A Slotted Substrate Integrated Waveguide Antenna for Millimeter Wave Applications

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Abstract: In this paper, a slotted substrate integrated waveguide (SIW) antenna is proposed and simulated. The simulation is done using High Frequency Structural Simulation (HFSS), which is based on the finite element method. The square-shaped slots array is formed in the upper ground plane of the SIW. The various parameters such as return loss, gain, and efficiency of the proposed SW antenna are investigated. The antenna is resonating at a frequency of 32.5, 35 GHz, and 38 GHz with a return loss of 12 dB, 25 dB, and 19 dB, respectively. The proposed antenna is designed on a dielectric of RT duroid of a thickness of 0.254 mm.

I. Introduction

Millimeter-wave frequencies in the electromagnetic wave spectrum have received a lot of attention due to their potential applications in future communications and radar systems such as high-definition video streaming, wireless back-haul links, space communications, high-resolution imaging radars, and so on. The available bandwidth at each atmospheric window within the millimeter wave is relatively large, allowing for high-data-rate communications [1]

The substrate integrated waveguide (SIW) technology has drawn much attention due to its low loss, low cost, and ease of integration in millimeter wave band applications. Several millimeter wave antennas were realized based on SIW cavities [2].SIW is a dielectric filled rectangular waveguide where the metal cladding is used on the upper and lower sides of the substrate acting as top and bottom walls. The vertical side walls of the waveguide are formed by the metallic vias on either side of the waveguide [3-6]. A. Dadgarpour et al. [7] presents a high-gain bow-tie antenna that operates across 57-64 GHz for application in high data rate point-to-point communication systems. The proposed antenna consists of a pair of bow-tie radiators, where each radiator is etched on the opposite side of the common dielectric substrate and fed through substrate integrated waveguide (SIW) feed-line. D. Zheng et al [8] design a A longitudinally slotted TE20-mode-driven substrate integrated waveguide (SIW) leaky-wave antenna (LWA) with low side-lobe and low cross-polarization is proposed and presented for millimeter-wave applications. A. Dadgarpour et al. [9] a high-gain bow-ti e antenna that operates across 57-64

GHz for application in high data rate point-to-point communication systems. The proposed antenna consists of a pair of bow-tie radiators, where each radiator is etched on the opposite side of the common dielectric substrate and fed through substrate integrated waveguide (SIW) feed-line. Y. M. Hussain et al [10] design of an antenna based on Substrate Integrated Waveguide (SIW). The structure consists of slot antenna designed to operate at Ka band frequency. The effect of introducing slots and diameter of vias have been extensively studied.

This work proposed an SIW antenna, the upper ground plane of the antenna is loaded with square slots. The separation between the square slots of separation of $\frac{\lambda}{2}$.

II. Antenna Design and Results Analysis.

The proposed antenna is constructed on an RT duroid 5880 dielectric substrate with a relative dielectric constant of 2.2. The substrate has a thickness of 0.254 millimetres. two square slots with measurements of 4.2 x 0.17 mm2 and 6.5 x 0.7 mm2. A taper transition and microstrip feed line are constructed for impedance matching; the analysis of the feed line is illustrated in [14]. The vias' diameters are assumed to be 0.5 mm, and the distance between them to be 1 mm. The suggested SIW antenna is seen in Figure. 1.

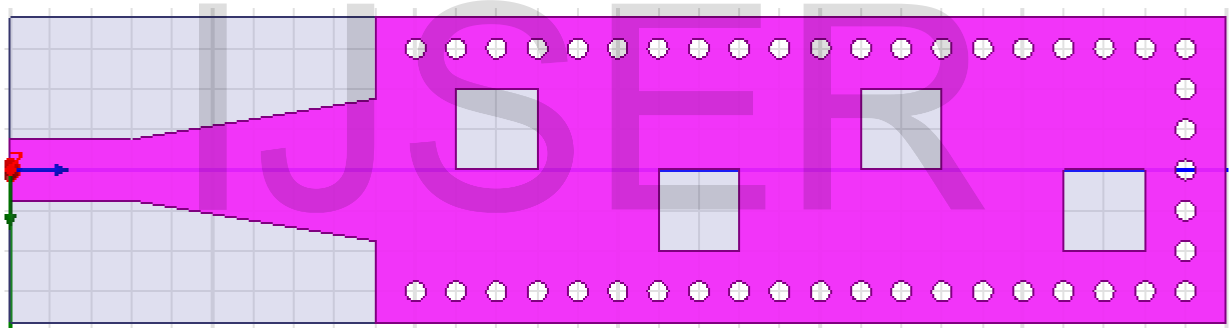


Figure 1. Configuration of proposed SIW antenna

The slots are in the form of the square of dimension 2 mm. Figure 2 shows the return loss curve of the proposed antenna.

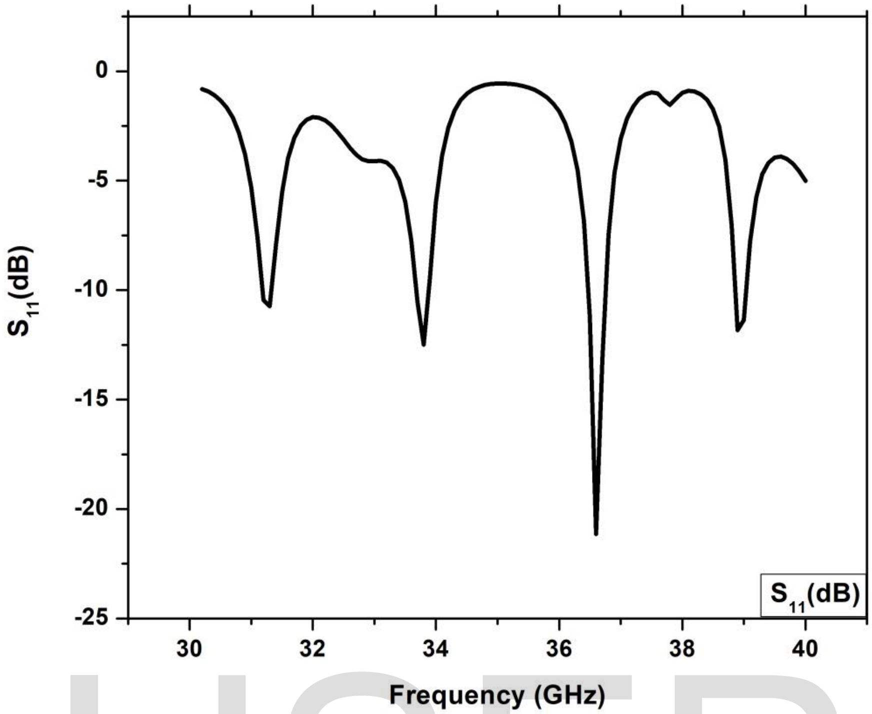
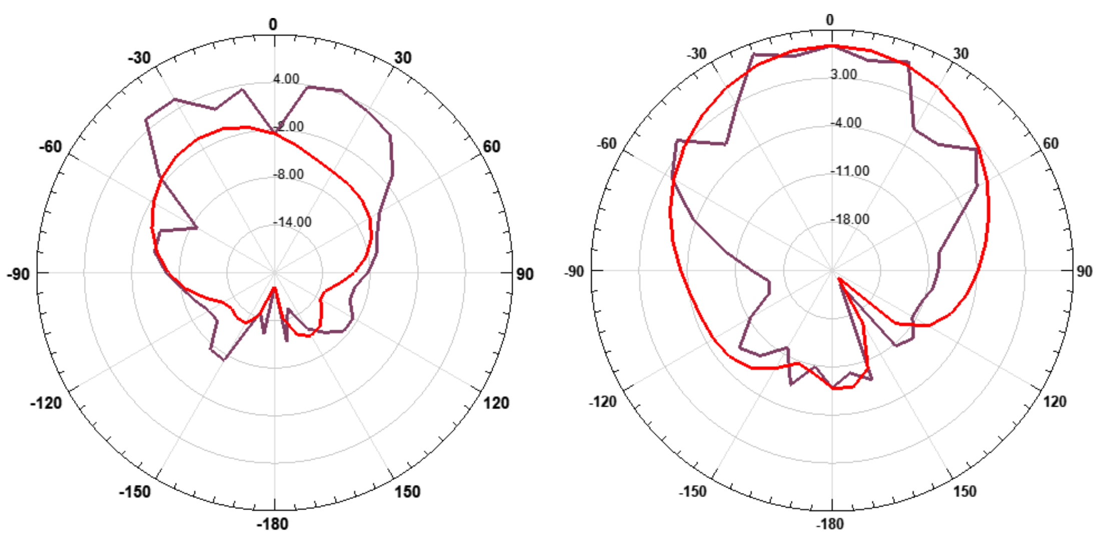
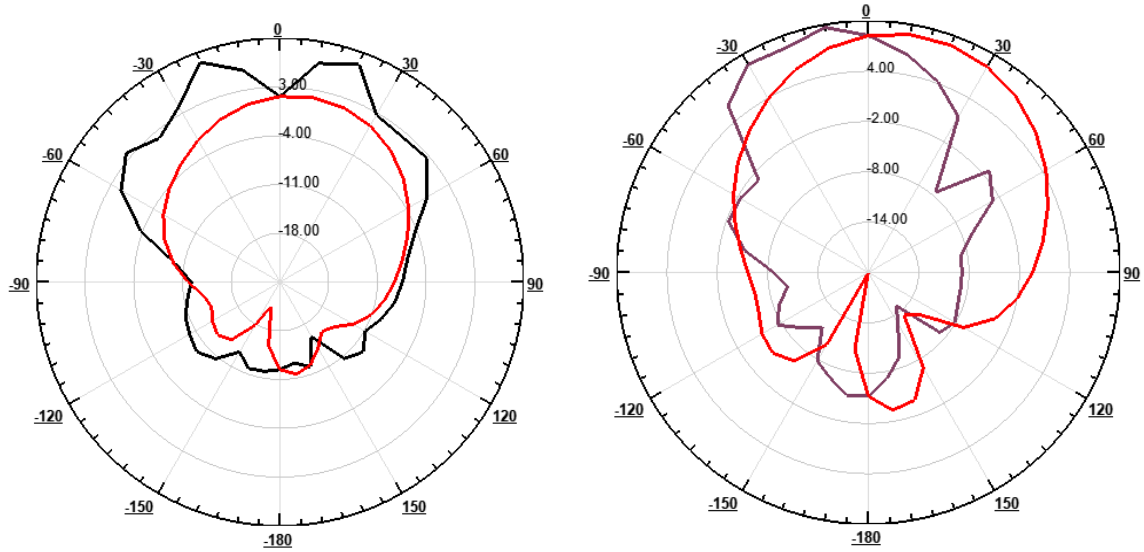


Figure 3. S_{11}(dB) Vs Frequency curve

The antenna is resonating at frequencies of 31.3 GHz with a return loss of -10.7 dB, 33.8 GHz with a return loss of -12.5 dB, 36.6 GHz with a return loss of -21.1 dB and 39 GHz with a return loss of -12 dB. Figure 3 shows the 2 D radiation pattern of proposed antenna at



(a) (b)



(c) (d)

Figure 3 2 Radiation Pattern at (a) 31.3 GHz (b) 33.8 GHz (c) 36.6 GHz (d) 39 GHz

As shown from the radiation pattern curve, at all the resonating frequency the antenna is resonating in the broadsided direction.

III. Conclusions

The proposed SIW antenna is applicable for millimeter frequencies of 31.3 GHz, 33.8 GHz. 36.6 GHz and 39. The Proposed antenna shows a high gain and broadside radiations. The antenna can be used in various future applications based on IOT, sensors for communications and perceptions. The antenna can be used easily as an element of antenna array systems.

IV. References

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