DESIGN & PARAMETRIC ANALYSIS OF OMNIDIRECTIONAL RADIATION PATTERN MICRO STRIP PATCH ANTENNA

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ABSTRACT— *Recently, a micro strip patch antenna (MPA) is getting famous in the field of antenna design because MPA can fabricate easily, have light weight, the cost of assembling is also low and it is easily analyzed by researchers. In this paper a MPA is designed with the central frequency 912 MHz and it is suitable for GSM (Global System for Mobile communication) band because of antenna has Omni-directional radiation patterns. There are four patches of material copper annealed, one substrate of FR4 material and a dipole are used in the design of the antenna. The parametric analysis of the designed antenna is performed in terms of change in the dimension of substrate, patches and dipole. We have seen the subsequently changes in return loss, resonant frequency and directivity of the antenna. The study on the parametric analysis of the antenna shows that a little change in the dimension of antenna structure can lead to the improvements in the antenna parameters.*

Keywords—Micro Strip Antenna, Frequency, FR4, Copper Annealed, Omnidirectional, GSM, Resonant Frequency, substrate.

I. INTRODUCTION

There are some benefits of each type of antenna. A GSM (Global System for Mobile communication) band antenna is designed by selecting the micro strip patch antenna (abbreviated as MPA) because of its amazing properties like easy fabrication, simplest design, low cost and having compactness in its size [1]. The micro strip patch antenna shows the narrowband wide beam. For the reception and transmission of Micro wave frequencies the MPA antennas are designed in wireless communication systems. The functionality of the MPA is that it radiates on the one side of the substrate which have patches. The other side of the micro strip antenna is ground plane [2], [3]. There are many shapes od radiating patches like rectangular, square, triangular, circular or square [4]. In this paper, the four patches of square shape are used. For an antenna design any material which have dielectric constant in the range of $2.2 \leq Er \leq 12$ can be used as substrate

In this paper, the work presents that without any external influence to the antenna, it basic parameters may be improved or changed as per requirement by just changing the antenna's internal elements dimensions. An antenna operating in a GSM band is designed by using CST MW studio tool. The radiation pattern is omnidirectional and antenna is light in weight and simple in design. The antenna is useful in the environment where priori position of the communicating device is unknown.

The simulation results show that the antenna basic parameters are improved with the change in the dimensions of the antenna like area of the substrate, area of patches and the length of the dipole used in the antenna design.

The basic antenna parameters which are changed by the parametric analysis are resonant frequency, S11 (Return loss) parameter and directivity of the antenna. The reconfigurable antennas are advance research topic where antenna's resonant frequency, Radiation pattern and polarization is changed by changing the antenna's internal structure by switches and other means [6,7,8,9].

II. RELATED WORK

In 2012, Leonardo Lizzi, Member, IEEE, Fabien Ferrero, Member, IEEE, Jean-Marc Ribero, and Robert Staraj implemented a "Light and Low-Profile GSM Omnidirectional Antenna" [5]. In this paper, the Antenna is designed and enhanced with parametric analysis. Four patches of equal length and width "p", dipole of length "d1" and substrate of length "l" is being used for antenna design. There are two wires of diameter 1 mm which are passes through the antenna. One wire is connected to the one arm of the dipole to the connector and other wire is connected with ground directly as shown is Figure 1.

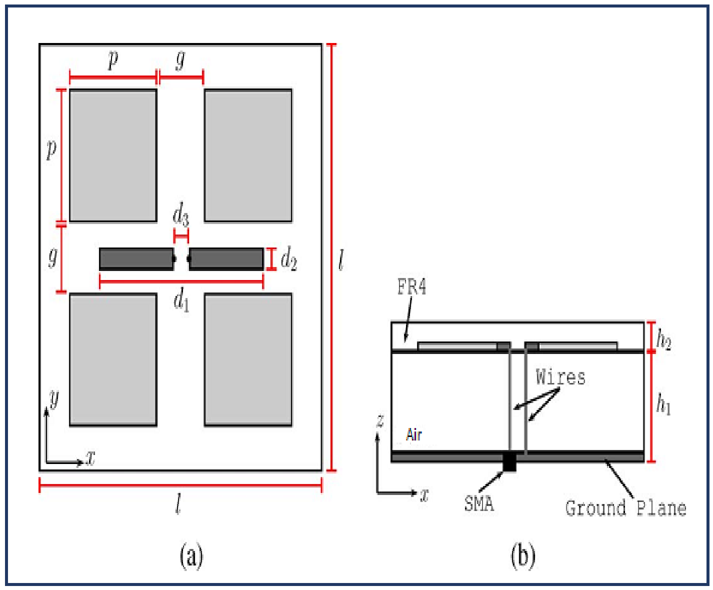


Figure 1: Structure of antenna (a) Top view (b) Side View

The values of the parameters are shown in Table 1

TABLE I
GSM ANTENNA PARAMETERS VALUES

Parameters	Values (mm)	Parameters	Values mm)
l	100	g	9
d_1	71.5	p	38.5
d_2	2	h_1	0.4
d_3	5	h_2	33

III. SINGLE BAND GSM ANTENNA DESIGN

CST MW Studio is sued as tool for designing of the antenna

A) Return Loss of the designed antenna

The antenna central frequency is at 914 MHz as shown in Fig 2. The antenna is operating in GSM (Global System for Mobile Communication) band. VSWR is 1.042 with return loss of -33 at central frequency of the antenna

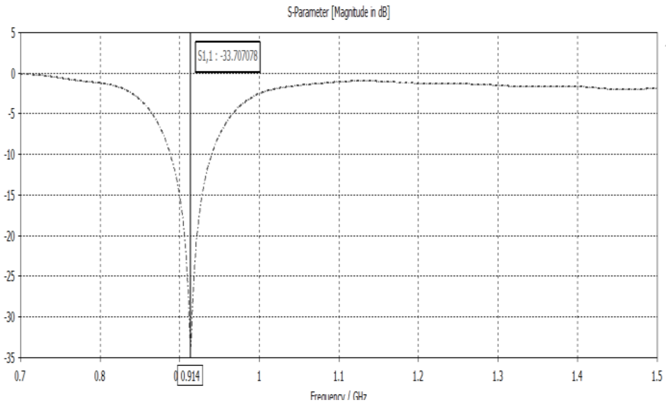
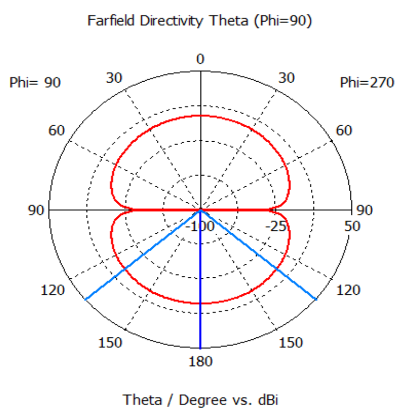


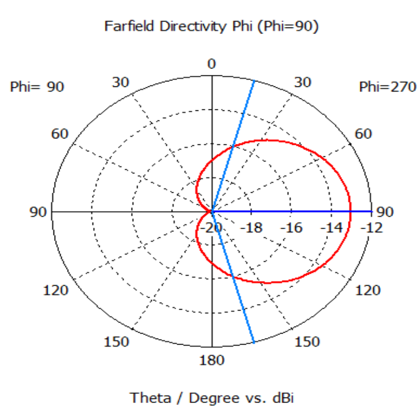
Figure 2: S11 parameters (Return Loss) of the antenna

B) Antenna's Directivity

The Figure 3. is showing the main lobe is magnitude 1.47 dBi in the horizontal plane at 180°.



E_θ = 180°



E_φ = 90°

Figure 3: Radiation pattern of maximum beam

From Figure 3, it is clear that the antenna has omni-directional antenna and performing in a GSM (Global System for Mobile communication) band

IV. PARAMETRIC BEHAVIOR OF THE GSM ANTENNA

In this section The parametric analysis is done using CST MW Studio. The antenna parameters which will change with the variation of area of substrate, area of patches and the length of dipole are described.

1) SIMULATION RESULTS: - VARIATION IN THE AREA OF ANTENNA'S SUBSTRATE

The area of substrate is varied from 94×94 mm^2 to 110×110 mm^2 and subsequent changes in the antenna parameters like return loss and shift in the resonant frequency are observed. The results are explained as below

A) Return Loss (S11Parameter) & Resonant Frequency

As the area of substrate of the antenna is decreasing the return loss of the S11 parameter is improving as shown in Figure 4.

In Table II the return loss is maximum at -49.736 when the area of substrate is 94×94 mm^2.The antenna's return loss can be improved with the change in the dimension of the substrat

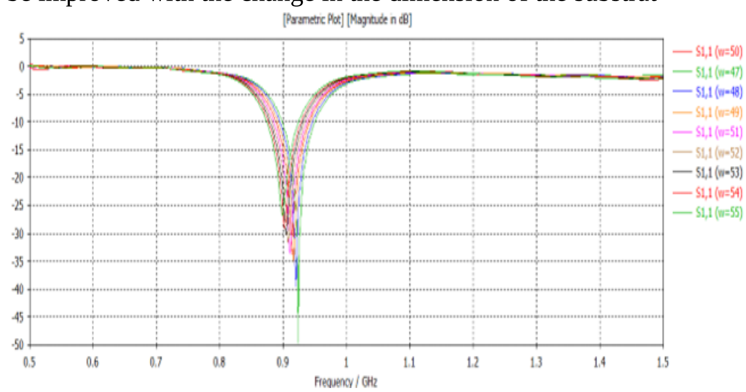


Figure 4: Return Loss of Antenna at substrate area

The Table II is showing the area of substrate and the return loss. The return loss is verying as area of the substrate is changing.

TABLE II
AREA OF SUBSTRATE AND RETURN LOSS

Sr#	Length X Width (Dimension of Substrate) mm^2	Return Loss
1	94X94	-49.736
2	96X96	-39.559
3	98X98	-35.256
4	100X100	-33.707
5	102X102	-33.686
6	104X104	-31.715
7	106X106	-30.273
8	108X108	-29.122
9	110X110	-26.799

B) Antenna Directivity and Area of the Substrate

From Table III, The antenna's directivity is slightly decreases as the area of the substrate is increasing. The table III is describing the different values of antenna directivity against the area of substrate.

TABLE III
AREA OF SUBSTRATE AND ANTENNA DIRECTIVITY

Sr#	Length X Width (Dimension of Substrate) mm^2	Directivity (dBi)
1	94X94	1.58
2	96X96	1.57
3	98X98	1.56
4	100X100	1.55
5	102X102	1.54
6	104X104	1.53
7	106X106	1.52
8	108X108	1.51
9	110X110	1.5

2) SIMULATION RESULTS: - VARIATION IN THE AREA OF ANTENNA'S PATCHES

A) Return Loss (S11Parameter) & Resonant Frequency

The table IV Presents as the area of patches is increased the S11 parameter is shifted from -51.85 to -27.55 The central frequency of the antenna is adjusted with the help of the area of the patches used in antenna design

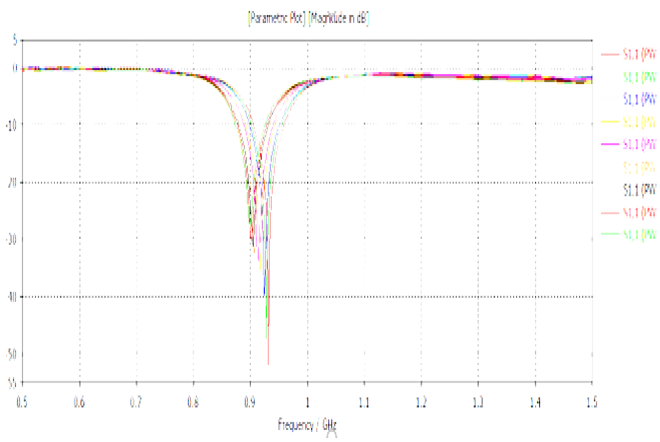


Figure 5: Return Loss of Antenna at different patches area

TABLE IV
AREA OF PATCHES AND RETURN LOSS

Sr#	Length X Width (Dimension of patches) mm^2	S11
1	33.5X33.5	-51.855
2	34.5X34.5	-47.396
3	35.5X35.5	-39.767
4	37.5X37.5	-36.06
5	38.5X38.5	-33.707
6	40.5X40.5	-32.346
7	41.5X41.5	-31.101
8	42.5X42.5	-30.001
9	43.5X43.5	-27.549

B) Antenna Directivity and Area of the patches

From Table V, the antenna's directivity is slightly decreased as the area of the substrate is increased. The Table V is describing the different values of antenna directivity against the area of Patches.

TABLE V
AREA OF SUBSTRATE AND ANTENNA DIRECTIVITY

Sr#	Length X Width (Dimension of patches) mm^2	Directivity (dBi)
1	33.5X33.5	1.59
2	34.5X34.5	1.583
3	35.5X35.5	1.576
4	37.5X37.5	1.558
5	38.5X38.5	1.55
6	40.5X40.5	1.533
7	41.5X41.5	1.521
8	42.5X42.5	1.508
9	43.5X43.5	1.497

3) SIMULATION RESULTS: - VARIATION IN THE LENGTH OF THE DIPOLE

A) S11 Parameters for different length of dipole

The table VI describes as the length of dipole is increased, the S11 parameter is being changed

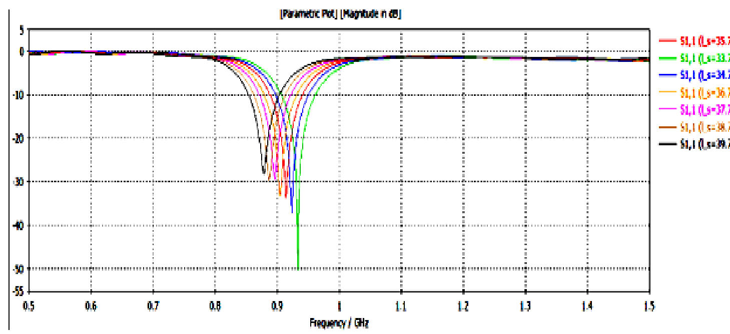


Figure 6: Return Loss of Antenna at different dipole lengths

TABLE VI
DIPOLE LENGTH AND S11 PARAMETER

Sr #	Length of Dipole	S11
1	67.5	-50.106
2	69.5	-36.998
3	71.5	-33.707
4	73.5	-33.339
5	75.5	-29.412

B) Antenna Directivity and length of dipole

The Directivity is being changed with dipole length change

TABLE VII
DIPOLE LENGTH AND DIRECTIVITY

Sr #	Length of Dipole	Directivity (dBi)
1	67.5	1.566
2	69.5	1.56
3	71.5	1.55
4	73.5	1.541
5	75.5	1.524

V. CONCLUSIONS

The simple and effective approach is adopted to improve in the antenna parameters by changing the area of substrate, patches and the length of the dipole So we can conclude that with the little change in the internal structure of the antenna we can get some good desired results.

The future work is recommended to convert the single band antenna to multiband antenna by parametric variations in the antenna structure.

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