Design and Implement Printed Rectangular Monopole Broadband Antenna for Wireless Networks

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Abstract- This paper tells how to construct rectangular monopole antenna which will be printed on printed circuit board (PCB). The antenna behaves as planar monopole antenna as it has rectangular patch and ground plane which lies in same plane of PCB. Also this antenna is a broadband antenna because its ratio bandwidth lies under broadband category. In comparison with monopole antenna broadband planer monopole antenna has more advantages in terms of their cost, ease of fabrication and bandwidth. As many wireless Networks require large bandwidth to carry huge amount of data at a time through medium so as to increase the data rate. We have designed a printed rectangular monopole antenna for wireless application at 2.4 GHz such that it can be used for commercial frequency such as Bluetooth, Wi-max, HSPDA, and Wi-Fi. Parameters of presented antenna are same as monopole antenna but with improve bandwidth.

Keywords: Printed Monopole Rectangular antenna, VSWR, broadband, S₁₁, radiation pattern

1. INTRODUCTION

Many applications require use of single broadband antenna which covers a broad range of frequencies including wireless and high data rate communication, sensing and imaging, position and tracking and radar. Planar rectangular monopole antenna is a desired solution. These antennas are very popular because of their broad impedance bandwidth, linearly polarized unidirectional radiation pattern and are very cost effective to construct. Structure of this type of antenna is planar, it has planar metal i.e. copper metal element which can be instead of conventional wire element of monopole antenna

Generally microstrip antennas are designed in small size with different forms. Basically, due to higher value of quality factor Q i.e. up to 100 causes narrow bandwidth[5], it has been found from research results that microstip antenna can have very wide field of frequency bands [1][2][8][9]. In their study, printed circuit board is built by rectangular patch and ground of antenna. Mobile communication system employs the most popular antenna that is monopole antenna and its family it is possible to match impedance of 50 Ω for monopole antennas as they are unbalanced. This eliminates the need for a balun, which may have a limited bandwidth (BW) [5]. Among the family of all monopole antennas the simplest member is the quarter wave monopole antenna above a prefect ground plane. The radius of the cylindrical stub decides impedance BW for quarter wave monopole antenna and it increases with increased radius. This is true up to a point where the stepped radius from the feed probe to the cylindrical element becomes abrupt.

2. ANTENNA DESIGN`

The geometrical configuration of the proposed broadband printed monopole antenna is shown in Figure 1. The antenna with substrate length 60 mm and width 80 mm is constructed on Glass Epoxy material with thickness of 1.59 mm and dielectric constant $\varepsilon_r = 4.3$. The microstrip probe feed line having 3 mm width is used to excite the proposed antenna. The basic antenna structure is a rectangular patch of 30 mm × 40 mm. The gap between the patch and ground plane i.e. feed length is 1 mm. The dimension of the ground plane is 60 mm × 22 mm. The dimensions of antenna were estimated using formulation given for planar disc monopole antenna the lower frequency for VSWR = 2 are given as [7]

 $2\pi rL=W*L$

which gives

 $r=W/2\pi$

The input impedance of a $\lambda/4$ monopole antenna is half of that of the $\lambda/2$ dipole antenna. Thus, the input impedance of an infinitesimally thin monopole antenna is 36.5 + j 21.25 Ω , which is inductive. The real input impedance is obtained when a slightly smaller length of the monopole is used as given by [7] $L = 0.241 \, \lambda F$

F = (L/r)/(1+L/r) = L/(L+r),

so that the wavelength
$$\lambda$$
 is obtained as

$$\lambda = (L + r)/0.24$$

Therefore, the lower frequency f L is given by $f_L = c/\lambda = (30 \times 0.24) / (L + r) = 7.2/(L + r)$ GHz where L = length of the monopole in cm, r = effective radius of an equivalent

cylindrical monopole antenna in cm and p = length of the feed line in cm.

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3. SPECIFICATION REQUIRED

The three essential parameters for the design of a rectangular Micro-strip Patch Antenna are as follow:

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i) *Frequency of operation* (f_o) : The resonant frequency of the antenna must be selected appropriately. The ISM Band frequency ranges from 2.4 - 2.4835 GHz. Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for my design is 2.45 GHz.

ii) Dielectric constant of the substrate (ε_r): The dielectric material select 80 my design is Silicon which has a dielectric constant of 3.4. A substrate with a high dielectric constant as been selected since it reduces the dimensions of the antenna.

iii) Height of dielectric substrate (h): For the microstrip patch antenna to be used in ISM Band Application, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.54 mm.



Figure 1: Designed Antenna geometry

4. DESIGN STEPS

Step 1: Software simulation

- i. Define basic parameters for simulation such as the dielectric constant of different layers, the units and layout dimensions, and metal types among other parameters.
- ii. To draw the antenna layout.
- iii. Select the feed location and type of feed.
- The next step is to run the simulation. However, before that, let us first mesh the structure; this mesh is used in the Method of Moment (MoM) calculation.
- v. Observe the result for various parameters such as radiation pattern, current distribution, gain v/s frequency plot, resonance frequency and bandwidth.

Step 2: Hardware Implementation

- i. Implement the designed antenna on dielectric substrate over finite ground plane.
- ii. Attach the feed port to the antenna.
- iii. Observe the result for above designed parameters that are mentioned in software simulation.

Step 3: Comparison of Result

Both software simulation and hardware result will be observed and tabulated. On the basis of software and hardware results obtained; comparative study of the results with other methods, antenna studied in literature survey and then conclusion will be deduced.



Figure 2: Frequency v/s VSWR plot

 Table No. 1 Comparison of Software and Hardware Results

Software Simulation Results		Hardware Results	
Lower Cut Off Frequency (F _L) in GHz	Bandwidth in GHz	Lower Cut Off Frequency (F _L) in GHz	Bandwidth in GHz
1.74	4.26	1.9	4.1

Table No. 1 shows the comparison of simulation result and hardware result. It shows reduction in bandwidth of hardware result as compare to simulation result and Figure 2 shows software simulation result of given monopole antenna.

5. CONCLUSION

In this paper, we have investigated printed monopole antenna, etched on ground plane for Broadband applications and multi-band applications. Printed monopole antennas are less fragile, planar and can be integrated with the integrated circuits unlike monopole antennas which have non-planar or protruded structures above the ground plane. Printed monopole antennas are studied first for such application. Then monopole antennas for high gain and high bandwidth are studied. It has been concluded that the printed monopole antennas are one of the versatile candidates for ISM band applications as well as it can be used for various Wireless Applications such as Wi-Max with a very large bandwidth of 4.245 GHz.

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