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Design and Simulation of slotted double E-shaped Microstrip Patch Antenna for Multiband Applications

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***Abstract*-This paper presents to design and analysis of E-shaped microstrip patch antenna with E-shape slot for c band operating frequency range for wireless applications. In order to make the proposed E-shape microstrip patch antenna by introducing the E-shape slots on both sides of the patch. This shape will provide c band applications like WI-FI, WLAN, WIMAX, and satellite applications. The proposed antenna shape was simulated by using ADS software and it can analysed by using various terms and parameter of the antenna like bandwidth, return loss, gain, and radiation pattern. The proposed antenna can resonates at different level of frequency in the range of 4.43GHz, 5.71GHz, 6.23GHz, 6.92GHZ, 7.5GHz. These resonance frequencies are able to operate in the range of c band applications. This antenna had the gain of 2.06dbi, 2.92, 3.42dbi, 4.96dbi, 5.23dbi, 5.28dbi, 6.03dbi, and 7.0dbi .**

***Keywords*- E-shape microstrip patch, satellite, Multi Band.**

I.INTRODUCTION

The microstrip patch antenna is a good choice for wireless mobile communication because it have several good characteristics like light profile, low wait, low fabrication cost and easy to fabricate. Antenna is a main building in wireless communication, Based on this antenna performance easily to analyse effectiveness of the wireless communication around the world. Antenna is a conductor which carrying the current.it is used to convert the electrical energy to electromagnetic waves and it can transmit over the longer distance. The main impact of the antenna in wireless communication is used to transmit and receive the information via the air. The transmitting antenna have different ranges like Low frequency range, Mid frequency range, High frequency range, Ultra high frequency, and microwave frequency range. In the transmitter side a radio transmitter supplies the electric current as electromagnetic waves. Antenna are essential components for all equipment that is used for radio broadcasting, television, two-way radio, communication receivers, radar, cell phones, and satellite communications as well as wireless microphones, Bluetooth enabled devices, wireless computer networks, and RFID.The antenna design can have different parameters like gain, VSWR, Directivity, Radiated power, efficiency, Return Loss, Impedance.

The proposed E-shape microstrip patch antenna are simulated using HFSS software .Which operates in the range between 8.80GHz-13.49GHz.This structure is more suitable for wideband applications[1]the propose -shape fractal antenna was simulated by using ie3d software the operating frequency ranges of the designed antenna lies in between 5.1 GHz- 9.6GHzwith good gain and bandwidth .this structure is more suitable for C,X and WLAN applications[2].To introduce the fractal structure in normal rectangular patch. It is more suitable for multiband applications. And compare performance of the antenna by using microstrip line feed and coaxial feed line. This antenna can resonate at three bands and which is more suitable for wideband applications. Compare to first iteration the antenna performance can improve in the second iteration method [3].

The proposed E-shape fractal antenna is suitable for wide and ultra-frequency bands by using iteration and co-axial feed method. This structure can analysed using different parameters with corresponding resonance frequency [4]. In this paper the authors can investigate and compare the performance of normal patch and fractal geometry applied patch antenna. The proposed fractal geometry with patch is more suitable foe GPS, UMTS, WIMAX applications with suitable bandwidth [5]. The propose E-shape patch antenna is adapt for LTE,-band applications, by introducing the fractal geometry the proposed design can achieve the various mobile standards applications[6].

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II. DESIGN METHODOLOGY OF THE PROPOSED ANTENNA

The main demand of antenna design for wireless communication is small size, low cost, easy to fabricate. The proposed antenna is widely satisfies the requirements of the wireless services. This structure can analysed using ADS software. The antenna performance can analysed the different parameters of the proposed antenna with corresponding frequency.

A.RECTANGULAR MICROSTRIP PATCH ANTENNA

To design the proposed E-shape antenna can make by using the rectangular patch. To measure the various and different applications by varying the antenna terms like length, width and thickness of the antenna. This structure is designed for c band application. It is designed using FR4 substrate material with 1.6 mm with 4.4 dielectric constant value. The length and width of the antenna can calculate using the mathematical equations.

Step 1: Calculation of Width (W)

For an efficient radiator, practical width that leads to good radiation efficiencies is calculated by Transmission line model equation.

$$f_0=c/2\sqrt{\{\varepsilon_{eff}[(m/L)\,2+(n/W)\,2]\}} \quad (1)$$

Step2: Calculation of effective dielectric co-efficient (ε_{reff})

The effective dielectric constant is obtained by referring to equation (2)

$$\varepsilon_{reff}=(\varepsilon r+1)/2+(\varepsilon_r-1)/2\,[1+12W/h]^{1/2} \quad (2)$$

Step 3: Calculation of effective length (L_{reff})

The effective length can obtain by using equation (3)

$$L_{EFF}=L+2\Delta L \quad (3)$$

Step 4: Calculation of Length Extension (ΔL)

The length extension can calculate by using equation (4)

$$\Delta L=0.412h\,(\varepsilon_{reff}+0.3)\,[W/h+0.264]\,/\,(\varepsilon_{reff}-0.258)\,[W/h+0.8] \quad (4)$$

Step 5: Calculation of Ground Dimensions (L_g, W_g)

The transmission line model apply infinite ground plane only. However the practical consideration, it is essential to finite ground plane, it has been shows that finite and infinite ground plane can obtained, if the size of the ground plane greater than patch dimensions approximately six times the substrate thickness all around the periphery. For this design the ground plane dimensions are given as:

$$L_g=6h+L\ (3.6) \quad (6)$$

$$W_g=6h+W \quad (7)$$

B.GEOMETRY OF THE E-SHAPE PATCH DESIGN

The E-shape patch design can make by introducing slot on the rectangular patch antenna with correspondence length and width. The proposed antenna geometry can see below the figure 1.based on this designing parameter the antenna can satisfies the applications.

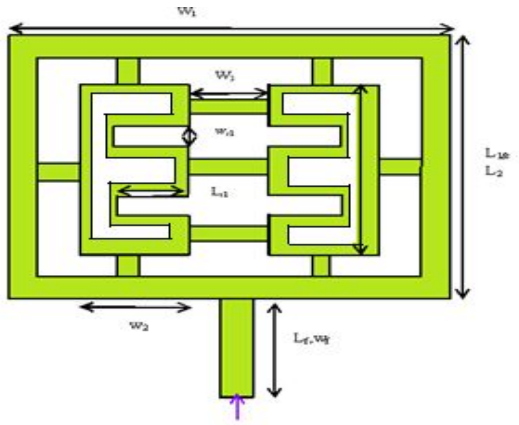


Figure 1.proposed antenna design

Parameter		Dimensions(mm)
Rectangular patch	Length(L_1)	10
	Width(w_1)	15
E-shape patch	length (L_2)	12.8
	Width(W_2)	20
Feed line	length(L_f)	2
	width(W_f)	3.8
slot	Length(Ls_1&Ls_2)	7.4,8.4
	Width($W_{s1,2,3,4}$)	1.0
Substrate thickness(FR4)		1.6

Table 1. Parameters of the proposed antenna

C.FEEDING TECHNIQUES

The antenna performance is mainly depends on the feeding methods and its position. Based on this feeding position we can easily to achieve the required applications. Antenna can feed by using various methods. These methods can be classified into two types-conducting and non-conducting. In the conducting method the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-conducting method, electromagnetic field coupling is done to transfer the power between the microstrip line and the radiating patch.

The popular feeding methods are microstrip line feed, coaxial probe(both conducting and non-conducting), aperture coupling, inset feed, and proximity feeding(both conducting and non-conducting).in this paper to analyse the proposed antenna parameter using inset feed method. The main purpose of the inset feed cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. The main advantage this feed method is to ease to fabrication, simple to modelling and good impedance matching. The bandwidth range of this feeding technique in between 2-5%

III. SIMULATED RESULTS AND DISCUSSION

To analyse and evaluate the antenna performance via the optimized parameters using ADS software. The simulated antenna results are return loss, ration pattern, current distribution, gain, directivity, and efficiency.

A.RETURN LOSS

Return loss is the important parameter for to analyse the antenna performance in wireless environment. Because it is used to analyse effective power delivery of the designed antenna. From this result the peoples can easily understand the performance and the designed antenna is suitable for our required services.

From this observation there are six resonance frequency are observed.at 4.43 GHz range the return loss value is -20dbi, At 5.7GHz the value of the return loss is -13.7dbi, At 6.23 GHz the value of the return loss is -18.8, At the resonance frequency range 6.9 GHz the return loss value is -12.32dbi, At 7.5GHz the return loss value is -12.1dbi,.

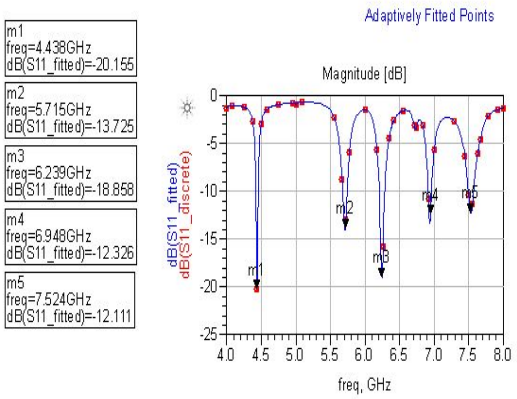


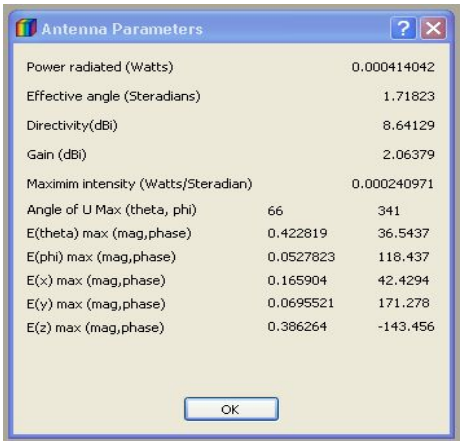
Figure 3. Return loss of the proposed patch antenna

From this loss the proposed antenna is suitable for c band applications. Because the c band frequency range occurs between 3.1GHz-10GHz.

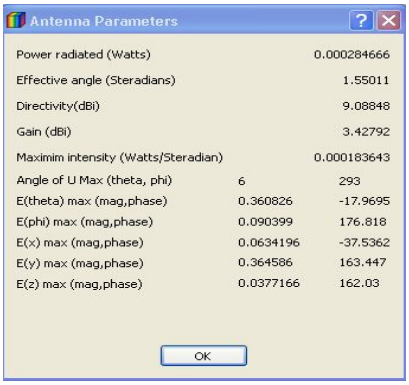
B.ANTENNA PARAMETERS

The antenna parameters includes radiated power in watts, effective angle(steradian), Directivity(dbi),Gain(dbi),Maximumintensity(watts /steradian), angle of intensity maximum with respect to theta and phi values. the antenna parameters for different resonant frequency ranges are shown in below figure4.

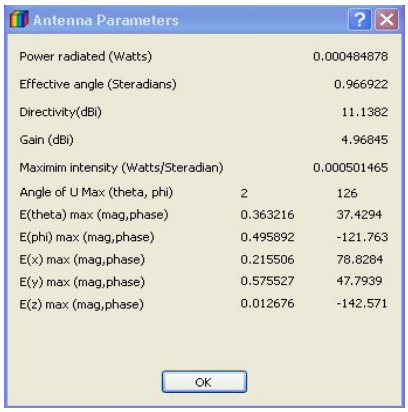
The proposed antenna is resonates at different level of frequency with good return loss and power delivery ratio. Initially the radiated power in the range of 0.00041dbi, the gain value is 2.06dbi, the range of directivity isn8.64 dbi, maximum intensity is 0.00024(w/sr) at the resonance of 4.43 GHz with -20 dbi return loss with 84.60% efficiency .The radiated power in the range of 0.00028dbi, the gain value is 3.42dbi, the range of directivity is 9.08dbi,maximum intensity is 0.00018(w/sr) at the resonance of 5.7 GHz with -13.7dbi return loss with 92.05% efficiency .



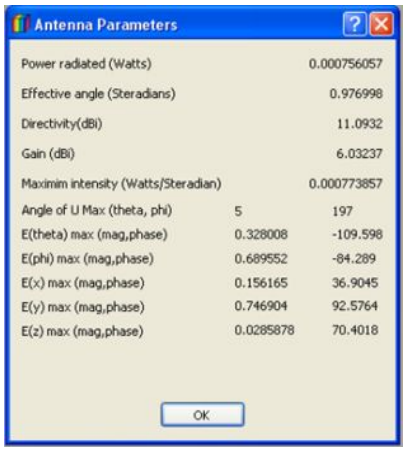
At 4.43GHz



At 5.7GHz

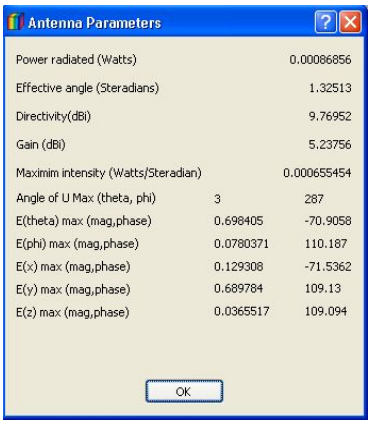


At 6.23GHz



At 6.9GHz

The radiated power in the range of 0.0007dbi, the gain value is 6.03 dbi, the range of directivity is 11.09dbi,maximum intensity is 0.00007w/sr) at the resonance of 6.23 GHz with -18.8 return loss with 88.54% efficiency .The radiated power in the range of 0.00048dbi, the gain value is 4.96 dbi, the range of directivity is 11.13dbi, maximum intensity is 0.00050(w/sr) at the resonance of 6.9 GHz with -12.32dbi return loss with 94.27% efficiency .The radiated power in the range of 0.0008dbi, the gain value is 5.23 dbi, the range of directivity is 9.76 dbi, maximum intensity is 0.00086(w/sr) at the resonance of 7.5 GHz with -12.1 dbi return loss with 85.81% efficiency .

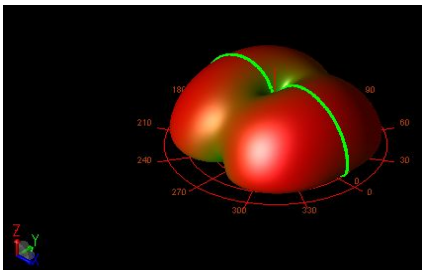


At 7.5GHz

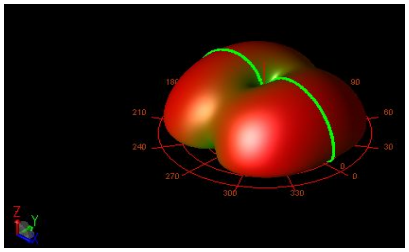
Figure 4.Antenna Parameter of the proposedpatchantenna

C.RADIATION PATTERN

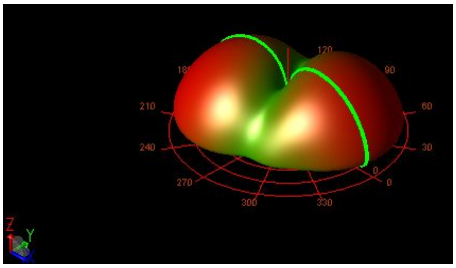
The radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. The radiation pattern of the proposed antenna can analysed with corresponding resonance frequency.an antenna radiation pattern (or) antenna pattern defined as mathematical and graphical representation of radiation properties of the antenna. The radiation pattern of the proposed antenna is shown in figure 5.



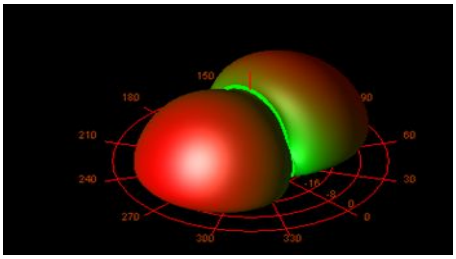
At 4.43GHz



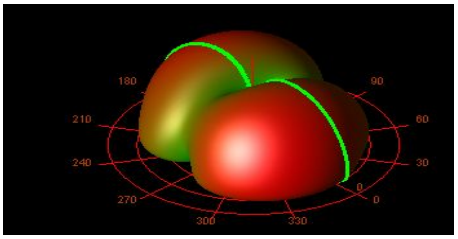
At 5.7GHz



At 6.23GHz



At 6.9GHz

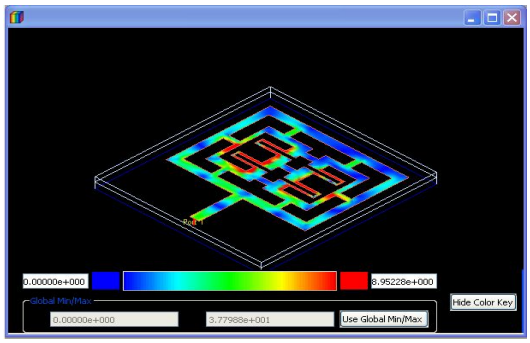


At 7.5GHz

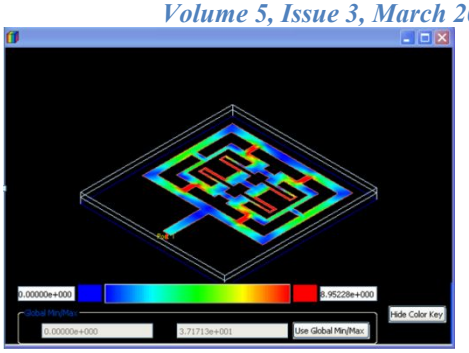
Figure 5. Radiation Pattern of the proposedpatch antenna

D. CURRENT DIATRIBUTION

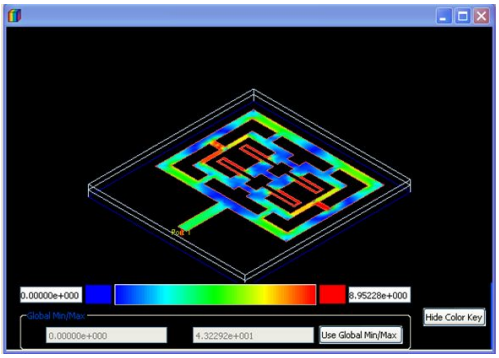
The current distribution is the important parameter for analyse antenna performance. The red colour shows the maximum radiation of the antenna. The current distribution is used to calculate the antenna resistance, reactance, impedance value. The current distribution of the start (4.4GHz) and(7.5GHz) ending frequency range issee in figure 6.



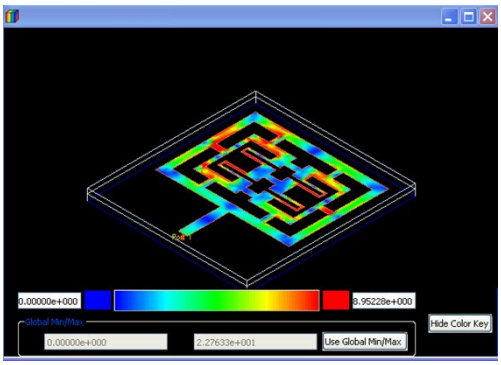
At 4.43GHz



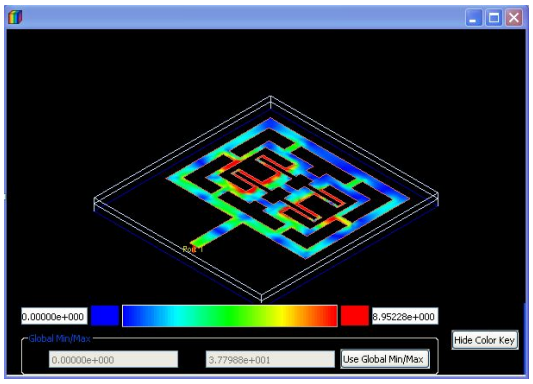
At 5.7GHz



At 6.23GHz



At 6.9GHz



At 7.5GHz

Figure 6. Current Distribution of the proposed patch antenna design

V. CONCLUSION

The proposed E-shape patch antenna is design and simulated using ADS Software. From the analysis of the proposed antenna result this structure is very suitable for ultra-wide band applications. The resonance frequency of this structure is 4.4GHz, 5.7 GHz, 6.23 GHz, 6.9 GHz, 7.5 GHz by changing the length and width of the patch to achieve high gain, directivity with sufficient efficiency.

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