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A Monopole Antenna at Quad Band Frequency for Indoor Application

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Abstract: In this paper we concentrate on design of multiband antenna for existing wireless services. At present, the available techniques are modifying the main radiator (bending, folding, meandering and wrapping) which affects the size of antenna. This makes it more complex in implementing on RF circuits. To achieve multiband capability along with compactness in size we go with slotted multiband planar system. Here we design antenna in such a way in works on quad band frequency i.e., GPS, WiMax and WLAN(IEEE 802.11 a,b) for indoor application.

I. INTRODUCTION

The multiband antenna plays an important role for wireless service requirements. At present, both in commercial and government communication systems required a low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies.

Slotted microstrip patch antenna can be printed directly into circuit board. Since the slotted microstrip patch antenna requires few materials, it is low in cost, easy to manufacture and light in weight.

These characteristics make slotted microstrip patch antenna makes it an ideal choice for use in cell phones and other small electronic devices. Also the slotted microstrip patch antenna is very well suited for applications such as wireless communication systems, cellular phones, pagers, radar systems and satellite communication systems. As the size of the slotted microstrip patch antenna is inversely proportional to its frequency.

For this reason, slotted microstrip patch antennas are generally used for ultra-high frequency signals and it's capable of sensing frequencies lower than microwave would be too large to use.

A well designed antenna relaxes the complexity and improves the performance of the receiver. The dimension, type and the configuration of the antenna depends on the application and the operating frequency.

A. Existing Antenna Systems

Antennas that are used before are capable of working in the particular frequency applications. Where quarter wavelength radiators used are subjected to miniaturization which affects to form limited bandwidth and low radiation efficiency.

1) *Draw Backs:* Less reception due to high return loss because of usage of single patch antenna for each individual device.

B. Proposed Antenna System

1) The proposed antenna system is capable of working on 4 frequency bands. Three applications (GPS, WiMax & WLAN) are build in a single antenna.
2) In the proposed system the miniaturization is done optimistically in various stubbed arms (two E shaped stubs and a T shaped stub)
3) Thus achieve the minimal return loss over the four bands of frequency spectrum. Such as

FREQUENCY RANGE	APPLICATION
1.575-1.665GHz	GPS
2.4-2.545GHz	IEEE 802.11b&g WLAN
3.27-3.97GHz	WiMAX
5.17-5.93GHz	IEEE 802.11a WLAN

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II. WORKING

A. Antenna Structure

Like all antenna system design our design consist of substrate, patch and ground.

1) 3 subsrate (two E-shaped and one inverted T-shaped),
2) Patch (Copper Pad)
3) Ground.

Fig.1 gives the top of the Monopole antenna at quad band frequency.

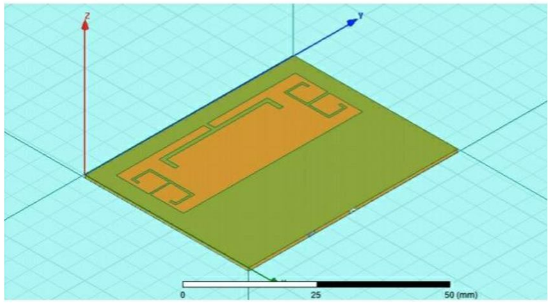


Fig. 1 Top View of antenna

B. Design Calculation For Microstrip Antenna

1) Calculation for width of the patch(W):

For efficient radiation, the width W is given as

$$W=\frac{1}{2f_{r\sqrt{\varepsilon_0\mu_0}}}\sqrt{\frac{2}{1+\varepsilon_r}}$$

2) Effective dielectric constant calculation($\varepsilon_{eff)}$:

$$\varepsilon_{eff}=\frac{\varepsilon_r+1}{2}+\frac{\epsilon_r-1}{2}(1+12\frac{h}{w})^{\frac{-1}{2}}$$

3) Effective length calculation(L_{eff}):

$$L_{eff}=\frac{c}{2f_{r\sqrt{\varepsilon_{reff}}}}$$

4) Length extension calculation(ΔL):

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

5) Actual length of patch calculation(L):

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

6) Ground plane dimension calculation(L_g *and* W_g)

The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. Similar results for finite and infinite ground planes can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design,the ground plane dimensions would be given a

$$W_g = 6h + W$$

$$L_g = 6h+L$$

Where,

ε_{eff}=Effective dielectric constant
ε_r=Dielectric constant of substrate
h=Height of dielectric substrate
W=Width of the patch.

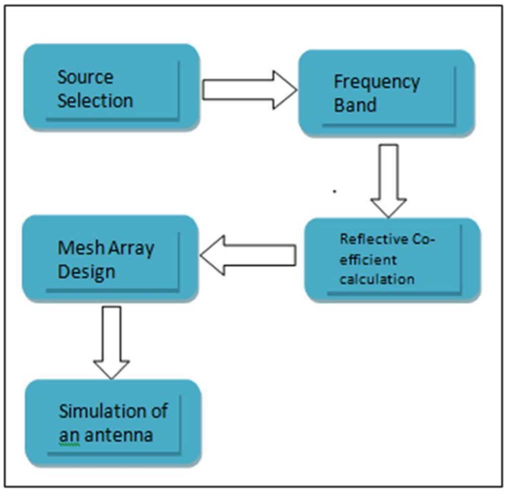
C. Software Description

1) The software used to model and simulate the microstrip patch antenna in Anasoft HFSS 13.0 is a high performance full wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modeling that takes advantages of the familiar micro soft graphical user interface.
2) HFSS can be used to calculate parameters such as S-parameters, resonant frequency and fields. HFSS is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. Ansoft HFSS 13.0 pioneered the use of the Finite Element Method (FEM) for EM simulation by developing or implementing technologies such as tangential vector finite elements, adaptive meshing and Adaptive Lancozos Pade Sweep(ALPS).
3) It has been widely used in the design of RFICs, patch antennas, wire antennas and other RF or wireless antennas. It has been used to calculate and plot the S11 parameters, VSWR, current distributions as well as the radiation pattern

D. Design Procedure

It comprises of the following five steps:-

1) Source Selection.
2) Frequency Band.
3) Mesh Array Design.
4) Reflective Co-efficient calculation.
5) Stimulation of antenna.



III. RESULT

HFSS has been widely used in the design of RFICs, patch antennas, wire antennas and other RF or wireless antennas. It has been used to calculate and plot the S-parameters, VSWR, current distributions as well as the radiation pattern For our observation we consider three parameter i.e., Return loss, VSWR, Radiation Pattern (Gain)

A. Return Loss

Proposed microstrip patch antenna with slot using microstrip feed line as a feeding technique, which gives the minimal return loss or reflection coefficient value to less than -10 dB, hence it is considered to be the working frequency

The transmission feed used in design to have a frequency range of 2.4 GHz is selected and frequency points are selected over this range to obtain accurate results.

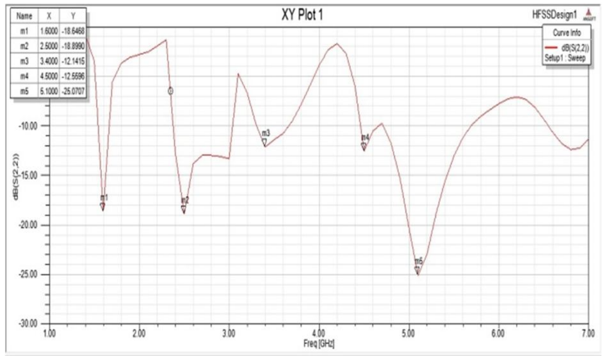


Fig 2 dB(S(2,2)

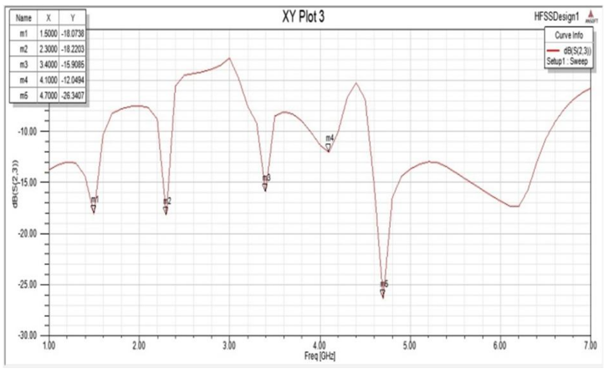


Fig 3 dB(S(2,3)

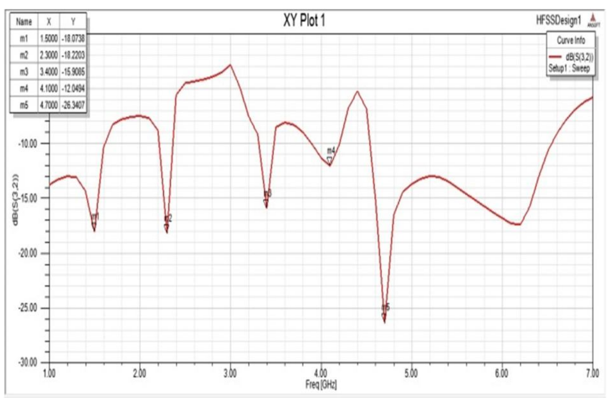


Fig 4 dB(S(3,2)

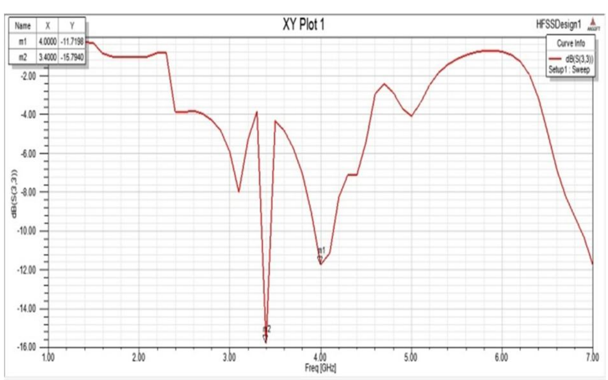


Fig 5 dB(S(3,3))

B. VSWR

The most common case for measuring and examining VSWR is when installing and tuning transmitting antennas. When a transmitter is connected to an antenna by a feed line, the impedance of the antenna and feed line must match exactly for maximum energy transfer from the feed line to the antenna to be possible. The desirable VSWR (<2 dB) is achieved in the frequency range 0 to 10 GHz.

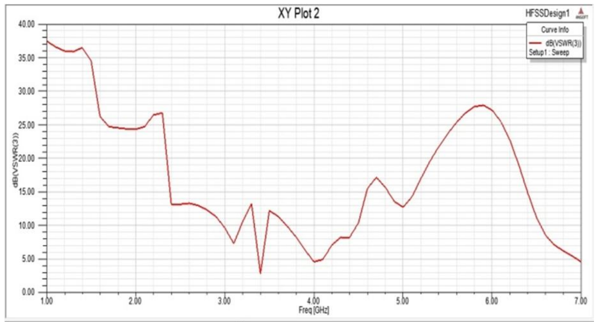


Fig 6 dB(VSWR(2))

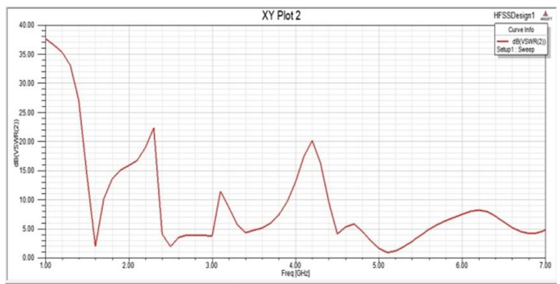


Fig 7 dB(VSWR(3))

C. Radiation Pattern

The result and radiation pattern is shown in fig. The spikes appearing below 20dB are the frequencies that can be used for the application like GPS, WLAN and Wi-Max etc.,

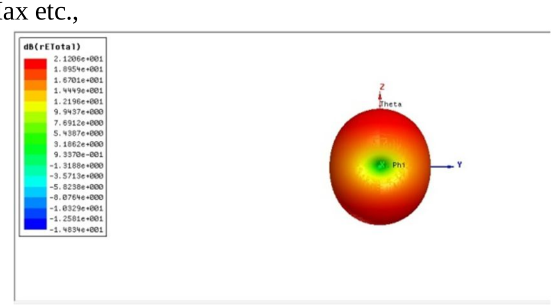


Fig 8 a radiation pattern

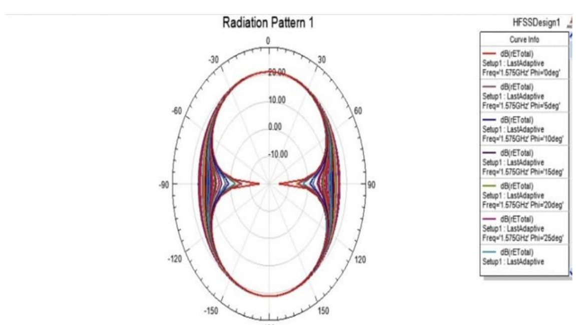


Fig 8 b polar plot

IV. CONCLUSION

The usage of ground slotted patch antenna in the radiator makes the design much compact,less in cost and easy to implement on RF circuits. The proposed antenna exhibits following frequency 2.4 GHz, 3.5GHZ, 5.3 GHz and 5.8GHz which fall on the selected quad band frequencies also they have good radiating properties. Therefore this antenna suitable for High Frequency application and also it is implemented in other wireless application that works in these frequencies. Patch antenna for multiband frequency applications with MIMO technique is simulated.

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