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Dual Band H Shaped Rectangular Microstrip Patch Antenna for WLAN/WiMAX/Bluetooth Applications

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ABSTRACT: In this paper, the bandwidth of rectangular Microstrip antenna is enhanced by 'H' shaped rectangular microstrip patch antenna. In some applications where the increased bandwidth is needed, dual frequency patch antenna is one of the alternative solutions.The proposed antenna has dual frequency band. In first frequency band (1.63-1.79 GHz) the fractional bandwidth is 9.35% and in second frequency band (2.4-3.34 GHz) the fractional bandwidth is 33.03% . The gain has been improved up to 3.82dBi, directivity 3.87dBi and efficiency 98.91%. The proposed 'H' shaped Microstrip antenna is fed by 50Ω Microstrip feed line. The antenna design and performance of 'H' shaped micro-strip antenna is stimulated by IE3D zeland software.

Keywords: H-shaped, enhance bandwidth, compact rectangular MSP, radiation pattern, gain, 50Ω feed line.

I.INTRODUCTION

Nowadays in radar and satellite communication applications, microstrip patch antennas are very popular due to their low profile, mechanically robust, relatively compact and light and possibility of dual frequency operation. Unfortunately they have some limitations, especially narrow bandwidth [1]. There are numerous and well-known methods to increase the band width of the antennas including: the use of the substrate thickness [2], the use of low dielectric substrate [2], the use of various impedance matching and feeding techniques [3]. The concept of Microstrip antenna was first proposed in 1953, twenty years before the practical antennas were produced. Since the first practical antennas were developed in early 1970's, interest in this kind of antennas was held in New Mexico [4]. Dual frequency operation of antenna is very necessary in recent wireless communication system for some applications such as GPS, WLAN etc [5]. The proposed antenna provides dual frequency band. In first frequency band (1.63-1.79 GHz) the gain is 3.83dBi and antenna efficiency is about 98.96% and it is suitable for wi-fi applications. In second frequency band (2.4-2.3.34GHz) the gain is 3.64dBi and antenna efficiency is about 99.95% and is suitable for WLAN/Wi-MAX/Bluetooth applications [5-6]. The proposed microstrip antenna is designed by using glass epoxy substrate at operating frequency 2.1 GHz. The patch length and width of proposed antenna are 32.4 mm and 43.4 mm respectively. Microstrip antenna has been established as a separate entity in the field of microwave antenna because of its numerous advantages such communication base stations, and as small size, light weight, low profile, low cost, and ease of integration with other microwave components. It is being used in large variety of applications such as radar, missiles, aircraft, satellite communications, and mobile handsets as well as in biomedical telemetry services [7]. The proposed H-shaped rectangular microstrip patch antenna is proved to be one of the effective methods in Dual frequency band operation. The proposed antenna has been designed on glass epoxy substrate (ε_r =4.2) [8, 9]. The proposed H-shaped Microstrip antenna is fed by 50Ω Microstrip feed line [10-11].

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II. ANTENNA DESIGN

The mathematical formula is used to calculate the dimensions of ground plane and patch in the form of length and width.

A. Width formula of Rectangular MSP is taken by [12, 9].

$$W = \left(\frac{c}{2f_r}\right)\left(\frac{\varepsilon_r + 1}{2}\right)^{-0.5}$$

Where c = 3×10^8 ms^{-1}, ε_r =4.2, f_r =2.1GHz

B. Formula of effective dielectric constant is taken by [8, 15].

$$\varepsilon_{eff} = \left(\frac{\varepsilon_r + 1}{2}\right) + \left(\frac{\varepsilon_r - 1}{2}\right)\left(1 + \frac{12h}{W}\right)^{-0.5}$$

At h=1.6mm

C. Formula of length extension is taken by [8, 9].

$$\Delta L = .412h\left(\frac{\varepsilon_{eff} + .3}{\varepsilon_{eff} - .258}\right)\left(\frac{\left(\frac{W}{h}\right) + .264}{\left(\frac{W}{h}\right) + .8}\right)$$

D. Length formula of Rectangular MSP is taken by [12, 14].

$$L = \left(\frac{c}{2f_r\sqrt{\varepsilon_{eff}}}\right) - 2\Delta L$$

E. Formula of length and the width of the ground plane are taken by [9, 13].

$$L_g = L + 6h$$

$$W_g = W + 6h$$

III. ANTENNA PARAMETERS

The design of proposed antenna is shown in fig 1. The proposed antenna is designed by substrate which has a dielectric constant 4.2 and the design frequency is 2.1 GHz. Height of the dielectric substrate is 1.6 mm and loss tangent *tan* δ is 0.0013. Antenna is fed through 50Ω Microstrip feed line. Antenna dimensions are given in table1 and other parameters are given in the table 2 (lengths in mm and frequency in GHz).

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Table 1: Antenna dimension

S.No	ANTENNA DIMENSION	SPECIFICATION
1.	Ground plane width , a	53
2.	Ground plane length , b	42
3.	c	43.4
4.	d	11.7
5.	e	13.3
6.	f	8.5
7.	g	19.7
8.	h	12.3

Table 2: Antenna parameter

S.No	ANTENNA PARAMETER	SPECIFICATION
1	Dielectric constant (ε_r)	4.2
2	Maximum frequency	3.5 GHz
3	Height of substrate (h)	1.6 mm
4	Loss tangent (tan δ)	0.0013

IV. ANTENNA DESIGN PROCEDURE

All the dimensions of proposed antenna are calculated by using the formulas A to E. Design frequency taken is 2.1 GHz. The H-shaped rectangular patch is shown in fig 1.

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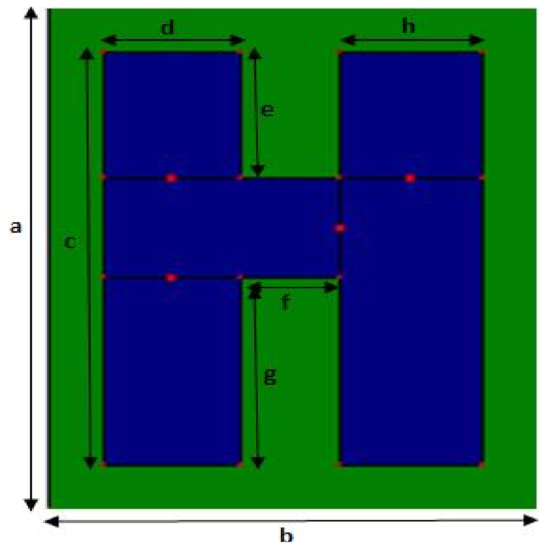

Fig.1: Geometry of proposed antenna

V. SIMULATION RESULT AND DISCUSSION

The proposed rectangular microstrip antenna studied successfully and Since the proposed antenna has dual frequency band (1.63-1.79 GHz) and (2.4 - 3.34 GHz) it is suitable for many applications. The fractional bandwidth of proposed antenna is found to be 9.35% in first frequency band and 33.03% in second frequency band. it is found that it provides high return loss upto -33.46dBi. The narrow bandwidth of Microstrip antenna is one of the important features that restrict its wide usage**.** From the above it is clear that H-shaped patch antenna which provides dual frequency operation and high return loss. The maximum gain of the antenna has been improved up to 3.83 dBi, directivity improved up to 3.88 dBi, efficiency of the antenna is found to be 98.96%, and the VSWR of the antenna is in between 1 to 2 over the entire frequency band which shows good impedance matching. The simulation performance of proposed micro strip patch antenna is analysed by using IE3D simulation software version 9.0 at select design frequency of 2.1 GHz. The performance specifications like gain, radiation pattern etc of proposed antenna is shown in the fig 2 to 8.
The plot graph of return loss Vs frequency is taken at the maximum frequency of 3.5GHz which is shown in Fig.2.

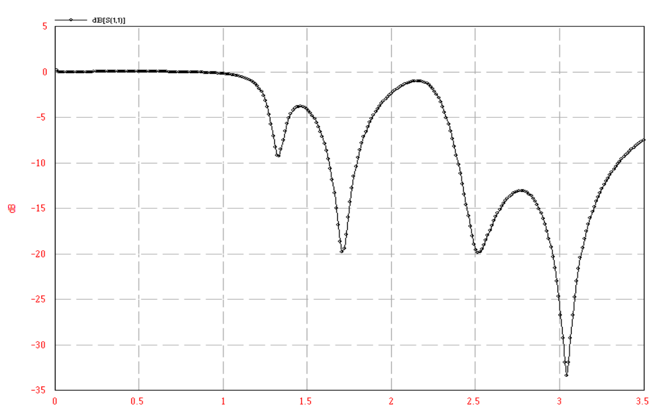

Fig.2: Return loss v/s frequency graph.

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In fig 3, the plot graph of 3D Radiation pattern of proposed antenna at resonant frequency 1.709 GHz.

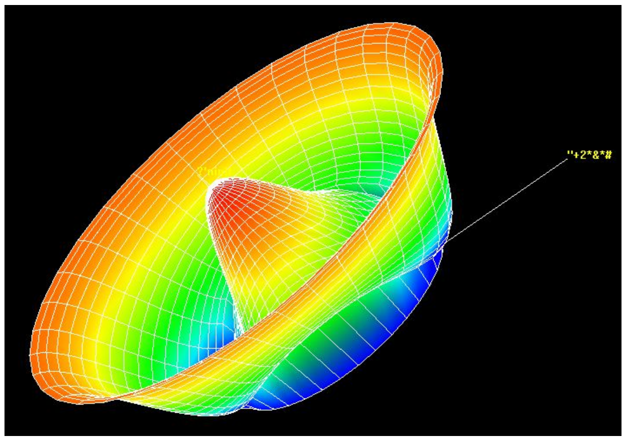

Fig.3: 3D Radiation pattern of proposed antenna.

In fig 4, the plot graph of Gain Vs Frequency shows the total field gain of the MSP antenna and obtain maximum gain of antenna is 3.83dBi at resonant frequency 1.709GHz

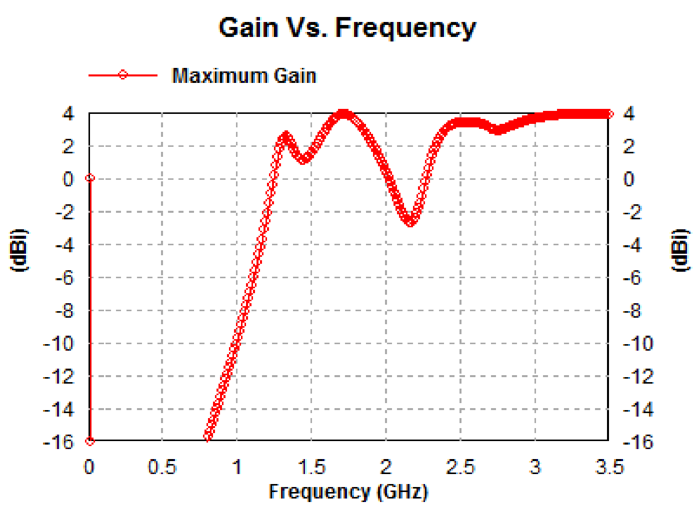

Fig.4: Gain vs. frequency plot.

In fig 5, the plot graph of VSWR Vs Frequency represents that the bandwidth of design antenna is useful or not. The obtain VSWR is 1.22 at resonant frequency of 1.709 GHz.

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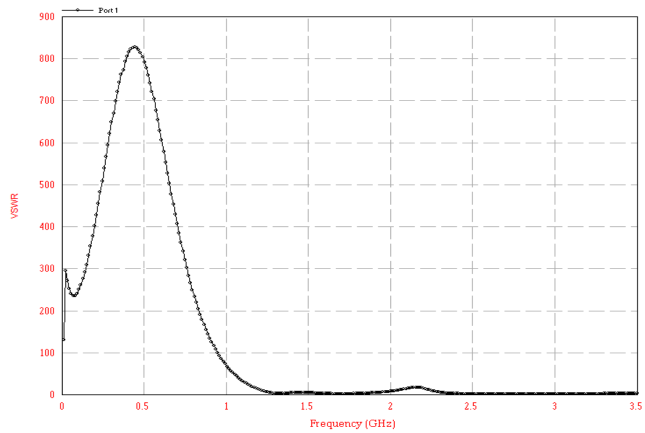

Fig.5: VSWR of proposed antenna.

In fig 6, the plot graph of total field Directivity Vs Frequency represents the ratio of radiation intensity in a given direction from the antenna to the radiation intensity averaged over all direction [16]. The obtain directivity of antenna is 3.88dB at resonant frequency 1.709GHz.

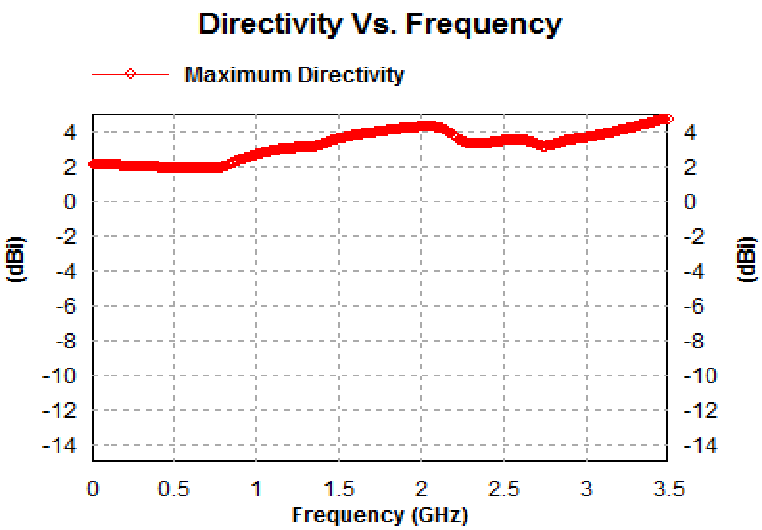

Fig.6: Directivity v/s frequency plot.

In fig 7, the plot graph of 2D radiation pattern of antenna represents radiating all power in one direction therefore design antenna has unidirectional radiation pattern. 2D radiation pattern of antenna is shown at resonant frequency 1.709GHz and phi=0(deg).

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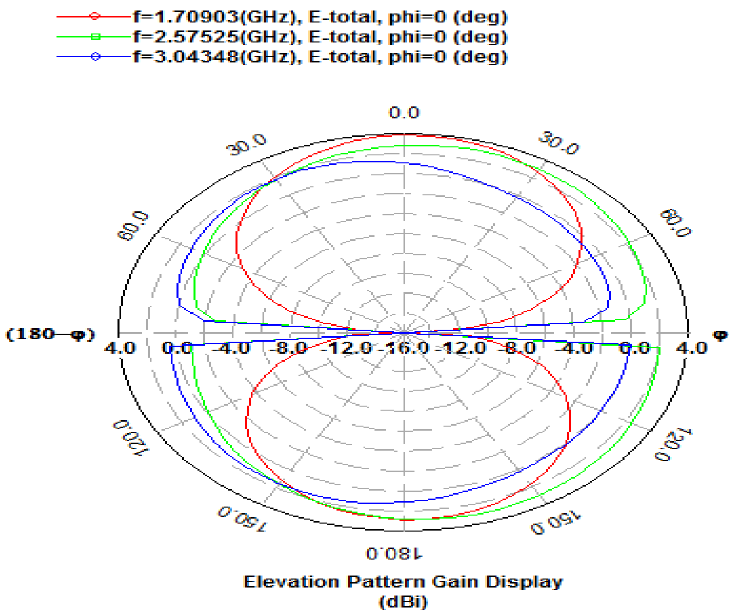

Fig.7: 2D radiation pattern of antenna

In fig 8, the plot graphs of Efficiency Vs Frequency represent antenna efficiency. The obtain percentage antenna efficiency is 98.96% at 1.709GHz.

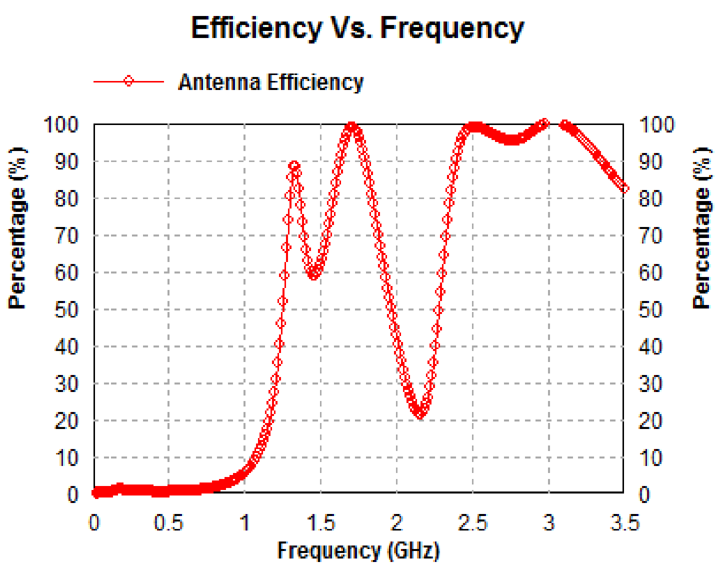

Fig.8: Efficiency graph of proposed antenna.

VI. CONCLUSION

A novel technique for enhancing bandwidth of a microstrip patch antenna with dual band characteristics and wide bandwidth capability for specific applications is successfully designed and discussed antenna provides dual frequency band (1.63-1.79 GHz) with fractional bandwidth of 9.35% in first band and 33.04% fractional bandwidth in second band (2.4-3.34). The proposed rectangular microstrip antenna it provides 66.12% high, return loss upto -33.46dBi, gain

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3.84dBi, directivity 3.88dBi and efficiency 98.96%. The simulated result of design antenna shows good performance and thus can be used as various applications such as WLAN/WIMAX, Bluetooth, missile, wireless, satellite, mobile communication, and military.

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