Single-Feed Multi Band Microstrip Patch Antenna

Abdul Mannan
M Tech. Scholar
ECE Department
DIT, Dehradun

Dinesh Kumar Saxena
Professor
DIT, Dehradun

Prachi Gupta
M Tech. Scholar
ECE Department
DIT, Dehradun

Manish Jaiswal
M Tech. Scholar
ECE Department
DIT, Dehradun

ABSTRACT
This paper presents a single feed rectangular micro strip patch antenna and a different approach to design dual and triple band antennas using triangular slots on patch. Three triangular slots are there for triple band in this design, two triangular slots are above the feed point one triangular is near the feed point. A triple band antenna for 3.65 GHz, 4.11GHz and 6.48 GHz applications using slot technique is presented. Results of simulation show that at 3.65 GHz, 4.11GHz and 6.48 GHz, the antenna has reflection coefficient (S_{11}) as -16.68dB, -23.42dB, -21.67dB respectively. The simulated results along with the different parameters like radiation pattern, VSWR etc. are presented and discussed in this letter. The design and performance of antennas are carried out using HFSS 14.0 software. Main objective of this paper is to achieve the multiple resonances within the same antenna at desired frequencies so that this could be applicable in Wi-max applications.

Keywords
Microstrip Patch Antenna, Reflection Coefficient, triple band, HFSS (High Frequency Structure Simulator).

1. INTRODUCTION
For both military and commercial application requirements of multi frequency antennas increasing with the development of wireless communication system and increasing demand on connecting to the internet. Many telecommunication operators using various frequencies [1] to meet their requirement an antenna is desire that has multiband characteristic than the antenna operate at single frequency. Therefore, dual/multiband Microstrip antenna designs with compact patch size are urgently desired. An antenna having various functions can make the communication simple. For multiple services introduced by different wireless technology network multiple band antennas is capable. In many wireless applications ,dual band antenna are of interest that uses two different frequency band for transmitting and receiving [2].

Due to many advantages like low profile, low cost, light weight, and easy construction Microstrip patch are widely used in wireless communication and satellite communication system. However, Microstrip antenna is still too large for many applications [3]. For antenna miniaturization, bandwidth enhancement lot of research has been carried out, the following antennas have been developed: design of Microstrip Antenna for modern wireless communication [4], design of Microstrip Antenna for GPS application [5],Multiband CPW-fed rectangular ring Microstrip Antenna design for wireless communication [6].

In this letter, a Microstrip triangular slotted antenna is proposed which is capable of tri-band frequencies operation for 3.65 GHz, 4.11GHz and 6.48 GHz applications. The basic element is a square patch. The antenna dimensions are determined to create the required bands resonant frequencies. Integrating multiple functions on an antenna can reduce the antenna's size and weight and increase the electrical properties of the antenna [8]. The design and performance of antennas are carried out using HFSS 14.0 software.

The rest of the paper is organized as follows: section two present the antenna structure and design. In section three, simulated results are discussed. Applications are presented in section four. The paper finishes with conclusion in section five.

2. ANTENNA STRUCTURE AND DESIGN
The design of conventional antenna1 is shown in figure 1. The square patch has dimension of 20mm x 20mm. The dielectric material selected for this design is FR4 epoxy with dielectric constant (ϵ_r)=4.4 and substrate height (h)= 1.6mm. The patch antenna is coaxially probe fed at (2.5,-4.5).

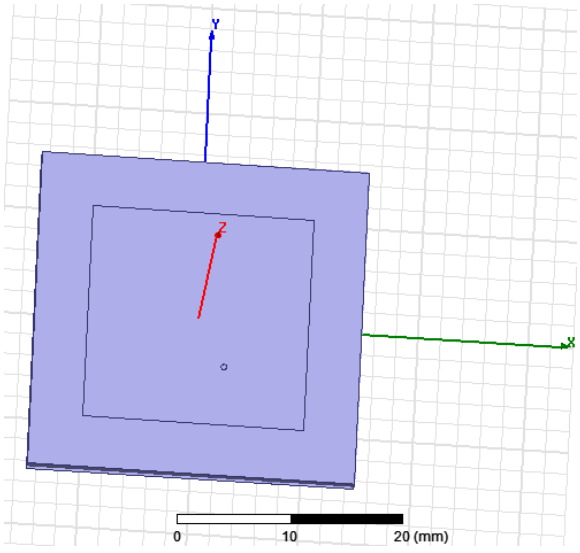


Fig 1: Antenna 1 design

Figure 2 shows design of antenna 2 which is designed with a similar substrate. All the dimension and position of feed is same as that of antenna1. In second design, two triangular slots are created on the rectangular patch at proper position as this slotting technique produces dual band as the two slots creates disturbance in current distribution and excites another resonant modes. Upper left slot (-7.25,10,1.6; -3.25,10,1.6; 4,2,1.6), upper right slot (7.25,10,1.6; 3.25,10,1.6; -4,2,1.6).

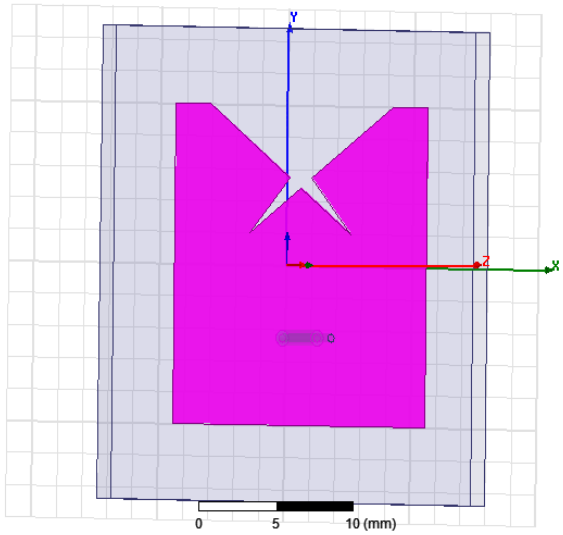


Fig2 : Antenna2 design.

Figure3 shows the proposed antenna3 design which is also designed with a similar substrate as that of antenna1. The antenna is also a 20mm x 20mm square patch. All the dimensions and position of feed is same as that of antenna2. In this one more triangular slot is present at the downwards side as shown in figure that is responsible for triple band. lower slot (-2,-10,1.6; 0,-2,1.6; 2,-10,1.6).

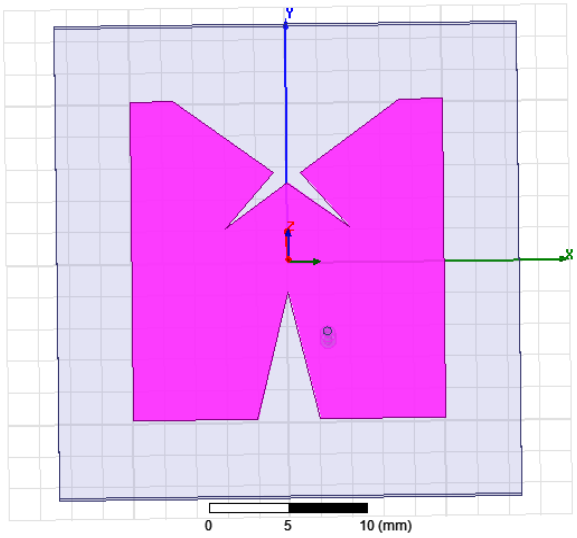


Fig3: Antenna3 design.

Table1. Parameters

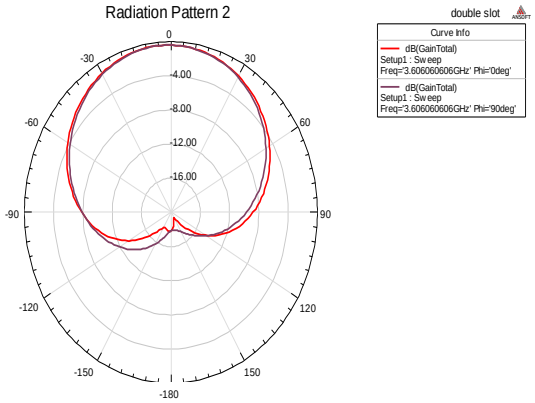
Parameters	Antenna1 In (mm)	Antenna2 (mm)	Antenna3 (mm)
Length(ground)	29.6	29.6	29.6
Width(ground)	29.6	29.6	29.6
Length(patch)	20	20	20
Width(patch)	20	20	20
Feed	(2.5,-4.5)	(2.5,-4.5)	(2.5,-4.5)
Substrate Thickness	1.6	1.6	1.6

3. SIMULATION RESULT

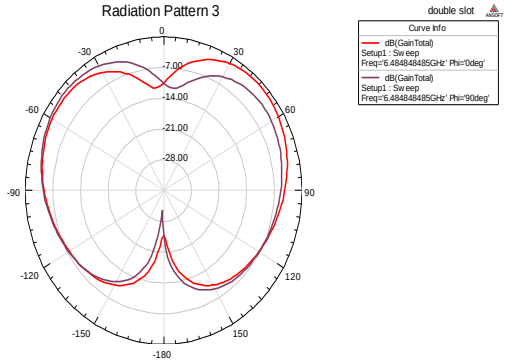
The simulation is done using Ansoft HFSS (14.0). Different parameters like radiation pattern, Reflection coefficient S_{11}, VSWR is discussed given below.

3.1 Radiation Pattern

The radiation pattern of antenna designs 2 and 3 are shown below. As the antenna 2 resonates at two frequencies 3.6 GHz and 6.4 GHz, the radiation patterns at two different frequencies are shown at different angles of phi 0° and 90° in figure 4.

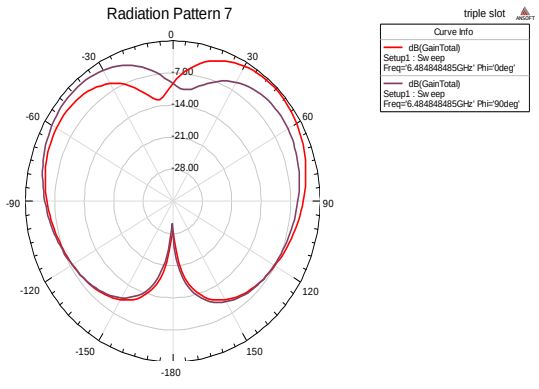


(a)

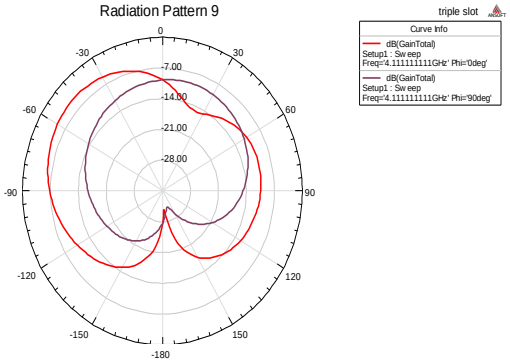


(b)

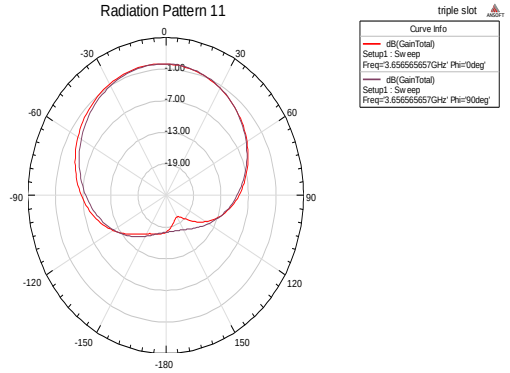
Fig4: Radiation pattern of antenna 2 (a) freq. 3.60GHz (b) freq. 6.48 GHz



(a)



(b)



(c)

Fig 5: Radiation pattern of antenna design 3 (a) freq. 6.48GHz (b) freq. 4.11GHz (c) freq.3.65 GHz

The radiation pattern of antenna design 3 at three different resonant frequencies 6.48, 4.11 & 3.65 GHz at different angles of phi 0° and 90° are shown in figure 5. It is observed from the above patterns that antenna shows its broadside radiation pattern at different resonant frequencies.

3.2 Reflection Coefficient

The two triangular slots on the patch is responsible for dual band operation as the slots perturbation on the patch changes the current distribution. The design of antenna 2 shows simulated reflection coefficient obtained at -16.6 dB and -22.7 dB that resonate at two frequencies 3.65GHz and 6.48 GHz respectively as shown in figure 6. In the third design another slot is created at the other side of the patch. The third slot as a perturbation segment by changing the current distribution excites another resonant mode and is responsible for third frequency band. The antenna3 thus resonates at three resonant frequencies 3.65 GHz, 4.11GHz and 6.48GHz thus shows simulated reflection coefficient at -16.6 dB,-23.4dB & -21.67 dB respectively forming triple band antenna as shown in figure 7. Table2 present resonate frequencies and reflection coefficients of antenna2 and antenna3.

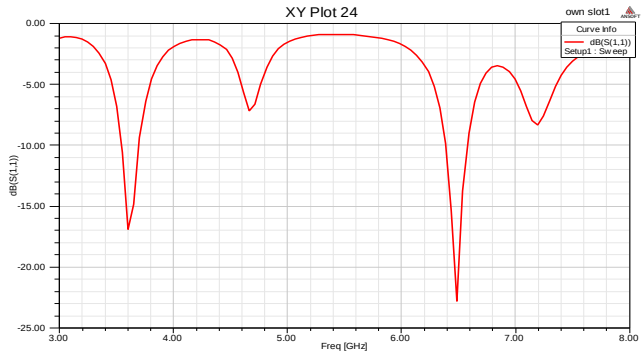


Fig6 : Antenna2

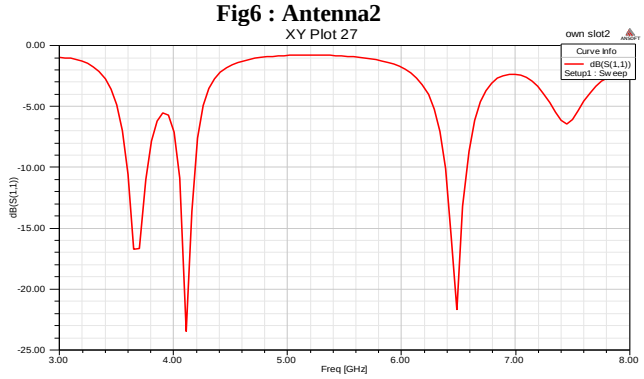


Fig7: Antenna3

Table2. Freq. and Reflection Coefficient

	Freq.	S_{11}
Antenna2	3.65GHz, 6.48GHz	-16.6dB -22.7dB
Antenna3	3.65GHz, 4.11GHz 6.48GHz	-16.6dB -23.4dB -21.67dB

3.3 Voltage Standing Wave Ratio

Voltage standing wave ratio of both antennas at their resonant frequencies lies in the range between 1 and 2 as shown in figures 8 & 9 respectively.

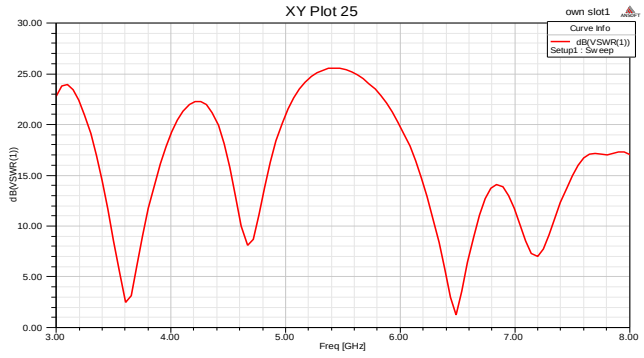


Fig 8 : Antenna2

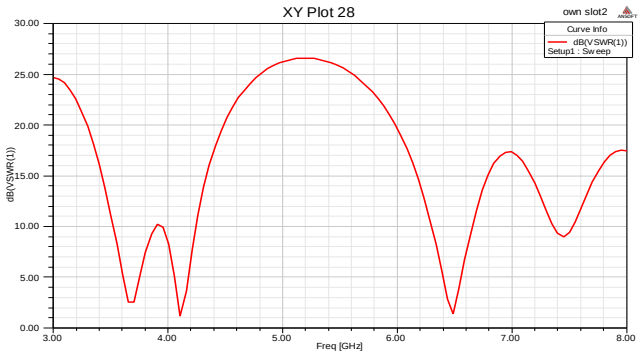


Fig9 : Antenna3

4. APPLICATIONS

The proposed antenna3 can be used for WiMax [1] and various S band and C band applications such as weather radar, mobile phones, wireless LAN, Bluetooth, Long distance radio telecommunication.

5. CONCLUSION

A single feed triangular slotted Microstrip antenna fed by co-axial probe feeding has been proposed in this paper. Two triangular slots are etched on the upper side of patch and one at the lower side. Proposed antenna3 operate in three frequency band Also triangular slots reduce the size of antenna to some extent that leads to light weight. The proposed antenna3 is suitable for WiMax and multi-frequency applications of wireless communication in S and C band. As the design resonate at desired frequency range 3 to 7 GHz. Different parameters are taken along with the radiation pattern.

6. ACKNOWLEDGEMENTS

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