Design of Parallel Plate Waveguide Antenna with Rectangular Patch Single VIAS

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***Abstract*:- In this paper, a parallel plate waveguide antenna is done with rectangular patch with vias. Here the work is based on three types: (a) parallel plate with rectangular patch double via (b) parallel plate with rectangular patch single via (c) parallel plate with rectangular patch without via. The frequency is achieved in multiband and the directivity of the gain is varied. The results show that when placing a single via on the rectangular patch the gain is 5.41dBi than compared with the others. The return loss is < -10dB is achieved.**

Keywords: Parallel Plate waveguide, parasitic patch loading, rectangular patch vias

I.INTRODUCTION:

Substrate integrated waveguide (SIW) is a new concept for planar waveguide structure, which exhibits the low profile, low insertion loss, simple manufacturing, easy integration with other planar circuits. In particular, the feeding of surface-wave or leaky-wave antennas, the SIW H-plane horn antenna. The conventional horn antenna, the SIW horn antenna has a distinct shortcoming: The inside horn antenna contains a dielectric material, and some electromagnetic waves will be reflected at the boundary of the antenna aperture due to the permittivity difference [1]. The horn antenna is probably and widely used microwave antenna that provides a transition between waves propagating in a transmission line and waves radiating in the free space. However, their bulky geometry sometimes limits their application in the compact forms. The substrate integrated waveguide (SIW) technology has employment of the planar horn antennas to be integrated into the microwave and millimeter-wave circuits. The H-plane sectoral horn, which is formed by flaring the rectangular waveguide in the plane normal to the electric field, can be accomplished by SIW technology. Since then, have been reported on the substrate integrated H-plane horn antenna [2]. Substrate integrated waveguide (SIW) technology allows the implementation of rectangular waveguide functionalities into compact planar structures.

The size reduction can be obtained with folded, half-mode, and quarter-mode SIWs. Therefore it was a quite obvious step to use SIW for the development of planar horn antennas, showing low profile and weight and able to fabricate in a single dielectric substrate. Similar to classic all-metal horn antennas, the phase distribution of the electric field in the aperture of a planar SIW-based horn is not uniform. This may results a sizeable reduction of the aperture efficiency and hence in a low antenna gain. The phase distribution and to enhance the gain. Some dielectric slabs and lenses are used as terminating loads in the horn aperture, to serve both as a guiding structure and a phase corrector. The metal-via arrays are embedded inside the horn to emulate a perfect electric conductor (PEC) boundary condition. This can be used to change the propagation constant of the mode, thus correcting the aperture phase and improving the gain. [3].These new circuits combine the classical non planar technologies (waveguide or coaxial transmission lines) such as high quality factors, and the benefits of planar circuits such as low cost and easy compact. In this, substrate integrated waveguide (SIW) allows to construct types of commonly used antennas. However, different limitations are used for the substrate that appear for implementation of certain types of antennas, i.e. low efficiency as frequency is increased due to dielectric loss, strong mismatch as a consequence of the use of thin substrate layers, and high reflection at the end of the aperture caused by the impedance difference between the dielectric and air [4]. Due to its planar structure, simple fabrication, easy integration, the substrate integrated waveguide (SIW) horn antenna has many applications. It is known that due to the mismatch between the substrate inside the horn antenna and the free space at the horn aperture, the planar SIW horn antenna works in a narrow band. Solution based on loading extended substrate provides a straightforward method to reduce the mismatch [5]. The substrate integrated waveguide (SIW) technology is a very especially for systems operating in the millimetre-wave region. The most significant SIW is the possibility to integrate all the components on the same substrate, including passive components (filters, couplers, etc.), active elements (oscillators, amplifiers, etc.) as well as antennas. This allows the possibility to create substrate integrated circuits (SICs) [6].

RECTANGULAR PATCH:

The traditional mushroom like EBG structure uses square patch units so that its reflection phase for normal incidence is independent on the polarization of the incident plane wave. When square patches are replaced by rectangular patches, the reflection phase of the EBG surface is dependent on the *X*- or *Y*-polarization state of the incident plane wave. When the incident plane wave is *Y* polarized, the rectangular-patch EBG surface has the same reflection phase as the square-patch EBG surface

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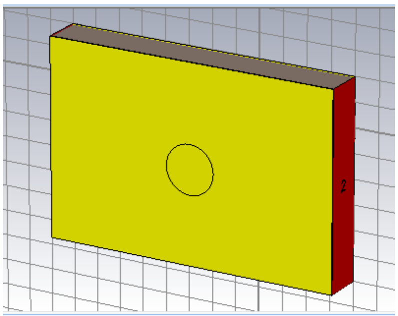
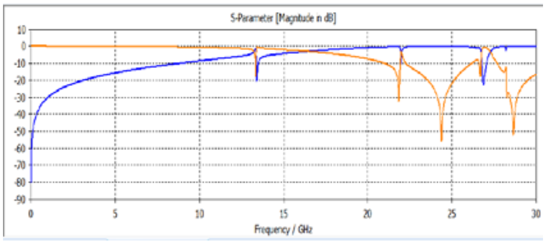
because the patch widths are the same. For the *X*-polarized incident plane wave, the patch length determines the reflection phase. Since the length is longer, the reflection phase shifts down to a lower frequency. But here the rectangular patches with single and double vias are done. The substrate of the unit cell is Roger 5880with thickness 1.67mm the via and patches are filled with copper.

RECTANGULAR PATCH UNIT CELL DESIGN:



Rectangular patch with single via

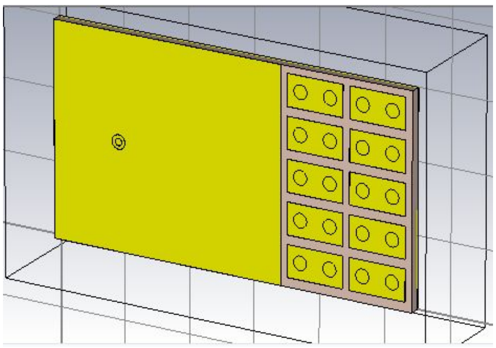


Characterization of Unit cell

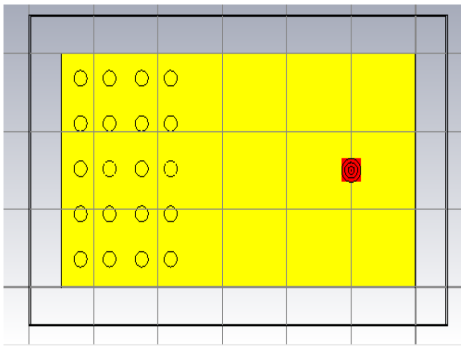
II.ANTENNA DESIGN:

(A) PARALLEL PLATE WAVEGUIDE ANTENNA WITH DOUBLE VIA:

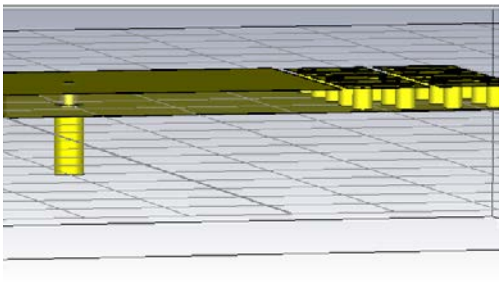
Here the parallel plate waveguide antenna is done by the material Rogers 5880 Substrate. The vias of the rectangular patch double via and the patches are filled with copper. The coaxial feeding is given in the substrate. The feeding probe is to avoid the radiation loss. Above the substrate a copper plate is placed. Likewise same for the parallel plate waveguide antenna with patches.



Perspective view

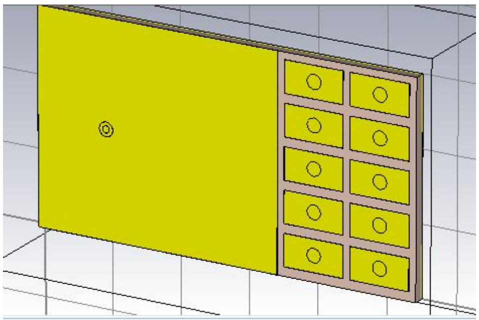


Back view

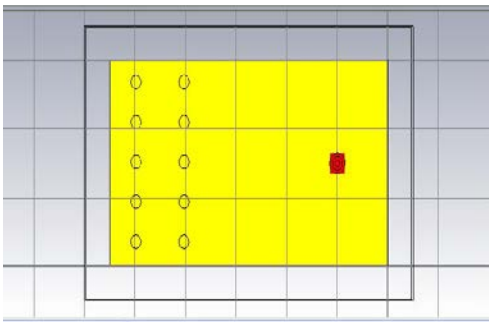


Side view

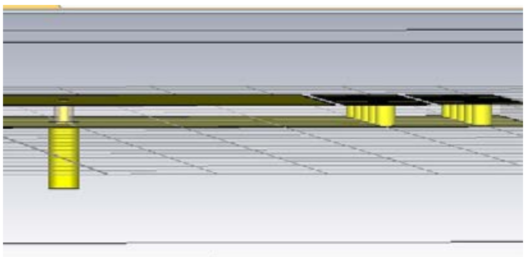
(B) PARALLEL PLATE WAVEGUIDE ANTENNA WITH SINGLE VIA:



Perspective view



Back view



Side view

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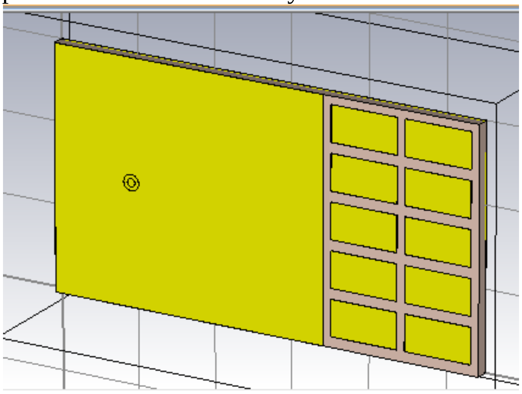
(C) PARALLEL PLATE WAVEGUIDE ANTENNA WITH RECTANGULAR PATCH WITHOUT VIA:

The parallel plate waveguide antenna with parasitic patches. Here the vias has been avoided due to the leakages problems and only the patches are remaining. By this antenna the result performance has been analyzed.



. Perspective view

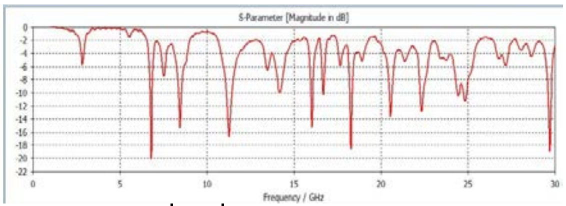
PARAMETERS USED:

S.NO	NAME	MATERIALS
1.	Substrate	Rogers 5880
2.	Vias	Copper
3.	Patch	Copper
4.	Ground	Copper

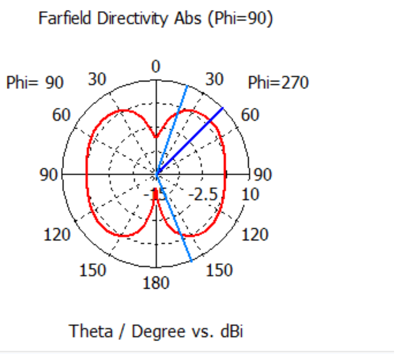
III.RESULT ANALYSIS:

The result analysis compared between the parallel plate waveguide with double vias and single via and parallel plate waveguide antenna with the parasitic patches.

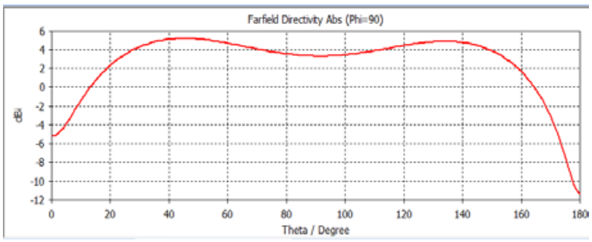
1. PARALLEL PLATE WAVEGUIDE ANTENNA WITH DOUBLE VIAS:



$|S_{11}|$ for Double vias

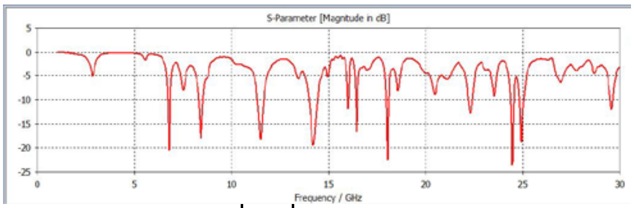


Polar plot

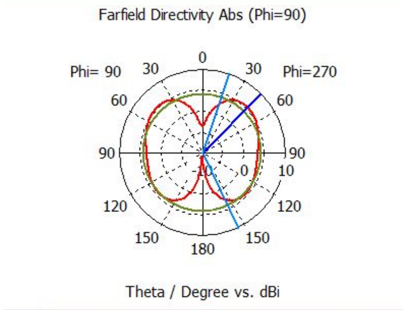


Directivity of double vias

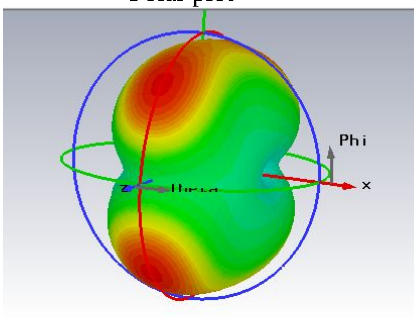
2. PARALLEL PLATE WAVEGUIDE ANTENNA WITH SINGLE VIA:



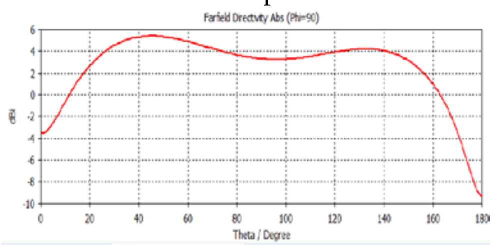
$|S_{11}|$ for Single via



Polar plot

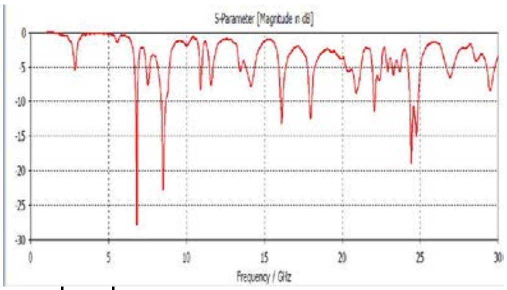


Radiation pattern

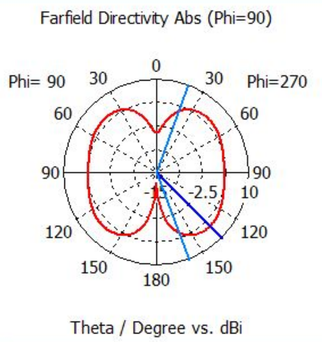


Directivity of single via

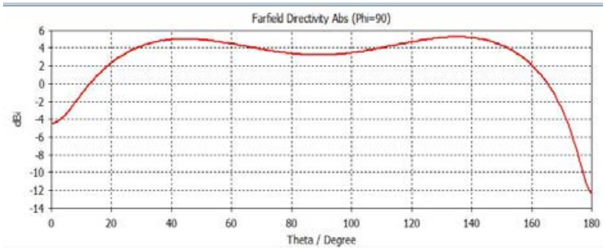
3. PARALLEL PLATE WAVEGUIDE ANTENNA WITH RECTANGULAR PATCH WITHOUT VIA:



$|S_{11}|$ for without via



Polar plot



Directivity of without via

COMPARSION RESULT:

Table 1: Comparison result for parallel plate waveguide antenna with single and double vias and rectangular patches

	PARALLEL PLATE WAVEGUIDE ANTENNA WITH DOUBLE VIAS	PARALLEL PLATE WAVEGUIDE ANTENNA WITH SINGLE VIA	PARALLEL PLATE WAVEGUIDE ANTENNA WITHOUT VIAS
$\|S_{11}\|$	< -10dB	< -10dB	< -10dB
Directivity	5.22dBi	5.41dBi	5.28dBi

IV.CONCLUSION:

In this paper, a Parallel Plate waveguide is placed in front of the rectangular patch with vias and parasitic patches. By this single and double vias and the patches are observed on the multiband frequency with bandwidth improvement. The directivity of gain for single via result shows is better and good performance is achieved when compared between the double vias and parasitic patches. In these cases the $|S_{11}|$ is below -10dB and multiband frequency is achieved.

V. REFERENCES

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