January 1975

B74-10283

NASA TECH BRIEF

NASA Pasadena Office

Low-Loss, Circularly-Polarized Dichroic Plate

The problem:

In order for a specialized antenna system to operate simultaneously on two frequencies, provision must be made for passing X-band signals to the X-band feed cone while reflecting S-band signals to the S-band feed cone.

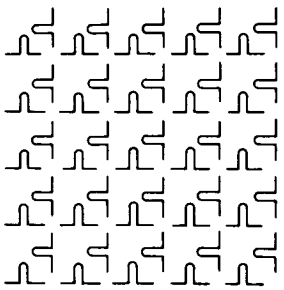
The solution:

A dichroic plate has been designed which has orthogonally-disposed, loaded dipole apertures with their orientations arranged so as to cancel the cross-coupling effects which would otherwise result in a power loss to a circularly polarized signal.

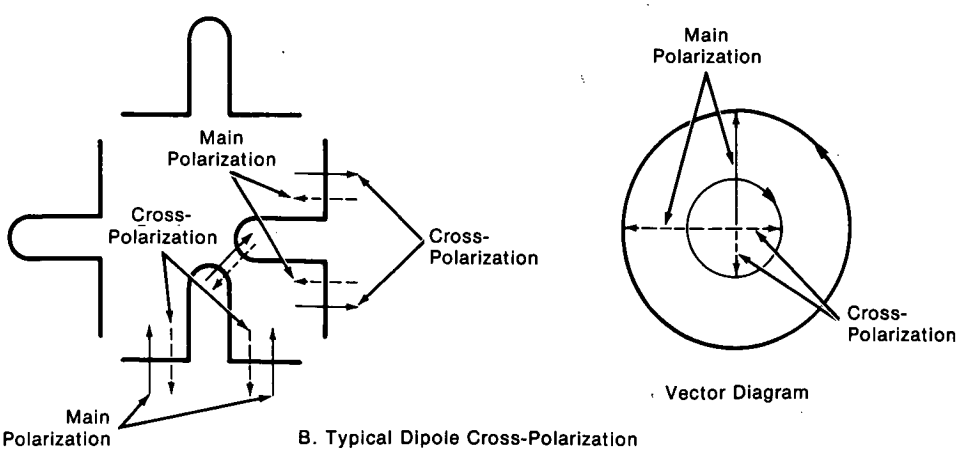
How it's done:

The original circularly-polarized dichroic plate (Figure 1A) showed low loss (<0.6 dB for angles of incidence up to 60°) for both parallel and perpendicular polarizations. However, an ellipticity loss exceeding 2 dB was also measured. Further study revealed the presence of a cross-polarized component with a magnitude small enough (approximately 17 dB down) to cause no significant transmission loss but large enough to produce substantial ellipticity loss.

The generating mechanism for cross-polarization in the circularly polarized plate of Figure 1A is entirely different from that in a comparable linearly polarized



A. Segment of Circularly-Polarized Dichroic Plate Showing Dipole Array



B. Typical Dipole Cross-Polarization

Figure 1. Circularly-Polarized Dichroic Plate Details

(continued overleaf)

plate. Cross-polarization is produced through the mutual coupling of adjacent orthogonal dipoles as shown in Figure 1B. The main polarization voltages are represented by solid arrows in one direction and by dashed arrows in the direction orthogonal to it. The coupling to the adjacent dipole and the resulting cross-polarization are also shown. The vector diagram shows that the circular polarization resulting from the cross-polarization is opposite in sense to the main circular polarization and therefore represents a power loss in transmission through the plate. To reduce the loss, two new dipole configurations for circularly polarized plates were devised.

The configuration in Figure 2 has the dipole elements so oriented that the cross-polarization generated by one dipole is cancelled by that generated by the adjacent orthogonal dipole. In the second new configuration (not shown), the cross-polarization generated by one dipole element cancels that generated in the other. The ellipticity loss for both modified plates is less than 0.2 dB, while the degradation in antenna gain is less than 0.4 dB. A previously-devised, circularly-polarized dichroic plate is unsuitable in this application as it requires a dielectric backing to prevent the center pieces of the elements from falling out, and the lossy dielectric adds substantially to the antenna noise temperature.

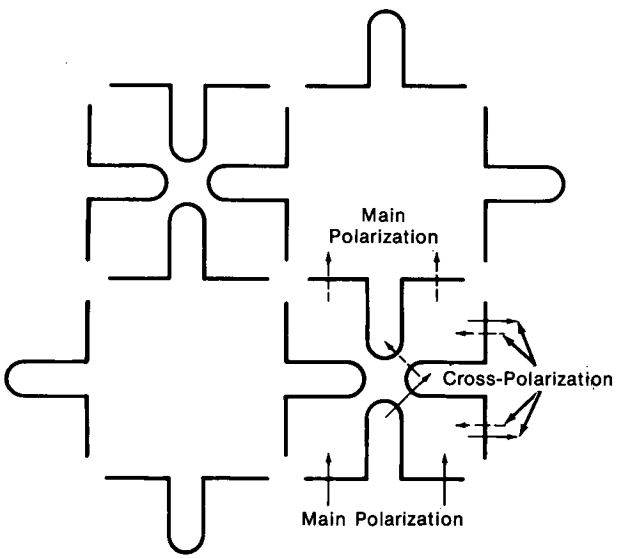


Figure 2. Typical Dipole Elements of Modified Circularly-Polarized Dichroic Plate

Figure 3 illustrates one intended use of the dichroic plate. The reflex antenna feed system is a two-frequency transmitting/receiving antenna feed system utilizing the JPL tricone assembly, an ellipsoidal reflector, and a 0.9-m by 0.9-m (3-ft by 3-ft) dichroic plate. Such an antenna is capable of simultaneous operation at two different frequencies.

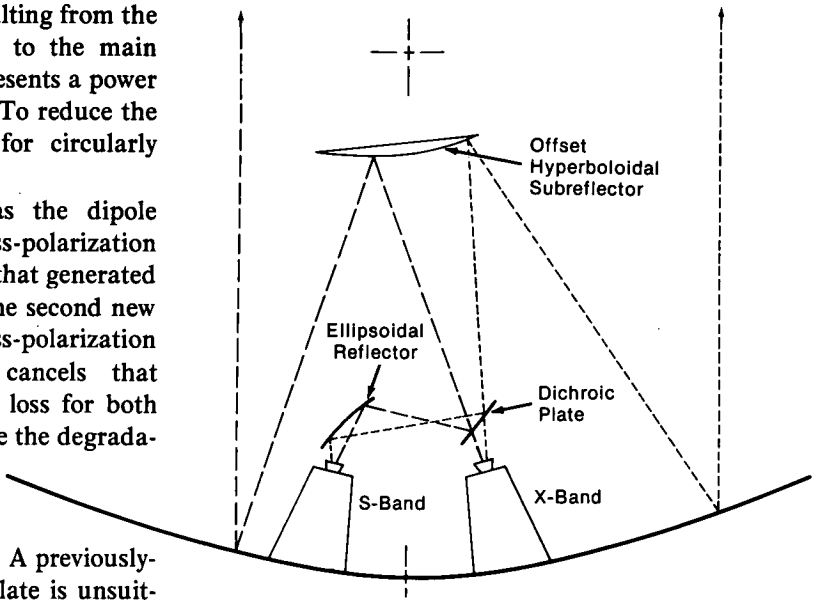


Figure 3. Use of Dichroic Plate in Reflex Antenna Dual-Frequency Feed System

Note:

Requests for further information may be directed to:

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Reference: TSP74-10283

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,769,623). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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Category 01 (Electronics - Components and Circuitry)

B74-10283

☆U.S.Government Printing Office: 1975 — 636-684