

Single Layer Monopole Slotted Microstrip Antenna for Ku-Band Applications

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Abstract: A Slotted microstrip patch antenna for Ku band is designed and thoroughly simulated in this paper. The designed antenna is worked at Resonant frequency of 14.25 GHz in Ku band and that can be used in Satellite Communication for Satellite Tv, DBS services, satellite tracking etc. It is shown that the simulated results are in acceptable agreement. More importantly, it is also shown that the microstrip antenna has higher gain of simulated 2.262dB at 14.25GHz and very low return losses -34.796db at 14.25 Ghz. Bandwidth of 0.35 Ghz And a VSWR of 0.3163db

Keywords: Compact, Patch, Slots, Resonant frequency, Bandwidth.

1. Introduction

In recent years, demand for small antennas on wireless communication has increased the interest of research work on compact microstrip antenna design among microwave and wireless engineers [1-6]. Because of their simplicity and compatibility with printed-circuit technology microstrip antennas are widely used in the microwave frequency spectrum. Simply a microstrip antenna is a rectangular or other shape, patch of metal on top of a grounded dielectric substrate. Microstrip patch antennas are attractive in antenna applications for many reasons. They are easy and cheap to manufacture, lightweight, and planar to list just a few advantages. Also they can be manufactured either as a stand-alone element or as part of an array. However, these advantages are offset by low efficiency and limited bandwidth. In recent years much research and testing has been done to increase both the bandwidth and radiation efficiency of microstrip antennas [7-8]. Due to the recent interest in broadband antennas a microstrip patch antenna was developed to meet the need for a cheap, low profile, broadband antenna.

This antenna could be used in a wide range of applications such as in the communications industry for cell phones or satellite communication. Our aim is to reduce the size of the antenna as well as increase the operating bandwidth. The proposed antenna (substrate with $\epsilon_r = 4.8$) has a gain of 6.24 dBi. The simulation has been carried out by HFSS software. Due to the small size, low cost and low weight this antenna is a good entrant for the application of X-Band microwave communication and Ku-Band RADAR communication & satellite communication.

The X band and Ku-Band defined by an IEEE standard for radio waves and radar engineering with frequencies that ranges from 8.0 to 12.0 GHz and 12.0 to 18.0 GHz respectively [10]. The X band is used for short range tracking, missile guidance, marine, radar and air bone intercept. Especially it is used for radar communication ranges roughly from 8.29 GHz to 11.4 GHz. The Ku band [11] is used for high resolution mapping and satellite altimetry. Especially, Ku Band is used for tracking the

satellite within the ranges roughly from 12.87 GHz to 14.43 GHz. In this paper the microstrip patch antenna is designed for use in a Ku band at 14.25 GHz. The results obtained provide a workable antenna design for incorporation in a satellite TV. Recently the Direct broadcast satellite (DBS) system uses the upper portion of the Ku band.

2. Antenna Design

The configuration of the designed antenna is shown in Figure 1 with rectangular path dimensions $L=6$ mm, $W=10$ mm, substrate (FR4 Epoxy) thickness $h = 1.6$ mm, dielectric constant $\epsilon_r = 4.4$. Coaxial probe-feed (radius=0.5mm) is located at coordinates (0,-1.5,0). Assuming practical patch width $W=10$ mm for efficient radiation and using the equation

$$f_r = \frac{c}{2W} \times \sqrt{\frac{2}{(1+\epsilon_r)}}$$

Where, c = velocity of light in free space. Using the following equation [9] we determined the practical length L (=6mm).

$$L = L_{eff} - 2\Delta L$$

$$\text{Where, } \frac{\Delta L}{h} = \left[0.412 \times \frac{(\epsilon_{reff} + 0.3) \times (W/h + 0.264)}{(\epsilon_{reff} - 0.258) \times (W/h + 0.8)} \right]$$

$$\epsilon_{reff} = \left[\left(\frac{\epsilon_r + 1}{2} \right) + \frac{\epsilon_r - 1}{\left(2 \times \sqrt{1 + 12 \times \frac{h}{W}} \right)} \right]$$

$$\text{and } L_{eff} = \left[\frac{c}{2 \times f_r \times \sqrt{\epsilon_{reff}}} \right]$$

Where, L_{eff} = Effective length of the patch, $\Delta L/h$ = Normalized extension of the patch length, ϵ_{reff} = Effective dielectric constant.

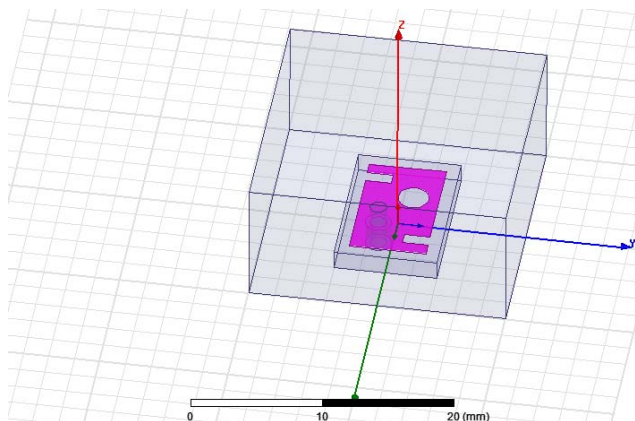


Figure 1: Proposed Antenna configuration

The dimensions of the ground of the designed antenna:

Width=12mm, Length=8mm

Details of the slots on the patch of proposed antenna:

There are two rectangular slots of 1mm*2mm size at coordinates (-4,-3,1.5) and (3,1,1.5) respectively. And one circular patch of radius 1.2mm at (-1.5,1,1.5)

3. Results and Discussion

Simulated (using HFSS [12]) results for the proposed antenna structure is shown in Figure 2 to Figure 6.

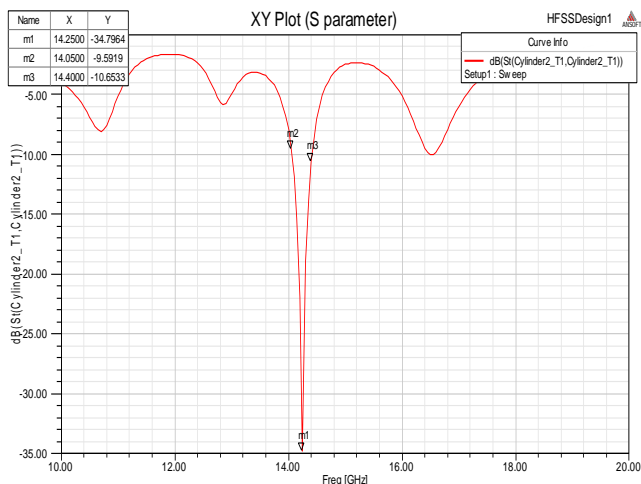


Figure 2: Return Loss vs. Frequency

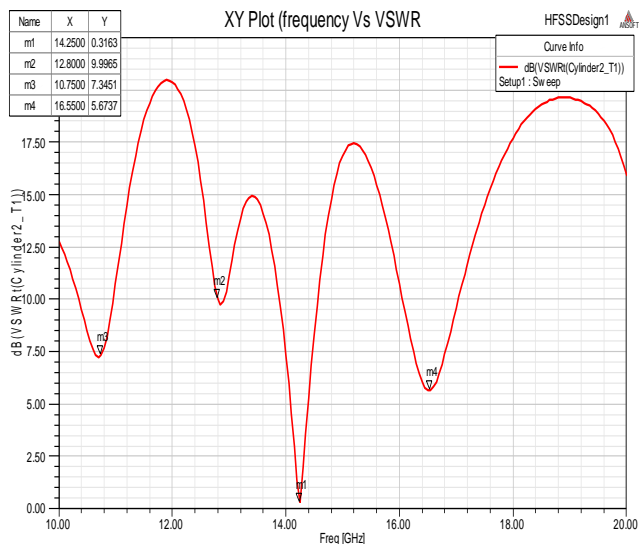


Figure 3: VSWR Vs Frequency

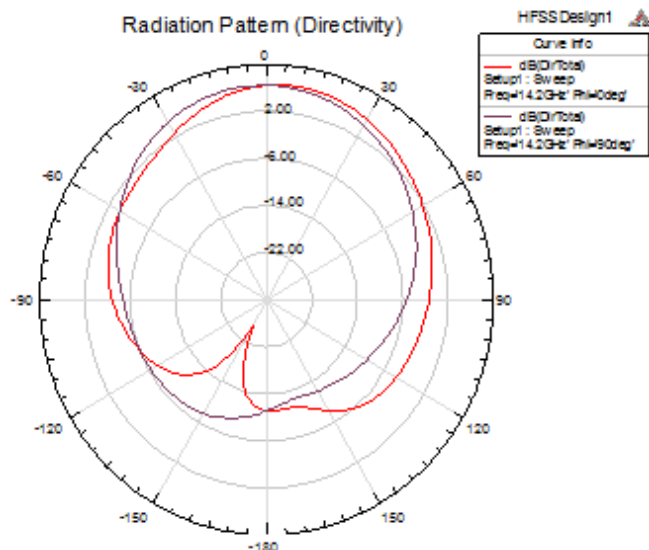


Figure 4: Radiation pattern (Directivity)

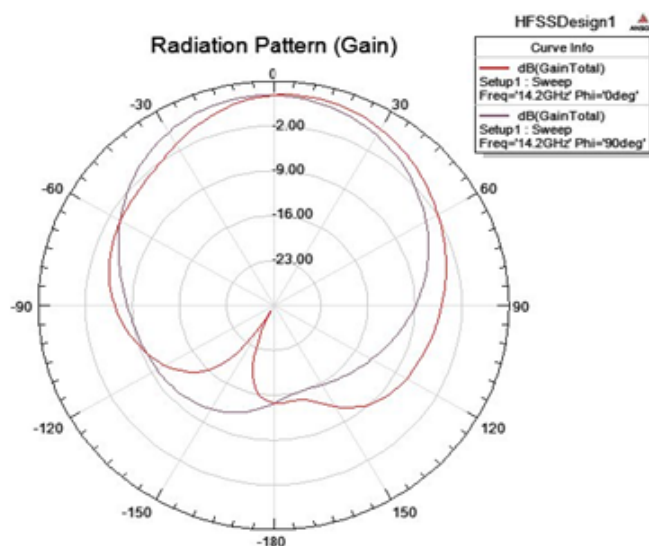


Figure 5: Radiation Pattern (Gain)

Quantity	Value	Units
Max U	0.0030153	W/sr
Peak Directivity	4.8411	
Peak Gain	2.262	
Peak Realized Gain	2.0186	
Radiated Power	0.0078273	W
Accepted Power	0.016752	W
Incident Power	0.018772	W
Radiation Efficiency	0.46724	
Front to Back Ratio	120.85	
Decay Factor	0	

Figure 6: Simulated antenna parameters

Designed antenna is resonating at the frequency Introducing $f=14.25$ GHz which comes in Ku band and can be use in Satellite Tv, Satellite Tracking and DBS services with a low return loss -34.796db , Bandwidth of 0.35Ghz And a VSWR of 0.3163db .

4. Conclusion

This paper focused on the simulated design on differentially-driven microstrip antenna. Simulation studies of a single layer monopole microstrip patch antenna have been carried out using HFSS software. can be use in Satellite Tv, Satellite Tracking and DBS services with a low return loss - 34.796db, Bandwidth of 0.35Ghz And a VSWR of 0.3163db.

The resonant frequency of slotted antenna, presented in the paper, designed for a particular location of feed point (5mm, -2mm) considering the centre as the origin. Alteration of the location of the feed point results in narrower 10dB bandwidth and less sharp resonances.

5. Future Work

1. The array can be used of propose antenna to increase the directivity. These arrays are used in those applications where high directivity values are needed.
2. For further improving the bandwidth of the antenna the radiating element can be loaded with active devices.
3. The radiating element can be stacked to form volumetric array which can be used to fulfill the fast growing requirements of communication systems.

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