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A Novel SIW Corrugated H-plane horn antenna

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***Abstract*—A novel H-plane Substrate Integrated Waveguide (SIW) horn antenna is designed in this paper. A new type of SIW feeding technique is presented that has well high gain and radiation efficiency. The feeding section of the horn antenna uses stepped transformer for the improvement in the impedance bandwidth. The corrugated horn section is used to increase the radiation characteristics of the proposed antenna. The center frequency of the proposed SIW horn antenna is 18.48 GHz. It has a gain of 7.03 dBi, impedance bandwidth 1.3 % and the radiation efficiency of 93.38%.**

***Keywords*—SIW, impedance bandwidth, Stepped, RL, gain and efficiency**

I. INTRODUCTION

Recently, the rectangular horn antenna is one of the preeminent widely used antennas in microwave applications. However, substrate-integrated-waveguide (SIW) horn antennas are not as frequently used as metallic rectangular horn antennas because of the low front-to-back ratio (FTBR) and impedance mismatch [1].Using the stepped transform can improvement the FTBR and matching impedance. The upper and lower triangular corrugated shape SIW structure has been considered in 2-D (pyramidal shape in 3-D). The corrugated unit helps improvement the radiation characteristics of antenna like conventional horns such as increasing in gain.

The RF circuit component must be compact in size and light in weight .SIW technology promising and emerging candidate for RF and microwave circuit because the structure have the advantages of convectional metallic waveguide, namely high power handling capacity, high quality factor and low loss radiation [2]

In this paper we present a NSIW H-plane horn antenna, this antenna is integrated by using single substrate. It is to fabricate and the structure is compact. To remove the higher order mode in the wave guide, the thickness of the substrate is kept constant. At the lower frequency region, the width of SIW becomes large. As a result the flare angle changing of SIW is challenging task for the researcher. By using stepped transform technique the impedance bandwidth can be increasing considerable [3].We achieve the gain of 7.03 dBi and efficiency of 93.38% at 18.48 GHz (K-band).

The structure is developed on Roger RT/duroid 5880 substrate with the permittivity (ε_r) of 2.2, height or thickness (h) Of 2.54 mm and loss tangent of 0.0009 and a working frequency of 18.48 GHz are used in all simulated result. All the simulated result is gotten from Ansoft HFSS that is associated with Finite Element Method (FEM).

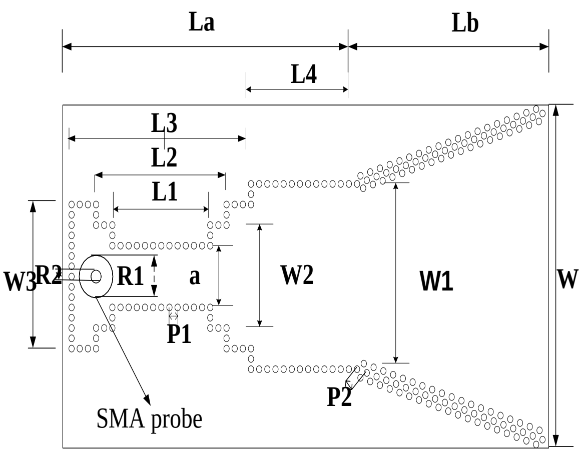


Fig.1.A Novel SIW H-plane horn antenna, top view

II. CONCEPT OF NSIW H-PLANE HORN ANTENNA

The large emphasis placed on horn antenna research was inspired by need to reduce spillover efficiencies and cross polarization loss and increase aperture efficiencies of large reflection used in radio astronomy and satellite Communication using the convectional feed aperture efficiencies of 50-60% microwave radiometry.

However efficiencies' of order of 75-80% can be obtained with improved feed system utilizing corrugated horn. [6].The NSIW H-plane horn antenna is shown in Fig 1. It consist of 50Ω feed line, ground plane and metallic vias on the both sides indicates in Fig 1.But in this paper efficiencies of the order of 90-95% can be obtain with improve the gain and improve feed systems utilizing the stepped transform .Configuration of a horn is shown in Fig 1.One end, it is open circuited whereas in the case of a SIW there is metallic vias on the both side. As the opposite of wall is open circuited, it is act as a magnetic wall.Consequantly in the waveguide section propagate the Transverse Electric with the dominant mode i.e. TE_{10} mode.

III. ANTENNA DESIGN

Fig 1.shows all the dimension of parameter of proposed a NSIW H-plane horn antenna. The antenna has been design on low cost and easily available Roger RT/duroid 5880 (tm) substrate of dielectric constant (ε_r) of 2.2,height or thickness

(h) of 2.54 and loss tangent (tan δ) of 0.0009. It consist of 50Ω feed line, ground plane metallic vias on the both sides.

TABLE 1.

Parameters	Dimensions (mm)	Parameters	Dimensions (mm)
La	43.3	W1	21.6
Lb	28.2	W2	12
L1	14.4	W3	16.8
L2	19.2	a	7.2
L3	27.7	R1	2.5
L4	15.6	R2	0.746
W	40	P2	1.5
P1	1.2	d	0.8

A 50Ω feed line design by a SMA probe of inner diameter R1 and outer diameter R2. The distance between two vias and radius of vias are important factor of the design of any kind of SIW antenna. Using the following equation, where w_{eff} is the width of the waveguide [4, 5].

$$w_{eff} = a - 1.08\frac{d^2}{p_1} + 0.1\frac{d^2}{a} \quad (1)$$

The empirical equation is very accurate when p_1/d is smaller than three and d/a smaller than 1/5.

In our design the center to center distance p_1 between two vias is 1.2mm and also center to center distance p_2 of corrugated part is 1.5mm and diameter of vias is 0.8mm each. his dimension of this antenna is 71.5 x 40 x 2.54 mm^3. The details dimension of proposed a novel SIW H-plane horn antenna in table l.

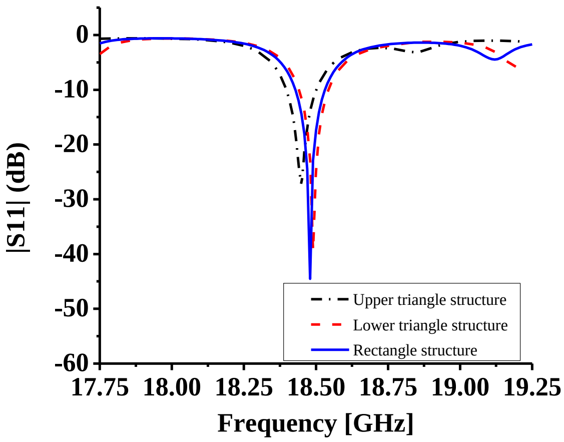


Fig.2. Simulated $|S_{11}|$ parameter.

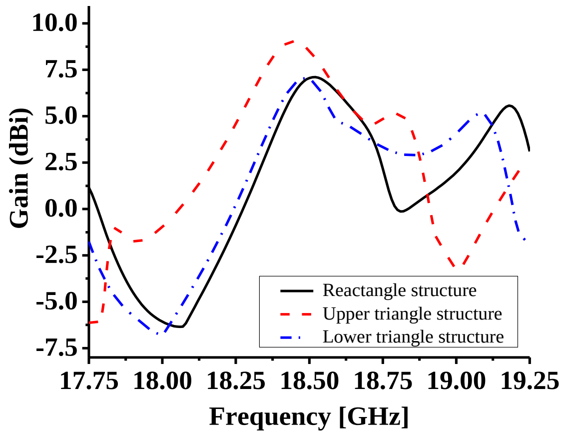


Fig.3.Peak gain versus frequency (Simulated by Ansoft HFSS)

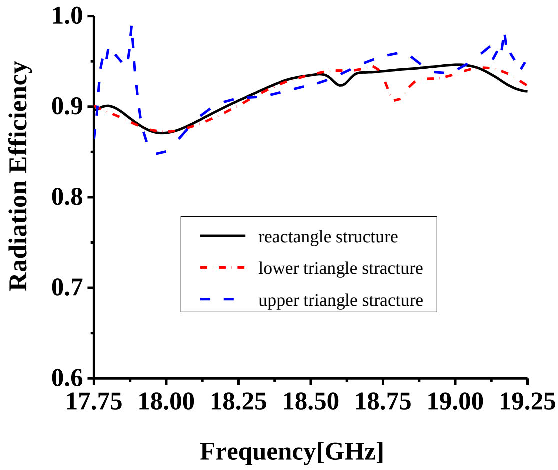
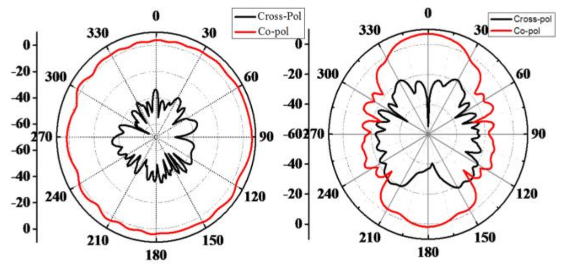


Fig.4.Efficiency versus frequency (Simulated by Ansoft HFSS)



(a) (b)

Fig.5.Radiation pattern of the antenna (a) H-plane at 18.48 GHz (b) E-plane at 18.48 GHz. (Simulated by Ansoft HFSS)

IV. RESULTS AND DISCUSSION

The NSIW H-plane horn antenna is designed to operate at 18.48GHz. The return loss of the proposed NSIW is presented Fig 2.for the three structure. It is observed from the Fig 2. That the return loss at 18.48 GHz is 44.53 dB with 1.28% of bandwidth..

The maximum gain of 7.03 dBi is obtained at resonant frequency for NSIW H-plane horn antenna shown in Fig 3.The maximum efficiency of NSIW H-plane horn antenna at 18.48 GHz is 93.38% is achieved shown in Fig 4.This type of antenna radiates normal to its surface, so the elevation pattern for $\varphi=0^0$ and $\varphi=90^0$ are important for measurement. Fig 5. (a) and (b) are shows the H-plane and E-plane. The radiation pattern at 18.48 GHz, and we observed that cross polarization level very less in both cases

V. CONCLUSION

In this work, a novel SIW H-plane horn antenna has been proposed. This antenna is basically miniaturized version of convectional H-plane horn antenna without degrading its performance. This antenna can be used for the speed radar, surveillance, imaging and wireless applications.

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