hand (RCP) or left-hand (LCP) circular polarization (Ref. 2). Originally designed to work with a single travelling wave maser (TWM), the XRO cone assembly has recently been upgraded to include dual TWM's (Ref. 3). As part of that reconfiguration, provision was made for a new feed assembly, the Mod III XRO, that would include two basic improvements over the feeds that have been in use since early 1977. The first improvement is the development of an orthogonal-mode transducer that permits simultaneous reception of two different polarizations. The second improvement is the incorporation of a dual hybrid mode feedhorn (Ref. 4) to increase the antenna gain.

II. The Mod III XRO Feed Assembly

The new feed assembly is shown in Figs. 1 and 2. It is designed to mount within the XRO cone assembly on the same circular mounting plate as the previous (Mod I and Mod II) feeds, so that replacement in the field is expedited. Each output arm of the orthogonal mode transducer has its own waveguide switch for TWM calibration. One of the precision ambient terminations may be seen at the bottom of the feed assembly.

The new orthogonal-mode transducer is shown in Figs. 3 and 4. The unit is based on a design by Microwave Development Laboratories, developed under contract to JPL, with the final units fabricated by the electroforming process. The unit has an isolation of 35 dB or better over the frequency band of 8400 to 8500 MHz, with the return losses shown in Table 1.

III. Noise Temperature Measurements

Using a vertically oriented single hybrid mode (corrugated) horn on top of a TWM for reference, the noise temperature contribution of the Mod III XRO feed was determined in ground tests. By disconnecting the reference horn at the TWM

input and connecting the Mod III XRO feed at the same point, variables such as weather, smog, TWM noise temperature, receiver followup noise temperature, etc., are compared in a relative measurement and the loss contribution of the added feed components can be determined with high precision (est. ±0.15 K). From the throat of the horn to the TWM interface, the following components contribute to the additional noise temperature compared to the simple horn: rotary joints (2 ea), quarter-wave plate polarizer, orthogonal mode transducer, waveguide twist (in the side path measured), and waveguide switch. The measurements were performed on two different feeds (for DSS 43 and DSS 63) and the resulting 2.43 K increase (over the simple horn) was the same for each feed within experimental tolerances. This indicates that the 64-meter antenna system temperature at zenith should not exceed 25 K, including the dichroic plate losses and the normal antenna and receiver noise contributions.

IV. DSN Implementation

The first Mod III XRO feed assembly has been installed at DSS 14, and measurements (Ref. 5) have confirmed 0.36-dB antenna gain increase. For reasons yet to be determined, the system noise temperature is indicating several kelvins too high. Since the system noise temperature was also too high before the feed change, the problem is thought to be elsewhere, and efforts are underway to locate and correct the problem. Nevertheless, excellent data was received from Voyager 1 as it passed through the Jovian system, verifying the feed capability.

The second and third Mod III feeds have been fabricated and tested and, together with some additional parts for the cone assembly, will be implemented at the overseas sites in late 1979 and early 1980.

References

1. Hartop, R., "X-Band Antenna Feed Cone Assembly," TR 32-1526, Vol XIX, Jet Propulsion Laboratory, Pasadena, Calif., pp. 173-5, 1974.
2. Hartop, R., "Selectable Polarization at X-Band," *DSN Progress Report* 42-39, Jet Propulsion Laboratory, Pasadena, Calif., pp. 177-80, 1977.
3. Hartop, R., "New X-Band Microwave Equipment at the DSN 64-Meter Stations," *DSN Progress Report* 42-48, Jet Propulsion Laboratory, Pasadena, Calif., pp. 126-28, 1978.
4. Thomas, R., and Bathker, D., "A Dual Hybrid Mode Feedhorn for DSN Antenna Performance Enhancement," *DSN Progress Report* 42-22, Jet Propulsion Laboratory, Pasadena, Calif., pp. 101-8, 1974.
5. Freiley, A. J., "Radio Frequency Performance of DSS-14 64 m Antenna at X-Band Using a Dual Hybrid Mode Feed" to be published in *DSN Progress Report 42-53*.

Table 1. Impedance match characteristics of X-band orthogonal mode transducer

Frequency, MHz	Return loss, dB	
	Thru port	Side port
8400	−24.0	−28.0
8425	−25.5	−33.5
8450	−28.5	< −40.
8475	−29.0	−32.0
8500	−26.0	−27.0

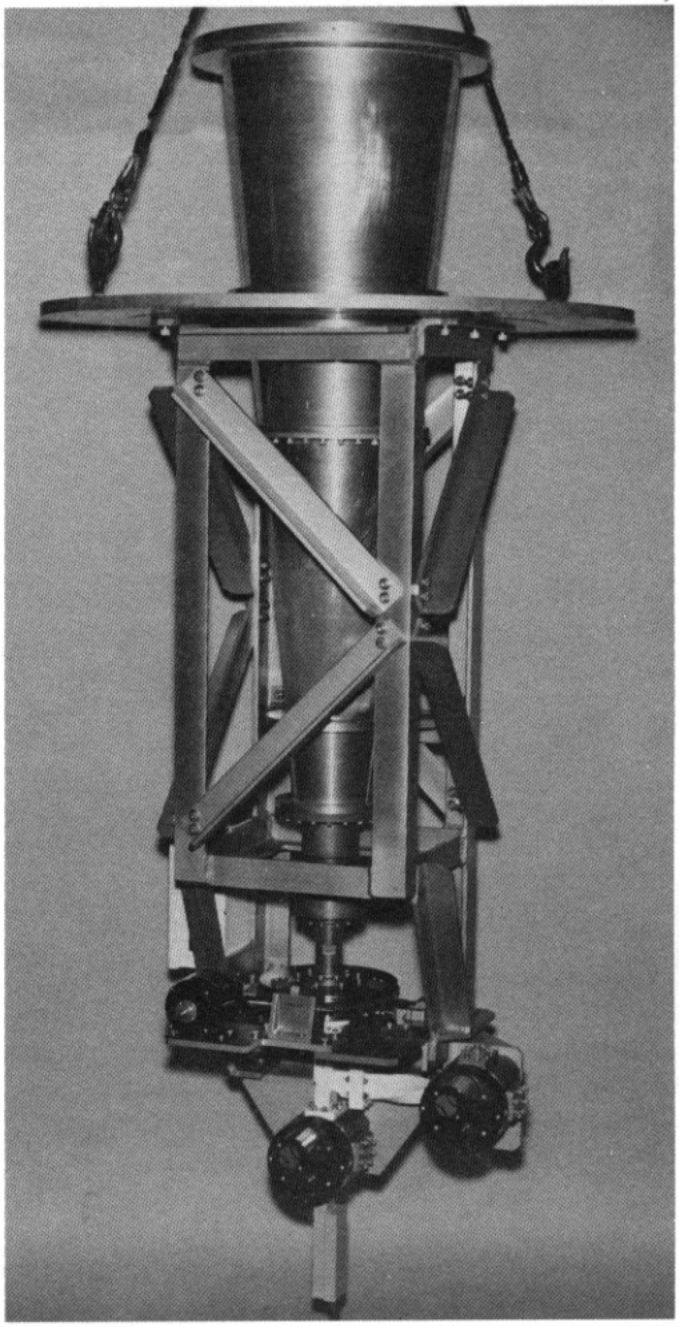

Fig. 1. XRO Mod III feed assembly

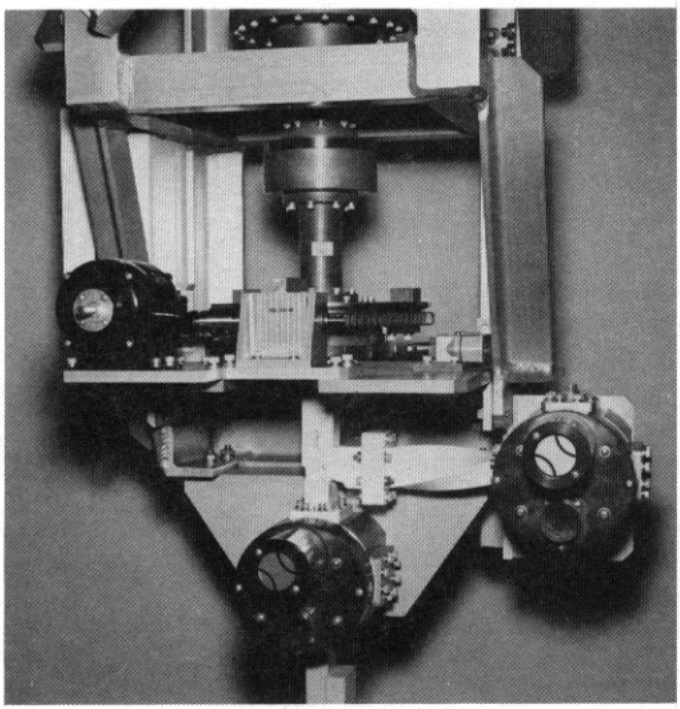

Fig. 2. Close-up of feed assembly showing orthogonal mode transducer and switch

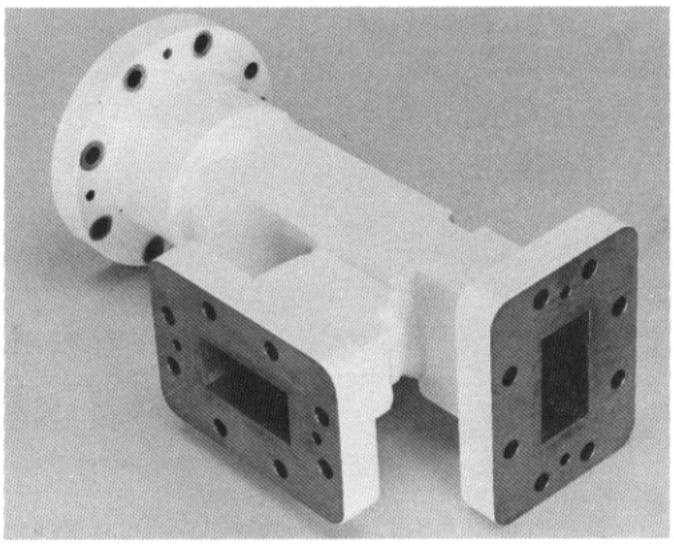

Fig. 3. Orthogonal mode transducer showing output flanges

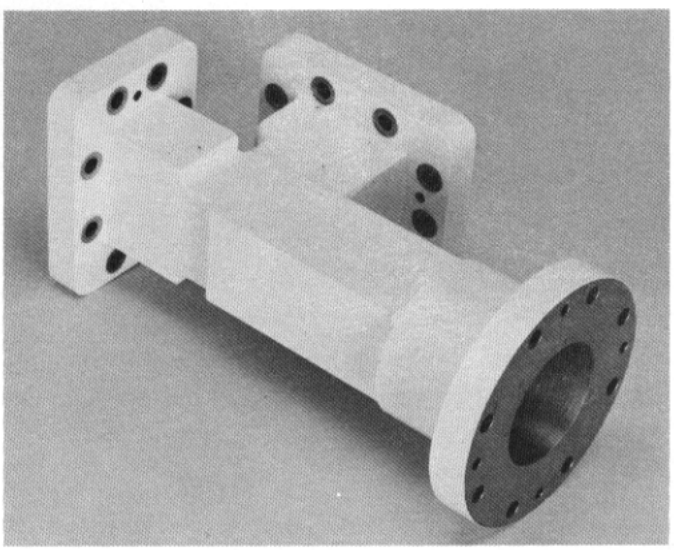

Fig. 4. Orthogonal mode transducer showing input flange