Design and Analysis of Multiband Slotted Antenna for C Band Wireless Applications Using HFSS

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Abstract - In this paper, after a review on different slotting method, a novel multiband micro strip patch with rectangular and double L shaped slotted has been designed and simulated. It is triple band antenna, operating at three resonant frequencies 5.65, 6.13 & 6.27 GHz with bandwidth of 200 and 400 MHz, in this design we have used probe feeding technique and HFSS simulation software. By this unique design and combination of this feeding we got good return loss up to -50 dB, VSWR, bandwidth impedance and gain. In this new design of micro strip antenna FR4_Epoxy substrate is used which has permittivity of 4.4 and thickness 1.6, loss tangent is 0.02. HFSS simulation software has used for designing and analysis of different parameters. We have observed that using triple slotted patch antenna and using probe feed at (8, 6 mm) from center feed, a better return loss, VSWR bandwidth and multiband operation is achieved.

Keywords- Triple band, Slotted micro-strip patch antenna, returns loss, VSWR, radiation pattern etc.

1. INTRODUCTION

In the recent years, there has been fast growth in wireless communication. As increasing the number of users and restricted bandwidth that is available, operators are trying very hard to optimize their network for better capacity and improved quality coverage area. This rush has lead the field of antenna engineering to constantly progress and accommodate the need for multiband, wideband, low-cost, miniaturized and easily fabricable antennas. Widely used antenna arrangements with basic features are Micro-strip antenna. The microstrip patch antennas are having several advantages like low profile, versatile, conformal and low-cost for devices. The advantages of micro-strip antennas make them appropriate for various applications like, satellite link antennas, global positioning systems (GPS), radar in missiles telemetry, tracking and mobile handheld radios or communication devices. But nevertheless, the micro-strip antennas are also associated with some drawbacks, such as narrow bandwidth, low gain and the low efficiency.

Modern telecommunication device have need of to be small and able to put together several functionalities. The antenna used for these wireless systems must possess multiband capabilities but yet to remain compact in size. They should have low cost, have a low profile and are easily to be fabricated. One of the major drawbacks of such device is their small bandwidth. Micro-strip patch antenna is generally considered to be proper for many wireless applications, even though it has a small bandwidth. The bandwidth limitation can be taken care by using thick substrates, cutting different slots in the metallic patch, using aperture coupled stacked for patch antenna. The stacked patch antenna has multilayer structure consisting of several parasitic radiating elements placed one above other. However, this approach has the innate disadvantage of increase in overall thickness and problems related on aligning it various precisely. In this paper we design a rectangular micro-strip patch antenna in which rectangular two L shaped slots are cut. By cutting a slot in micro-strip patch antenna enhancement in bandwidth achieved.

2. ANTENNA DESIGN

The proposed antenna is designed by cutting double two L slots with different dimensions than other as shown in Fig. 1. Due to cutting of these slots in antenna increases the current path resulting in increase in current density due to which efficiency is also increased. First a rectangular micro-strip patch antenna is designed based on standard design procedure is to calculate the length (L) and width (W) for resonance frequency. The resonance frequency and the size of the radiation patch can be found out by using these following formulas.

$$f = \frac{C}{2L\sqrt{\varepsilon}} \quad (1)$$

$$W = \frac{C}{2f}\sqrt{\frac{2}{\varepsilon+1}} \quad (2)$$

$$L=\frac{c}{2f\sqrt{\varepsilon}}-2\Delta L \quad (3)$$

where f is the resonant frequency of the antenna, c is the free space velocity of the EM waves equal to velocity of light, L is the actual length of the current element, ε_r is the effective dielectric constant of the substrate material and ΔL is the length of equivalent radiation parameter.

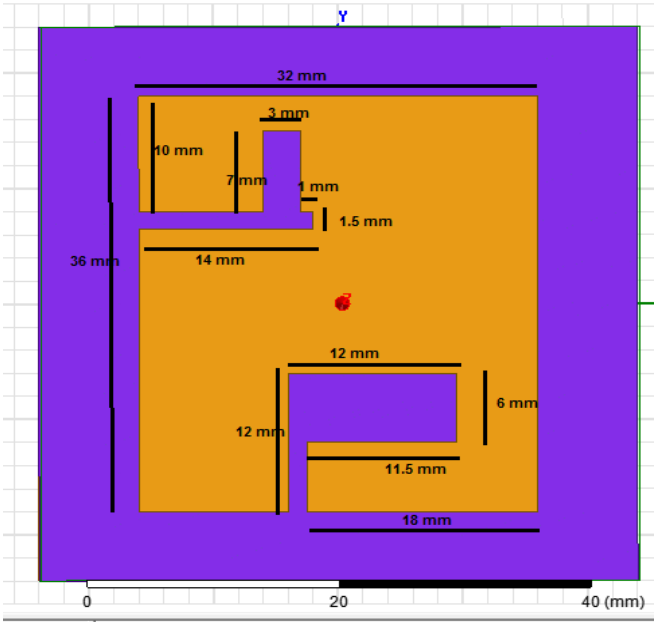

Figure 1: Proposed Antenna with Double L slot.

The dimension of the patch are L=32mm and W=38mm. Inside this rectangular patch two L shaped slots are cut. The antenna is fabricated on a substrate of FR4_epoxy with dielectric constant 4.4 and thickness h=1.6mm. The probe feed is applied at feeding is used at (x=8, y=6) from centre of the patch for optimum results. The ground dimensions are 48x48 mm resulting in miniaturization in size of antenna.

3. SIMULATION AND RESULTS

The simulation of micro-strip patch antenna is done by using HFSS simulation software. The variation of return loss with frequency of rectangular patch antenna with a single L shaped and further with second L slots are shown in figure 1, 2, 3. The return loss is defined as the ratio of the Fourier transform of the incident power and the reflected power. It is an important parameter to decide the usage of antenna in wireless application.

The VSWR graph for rectangular, single L slot and Double L slotted rectangular patch antenna is shown in figure 4. The VSWR indicate the mismatch in impedance between the antenna and the transmission line. For proper impedance matching the VSWR values should be close to 1-2. The bandwidth is calculated at the frequency range where the return loss is approximately below the -10 dB. VSWR is also shown in figure 5 for the all analyzed slotted rectangular micro-strip patch antenna.

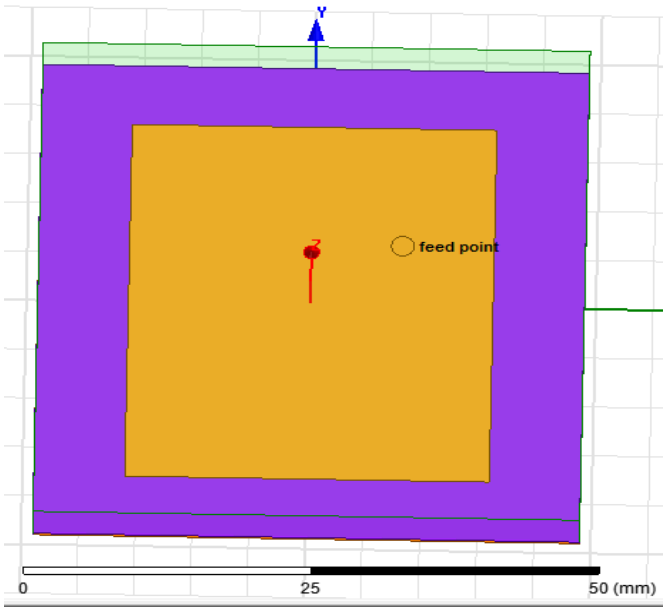

Figure 2: Configuration of basic rectangular patch antenna.

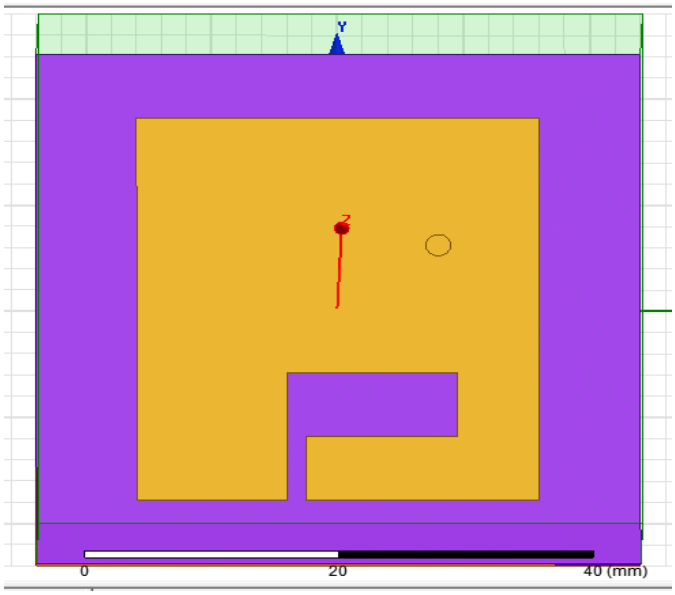

Figure 3; Geometry of single slot antenna.

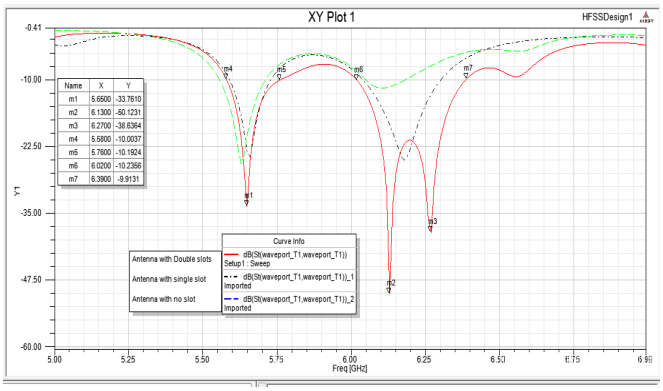

Figure 4: Return loss Vs Frequency curve for designs

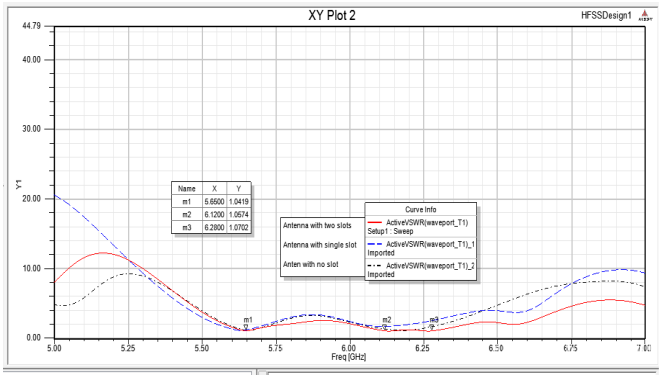

Figure 5: VSWR Vs Frequency curve for designs.

The simulated results are shown in Table I for all three designs.

Table I Simulated Results for two slot antenna.

Parameter	F1	F2	F3
	5.65 GHz	6.13 GHz	6.27 GHz
Return loss	-33.76 dB	-50.12 dB	-36.63 dB
VSWR	1.04	1.06	1.07
Impedance	51.5 Ω	49.9 Ω	47.7 Ω
Bandwidth	200 MHz	400 MHz	
Directivity	3.31 dBi	2.15 dBi	3.89 dBi

4. CONCLUSION

In this paper, a novel multiband microstrip patch with double L shaped slotted has been designed and simulated. It is triple band antenna, operating at three resonant frequencies 5.65, 6.13 & 6.27 GHz with bandwidth of 200 and 400 MHz With this proposed design various applications in C band of electromagnetic spectrum can be covered as it provides significant bandwidth and directivity.

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