

A Compact design and fabrication of RMP Antenna for 3G Application

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ABSTRACT

In this world the design of antenna for 3G application were developed fastly in the field of wireless communication. This paper focuses the design and fabrication of rectangular microstrip patch antenna (RMP) for 3G application. This antenna covers three region, substrate made-up of FR4 material, patch and ground made up of copper material. This antenna provides a good return loss as -33.37dB, VSWR as 1.044, Impedance as 51.7 ohm ,gain(dBi) as 4.49148, directivity(dBi) as 4.95856, efficiency as 89.803%, bandwidth as 0.25GHz and Fractional Bandwidth as 0.089 GHz. This type of antenna is more suitable for 3G application to transfer the information from one place to the remote area.

Keywords:

Rectangular microstrip patch antenna, Network analyzer, return loss, mobile telecommunication networks, 3G applications

1. INTRODUCTION

Microstrip patch antennas play a very significant role in today's world. A microstrip patch antenna is very simple in the construction using a conventional microstrip fabrication technique. The patch can take any shape but rectangular and square configurations are the most commonly used configurations [1,2]. These patch antennas are used as simple and for the widest and most demanding applications. Dual characteristics, circular polarizations, dual frequency operation, frequency agility, broadband width, feedline flexibility and beam scanning can be easily obtained from these rectangular and square microstrip patch antennas.

3G, short for third generation, is the third generation of wireless mobile telecommunications technology. It is the upgrade for 2G and 2.5G GPRS networks, for faster internet speed. This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G finds application in wireless voice telephony, mobile internet access, fixed wireless Internet access, video calls and mobile TV [3,4].

II. ANTENNA STRUCTURE

The RMP antennas were designed by the following parameter such as length and width. The patch length and width denoted by L_p and W_p . The inset transmission line feed techniques were used to excite the antenna structure and the length and width of this feeding structure is denoted by L_t and W_t . The depth of feed insertion in the patch is denoted by h , the gap between the feed and patch is denoted by g , length and width of the ground plane is denoted by L_g and W_g . The above said antenna structure design values were listed in the Table 1, the antenna design parameters were marked in the Figure 1 and the designed antenna structure based on the antenna parameter value is given in the Table 1 and operated in 3GHz shown in the Figure 2[5,6,7,8].

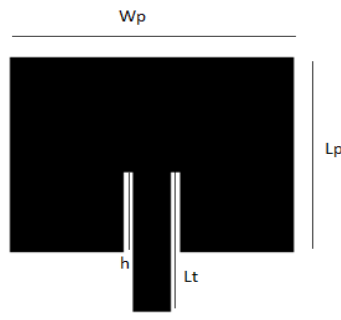


Fig 1 Basic Structure of RMPA



Fig 2 Structure of RMPA for 3G

TABLE I THE DESIGN PARAMETERS OF RMPA FOR 3G

DESIGN PARAM ETERS	DESIGN VALUES
	RECTANGULAR MICROSTRIP PATCH ANTENNA
	ISM
L_p	22mm
W_p	29mm
L_t	18mm
W_t	3mm
g	1mm
h	9mm
L_g	33mm
W_g	59mm

III. ANALYSIS OF SIMULATION RESULT

The antenna parameter values were entered in the ADS software tool. The patch made up of conductive material such as copper indicated by yellow color, behind the patch the substrate layer is located which is made up of FR4 material and have the dielectric constant as 4.6, final layer behind the substrate made up of conductive layer such as copper having conductivity $5.8 \times 10^7 S/m$ with tangent loss 0.001 which is indicated by the color green in the layout window in ADS software which is shown in Figure 3[9,10].

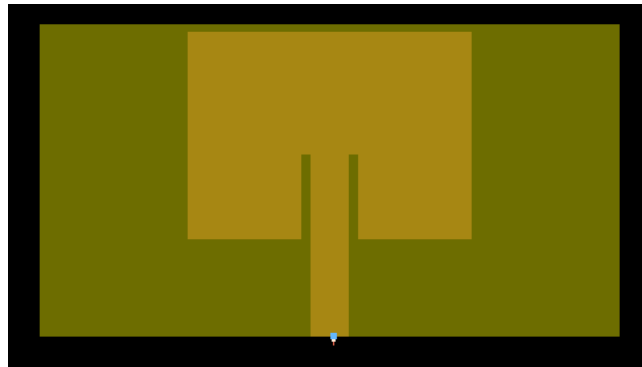


Fig 3 Layout diagram of RMPA for 3G

The designed antenna structure were simulated using ADS tool and observed Return Loss as -25.011 dB at 3.023GHz ,which is shown in Figure 4.The reduced amount of return loss value -25.011 dB indicates maximum amount signal transmitted without disturbance.The RMP antenna provides the bandwidth as 0.25GHz and Fractional Bandwidth as 0.089 GHz.

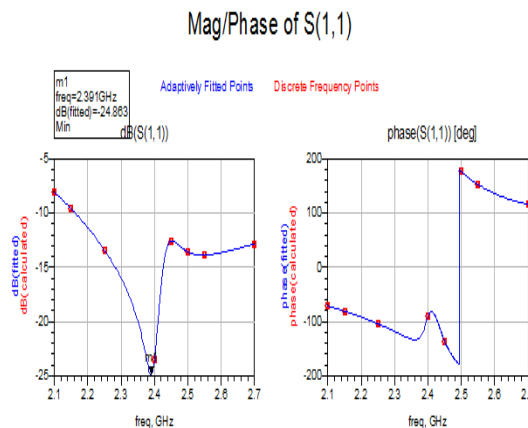


Fig 4 Magnitude and phase plot of RMPA for 3G

The VSWR values were calculated using the graph data shown in Figure 5 which as 1.119 at 3.023GHz.The calculated VSWR value indicates no reflection. the increased amount of VSWR leads reflection and signal may be distorted during the signal transfer.so reduced amount of VSWR is recommended for good antenna to improve their performance.The impedance value were calculated using the formulae and the data observed from the software tool, which is shown in Figure 5[13,14,15] .The calculated impedance is 44.75ohm at 3.023GHz, which indicates impedance mismatch were not occurred between transmitter and the receiver and maximum amount of the signal transmitted during the communication process without any signal degradation.

The Electromagnetic far field cut occurred at Angle of U Max (theta, phi) as 169,90E(theta) max (mag,phase) as 1.41678,160.664, E(phi) max(mag,phase) as 0.00121671,-162.937, E(x) max(mag,phase) as 0.00121671,17.0635, E(y) max(mag,phase) as 1.39075,-19.3362, E(z) max(mag,phase) as 0.270334,-19.3362,efficiency of the antenna system is 89.803 with power radiated value of 0.010688W.the above said results were observed from the Figure 6 and absolute fields with respect to the angle of theta and phi is shown in Figure 9[11,12].

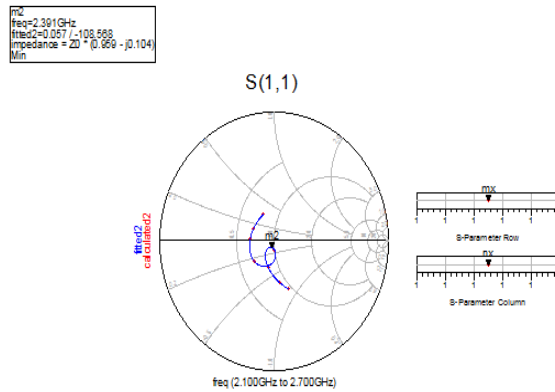


Fig 5 Smith chart plot of RMPA for 3G

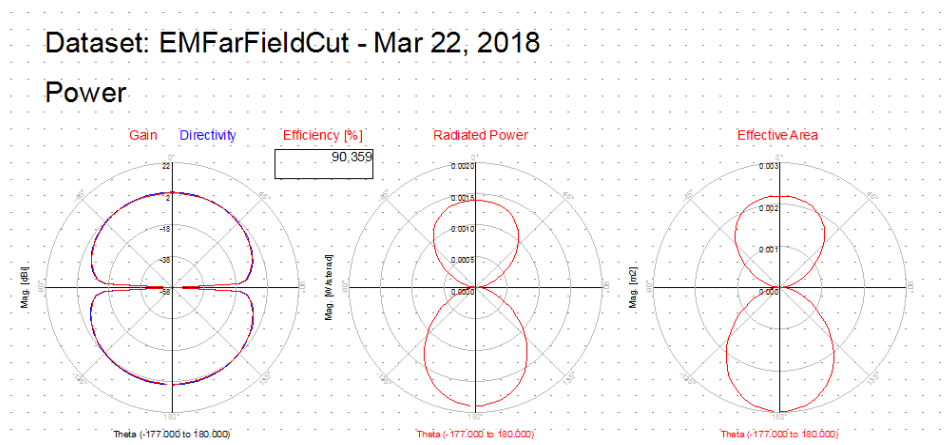


Fig 6 EM far field cut of RMPA for 3G

The radiation pattern of RMPA for 3G is shown in Figure 7, which indicates maximum main lobe level with no side lobe level .maximum power is occupied in the main lobe at an angle of 90 and 270 degree, minimum power is occupied in the side lobe at an angle of 0 and 180 degree and the RMP antenna structure has the good circular and linear polarization which is shown in Figure 8 and the current distribution of RMP antenna is shown in Figure 10.

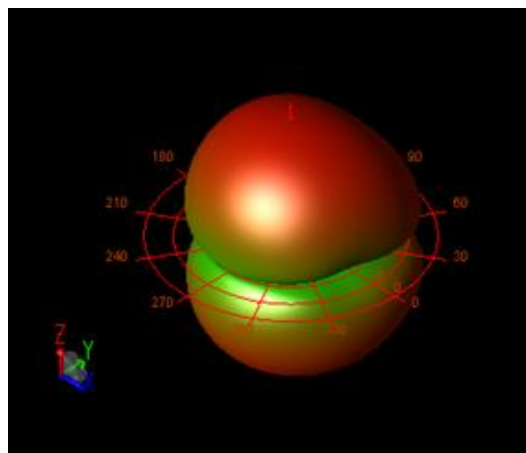


Fig 7 Radiation pattern of RMPA for 3G

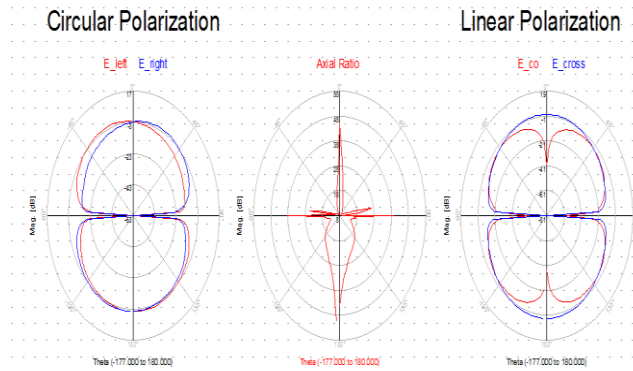


Fig 8 Circular and linear polarization of RMPA for 3G

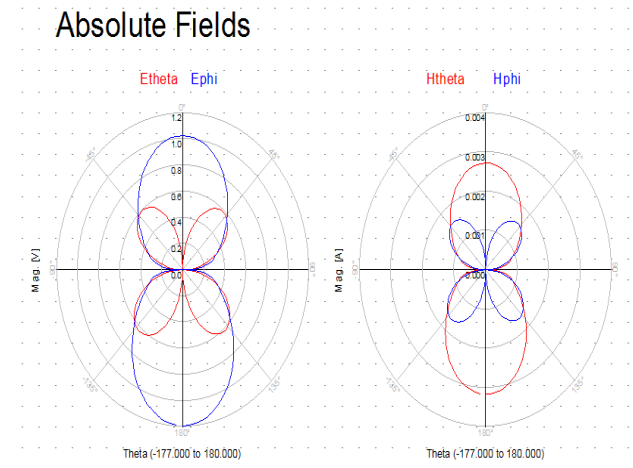


Fig 9 Absolute fields of RMPA for 3G

IV. FABRICATION TECHNIQUE

The RMP antenna were fabricated using substrate material as FR4 and conductive material as copper and SMA connector were connected in the transmission line feed to energies the antenna system. The fabricated RMP antenna is shown in Figure 10



Fig 10 Fabricated Rectangular MPA for 3G

V. ANALYSIS OF MEASURED RESULTS

The fabricated antenna structure were measured using N9926A hand held vector network analyzer and observed return Loss as -33.37dB at 3.009GHz, which is shown in Figure

11.The reduced amount of return loss value -33.37dB indicates maximum amount signal transmitted without disturbance.

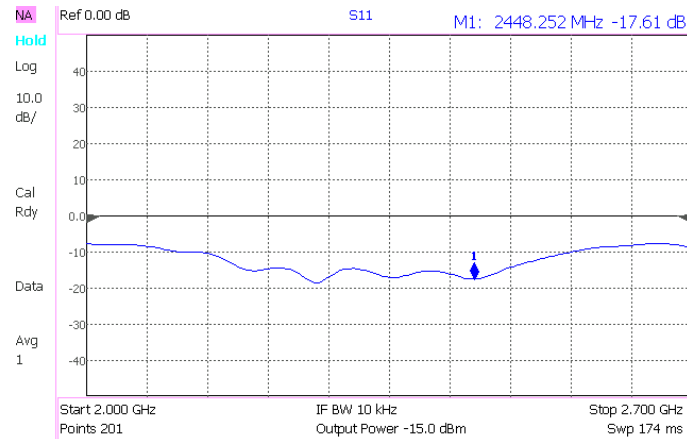


Fig 11 Measured value of return loss of RMPA for 3G

The VSWR values were observed from the network analyzer as 1.044 at 3.009GHz, which is shown in Figure 12. The observed VSWR value indicates no reflection. The increased amount of VSWR leads reflection and signal may be distorted during the signal transfer. so reduced amount of VSWR is recommended for good antenna to improve their performance.

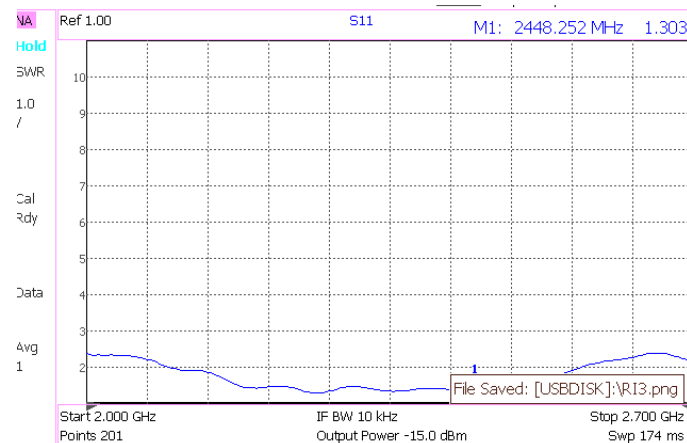


Fig 12 Measured value of VSWR of RMPA for 3G

The impedance value were calculated using formulae and the data observed from the measurement tool, which is shown in Figure 13. The calculated impedance is 51.7 ohm at 3.009GHz, which indicates impedance mismatch were not occurred between transmitter and receiver ,maximum amount of the signal transmitted during the communication process with out any signal degradation.

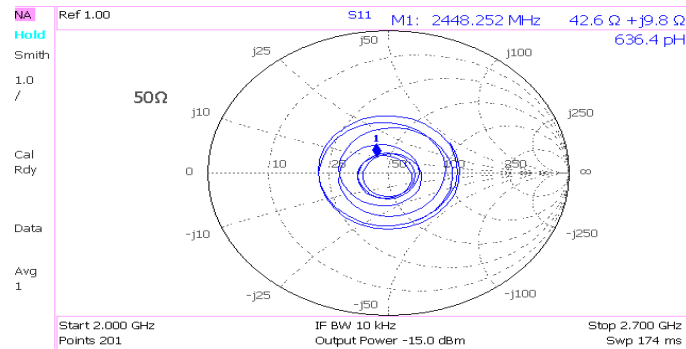


Fig 13. The Measured value of smith chart of RMPA for 3G
VI. ANTENNA PARAMETERS FOR ISM BAND APPLICATION

The rectangular microstrip patch antenna was designed and simulated using ADS software. The observed antenna parameter were listed in the Table 2 which indicates the antenna structure has good directivity as 4.95856, gain as 4.49148, power radiated as 0.010688 and good efficiency as 89.803%. the above parameters indicates the antenna were working in good condition.

Table II
 The antenna parameters of RMPA for 3G

ANTENNA PARAMETERS	RMP ANTENNA
	ISM
Power Radiated(Watts)	0.010688
Effective Angle(Steradians)	4.01193
Directivity(dBi)	4.95856
Gain(dBi)	4.49148
Efficiency(%)	89.803
Maximum Intensity (Watts/Steradians)	0.00266405
Angle of U Max(theta,phi)	169,90
E(theta)max(mag,phase)	1.41678,160.664
E(phi) max(mag,phase)	0.00121671,-162.937
E(x) max(mag,phase)	0.00121671,17.0635
E(y) max(mag,phase)	1.39075,-19.3362
E(z) max(mag,phase)	0.270334,-19.3362

VII. RESULTS AND DISCUSSION

The simulated results were tabulated in Table 3 which indicates return loss, VSWR and impedance value to identify the antenna performance.

Table III
 The simulation results of RMPA for 3G

S. no.	Frequency Band	Applications	Measured results			
			Freq. (Ghz)	Return Loss(db)	VSWR	Impedance (Ω)
1	3GHz	3G	3.023	-25.011	1.119	44.75

The Measured results were tabulated in Table 4 which indicates return loss, VSWR and impedance value to identify the antenna performance and used to make comparison with simulated results.

Table IV
 The measured results of RMPA for 3G

S. no.	Frequency Band	Applications	Measured results			
			Freq. (Ghz)	Return Loss(db)	VSWR	Impedance (Ω)
1	3GHz	3G	3.009	-33.37	1.044	51.7

The resonant frequency difference between simulated and measured result is 0.014, the return loss value difference between simulated and measured result is -8.359, the VSWR value difference between simulated and measured results is 0.075. The Impedance difference between simulated and measured result is 6.95.

From the above results this research work concludes the difference between simulated and measured result were small there by the fabricated rectangular microstrip patch antenna were working in good condition and improves antenna parameter such as directivity, gain, efficiency and bandwidth and more suitable for 3G application and transfer the signal from one place to another place or remote area. This type of antenna was mainly working in the mobile telecommunication networks.

VIII. CONCLUSION AND FUTURE WORK

The rectangular shape microstrip patch antenna (RMPA) for 3G application were simulated and tested by using N9926A handheld network analyzer to determine the parameters such as return loss, VSWR and impedance. The simulated and measured results were compared and evaluated based on the antenna performance Parameter such as directivity, gain and power radiated. To find the suitable antenna design the special parameters such as bandwidth and efficiency were calculated. This research work conclude that the rectangular shape microstrip patch antenna have the better gain, directivity, efficiency and narrow bandwidth compared with the conventional microstrip patch antenna. So the rectangular microstrip patch antennas are more suitable for the applications such as 3G application.

The future work of this research has been extended for the design and implementation of square patch antenna for 3G and 5G applications.

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