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DESIGN OF COMPACT MICROSTRIP PATCH ANTENNA FOR WIRELESS APPLICATIONS

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***ABSTRACT*---** **In this paper, a novel microstrip patch antenna based on composite material and radiating part is presented. A microstrip patch antenna has low profile, light weight and easy to fabricate. The radiating part is presented for wireless applications. By selecting a suitable offset feed position, it is feasible to provide 50 Ω characteristic impedance and thus making better impedance matching. The proposed antenna has been improved gain by using apposite dimensions and air gap between ground plane and substrate material. The proposed antenna has to be fabricated with RT/Duroid substrate and dimensions of 19×22×0.8mm. The proposed antenna has miniaturized size, high gain and homogeneous radiation pattern rendering for wireless communication applications. The simulation had performed using ANSOFT HFSS 13.0 simulator. HFSS is an interactive software package for calculating the electromagnetic behavior of a structure.**

Keyword--- Microstrip, Wi-Max, Satellite Communication, RT/Duroid, Wireless Application

I. INTRODUCTION

Antennas are a very important component of communication systems. By definition, an antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, Which means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band of the radio system to which it is connected, otherwise the reception and the transmission will be impaired. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in pace is called a radiation pattern.

Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low profile structure. Therefore, they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers etc. The telemetry communication antennas on missiles need to be thin and conformal and are often Microstrip patch antennas. Another area where they have been used successfully is in Satellite communication.

Microstrip has been used as a radiating structure for achieving compact dual band antennas in the WLAN frequency range. Their role in antenna design becomes more desirable because of their ability to achieve multiband, reconfigurability, gain and bandwidth enhancement and miniaturization.

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In this paper, a novel microstrip patch dual band antenna and radiating part is presented for (3.8 GHz) and (6.9 GHz) applications.

II ANTENNA DESIGN METRICS

The proposed antenna have the dimensions with a compact size of 19 mm×22 mm×0.8 mm and the RT/Duroid 5880 (εr is 2.2 and tand is 0.0009) substrate used here. The fabrication has to be done on single surface of the substrate, since the antenna here is ground and the conducting part has to be fabricated on double surface. The design procedure and geometrical view of the proposed antenna is shown in Fig. 1. The proposed antenna is fed by a 50 X offset line and has a partial ground plane. This combination is used to generate a resonant frequency of 3.8 and 6.9 GHz. In back side of the ground plane is used to induce magnetic resonance and in turn improves the bandwidth.

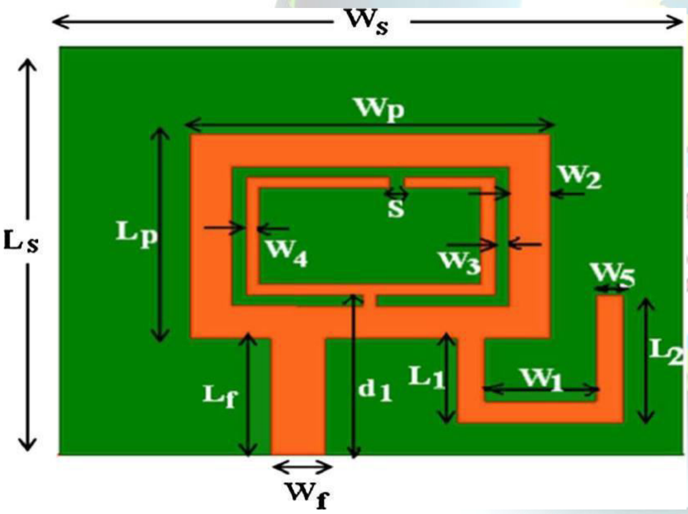

Fig. 1 Geometrical view.

The proposed antenna dimensions are given in Table 1.

Table 1Proposed antenna parameters (mm).

Ls	Ws	Lp	Wp
19	22	9.5	13
W3	W4	W5	S
0.5	0.5	1	0.5
Wf	W1	W2	Lf
2	4	1.5	5.5
L1	L2	d1	S1

The side view of an antenna is shown in Fig. 2. The Air gap between ground plane and substrate material is used for improving gain of an antenna.

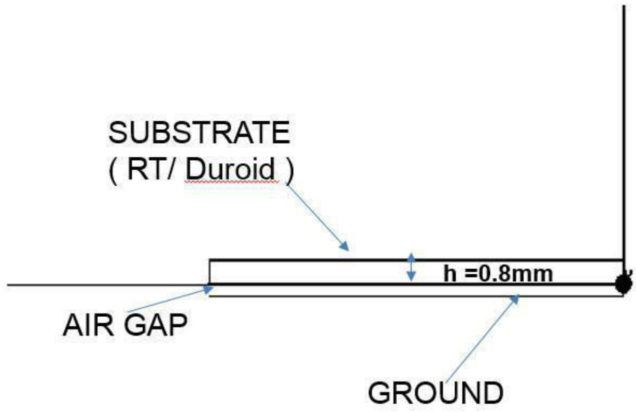

Fig. 2 Side view of an antenna.

III. ANTENNA DESIGN PARAMETER CALCULATION

Step 1: Calculation of the Width (W) -

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Step 2: Calculation of the Effective Dielectric Constant. This is based on the height, dielectric constant of the dielectric and the calculated width of the patch antenna.

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Step 3: Calculation of the Effective length

4	7	7.5	0.5

Step 4: Calculation of the length extension ΔL

$$\Delta L = 0.412h\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

Step 5: Calculation of actual length of the patch

$$L = L_{eff} - 2\Delta L$$

IV. RESULTS AND DISCUSSIONS

The simulation of microstrip antenna is simulated using HFSS software. The simulated results of return loss characteristics as shown in Fig. 3. The electrical length of the radiating branch performs a significant function in realizing the lower most frequency to achieve miniaturization.

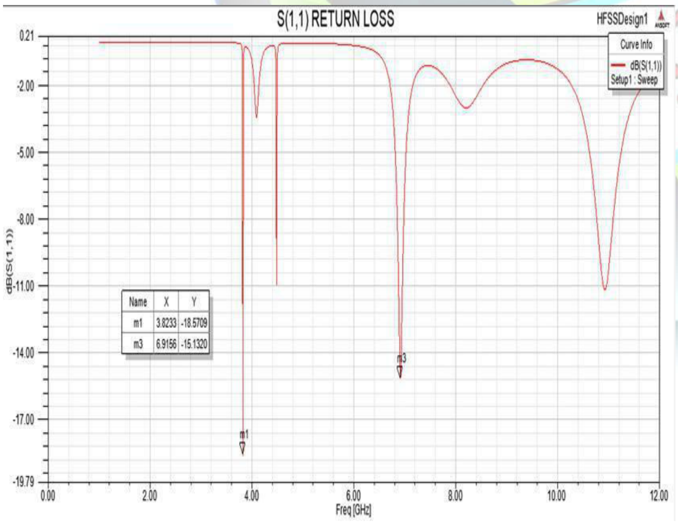

Fig. 3 Frequency Vs. Return Loss

The simulated far field Radiation pattern, VSWR, Gain, Directivity and Surface current distribution of proposed antenna at resonance frequency of 3.8 GHz and 6.9 GHz are shown in Figs. 4, 5, 6 and 7 respectively

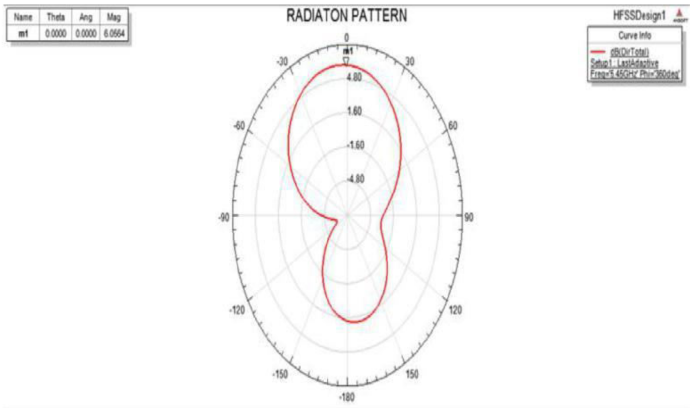

Fig. 4 Radiation Pattern

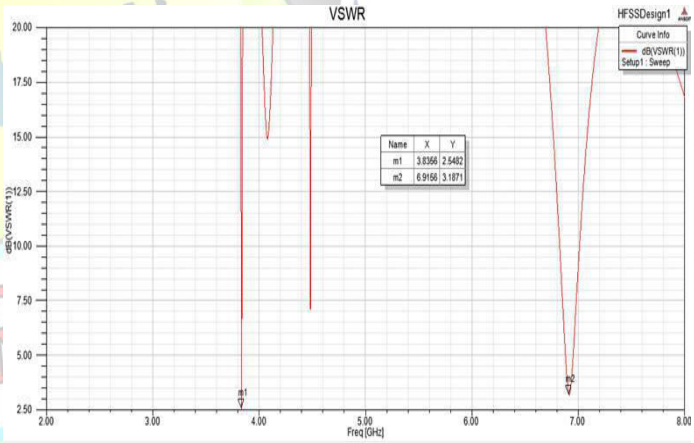

Fig. 5 VSWR

Fig. 6 Gain

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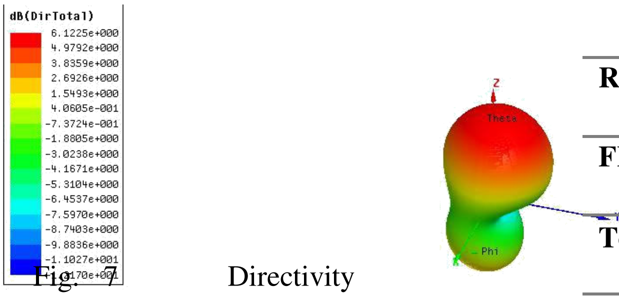

Fig. 7 Directivity

SUBSTRATE	RESONANCE FREQUENCY (GHZ)	GAIN (dBi)	DIRECTIVITY (dBi)	EFFICIENCY
RT/Duroid	3.8, 6.9	6.02	6.12	98.366%
FR4	3.4, 5.7	3.67	6.49	56.55%
Teflon	6.9	6.10	6.22	98.07%
Alumina	9.3, 11.7	5.17	5.87	88.07%

Table. 2 Comparison between various substrate material and its efficiency

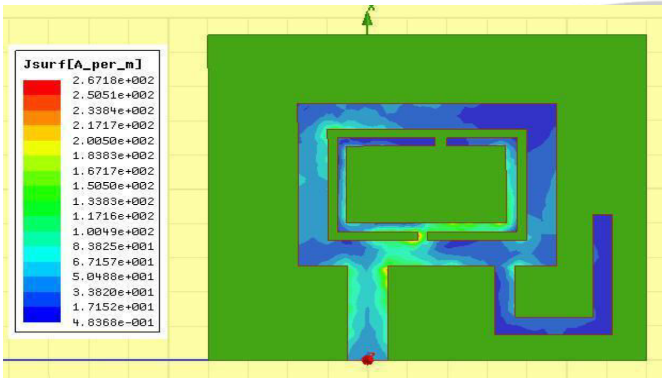

Fig. 8 Surface current distribution

The area coverage of an antenna by gain, directivity and radiation pattern as shown in Fig. 9.

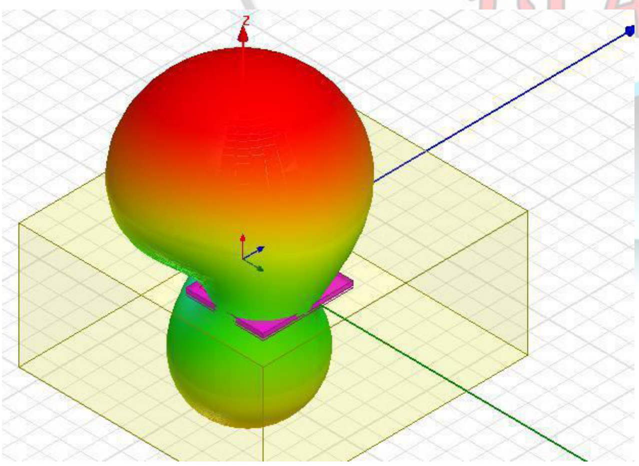

Fig. 9 Radiation of an antenna

V. CONCLUSION

A novel microstrip patch antenna for Wi-Max and Wireless applications is proposed, with a compact size of 19× 22× 0.8 mm^3.A good impedance matching and efficiency are achieved by offset fed microstrip line and RT/Duroid substrate. The radiating branch is used to achieve Wireless resonance frequency of 3.8 and 6.8 GHz. The simulated and measured results match with each other. The proposed antenna has a miniaturized size, high gain and homogeneous radiation pattern rendering it effective for wireless communication applications.

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