1-III C3

A WIDE-BAND DIELECTRIC FILTER FOR THE ANTENNA AND FEED SYSTEM FOR THE 4-6 GHz, 17-30 GHz DOMESTIC SATELLITE COMMUNICATION SYSTEM

Masaki Koyama and Sadakuni Shimada
The Musashino Electrical Communication Laboratory,
Nippon Telegraph and Telephone Public Corporation
Musashino-shi, Tokyo, Japan

Abstract--An antenna and feed system is described which can be applied to the proposed domestic satellite communication system. This antenna and feed system is composed of the usual Cassegrain antenna, several beam reflectors, a wide-band dielectric filter and exclusively designed long and short centimeter-wave primary horns and branching filters. Merits of this antenna and feed system are: (1) freedom from unwanted higher-order modes (2) low loss and high power handling capacity (3) freedom from the need for a very wide-band phase shifter which is usually required for space communications system to receive or to transmit arbitrarily polarized waves (4) flexible fabrication of the system.

Introduction

In the past few years, a number of papers have been published on domestic satellite communications systems. At the Electrical Communication Laboratory of NTT, a domestic satellite communications system has also been proposed. This system is characterized by the use of both long and short centimeter waves(4-6 GHz and 17-30 GHz, for example). The use of the long centimeter wave can compensate for the deterioration of the transmitted signals of the short centimeter wave due to rainfall. This system is, therefore, particularly useful for a country suffering from much rainfall such as Japan. The ratio of the lowest to the highest frequency is about 8 for the system under consideration. On the other hand, this ratio is 2 or 3 at most for the conventional microwave communication systems (4-6 GHz) and millimeter-wave communication systems (40-120 GHz). This fact makes the realization of the hardware of the antenna and feed system extremely difficult. Especially, the conventional waveguide feeder is not likely to be applicable, because many higher-order modes of the short centimeter wave will propagate in the feeder and degrade the transmission quality.

In this paper, the design of the wide-band dielectric f lter and its applications to the proposed domestic satellite communication system are described in detail.

Design of a Dielectric Filter

The wide-band dielectric filter described here is composed of multi-layered dielectric stacks and is installed obliquely with respect to the incident wave. This dielectric filter is designed for the short centimeter wave to reflect obliquely from its surface and for the long centimeter wave to transmit through it. Thus, the long and short centimeter waves are independently fed by each primary horn. An example of the antenna and feed system using this dielectric filter is shown in Fig.1.

In designing the dielectric filter, the following two points are particularly taken into consideration. (1) Since the dielectric filter is installed obliquely, the two independently polarized waves have different reflection and transmission coefficients, and, therefore, deterioration of the desired circular polarization can occur. To avoid this deterioration, we determined the optimum incident angle. (2) The dielectric filter allows some reflection of the long centimeter wave which is undesirable for our purpose. In order to reduce this undesired reflection, we designed dielectric matching transformers to attach to each side of the dielectric filter.

Fig.2 and 3 show the theoretically and experimentally determined reflection

and transmission characteristics of the dielectric filter. This filter consists of a five-layer dielectric filter with a center frequency of 23.5 GHz in the stop band and of a two-layer matching transformer with a center frequency of 5 GHz in the pass band. In Fig.2, the electric field is parallel to the incident plane (E-wave case) and in Fig.3, the electric field is perpendicular to it (H-wave case). Theoretical curves are derived from the conventional image parameter method. Sections for the matching transformer are designed to give equal-ripple characteristics in the pass band.

The experimental set-up is shown in Fig.4. Several horns were used to feed to the dielectric filter. Although some aberrations due to the spherical wavefront have been anticipated theoretically, little deterioration was observed in the experiment.

Examples of the Antenna and Feed System Using the Dielectric Filter

Fig.5 shows another antenna and feed system. The merit of this system is mechanical feasibility. In this system two primary horns and the dielectric filter are fixed on the ground, whereas, for the system shown in Fig.1, those should be movable. Fig.6 shows the antenna particularly useful for the satellite antenna. The antenna shown in Fig.7 is also applied to the satellite antenna system. Other antennas may be designed by the use of the dielectric filter. They offer flexible fabrication in space communications antenna systems.

Conclusion

It is concluded that, using this filter, the antenna and feed system for the proposed domestic satellite communications system should be satisfactory.

Acknowledgment--The authors wish to thank Dr. D. Kumagai and Mr. Y. Mori for their constant encouragement, and Mr. S. Morimoto, Dr. M. Mizusawa of Mitsubishi Electric Co. and Mr.S. Soma of Nippon Electric Co. for their valuable discussions.

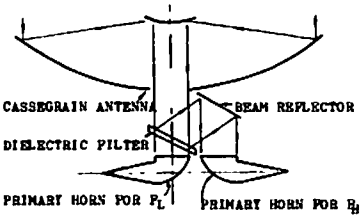

Fig.1

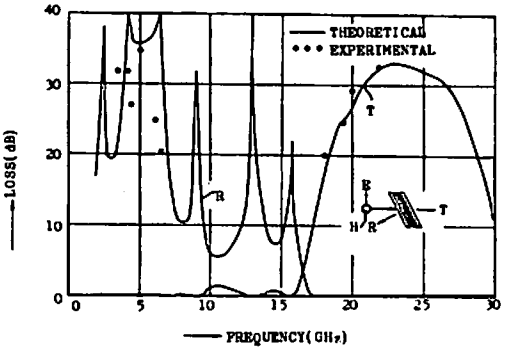

Fig.2

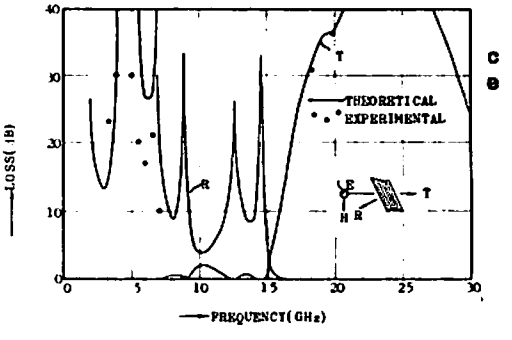

Fig.3

Fig.4

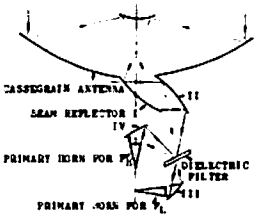

Fig.5

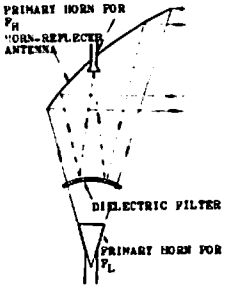

Fig.7

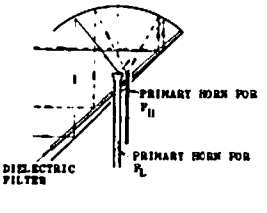

Fig.6