Compact U-Slotted Dual Band Conformal Microstrip Antenna

Priyanka Mishra
PG student, Department of
Electronics and Communication
Sagar Institute of Research and Technology
Bhopal, Madhya Pradesh, India

Paras Gupta
Professor, Department of
Electronics and Communication
Sagar Institute of Research and Technology
Bhopal, Madhya Pradesh, India

***Abstract*—A single element of conformed rectangular microstrip antenna is presented in this paper. The paper shows much miniaturized structure of conformal antenna which works in dual frequency bands. This rectangular shaped slotted conformal Antenna is designed for utilizing the frequency range of wireless communication System. Thus an efficient with 6.7 and 7.3 GHz accommodates two wireless bands achieving very high gains of 8.2 and 8.5 dBi respectively. This conformal u-slotted antenna is commercially viable for Dual Frequency Bands. Return loss S11, Radiation pattern, Gain, Directivity, VSWR and Designed of Antenna is discussed for both frequency Bands. Very compact size and Dual Band performance of conformal Antenna provides many advantageous features for wireless Communication System.**

Keywords— Conformal, Directivity, Gain, Radiation Pattern, Wireless comm.., Return Loss, Port.

I. INTRODUCTION

Now a days the technologies necessity is increasing very rapidly, due to excessive need of miniaturization of devices, there is also need of high performance durable compact size antenna, so the installation of this antenna helps to overcome the such problems [1]. The use of multiband antennas in portable devices like mobile phone, laptop, gaming console etc. is inevitable now-a-days. Microstrip Antenna generally have very low profile, These small size radiating element can have wide range to ultra wide frequency bandwidth range having the freedom to construct in any of the shape that may rectangular, circular, triangular etc[2]. Slotting in the patches and ground planes results in increase of bandwidth and allocation or shifting of the frequency bands [3]. Various types of feeding networks can also be fed to antenna like Coaxial, Proximity, coplanar microstrip lines. Beside the many advantages these antenna undergoes with some of the draw backs like narrow bandwidth [4]. However for such drawbacks there are some techniques for overcoming from these type of problems. The conformal antenna are also capable for showing the aerodynamic shapes These conformal antenna provides radiation in wide scan range and low aerodynamic structures. Conformal shapes allows the antenna to install in any of the bend or curved surface thus antenna radiates in large ranges.

The paper shows the aim of the miniaturized dual band with u-shaped slotting for employing the wireless communication band also gives the balance between the dimensions and the parametric studies [5]. The structure of conformal antenna design is shown below in Figure no 1.

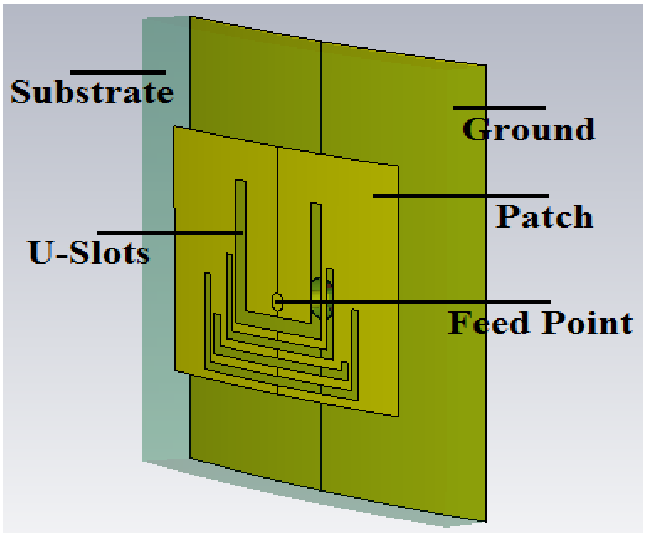

Fig1. Diagram of Designed Model of Conformal Microstrip Antenna.

To describe the performance of an antenna, definitions of various parameters are necessary. Some of the parameters are interrelated and not all of them need be specified for complete description of the antenna performance [6]. The definitions of fundamental parameters are given in this chapter [7].

Radiation Intensity

$$U = r^2 W_{rad}$$

Where U is radiation intensity (W/per unit solid angle) and W_{rad} is radiation density (W/m^2)

Directivity

$$D = \frac{U}{U_0} = \frac{4\pi U}{P_{rad}}$$

Where D = Directivity, D_0 = Maximum Directivity, U = Radiation intensity, U_0 = Radiation intensity of isotropic source (W/unit solid angle), P_{rad}= Total radiated power (W)

Gain

$$\text{Gain (G)} = 4\pi\frac{radiationintensity}{to\,talinputpower} = 4\pi\,\frac{U(\theta,\ \emptyset)}{P_{in}}$$

Where η is antenna efficiency, expressed as

$$\eta = \frac{P_{rad}}{P_{in}}$$

Quality Factor

$$\frac{1}{Q_t} = \frac{1}{Q_{rad}} + \frac{1}{Q_c} + \frac{1}{Q_d} + \frac{1}{Q_{sw}}$$

Where

Q_{rad} = Quality Factor due to radiation losses

Q_c = Quality factor due to conduction losses

Q_d = Quality factor due to dielectric losses

Q_{sw} = Quality factor due to surface wave

VSWR

$$SWR = \frac{1+\Gamma}{1+\Gamma}$$

Bandwidth

$$\frac{VSWR - 1}{Q\sqrt{VSWR}}$$

Return Loss

$$RL = -20\log \Gamma \text{ (dB)}$$

II. ANTENNA DESIGN AND CONFIGURATION

Basically microstrip Antennas are designed from Four basic elements they are Patch, Ground, Substrate and Feeding network these all constitute to form radiating elements[8]. Patch above most is the significant element for the radiation of electric energy that is mostly mounted above the surface of substrate material in some value of permittivity is 1. Patch Designed from the use of Hammerstad Formulae[9], which helps for finding the approx dimension of length and width.

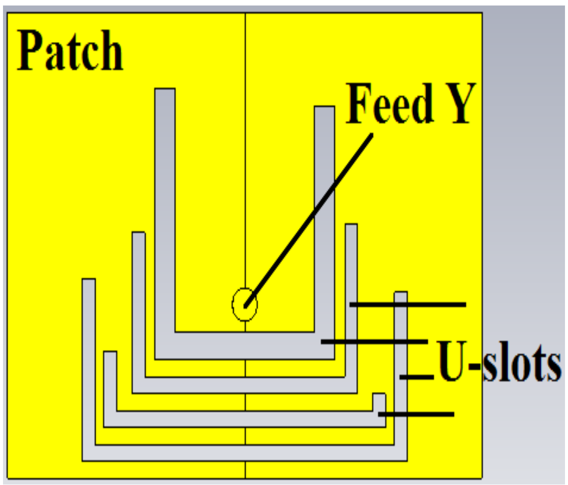

Fig 2. Diagram of Microstrip Antenna Slotted Patch

In this model slotting technique is introduced for increasing the performance of microstrip antenna and the aim was to design compact size device, prototype model have these compatibilities[10]. Figure below shows the description about the patch material. Patch is made up of copper material which good electric conducting element helps antenna to resonate at desired frequency. Four u-shaped slotting is done one by one in surface of patch, their dimension are described below.

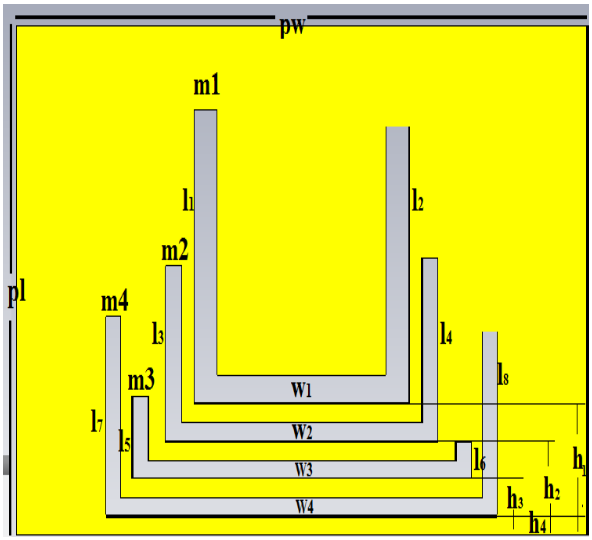

Fig 3. Dimension specification of U-Slotted Microstrip Antenna

Patch material is to bend conformal shape which on excitation radiates with wider angular width approx the degree of 67.5, peak lobe at the direction of 4 degree at the frequency of 7.2 GHz. Below the patch material substrate is placed in this prototype design the permittivity value of 1 is taken which is air. Substrate is used for the utilizing the electric energy as much as which confine beneath the patch, as a result better performance of antenna is achieved. Width and length of substrate for antennas are 19mm and 13.75mm respectively. The size of the substrate is the size of the antenna which is achieved by the parameterization technique simulation and analysis. All the surface waves are confined due to introduce of substrate area as a result antenna radiates with more power.

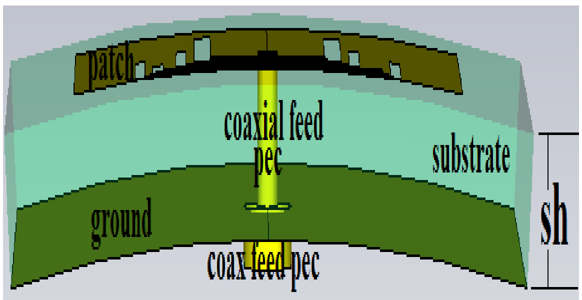

Fig 4. Side view of conformal Antenna

Ground is placed below the substrate material which is made up of perfect electrical material in this structure copper material is used. Ground is excited to generate the electric lines in substrate material with patch. Coaxial feeding network is introduced for impedance matching of antenna. Ground is matched to the feeding network with 50 ohm impedance, the conformed ground has coax size etched in its surface for inserting the feed pec coaxial line through the substrate.

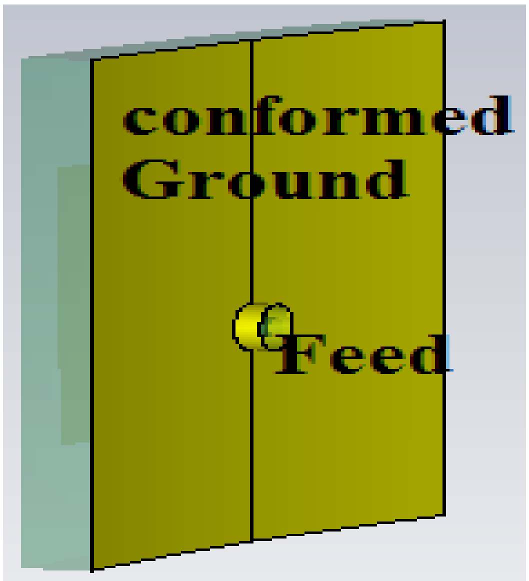

Fig 5. Diagram of Ground and Coaxial Feedline

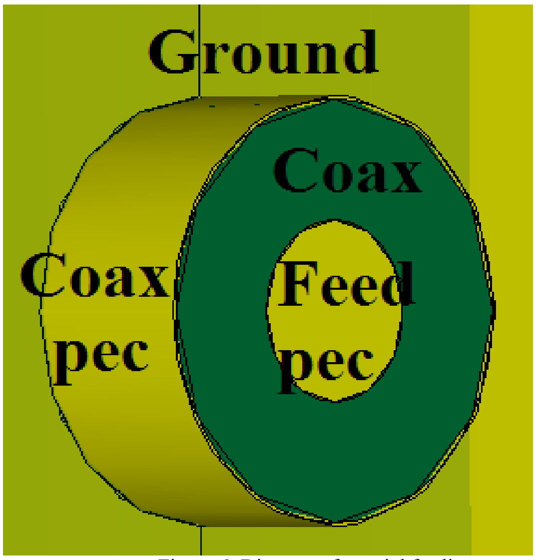

Figure 6. Diagram of coaxial feeding

For the impedance matching the choice of feeding network must matched to the antenna with 50 ohm impedance. The coax permittivity value is 2.2 having outer radius of 1.75 mm and inner radius of 0.5mm. The outer surface of the coax material is constructed with the perfect electric conducting material of 0.01mm height. The feed pec of coaxial line which is perfect electric conductor of has outer radius 0.5 mm. Wave guide port is established for matching the coaxial cable for the excitation of antenna. The feeding point is located at the position of x=0 and y=-3.

Table 1. Dimensions of Conformal Microstrip Antenna, All the Dimensions is in mm

Patch Length pl	13.75	m_1	0.8
Patch Width pw	19	m_2	0.5
Substrate Length sl	25	m_3	0.5
Substrate width sw	25	m_4	0.5
Substrate height sh	2.8	l_1	8
Ground Length gl	25	l_2	7.5
Ground Width gw	25	l_3	4.75
Feed radius	0.5	l_4	5
coax outer radius	1.16	l_5	2.25
Inset feed Length	3.5	l_6	1
Inset coax length	1	l_7	5.4
Feed location Y	-3	l_8	0.5
h_1	3.5	w_1	7.2
h_2	2.5	w_2	9
h_3	1.5	w_3	11.25
h_4	0.5	w_4	14

III. DISCUSSION OF DUAL BAND CONFORMAL ANTENNA RESULTS

Table above shows all the parameterized value of antenna after processing of finite integral method simulations. The antenna resonates at the frequency of 6.8 GHz and 7.2 GHz has the bandwidth around 100 MHz and 300 MHz respectively, Antenna capable for wireless communication system. The aim of paper is to design a high Gain and compact size conformal antenna. The prototype design accommodates both the requirement compact size and high Gain of antenna. All the significant results are shown in below.

RETURN LOSS

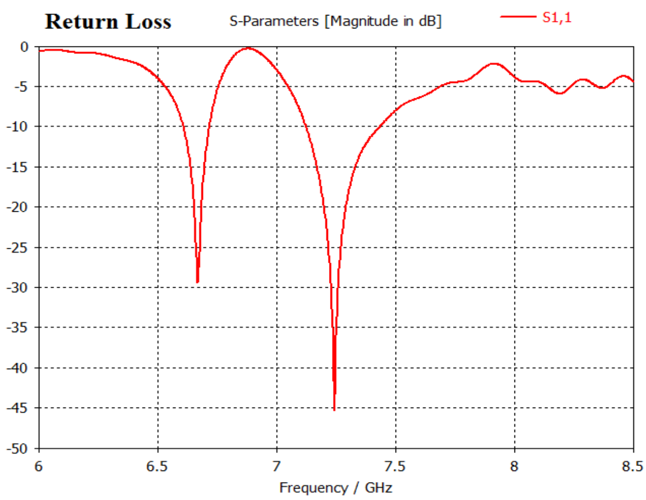

Fig 7. Result of return loss S11 Parameter

VSWR

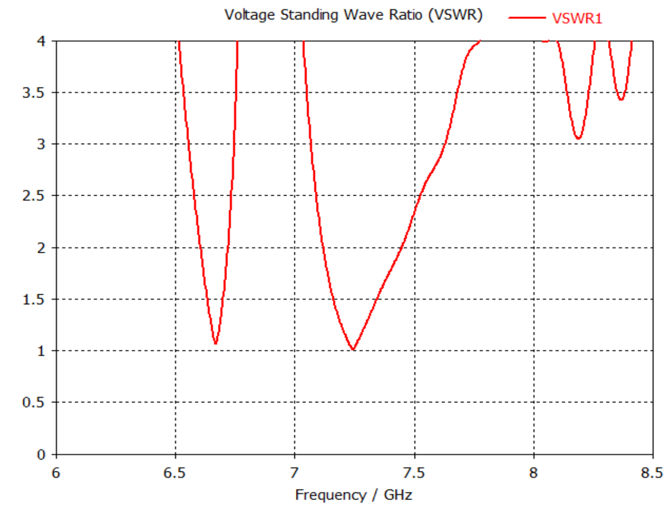

Fig 8. Result of Voltage standing wave ratio

3d view of antenna gain radiation pattern at 6.7GHz.

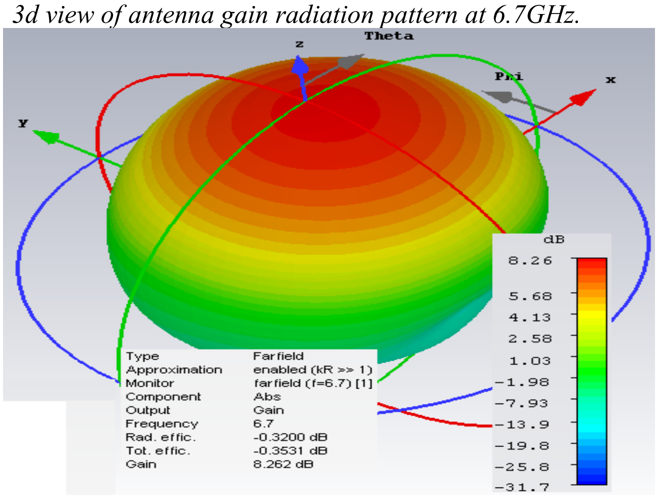

Fig 9. Result of 3d radiation pattern of antenna gain.

3d view of antenna gain radiation pattern at 7.3GHz.

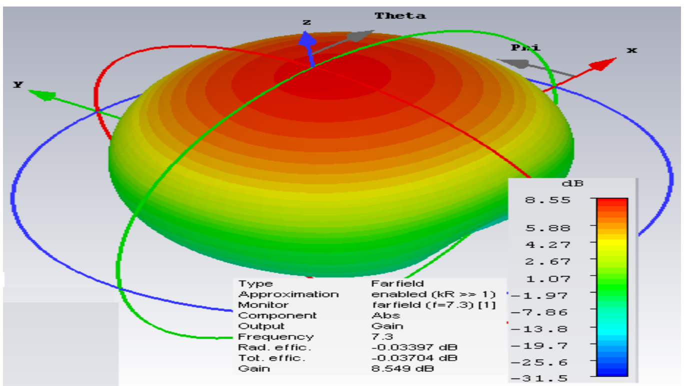

Fig 10. 3D radiation pattern of antenna gain.

Conformal u-shaped Antenna resonates on the frequency of 6.7 and 7.3 GHz, having the bandwidth of 100 and 300 MHz . Prototype design has very compact facilitates installation in monolithic equipment devices designing. Configuration is helpful for the increase of its efficiency and its significant results.

When conformal antenna is fed to electrical energy the wider angular width of 67.5 deg. at frequency 7.3 GHz and 67.7 Deg. at 6.7GHz is achieved the antenna are excited by 50 ohm impedance network of coaxial cable. Due to excitation antenna radiates its energy with more efficiency and high gain. Waveguide port at coaxial feeding is mounted for excitation of Patch. The curvature radius of patch is at the distance of 100mm. and the ground conformed curvature at the radius of 98.75mm and curved substrate is present between these two copper materials, single slab of substrate with height of 2.5mm is used to design the conformal Antenna.

IV. CONCLUSION

This paper presents the simulation and analysis about the miniaturized Dual Band Conformal microstrip antenna at the frequency of 6.7 and 7.3 GHz. All the significant results are shown for designed antenna. Antenna also presents good performance on conformal design. Where single element gives the gain of 8.2 and 8.5 dB and after the of angular width of reaches to 67.5 deg. Achieved gain for such a small sized Antenna is compatible for today's equipment designs. Antenna uses the slots at patch in u-shaped slotted structure which helps the antenna to accommodate its frequency at 6.7 and 7.3 GHz range.

A very directive Antenna shows excellent results of Far-field and unidirectional radiation pattern results with high gain. This is very compact sized Antenna, has various utilization in the field of wireless communication. It can be also experimented for the military purposes. Due to simple design structure possibly will attract the antenna designers. All the simulations and designing's are performed by the use of CST-15 microwave solver software [11]. Table below shows the Comparative Results of Both the frequency bands of conformal micro-strip antenna. At any of frequency can be utilized for the antenna performance.

Table 2. Comparative Results of Both the frequency bands of conformal microstrip antenna.

Parameter	Single 6.7 GHz	7.3 GHz
Bandwidth	100 MHz	300 MHz
Gain	8.2 dB	8.5 dB max
Directivity	8.5 dB	8.6 dB
ReturnlossS11	-30dB	-45dB
Angular Width	67.7 Deg.	67.5 Deg.

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