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Design and Analysis of different shaped Slots in Substrate Integrated Waveguide at Ku Band

G Naveen Kumar[1], T Vijaya Kumar[2], Mande Srinivasa Rao[3], K Ramesh Babu[4]

[1]Associate Professor, Vasireddy Venkatadri Institute of Technology, gnaveen.nani@gmail.com

[2]Assistant Professor, Vasireddy Venkatadri Institute of Technology, tvk916@gmail.com

[3]Assistant Professor, Vasireddy Venkatadri Institute of Technology, mande438@gmail.com

[4]Assistant Professor, Vasireddy Venkatadri Institute of Technology, rammi.ramesh50@gmail.com

Abstract

In this paper slots of different shapes like rectangular slot, O-shaped Slot and L-Shaped Slot are cut in Substrate Integrated Waveguide and designed using CST at 15GHz. The Simulated results of Reflection Coefficient S_{11}, and radiation Patterns of different shapes are presented and the bandwidth is improved so that the antennas can be used in wide band applications.

Keywords- *Substrate Integrated Waveguide, CST, slot, Reflection Coefficient, Bandwidth*

1. INTRODUCTION

Antennas for high frequency applications has become a challenge. Rectangular waveguides and Microstrip Antennas are mostly used. More number of papers are Published on Wave guide slot antenna arrays and Microstrip Antennas. The Rectangular waveguide structures are better than transmission lines with their own advantages like high quality factor, low losses, but they are bulky and non-plannar in structure .Microstrip antennas has advantages like light weight and easy to fabricate and they are plannar structures but they suffer from losses and has low quality factor. Substrate Integrated waveguides emerged as a promising technology in which two rows of vias are inserted between two metal plates. It implements the rectangular waveguide structure in plannar form. [1] gives the comparative study between FR-4 and Rogers substrate listing all the typical values of parameters. [3] describes the linear slots cut in SIW to improve the gain around 14 GHz but its bandwidth is too narrow and can be used only for fixed frequency applications. In this paper Rogers Substrate with relative permittivity of 2.2 and loss tangent of 0.0009 is used instead of FR-4 to minimize the losses and give better performance at high frequencies. Different structures are designed and simulated and observed that the performance is improved.

2. PROPOSED ANTENNA STRUCTURES

Three different shapes of slots are cut in the Substrate Integrated Waveguide and simulated using CST(Computer Simulation Technology-Microwave Studio). In the first structure an outer rectangular slot with 8x13 mm and inner rectangular slot with 4x9 mm dimensions is cut as shown in the figure below. The metallized vias around the rectangular slot prevents the loss that occurs during excitation. Rogers RT 5880(lossy) substrate is chosen with dimensions height (h) = 1.588 mm , dielectric constant

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(ε)=2.2 and loss tangent is 0.0009.

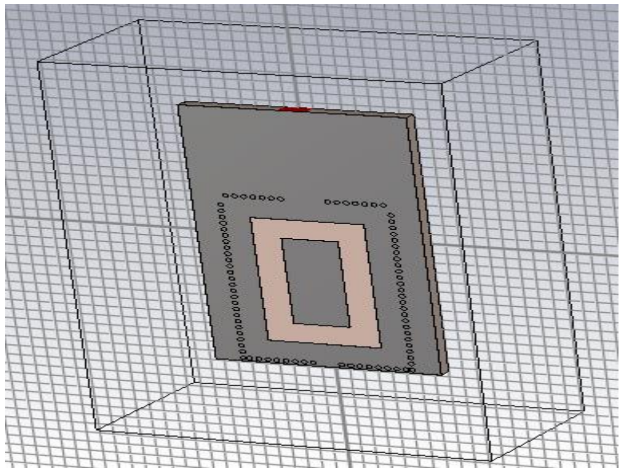

Fig 1: Rectangular Slot in SIW

In the second structure a simple O-shape is cut in the rectangular patch as shown in the below figure. This structure is also designed and simulated using CST and the substrate used is Rogers RT 5880(lossy).

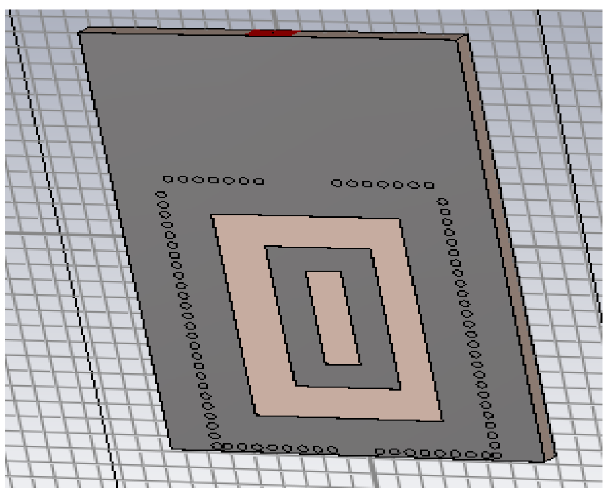

Fig 2: O-Shaped Slot in SIW

In the third structure a simple L-shape slot is cut in the rectangular patch as shown in the below figure. This structure is also designed and simulated using CST and the substrate used is Rogers RT 5880(lossy).

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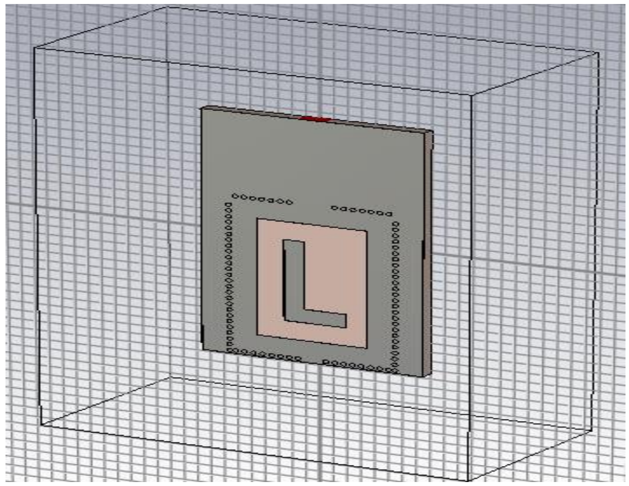

Fig 3: L-Shaped Slot in SIW

3. RESULTS AND DISCUSSIONS

In this section the results of the three proposed structures are discussed.
A. Reflection Coefficient (S_{11})

In Antenna terminology, Reflection Coefficient is defined as the amount of the electromagnetic energy that is reflected due to impedance mismatch in the transmitting medium. It is the ratio of reflected wave to the incident wave.

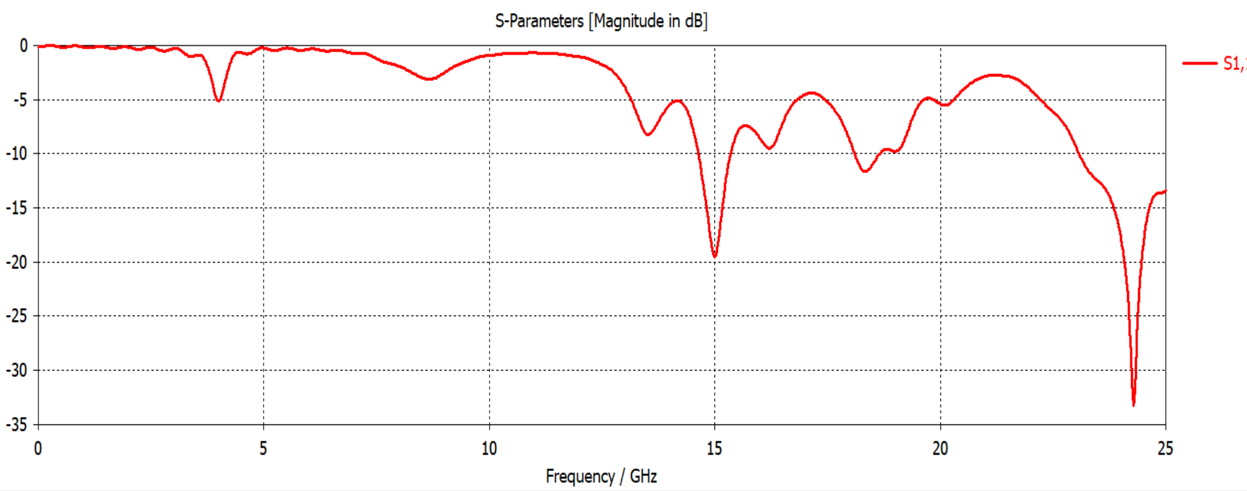

Fig 4: S_{11} of structure 1

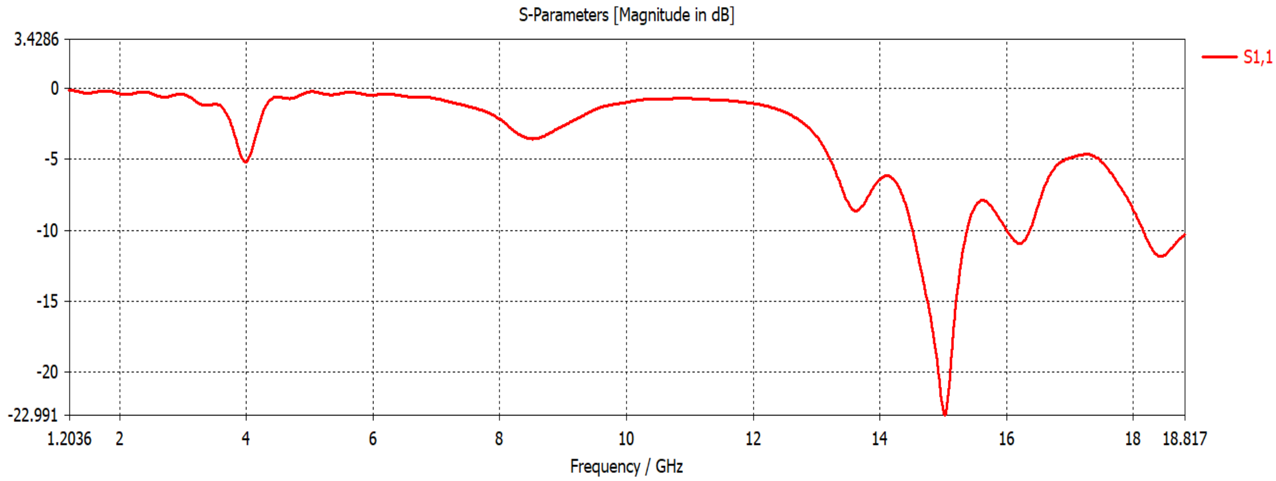

Fig 5: S_{11} of structure 2

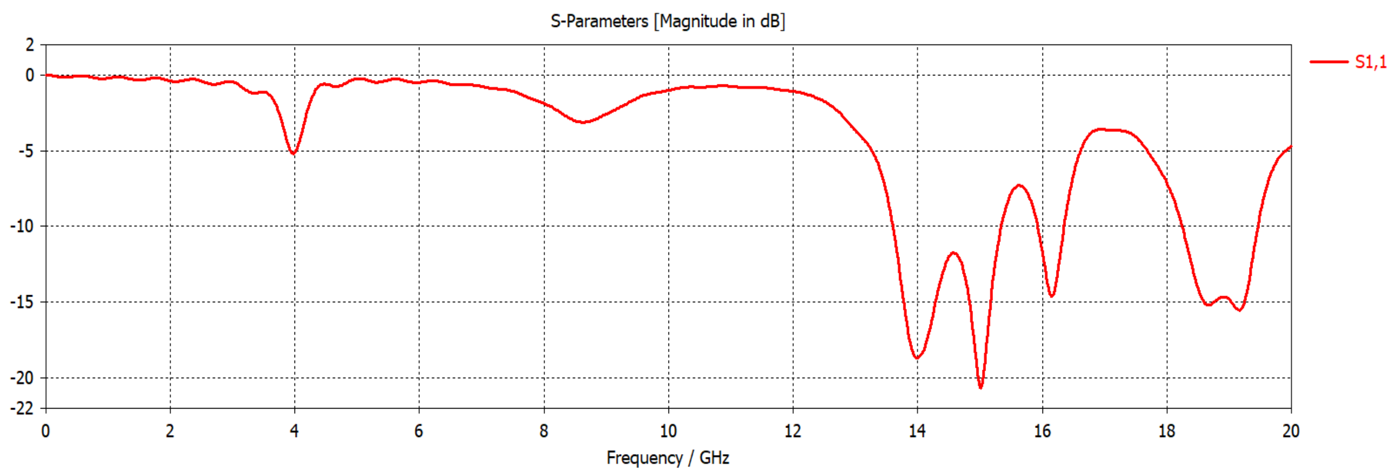

Fig 6: S_{11} of structure 3

In the three structures , the magnitude of S_{11}< -10 dB at frequency 15GHz, the Bandwidth is more in L-shaped slot when compared to another two structures .

B. Far field Patterns

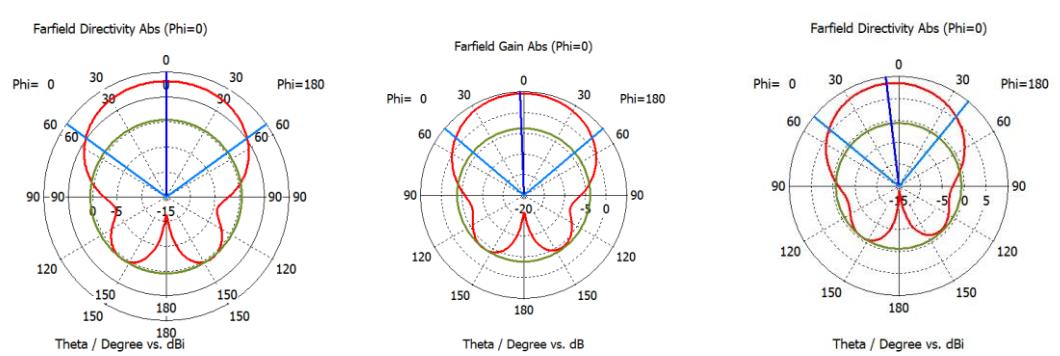

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Fig 7: Radiation Patterns of 3 structures respectively.

The results at f=15 GHz are summarized in the table given below

Slot Shape	**Main Lobe Magnitude**	**Side Lobe Level[SLL]**	**3-dB Angular Width**	**Reflection Coefficient S_{11}**
Structure-1 [Rectangular]	8.2 dBi	-7.8 dB	54.4^{o} degrees	-20 dB
Structure-2 [O-shaped]	4.56 dBi	-8.4 dB	50 ^{o} degrees	-22.991 dB
Structure-3 [L-Shaped]	8.54 dBi	-9.2 dB	50.8^{o} degrees	-21 dB

4. CONCLUSION

The Substrate Integrated Waveguide with different slot shapes are designed and simulated using CST and it is observed that these antennas are applicable for Ku band applications and the enhancement of bandwidth in O-Shape structure signifies the slight improvement of bandwidth

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