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DESIGN OF SUBSTRATE INTEGRATED WAVEGUIDE H- PLANE HORN ANTENNA ON A PTFE SUBSTRATE

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Abstract —- Rectangular dielectric loaded substrate integrated waveguide (SIW) H-plane horn antenna, operating at 26 GHz has been proposed in this paper. For the simulations, a substrate of thickness 3.2mm and a dielectric material of Poly Tetra Fluoro Ethylene (PTFE) has been used. The size of antenna was reduced and a dielectric slab was loaded in front of the horn. This resulted in the increase of gain and also narrow beamwidths in the E- plane and H- plane. A comparison between two horn antennas, one without dielectric loading and one with dielectric loading has been presented in this paper.

Keywords*— Substrate Integrated Waveguide, Dielectric loading, H-plane sectoral horn, HFSS.*

I. INTRODUCTION

Substrate integrated waveguide (SIW) is a type of transmission line which allows a nonplanar structure like an antenna to be transformed into a planar form by integrating it on a single substrate. This results in a compact structure. The substrate-integrated waveguide (SIW) technique has been investigated and developed to construct the planar rectangular waveguide [1]–[10]. It implements a waveguide on a piece of printed circuit board by emulating the side walls of the waveguide using two rows of metal posts. It inherits the merits both from the microstrip for compact size and easy integration, and from the waveguide for low radiation loss, and thus allows design of efficient microwave circuits and antennas at a low cost.

The design and fabrication of dielectric loaded SIW horn antennas on a substrate having a dielectric constant of 4.8 and thickness of 2.5 was carried out in [11] . In this paper, a substrate with dielectric constant of 2.45, thickness of 3.2 mm and loss tangent of 0.002 is used in all the simulations. All the simulations are carried out using Ansoft HFSS. The two structures that have been simulated are the SIW H- plane horn antenna without dielectric loading and short length rectangular dielectric loaded SIW H-plane horn antenna. The dielectric slab loaded in front of the short length horn results in a narrow E-beamwidth. By choosing proper length of the dielectric slab, the beamwidth in the H -plane can also be narrowed and consequently high gain can be obtained.

II. SIW H-PLANE SECTORAL HORN ANTENNA

The HFSS model of substrate integrated waveguide h- plane horn antenna without dielectric loading is shown in Figure.1.

Based on the design rules for SIW given in [12], the radius of the vias is chosen to be 0.5mm and the centre to centre distance is 1mm.

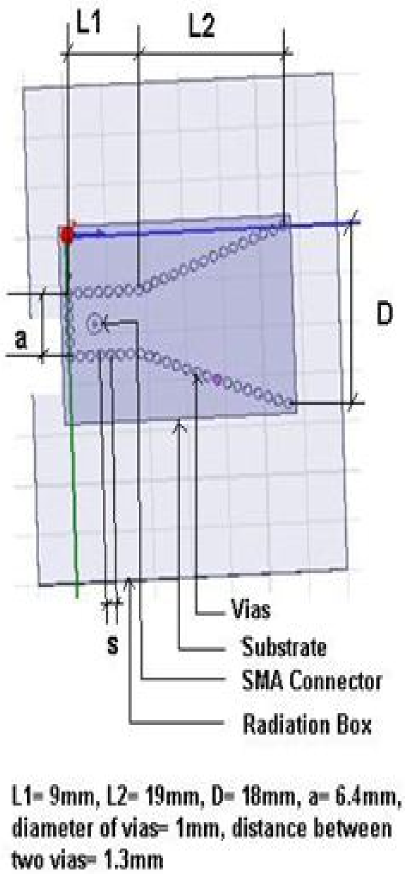


Fig.1 SIW H- plane horn antenna without dielectric loading

Figures.2, 3, 4 and 5 show the simulated results for S11, gain and beamwidths respectively.

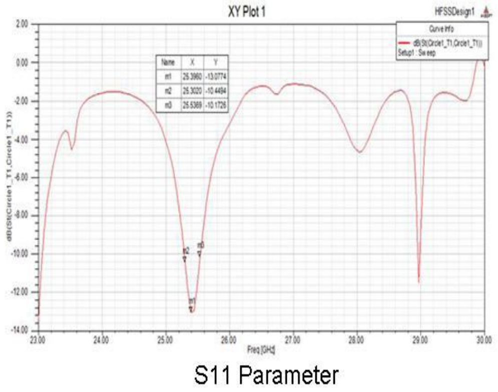


Fig.2. SIW horn antenna without dielectric loading- S11 plot

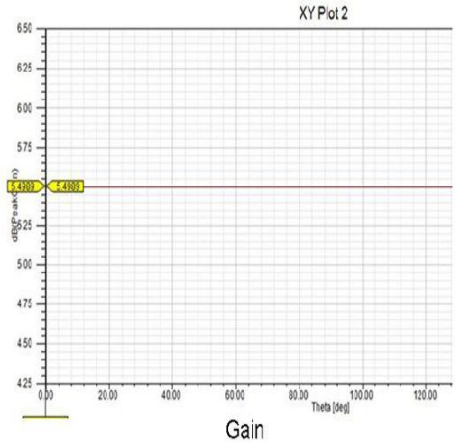
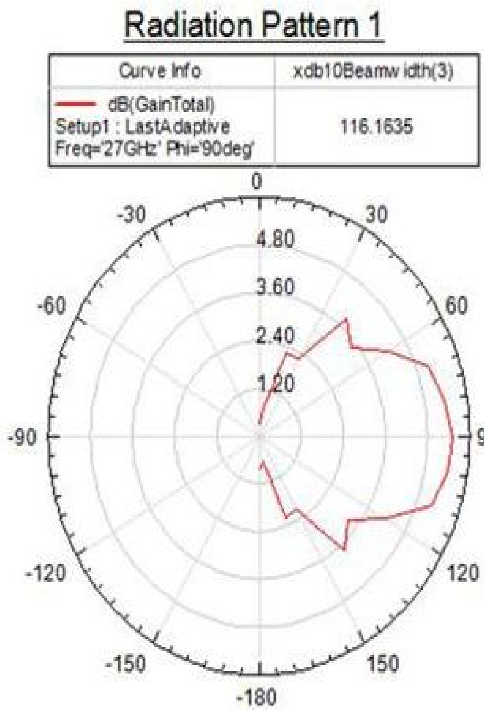
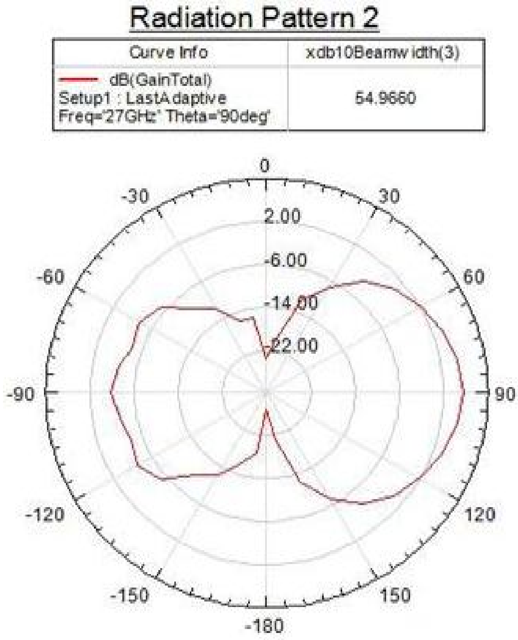


Fig 3 SIW horn antenna without dielectric loading- Gain plot



E-Beamwidth

Fig 4. SIW horn antenna without dielectric loading- E-beamwidth plot



H-Beamwidth

Fig 5 SIW horn antenna without dielectric loading- H-beamwidth plot

III. DIELECTRIC LOADED SIW H-PLANE SECTORAL HORN ANTENNA

The structure can be made even more compact by reducing the size of the horn. This can be achieved by reducing the length of horn and placing a dielectric slab of proper length infront of the aperture. Such a structure is shown in Fig.6. The length (L2) of the horn has been reduced to 12.45mm and a dielectric slab of length 9.5mm has been placed in front of the horn. The gain obtained is maximum for this length of the dielectric slab.

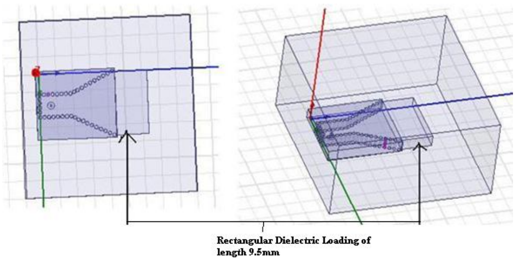


Fig 6 Short length SIW H-plane horn antenna with dielectric loading

Figures.7, 8, 9 and 10 shows the simulated results for this structure.

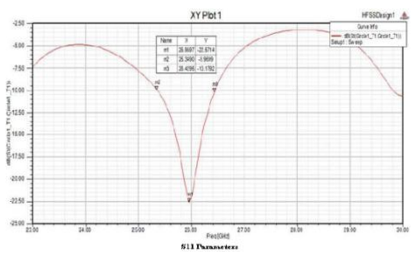


Fig 7 SIW horn antenna with dielectric loading- S11 plot

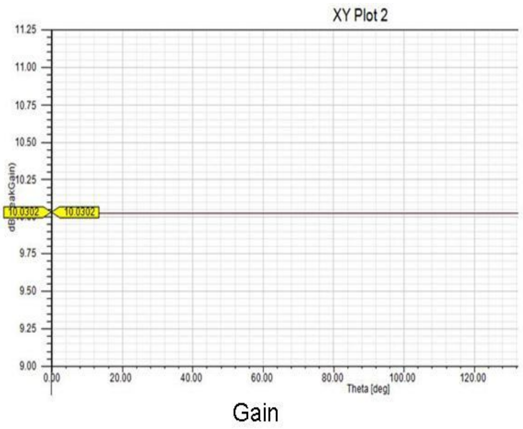


Fig 8 SIW horn antenna with dielectric loading- Gain plot

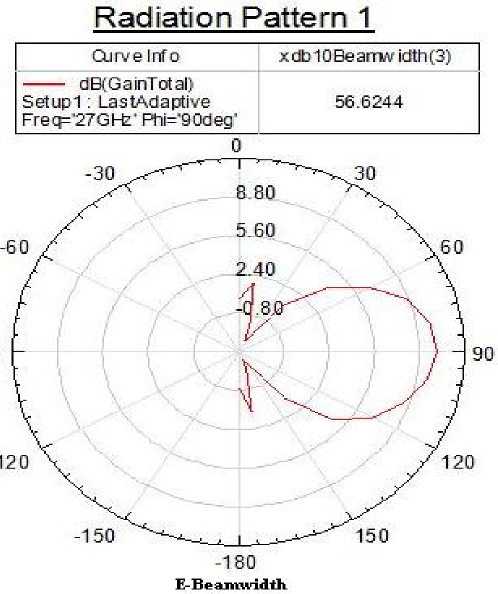


Fig 9 SIW horn antenna with dielectric loading- E-beamwidth plot

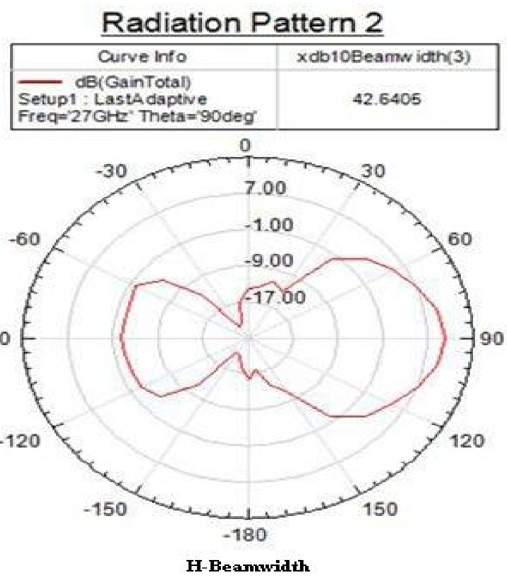


Fig 10. SIW horn antenna with dielectric loading- H-beamwidth plot

A comparison of the simulated results for without dielectric loading and with dielectric loading is shown in Table 1. It can be observed from Table 1 that, with dielectric loading, the gain is almost double than that of without loading. The frequency at which best results are obtained has been considered.

TABLE 1. COMPARISON BETWEEN WITHOUT DIELECTRIC LOADING AND WITH DIELECTRIC LOADING

SIW H-plane horn antenna	Return Loss (dB)	Gain (dB)	E-Beamwidth (degree)	H-Beamwidth (degree)
Without dielectric loading	-13 @ 25.39 GHz	5.49	116.16	54.96
Short length with dielectric loading	-22.5 @ 26 GHz	10.03	56.62	42.64

CONCLUSION

Dielectric loaded Substrate Integrated Waveguide (SIW) H-plane horn antenna showing best results at 26 GHz has been presented in this paper. A comparison between the simulated results of horn antenna without dielectric loading and with dielectric loading shows that by placing a dielectric slab of proper length in front of the aperture of horn results in the reduction of beamwidths in the E-plane and H-plane, as a result of which the gain of the antenna increases. Such antennas are very much suited for automotive radar applications.

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