AN INTEGRATED ANTENNA FOR NON-RADIATIVE DIELECTRIC WAVEGUIDE

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Abstract: An antenna for integrated use with the Non-Radiative Dielectric Waveguide is described. The polyrod radiator is fed by a dielectric waveguide which extends without interruption from the NRD. A tapered section is used to accomplish both impedance and mode matching.

I INTRODUCTION

The Non-Radiative Dielectric Waveguide (NRD-guide) described by Yoneyama, Nishida and co-workers [1]-[3] is a recent development in the field of microwave integrated circuits that holds great promise for practical applications [4],[5]. In order for an integrated system to be practical, it must employ antenna systems that are directly compatible with the technology used. Up to the present only the basis for a leaky wave antenna [4] and the design of an antenna array in NRD-guide [6],[7] has been described in the literature. In this paper a novel way of integrating a dielectric rod antenna directly into an NRD-guide is described.

II PHYSICAL DESCRIPTION

Fig.1 shows an oblique view of the complete antenna. The NRD-guide is terminated in a transitional taper which is used to transform the NRD-mode to that of a free dielectric waveguide. In this area the dimensions of the Polypenco O200.5 dielectric are held constant at 15x10.16 mm while the gaps between the dielectric and the metal walls are increased. Finally, the dielectric waveguide is terminated in a dielectric rod antenna.

III THE TRANSITION

The cross section of the guide in the transitional area is shown in Fig.3. By making use of the method of effective dielectric constants, [3], the wave number, k_z, can be calculated by first solving two sets of transcendental equations. From this the guide wavelength and wave impedance can be easily obtained.

In the present case, the wave impedances at the extremities of the taper, i.e. where the gap between the dielectric and the metal sidewall equals zero and infinity respectively, are 474.5 and 195.6 Ohms. This represents a return loss of 7.6 dB and if a matching taper of 30 dB return loss is employed, will yield an overall return loss of 37.6 dB. Using the method described by Hecken [8], the necessary impedances $Z(\xi)$ for equal electrical spacing ξ was determined.

The total length of the taper is 4.7533 radians at 9.0 GHz and it is divided into 20 equal electrical intervals [9]. The variation of impedance level along the taper is shown in Fig.2.

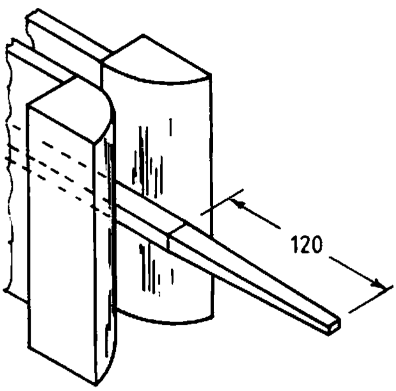

Fig.1. Antenna Construction

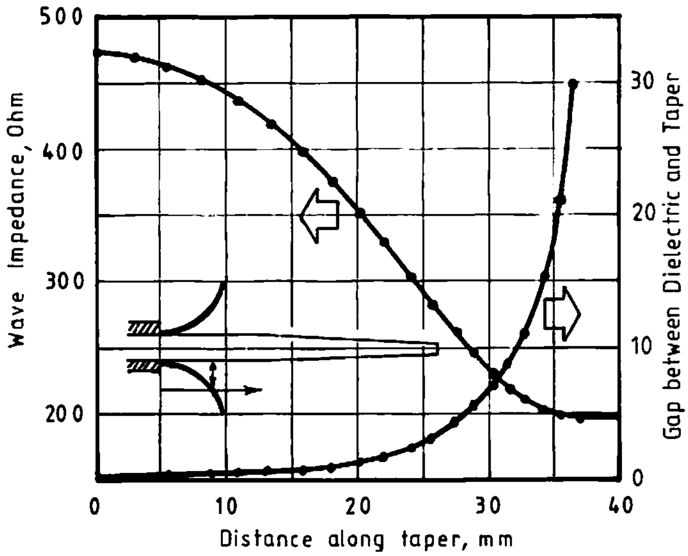

Fig.2. Impedance and gap.

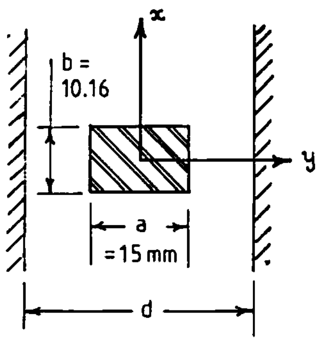

Fig.3. Cross Section

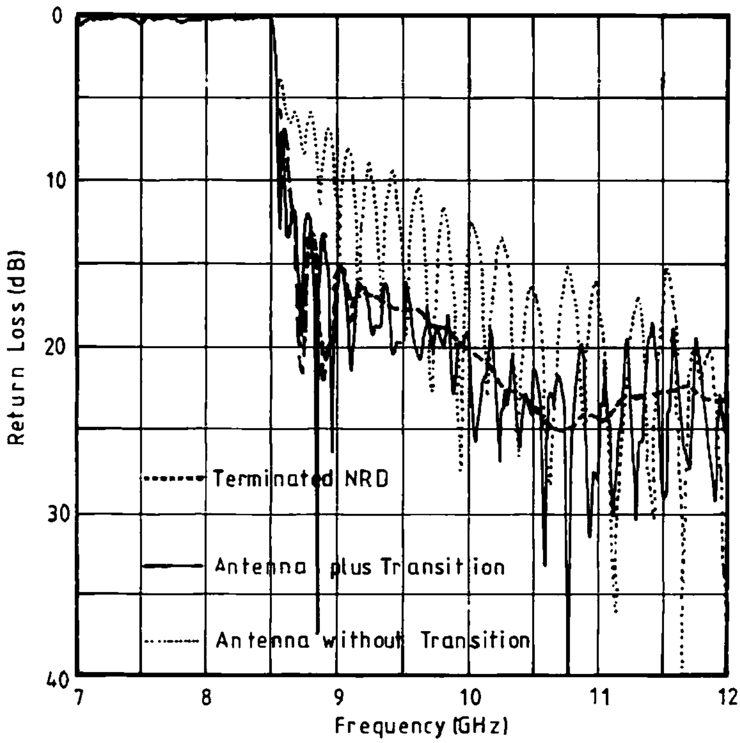

Fig.4. Return Loss Performance

IV THE ROD ANTENNA

The dielectric rod antenna was designed in accordance with the procedure described in [10]. At the design frequency of 9.5 GHz, the freespace to guide wavelength ratio is 1.09 which is very close to the optimal of 1.1. At the end of the rod, the dimensions are calculated to be 7.5x7.5 mm for a unity wavelength ratio. The total antenna length was made 120 mm.

V MEASURED RESULTS

The return loss performance of the NRD-guide when terminated in a matched load [7],[9] is shown in Fig.4 as a broken line. The

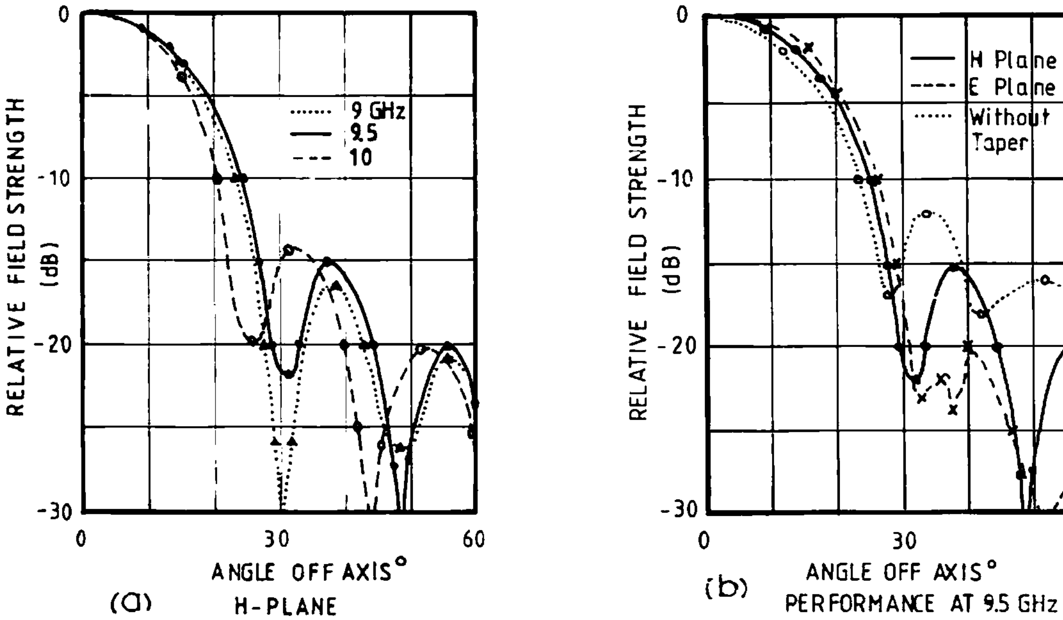

Fig.5. Radiation Patterns, (a) for H-plane at various frequencies and (b) at 9.5 GHz

performance without the taper is shown as a dotted line, and the return loss at 9 GHz is almost exactly equal to the 7.6 dB predicted. When the taper is fitted, the total return loss is only slightly above the level of the termination. Using the termination as a calibration, the return loss of the transition plus dielectric rod is calculated to be between 30 and 40 dB over the range 9 to 10 GHz.

H-Plane radiation patterns at 9.0, 9.5 and 10.0 GHz are shown in Fig.5(a) while the E- and H-plane patterns at 9.5 GHz are shown in Fig.5(b). Note the degradation caused to the radiation pattern if the matching taper is removed.The gain was measured as 15.9 dB which is virtually the maximum that can be expected from an antenna of this size.

VI CONCLUSION

The dielectric rod antenna that has been described offers excellent performance for cases where modest gain is required and an integrated construction is desired.

ACKNOWLEDGEMENT

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