Dual Band Microstrip Patch Antenna

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Abstract **- The main content of this paper presents square microstrip patch antenna operating in Dual Band i.e., in C band (4-8 GHz) and X band (8-12 GHz).we have designed the patch at 5.8 GHz and the dimensions of the square patch are 17.4x17.4mm.As it is a square patch the length and width are same. The resonating frequency in C-band is 5.4GHz, 7.8 GHz and in X-band is 9.2 GHz. The most return loss obtained both the bands are in the range of 27, 24, 31. The gain obtained in the resonating frequencies of C-band and X-band are 6.1, 7.2 and 6.8 respectively. As both the bands of VSWR are in between 1-2 range, so it also satisfies ideal antenna specifications. As the VSWR, Return Loss, Gain are better than our reference paper we can also use our Dual Band antenna in Satellite Communications, Weather radar systems, Wi-Fi, ISM band, WiMAX, WLAN and Wireless Computer Network applications.**

Keywords: Antenna, Microstrip, ADS, WiMAX, RT Duroid.

I. INTRODUCTION

Microstrip patch antennas that are compact and have high gain, narrowband operating frequencies are very much in demand for wireless communication systems. There are many merits of microstrip patch antenna such as low profile, light weight, simple realization process and low manufacturing cost. Though these antennas have so many advantages, they also have some disadvantages like narrow bandwidth. Enhancement of the performance to cover the demanding bandwidth is necessary [1]. There are numerous well- known methods to increase the bandwidth of antennas, including increase of the substrate thickness, the use of a low dielectric substrate, the use of various impedance matching and feeding techniques, and the use of multiple resonators .In this paper, a wide-band antenna fed by a microstrip line is presented.

Microstrip patch antenna consists of a radiating patch, dielectric substrate and a ground plane. The thickness of the ground plane or of the microstrip is not very important. The height h is much smaller than the wavelength of operation, but it should not be much smaller than 0.025 of a wavelength otherwise, the antenna efficiency will be degraded. There are several types of patches like rectangular, square, circular, pentagon, hexagon, etc [2]. The proposed antenna is designed using a square patch. The main reason for choosing square patch over the most commonly used rectangular patch is that it works well at higher frequencies and also provides better efficiency. The electric field is zero at the center of the patch, maximum at one side, and minimum on the other side. It can be seen that the minimum and maximum continuously change sides according to the instantaneous phase of the applied signal. The following Fig.1. shows the structure of Microstrip Patch Antenna

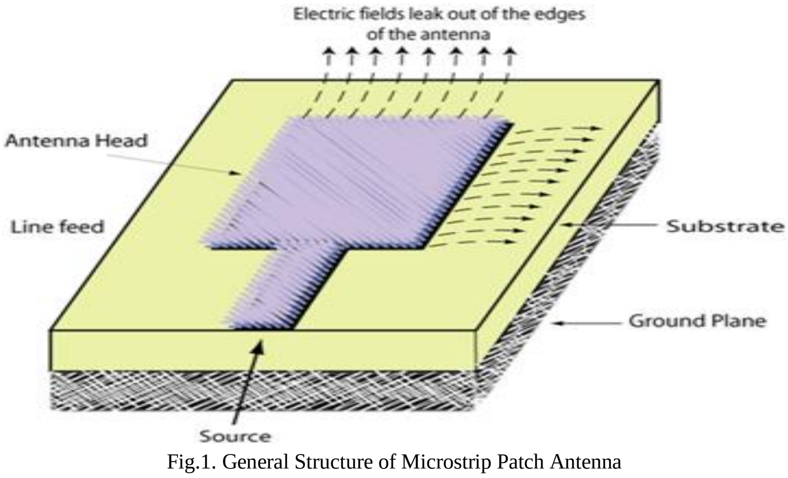

Fig.1. General Structure of Microstrip Patch Antenna

II. ANTENNA DESIGN

The proposed antenna is designed using Advanced Design System (ADS) software. ADS has powerful and easy-to-use interface .It provides complete schematic capture and it also provides complete layout environment. The antenna design consists of RT duroid 5880 as substrate with dielectric constant 2.2 and thickness of 1.6. It has relative permittivity tan value as low as 0.0009. When compared to other substrates, the efficiency, gain, return loss are higher for RT duroid [3]. A substrate of low dielectric constant provides compact radiating structure to meets the required bandwidth. Low dielectric constant of the substrate produces larger bandwidth and the high dielectric constant of the substrate results in smaller size of antenna. Therefore, trade-off relationship exists between antenna size and bandwidth.

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The frequency is inversely proportional to the antenna size .The fig.2. Explains the layout of dual band structure. We have used 2 slits each of 2mm and a slot of 0.5mm. The respective magnitude waveforms are shown in the fig.3.The dimensions of the square patch are 17.4x17.4mm

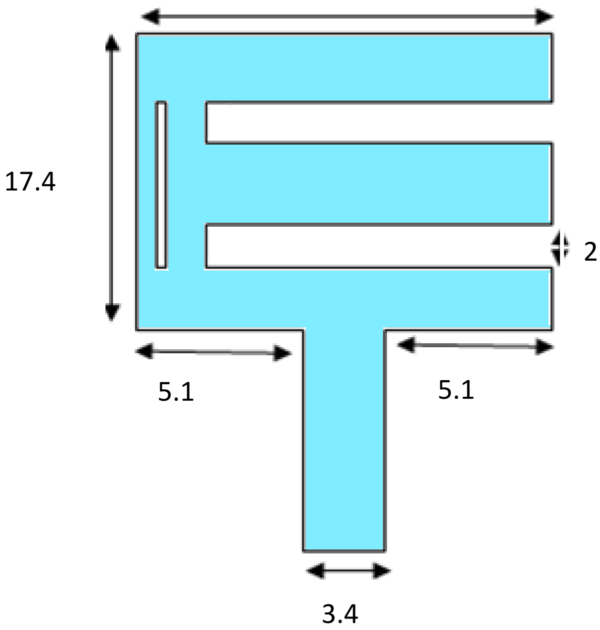


Fig.2. Square patch layout

III. FORMULAS USED

As the patch is in square shape, the length and the width are same. The parameters are calculated using the formula given below.

Width and Length:

$$w = \frac{c}{2} f_r \sqrt{\varepsilon_r} \quad \dots (1)$$

Wavelength:

$$\lambda = \frac{c}{fr} \quad \dots (2)$$

Transmission line parameter:

$$X = \frac{\lambda}{4} \quad \dots (3)$$

$$Y = \frac{w}{5} \quad \dots (4)$$

Where

f_r is the resonant frequency of the antenna
c is the free space velocity of the light
L is the actual length
ε_r is the effective dielectric constant of the substrate

By reducing the size of the antenna, the size of wireless communication devices can be minimized. However, reducing the antenna size will usually reduce its impedance bandwidth as well. Therefore designing a small antenna with a wide impedance bandwidth which satisfies future generation wireless application, especially having stable radiation patterns across the operating frequency band.

Parameters	Values
Width and Length	17.4mm
Wavelength	51.7mm
Feed length	12.9mm
Feed width	3.4mm

IV. OUTPUTS OBTAINED

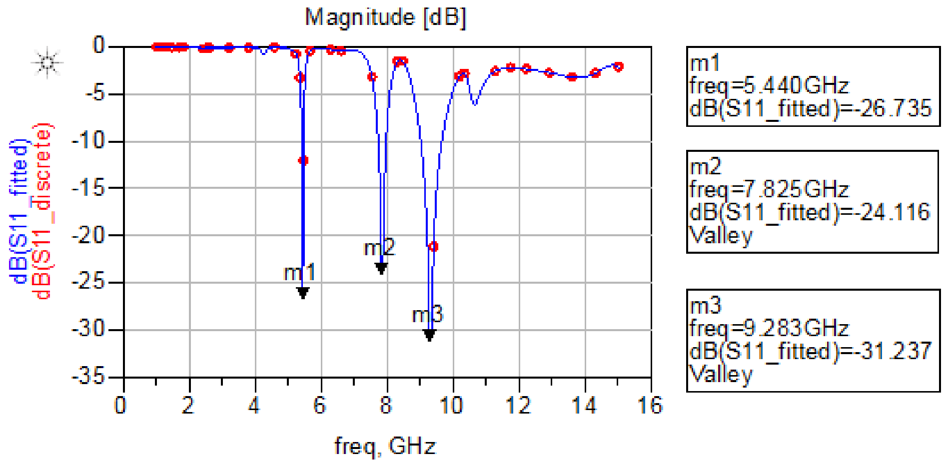


Fig.3. Magnitude waveform

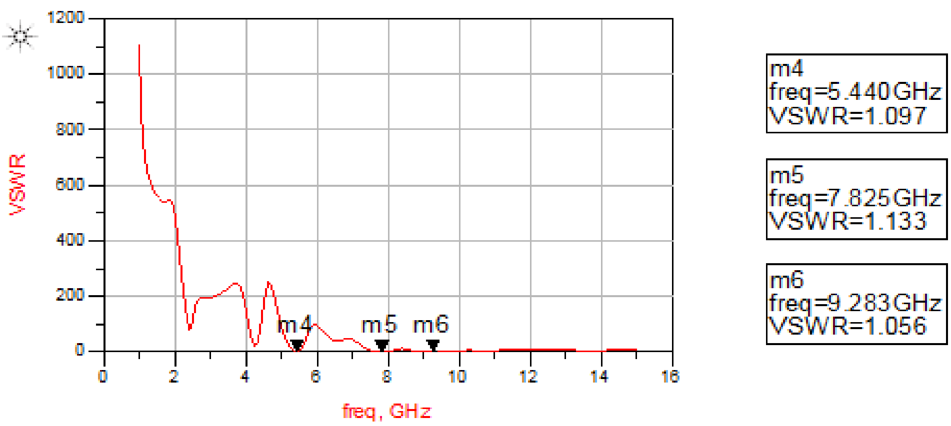
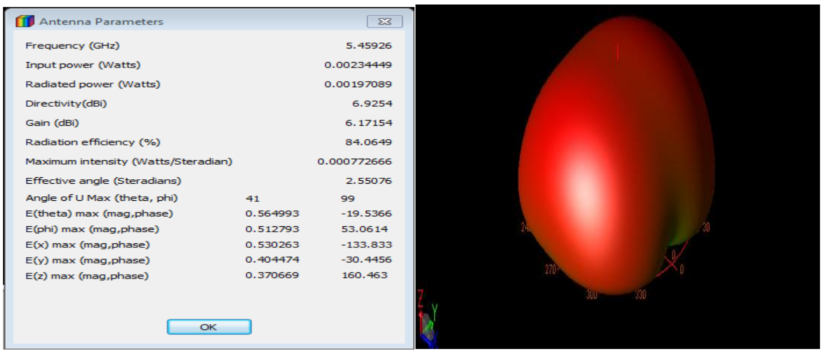


Fig.4. VSWR waveform

The obtained waveforms for the structure is shown above in the Fig.2. & Fig.3. The Fig.2. Explains the magnitude waveform, the frequency resonates at two bands with multiple frequencies i.e., 5.44GHz, 7.82GHz, 9.28GHz. The Fig.3. explains the VSWR which is practically and theoretically in the ideal value i.e., between 1-2, so it can also give better results in practical applications.

V. ANTENNA PARAMETERS AND RADIATION PATTERN

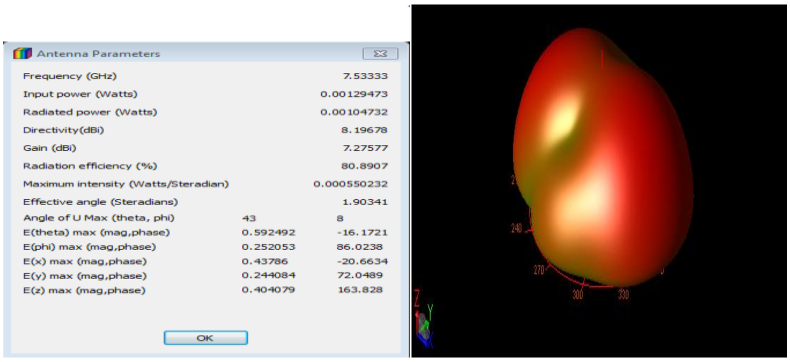
The antenna resonates at three different frequencies 5.44GHz, 7.82GHz, 9.28GHz. In Fig.5, 5.44GHz the obtained gain is 6.17dB and it is almost equal to directivity, this C-band frequency can be widely used in Satellite Applications. In Fig.6, 7.82GHz the obtained gain is 7.27dB and it is also equal to directivity, this X-band can be widely used in Radar Applications. In Fig.7, 9.28GHz, the obtained gain is 6.86dB. It radiates in narrow band pattern. Due to this, it involves in narrow range of frequencies it is a directional antenna.



Antenna Parameters

Frequency (GHz)		5.45926
Input power (Watts)		0.00234449
Radiated power (Watts)		0.00197089
Directivity(dBi)		6.9254
Gain (dBi)		6.17154
Radiation efficiency (%)		84.0649
Maximum intensity (Watts/Steradian)		0.000772666
Effective angle (Steradians)		2.55076
Angle of U Max (theta, phi)	41	99
E(theta) max (mag,phase)	0.564993	-19.5366
E(phi) max (mag,phase)	0.512793	53.0614
E(x) max (mag,phase)	0.530263	-133.833
E(y) max (mag,phase)	0.404474	-30.4456
E(z) max (mag,phase)	0.370669	160.463

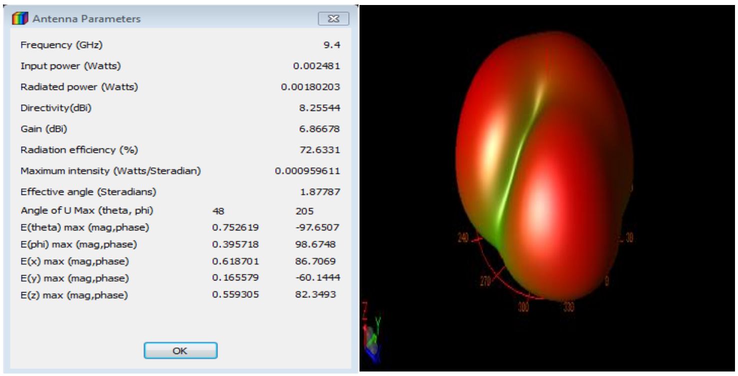
Fig.5. Antenna Parameters & Radiation Pattern for 5.4GHz



Antenna Parameters

Frequency (GHz)		7.53333
Input power (Watts)		0.00129473
Radiated power (Watts)		0.00104732
Directivity(dBi)		8.19678
Gain (dBi)		7.27577
Radiation efficiency (%)		80.8907
Maximum intensity (Watts/Steradian)		0.000550232
Effective angle (Steradians)		1.90341
Angle of U Max (theta, phi)	43	8
E(theta) max (mag,phase)	0.592492	-16.1721
E(phi) max (mag,phase)	0.252053	86.0238
E(x) max (mag,phase)	0.43786	-20.6634
E(y) max (mag,phase)	0.244084	72.0489
E(z) max (mag,phase)	0.404079	163.828

Fig.6. Antenna Parameters & Radiation Pattern for 7.8GHz



Antenna Parameters

Frequency (GHz)		9.4
Input power (Watts)		0.002481
Radiated power (Watts)		0.00180203
Directivity(dBi)		8.25544
Gain (dBi)		6.86678
Radiation efficiency (%)		72.6331
Maximum intensity (Watts/Steradian)		0.000959611
Effective angle (Steradians)		1.87787
Angle of U Max (theta, phi)	48	205
E(theta) max (mag,phase)	0.752619	-97.6507
E(phi) max (mag,phase)	0.395718	98.6748
E(x) max (mag,phase)	0.618701	86.7069
E(y) max (mag,phase)	0.165579	-60.1444
E(z) max (mag,phase)	0.559305	82.3493

Fig.7. Antenna Parameters & Radiation Pattern for 9.2GHz

VI. CONCLUSION

Simulation results of a narrowband microstrip patch antenna having 5.4 GHz, 7.5 GHz and 9.4 GHz frequency has been presented. Good antenna performance and impedance matching can be realized by adjusting the probe position and the dimensions of the patch. It can be concluded from the results that the designed antenna has satisfactory performance and hence can be used for Satellite Communications, Weather radar systems, Wi-Fi, ISM band, Wireless Computer Network, WiMAX, WLAN applications.

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