Novel Design of Thz Microstrip Patch Antenna for Radar Applications

Y. E. Vasanth Kumar, B. Srinivas, V. Praveen Kumar, T. Kamalesh, A. Mounica

Abstract- The growth of Microstrip patch antennas is rapidly increased in modern era of wireless communications due to their tremendous advantages like low cost, low profile and easily integrable to many VLSI circuit boards. As the demand of frequency spectrum is increases rapidly due to all communication applications are done using wireless. So, there is requirement of designing the antennas at Tera Hertz frequency range. In this paper, a U-shape slotted microstrip patch antenna is designed for tera hertz frequency RADAR applications. U-Shaped slot on the rectangular patch with substrate ROGERS/RT Duriod (5880) of relative permittivity of 2.2 is used. The designed antenna is used in police RADAR to monitoring the speed of vehicles and detecting the range. The performance characteristics of the antenna are evaluated by exploiting the parameters like Return loss, VSWR, Gain, and Directivity. The projected antenna is simulated using the EM Simulation Tool High Frequency Structure Simulation Tool (HFSS). All these parameters are tabulated with detailed analysis and calculations are listed.

Keywords--U-shaped slot, microstrip patch antenna, RADAR, gain, VSWR and HFSS.

I. INTRODUCTION

In a wide range of applications where size, cost, ease of installation are may requirements for antenna. Microstrip patch antenna having all these characteristics which they are low cost, small size, simple to design but the performance is limited by their low efficiency and narrow bandwidth [1]. Microstrip patch antennas are receiving a considerable attention in 1970s and later developed slot cutting techniques to overcome these limits. From the literature survey the U-shape slot on the patch will improve the performance. U-shaped slot antennas are used not only for wider bandwidth but also for dual band, quad band applications [2][3]. For multi band applications E+U shaped antennas are designed [4]. The Circular shaped patch with defected Ground Structure (DGS) is designed for Multiband frequencies in X-band frequency range [5]. There are many configurations used to feed microstrip antennas, but the microstrip line feeding technique is used as it is easy to fabricate, simple to match the model. The substrate dielectric constants are usually in the range of 2.08 to 12, In this paper RT Duriod substrate is used with Dielectric constant 2.2. The Dimensions of the proposed antenna is calculated using the following equations.

Width of patch $W_p = \frac{c}{2f}\sqrt{\frac{2}{1+\varepsilon_r}}$

Where, C = $3X10^8$ m/s.

Length of patch $L_p = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta L$

Where, $\Delta L = 0.412\frac{(\varepsilon_{eff}+0.3)(\frac{W_p}{h}+0.264)}{(\varepsilon_{eff}-0.258)(\frac{W_p}{h}+0.8)}$

ε_{eff} is effective dielectric constant

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+12\frac{h}{W_p}}}$$

Width of substrate $W_s = W_p + 6h$;

Length of substrate $L_s = L_p + 6h$;

A Tera Hertz microstrip antenna is characterized with U-Shaped on the patch with slot dimensions 2X2.8(mm^2) with substrate dimensions 9.5x11 (mm^2). The proposed antenna will operate at Tera Hertz frequency range from 20.3 GHz to 21.3 GHz with resonant frequency 20.8GHz.

II. ANTENNA DESIGN

In this paper, A RT Duriod substrate with ε_r= 2.2 having the dimensions 9.5x11 (mm^2) designed on the metallic ground plane. On the substrate a rectangular metallic patch is designed with dimensions 3.5x5 (mm^2). To achieve the Tera hertz frequency of operation a u-shaped slot is etched on the patch with dimensions 2x 2.8 (mm^2). The Microstrip line feeding is used with dimensions 3x0.4 (mm^2).

The detail dimensions of U-shaped slot microstrip patch antenna as shown in figure.1

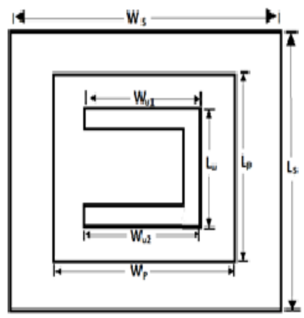

Figure.1 The proposed antenna detailed dimensions

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The intended antenna scope are tabulated in Table-1

Table-1 Dimensions of the designed antenna.

Design considerations	Value
Width of substarte 'Ws'	11 mm
Length of substrate 'Ls'	9.5 mm
Width of patch 'Wp'	5 mm
Length of Patch 'Lp'	3.5 mm
Length of U-slot 'Lu1 = Lu2'	2 mm
Width of U-slot 'Wu'	2.8 mm
Thickness of U-slot 'Tu'	0.08 mm

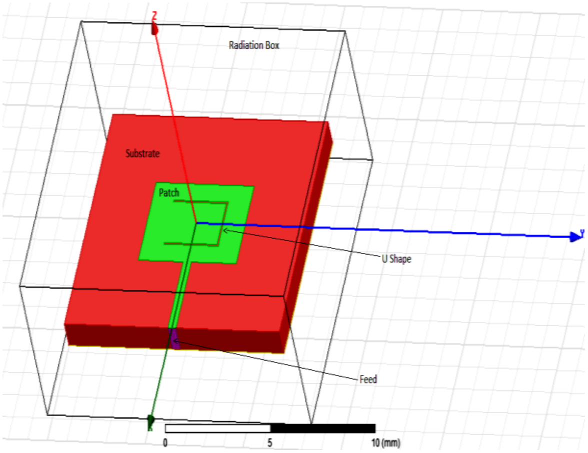

Figure 2 shows the simulated antenna design

III. SIMULATED RESULTS

The performance characteristics of the proposed antenna are evaluated using the following design considerations like VSWR, Return Loss, Directivity and Gain. The Return Loss characteristics of the anticipated antenna is shown in Figure.3

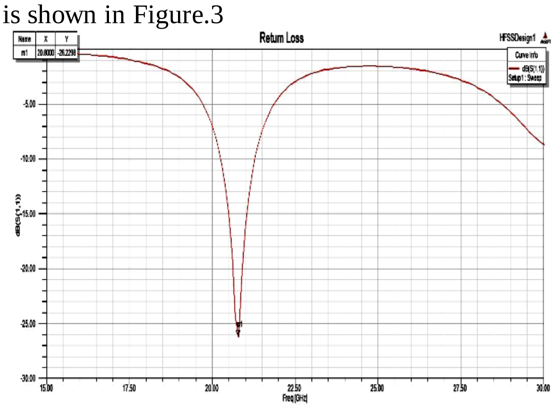

Figure .3 Antenna Return Loss.

The Return loss of the proposed antenna is < -10 dB from 20.3GHz to 21.3 GHz with Bandwidth of 1000 MHz. The return loss of the estimated antenna is -26.2298 dB at resonant frequency 20.8GHz. The VSWR plot of the antenna is shown in Figure.4

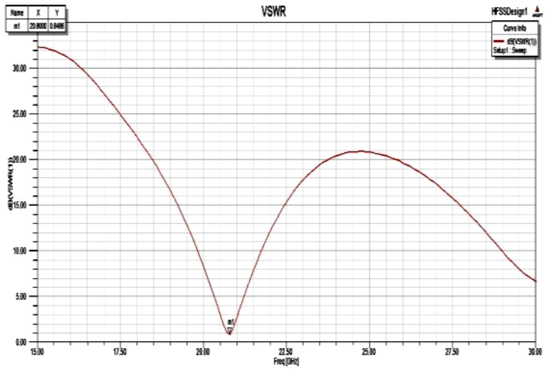

Figure.4 VSWR plot of proposed antenna

The VSWR, defined as the maxima to minima voltage level of a standing wave, is considered here for the anticipated antenna for <2dB from 20.6 GHz to 21 GHz. The VSWR is obtained at 0.8426 at resonating frequency of 20.8 GHz.

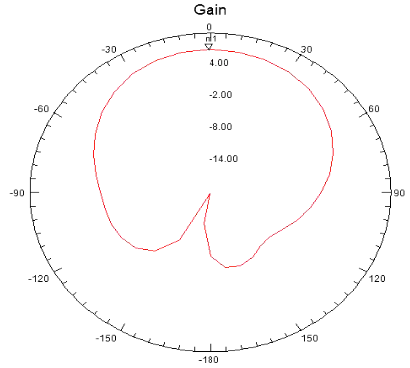

Figure.5 Gain of Designed antenna

The Maximum Gain of antenna is observed at 6.9250 dB at resonant frequency 20.8GHz. The Directivity of Designed antenna is shown in Figure.6

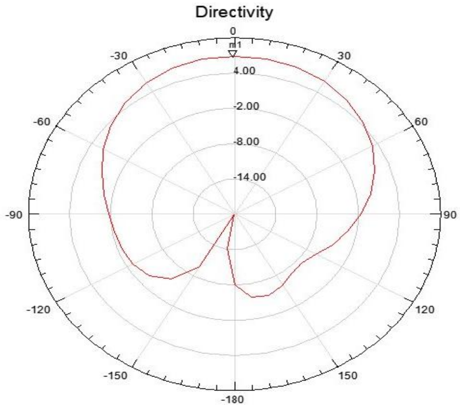

Figure.6 The Directivity of designed antenna

The Maximum directivity of proposed antenna is obtained at 6.8826 dB at resonating frequency 20.8GHz. The 3D gain plot of the proposed antenna is shown in Figure 7

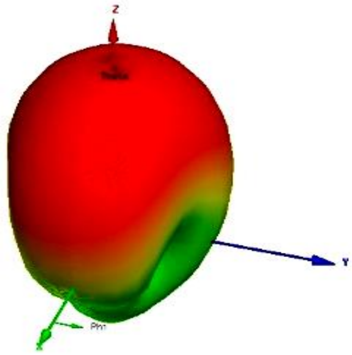

Figure.7 3D gain of antenna

IV. CONCLUSION

The U-shape slotted microstrip patch antenna with less return loss,high efficiency and good bandwidth is designed and simulated at THz frequency used for RADAR applications. The simulation results shows that S_{11} is -26.22 dB with VSWR is approximately 1 at 20.8GHz. The gain of the antenna 6.925 dB at 20.8GHz. The proposed microstrip patch antenna can be used mostly in radar applications.

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