DICHROIC SUBREFLECTOR FOR ROSMAN II

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This paper reports on the dichroic subreflector of the Rosman II antenna. Figure 1 is a picture of the Rosman II dish, which has both focal-point and Cassegrain feeds. The rear of the ground screen on which the focal-point feeds are mounted can be seen between the square feed box and the solid metal subreflector, which was used with the Cassegrain feed operating at 4 and 6 GHz. In order to use the focal-point feeds in this system prior to installing the dichroic subreflector, it was necessary to remove the subreflector and to replace it for Cassegrain feed use. The turnaround time required for this was several hours and required that riggers be available whenever the changeover had to be made. The risks to personnel and equipment involved in removing and replacing the subreflector, and the personnel complications associated with changes in shifts made this operation somewhat undesirable.

A dichroic subreflector functions as shown in Figure 2. It is virtually transparent to a baseband of frequencies and the focal-point feeds look through it as though it were not there. At the Cassegrain feed frequencies, on the other hand, it is highly reflective, which permits normal Cassegrain operation. Simultaneous operation with both focal-point and Cassegrain feeds is thus provided without the need of removing the subreflector.

Also shown in Figure 2 is a picture of the 3.35-m dichroic subreflector, developed at GSFC, for the Rosman II antenna system. It is a sandwich construction, 1.9-cm thick, and consists of two laminated epoxy glass skins 1-mm thick separated by a phenolic honeycomb core. Visible on the front surface is an array of circular copper discs. On the opposite surface is a similar array. These two surfaces were designed to give maximum reflectivity in the 4-GHz portion of the C band. Since the arrays are resonant, some deterioration in performance is to be expected in the 6-GHz portion of the band.

The dichroic subreflector was installed in the Rosman II dish during the latter part of last November and is still in operation. Some solar heating of the dichroic was encountered in the dish. This was eliminated by painting the surfaces with white epoxy paint so that if one were to see the dichroic now it would be very similar in appearance to the solid metal subreflector which it replaced. Tests made to date have been directed at (1) making focusing adjustments and measuring those system parameters which would be most indicative of a focused condition for the Cassegrain feed and, to a lesser extent, (2) determining losses for the focal point feeds due to the presence of the dichroic.

The C-band test results were derived from measurements of radiation patterns, noise temperatures and carrier-to-noise ratios at 4.1 GHz, and the relative transmitter power at 6.3 GHz that was required to produce a 1-MHz tone in the ATS 3 satellite. This latter measurement, when compared to transmitter power level required in operations with the original solid metal subreflector, provides a measure of loss at the transmitter frequency attributable directly to the dichroic subreflector. The measured loss at 6.3 GHz was 1.3 dB at the best focus position.

The increase in noise temperature caused by the use of the dichroic over that caused by the use of the solid metal subreflector arises from resistive losses in the dichroic. The measured increase in noise temperature for the dichroic over that for the original metal subreflector at 4.1 GHz was approximately 8 K, corresponding to a resistive loss of about 0.1 dB.

There is also a reactive or scatter loss at 4.1 GHz which must be added to the resistive loss to account for the total loss in gain when the dichroic is used. This scatter loss does not, in general, contribute to noise temperature but does represent energy not collimated usefully by the antenna. With the ATS 3 used as a source, the carrier-to-noise ratio was measured. When this parameter is related to the noise temperature of the system, a gain figure can be established. If the gain figure obtained using the dichroic is compared with that obtained using the solid metal subreflector, the total gain loss due to the dichroic can be deduced. At the best focus position, this gain loss was 0.3 dB at 4.1 GHz. It was felt at the time those measurements were made that even better performance could have been obtained with more time available for adjustments.

For the focal-point feeds, abbreviated measurements of loss due to the dichroic were made at 137, 400, and 1700 MHz and compared to that with no subreflector at all. Gain degradation at 137 and 400 MHz was virtually unmeasurable. At 1700 MHz, the measured value was under 1 dB.

We have heard that the focal point feeds have been used more extensively since the installation of the dichroic. The deterioration in performance associated with use of the dichroic is believed to be more than offset by the increase in operational availability of the system.

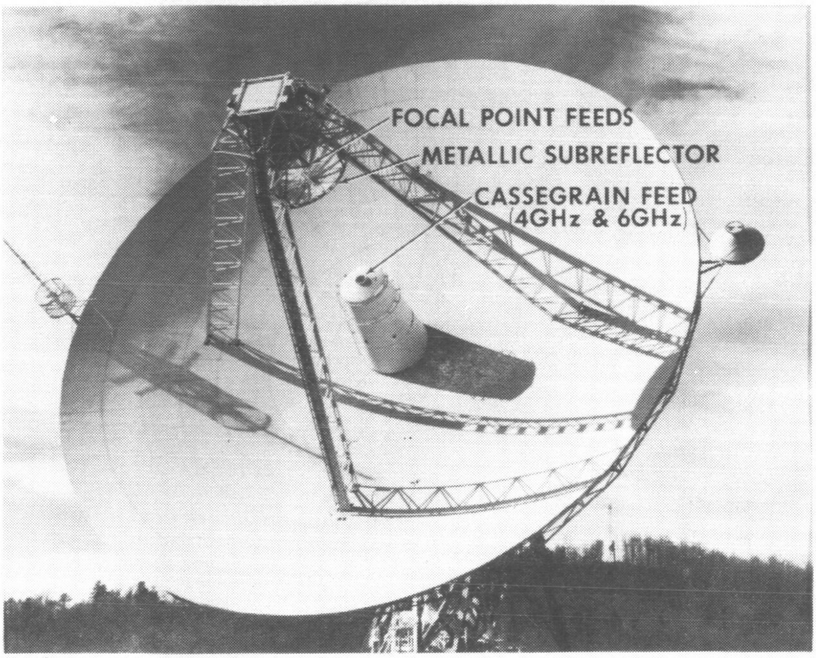

Figure 1–Rosman II antenna.

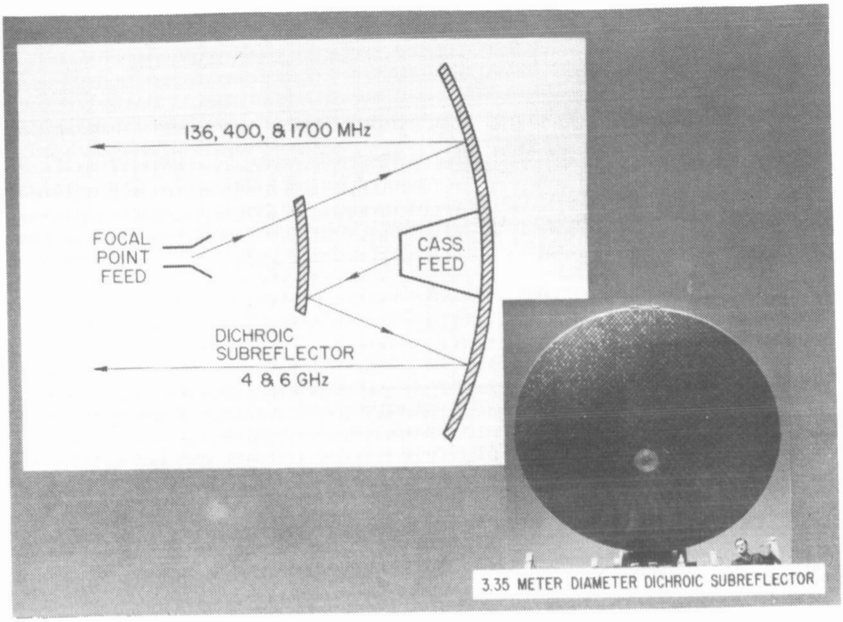

Figure 2–Dichroic function.