2 GHz FEED FOR HORN-REFLECTOR ANTENNA

UTILIZING EVANESCENT MODE FILTER

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Abstract

A network is described which is capable of coupling 2 GHz frequencies into the horn-reflector antenna used with the existing 4, 6 and 11 GHz radio systems without disturbing their performance. The use of the 2 GHz band is an economically attractive solution to communication congestion near urban areas.

Introduction

The utilization of the two frequency bands at 2.11 -2.13 and 2.16 -2.18 GHz in the microwave radio spectrum is essential to meet the pressing demand for additional services near frequency congested urban areas. Furthermore, it could be very economical if appropriate means could be found to carry these frequency bands through the horn-reflector antennae of existing 4, 6 and 11 GHz radio systems. To accomplish this goal, a network is required which must satisfy two basic design objectives:

(1) The network must not disturb the existing 4, 6 and 11 GHz signals.
(2) The 2 GHz bands must be launched with minimum loss, free from the cross polarized mode and other spurious modes.

In a typical radio system, a common circular waveguide (WC281) carrying 4, 6 and 11 GHz signals is connected to the feed horn of the antenna (Fig. 1). The signals are propagating in H_{11} mode in the circular waveguide and transduced into H_{10} mode in the feed horn as its cross section tapers from circular into square. Since the 2 GHz signal is below cut-off in WC281, the feed horn is evidently a natural place to launch the 2 GHz signal.

In order to meet the design objectives as specified above, the discontinuities, such as apertures, to be added to the wall surface of the feed horn for coupling the 2 GHz signal, must be kept at a minimum and must maintain certain symmetry. The combining network to be presented in this paper is capable of fulfilling all these requirements.

Design Principle

Referring to Figure 1, to couple the 2 GHz signal into the feed horn through a small aperture without appreciable reflection and with practical bandwidth, resonant cavities (or filters) are required. In this application, the requirement for not disturbing the 4, 6 and 11 GHz signals in the feed horn renders most conventional transmission line filters useless, since they will not only have a passband at 2 GHz but at all multiples of the 2 GHz frequency bands. The evanescent mode waveguide bandpass filter[1] was, therefore, used for its unique characteristics of broad stopband. In principle, the filter may be designed in evanescent mode waveguide for frequencies up to 11 GHz such that it has a passband at 2 GHz and a broad stopband covering all 4, 6 and 11 GHz signals. In practice, however, the minimum size of the evanescent mode waveguide is limited by requirements of bandwidth, intrinsic loss and dimensional tolerance. For meeting such requirements in this application, a WR90 waveguide was used in the filter design which, as an evanescent mode filter, has a passband at 2 GHz and a stopband covering 4 and 6 GHz signals. But WR90 supports the propagating mode of the 11 GHz signal. Thus, in the design of the evanescent mode filter, one additional condition was imposed such that the same filter structure will also be a conventional waveguide bandpass filter with a stopband located at the 11 GHz frequency band.

To increase the coupling between the 2 GHz rectangular waveguide (WR430) and the evanescent mode waveguide filter (WR90), WR430 with reduced height of 0.4" was used. In addition, a resonant cavity between the inductive posts in WR430 and the junction of the two waveguides was also incorporated as an integral part of the bandpass filter of the 2 GHz feed. The remainder of the network comprises a coax to waveguide (WR430) transducer and an impedance matching network.

As stated in the preceding section, maintaining symmetry is one of the most important design factors in minimizing mode conversions and the cross polarized mode excitation. A dummy evanescent mode filter of identical design was coupled to the opposite wall of the feed horn to preserve the field symmetry inside the feed horn. The dummy filter was terminated into a load.

For utilization of the full system capacity, the transmitting and receiving signals will be carried separately by each of the two orthogonal polarizations. Fig. 2 shows a dual-polarization 2 GHz feed which comprises two filters and their associated dummy networks coupled to the feed horn.

Experimental Verification

Numerous models of the dual-polarization 2 GHz feed were designed and fabricated with operating frequency bands of 2120±10 and 2170±10 MHz. Typical minimum return loss at the coax port is 14 dB across the band. The insertion loss was estimated to be about 1 dB*. There were no measurable disturbances to the 4, 6 and 11 GHz signal and the isolation between the cross polarized modes is 25 dB or greater.

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References

1. Craven, G. F. and Mok, C. K., "The Design of Evanescent Mode Waveguide Bandpass Filters for a Prescribed Insertion Loss Characteristic," IEEE Trans. MTT, Vol. MTT-19, No. 3, March, 1971.

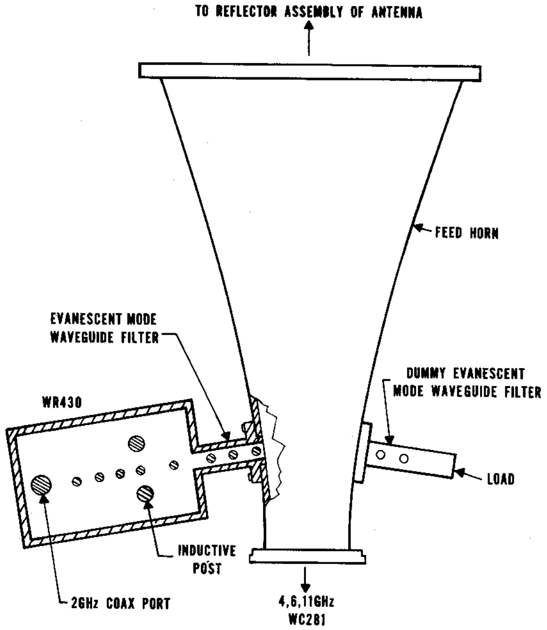

FIG. 1 2 GHz Launching Network for Microwave Radio Antenna System

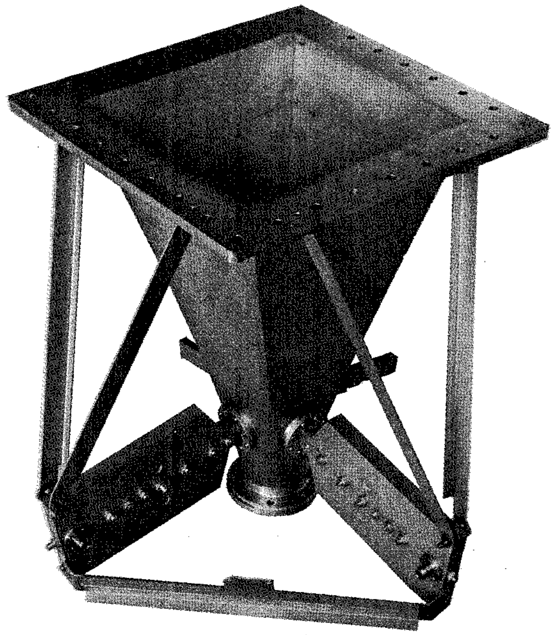

FIG. 2 Dual Polarization 2 GHz Feed

* The insertion loss was estimated indirectly from measured data with ±.25 dB accuracy.