Quad-Band H-Slot Microstrip Patch Antenna

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Abstract— Microstrip Patch Antennas are widely used in many wireless communication applications. In this paper an H-Slot microstrip antenna has been proposed, analysed and investigated using the Ansoft HFSS. For this purpose a rectangular defected ground plane is used along with a defected patch using transmission line feed. The defected patch includes H-Slot shaped patch while the defected ground plane includes a full parametric study of reconfigured ground. The antenna structure proposed in this paper is mounted on a FR-4 substrate with a dielectric constant of 4.7. Transmission line feeding technique is used to feed the antenna with 50 ohm impedance. The return loss is enhanced by using the antenna resonating at multi-frequencies.

Key words: H-Slot Patch, Defected Ground, Radiation Pattern

I. INTRODUCTION

Microstrip Patch Antennas are widely used in wireless communication applications. This is due to the fact that they are less hefty, smaller in size, have low manufacturing cost and can be easily fabricated. The aim for designing an antenna should be reduction in structure complexities and performance enhancement at the receiver end. The configuration and dimension type of the antennas are determined by the operating and application frequency. The multi-band antennas widely contributes in the wireless services. The antenna proposed in this paper provides four bands for WLAN (3.6 – 5GHz), RADAR, satellite applications and various other applications that come under SHF band (3 – 30 GHz). For the high frequency applications the microstrip antennas are preferred more because of the size of the antenna which depends upon the wavelength and resonant frequency.

This paper presents a Quad-band H-slot microstrip antenna having an operating band range of 3.75 – 4.23, 7.99 – 9.35, 11.69 – 13.57, 16.93 – 22.8 GHz. The antenna also provides a Return Loss of -21 db at 4 GHz, -29 db at 8.8 GHz, -13.83 db at 12.8 GHz and -42.19 db at 17.8 GHz frequencies.

The organization of the paper is done in four sections. The detailed designing of the H-slot antenna is discussed in section 2 followed by the presentation and discussion of simulated result in section 3.The section 4 concludes the paper.

II. ANTENNA DESIGN

The figure 1 presents the configuration of the proposed antenna and table 1 provides the dimensions of the proposed antenna.

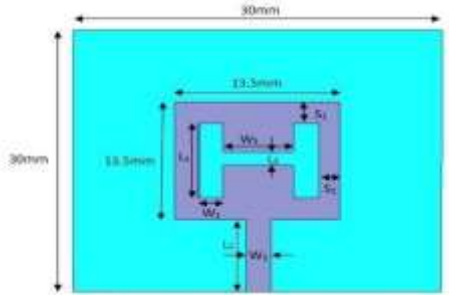

Fig. 1: Top view of the proposed antenna

Symbols	Value (in mm)	Symbols	Value (in mm)
L_1	8.5	W_2	2
L_2	8.25	W_3	5.94
L_3	1.5	S_1	2.5
W_1	2	S_2	2

Table 1: Dimensions of the proposed H-slot antenna

The antenna is mounted on a FR-4 substrate (ε_r = 4.7, tangential loss of 0.025) having a thickness of 2mm.The thickness of conductor is chosen to be 0.035mm.According to the operation and applications of the antenna the dimensions of the patch and substrate are determined. The dimensions of substrate in the proposed antenna are L_{SUB} = 30mm and W_{SUB} = 30mm.The basic patch dimensions are L_P= 13.5mm and W_P= 13.5mm. Transmission line feed of 50Ω is provided to the antenna with dimensions L_T = 8.25mm and W_T = 2mm, where L_T represents length and W_T represents width respectively. The defected ground configuration is used to optimize the result of the antenna. The defects of slotting and cutting in ground geometries are explained by defected ground configuration. The optimized ground dimensions are taken to be L_G= 30mmand W_G= 8mm where L_G and W_G are length and width of the ground plane respectively. The antenna is designed for SHF band hence the size and dimensions are chosen carefully for various applications. For designing the antenna various parameters are to be considered. The defected ground geometry is considered to be the most important factor in increasing the number of bands and the bandwidth of the antenna. But for the ideal performance the antenna must converge to the centre of voltage standing wave ratio (VSWR) point on Smith chart where VSWR=l. For the practical applications VSWR must be less than or equal to 2 or 10dB.

III. SIMULATION RESULT DISCUSSION

The simulation and analysis of the proposed antenna done by using Ansoft HFSS is presented in this section. The study and analysis of the various parameters are also carried out. The parameters like return loss, gain, VSWR, and radiation patterns are discussed here.

The return loss graph shows that multi resonance frequencies are created by the H-slot patch. The range of resonance is from 4 GHz to 18 GHz .In figure 2 we see the

antenna has the return loss of -21db at 4 GHz, -29 db at 8.8 GHz, -13.83 db at 12.8 GHz and -42.19 at 17.8 GHz.

The dimension and location of the H-slot determines the number of resonance frequencies and bands.

Figure 3 represents the gain of the proposed antenna.

The Voltage Standing Wave Ratio (VSWR) for the proposed antenna is given in figure 4.According to the figure the VSWR is less than 2 or 10 db for the resonance range of 3.75 – 4.23, 7.99 – 9.35, 11.69 – 13.59, and 16.9 – 22.8.

The radiation pattern at 8.8 GHz is shown in figure 5.

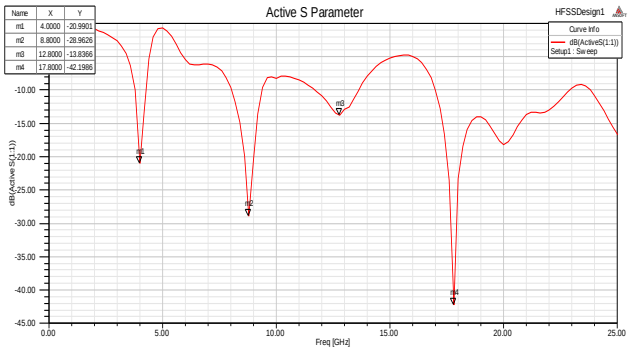

Fig. 2: Simulated Return Loss of the proposed antenna

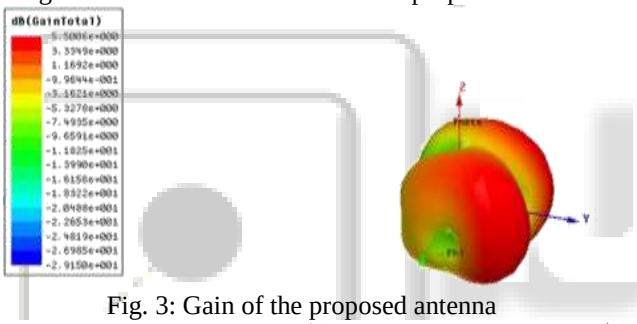

Fig. 3: Gain of the proposed antenna

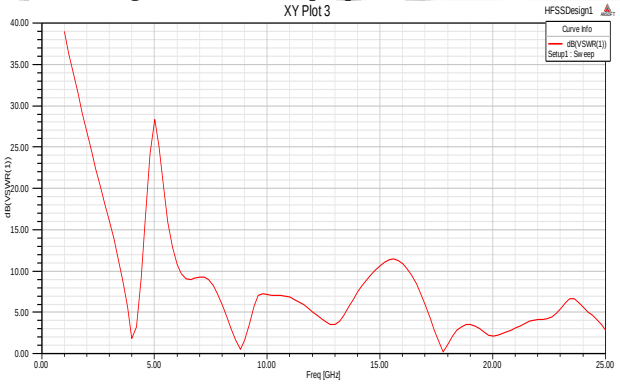

Fig. 4: Simulated VSWR plot of the proposed antenna

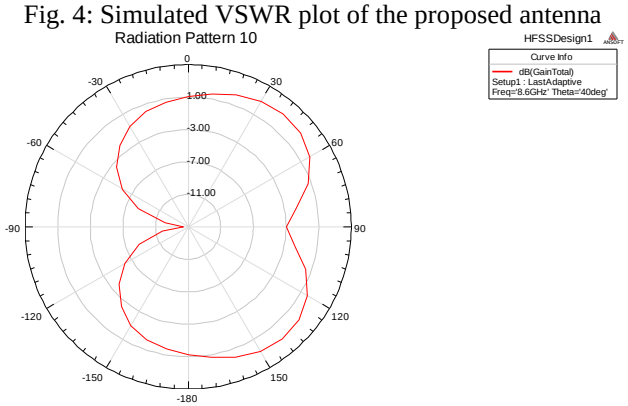

Fig. 5: Radiation Pattern at 8.8 GHz

IV. Conclusion

In this paper a Quad-band antenna with an H-slot and defected ground is designed and simulated. The position and dimension of H-slot determines the number of the resonant frequencies and bands. The defect in ground helps in increasing the bandwidth and return loss. In this design the return loss is increased due to the introduction of defect in the ground. The proposed antenna is simulated on Ansoft HFSS 13.0 simulator. The designed antenna is compact in size and is suitable to operate in four frequency bands with the return loss of -21db at 4 GHz, -29 db at 8.8 GHz, -13.83 db at 12.8 GHz and -42.19 at 17.8 GHz respectively. Hence, the designed antenna can be used in SHF frequency range, WLAN, RADAR, Satellite, Defence and Research applications.

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