Three Slot Multibanded Patch Antenna For Wban Application

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Abstract

A multiband microstrip patch antenna along with three slots in a rectangular patch antenna is presented.The size of the rectangular patch antenna is 95 mm × 50 mm,which have two L- form slots and single strip-form slot on it.The antenna exhibits nearly omnidirectional radiation characteristics at all the operating frequencies with good cross polarization level and moderate gain.It is simulated using the software HFSS.The designed antenna operated in the bands 1.46/2.41/4.49 GHz, while the return loss S11<-10dB. Thus, the antenna is suitable for multiband wireless communication applications. This paper presents the analysis of testing and simulated result of return loss, VSWR,gain and directivity for FR4 epoxy substrate with dilelectric constant of 4.4. It simulate results display impedance bandwidth from 2-10GHz, The antenna compiles with the return loss of S11 less then -20dB and VSWR<2throught the impedance bandwidth.

Index Terms – *multiband antenna, radiating patch, simple structure, WBAN, UWB, WLANs*

I.INTRODUCTION

Recently, the use of wireless communication technology have an explosive growth. A design of multiband antenna operated in wideband is useful.Antena is a device for radiating and receiving an electromagnetic wave in free space.The antenna works as an interface between transmission lines and in free space.Microstrip patch antenna have many attractive advantages, such as low profile, light weight, easy fabrication, Less volume and compatibility to curved surfaces. In this paper, a simple structure multiband microstrip patch antenna is designed. The antenna designed will cover multiple UWB frequencies ranges from 2 to10 GHz WLAN band. This antenna consists of groundplane, substrate and rectangular patch with three slots on it. This designed antenna is simulated on HFSS software. For this antenna, sufficient bandwidth was achieved by utilizing microstrip line technique, the desired frequency of 2.4 GHz is achieved, like wise the VSWR value of 1.2 is achievable. The designed microstrip antenna is optimized to cover WLAN. The microstrip antennas are design to operate in dual band and multiband application. The ultra wide band antennas can be classified as directional and omni directional antennas. In this method we classify antennas in omni directional because it has low gain, small size and radiate in all directions. UWB antennas are typically required to attain a bandwidth.

II.ANTENNA DESIGN AND GEOMENTRY

The structure of a simple structure multiband patch antenna is shown in Fig. 1 and Fig. 2, It consists of a rectangular groundplane 95mm×50mm, a dielectric plane , and a patch. The patch is printed on a substrate with relative permittivity £*r* =3.55(Rogers R04003) and thickness H=1.5mm and is fed by a coaxial line with 50Ω impedance, The probe fed point is put at the position near an right angle of the patch (Fig.1) . There are three slots on the rectangular patch, Two L-form slots and one strip-form slot. L1, L3 is the bottom length of the L-form slots, and G1,G2 are the bottom width of the L-form slot, L2, shows the position of the strip-form slot, W1, W2, W3 show the length of the slots, S1, S2, S3 show the width of the slots(Fig2). The rectangular patch antenna is separated from ground plane with FR4 Epoxy dielectric substrate with relative ε_r=4.4, and thickness of 1.5mm.

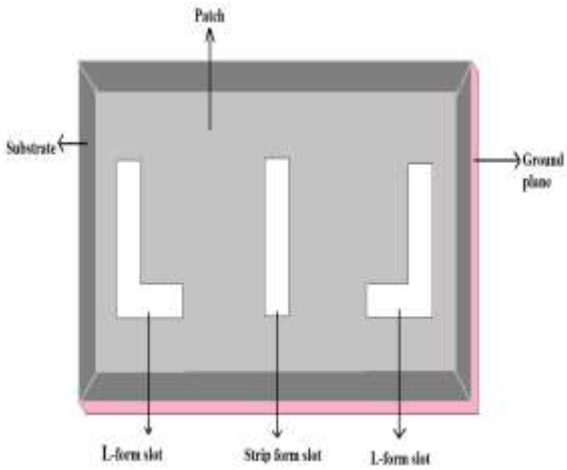

Fig 1. Simulated antenna design with slots

The sizes of patch and slots shown in Fig. 2 are as follows: L=50mm, W=30mm, S1=5mm, S2=5mm, S3=5mm,G1=5mm,G2=5mm,W1=20mm,W2=20mm,W3=20mm,L1=15mm,L2=5mm,L3=15mm.

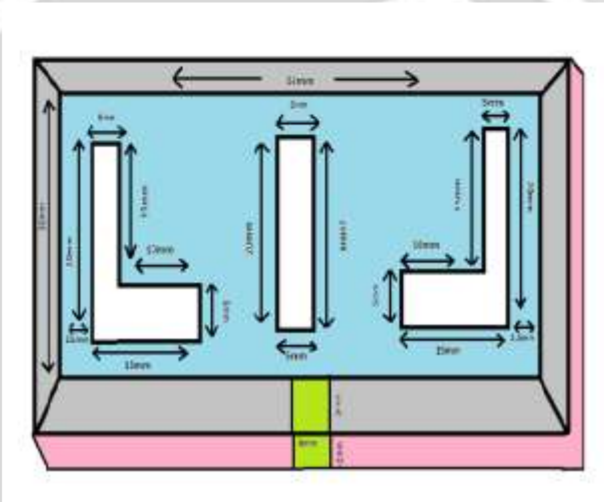

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Fig 2. Antenna Geomentry

The effective dielectric constant is given by,

Here h is the height of the substrate i.e. FR-4 epoxy material, W is the width of the patch, ε_r is the dielectric constant of the substrate. Hence by substituting the values we get the value of effective dielectric constant as ε_{eff} =4.10

The effective length L ε_{eff} is calculated by,

Substitute the values of C and ε_{eff} , the effective length will be L ε_{eff} =0.6934 mm.

The difference in length ΔL, which is the function of **effective dielectric constant and the ratio of the width is given by**

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

$$L_{eff} = \frac{C}{2f_r\sqrt{\varepsilon_{eff}}}$$

$$\epsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + \frac{12h}{W}\right]^{-\frac{1}{2}}$$

III ANALYSIS AND DESIGN EQUATIONS

Three basic parameters for Rectangular Microstrip Patch Antenna design are,

1. **operating frequency (f_o)**

The ISM frequency band is 2400MHz to 2883.5MHz,which is used for Bluetooth, WLAN and other applications. Hence the resonant frequency selected for this design is 2.4GHz.

2 .**Dielectric constant of the substrate (ε_r)**

The dielectric material selected for design is FR4-epoxy having dielectric constant of 4.4 ,A substrate having high dielectric constant should be selected because higher the dielectric constant smaller the dimensions of the antenna.

3.Height of the dielectric substrate (h)

The height of the dielectric substrate should be small. Here FR4-epoxy substrate of standard height 1.5 mm is selected.

The width of the rectangular microstrip patch antenna is given as,

Where, C is the speed of light, ε_r is the dielectric constant of the substrate, fr is the resonant frequency. By substituting the values of C =3 x 10^8 m/s, F =2.4GHz and εr =4.4. Thus the width of the patch is 38.48.

By substituting the values the difference between the length is ΔL=0.693mm.
Finally, the actual length of the patch is given as L= $L\varepsilon_{eff}$ -2ΔL. Hence ,L =29.4732 mm. This is again optimized to 29.48mm. After calculating the values of all material which are used in Microstrip slotted antenna design we simulate that design on the HFSS software and got the simulated results.

$$W = \frac{C}{2f_r\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

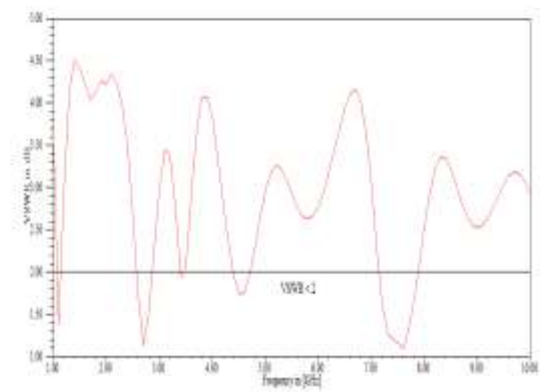
Table 1. Dimensions of patch antenna.

1.	Solution frequency	2.4GHz
2.	Length	90mm
3.	Width	55mm
4.	Length of the patch	28mm
5.	Width of the patch	38mm

6.	Thickness	1.5mm
7.	Feed width	2mm
8.	Slot length	20
9.	Slot width	15

IV.SOFTWARE TOOL

The software used to model and simulate the microstrip patch antenna is High frequency structure simulator. HFSS is a high-performance full wave EM field



simulator for arbitrary D volumetric passive device modeling that takes advantage of the familiar Microsoft window Graphical user interface. Ansoft software is used to calculate the parameters such as S parameters, return loss, VSWR, Radiation pattern, Gain and bandwidth. It was assigned with a air box boundary and virtual radiation to create far field radiation pattern.

V.RESULTS AND DISCUSSIONS

The designed antenna by using HFSS the return loss andVSWR is obtained..From the result obtained, We could observe that the designed antenna is having a band frequency operation of 2.4GHz with -14dB return loss and the VSWR is 1.2.This indicates the impedance matching between the field and the load and the value should be equal to 1 in an ideal situation but in practical it should be less than 2 for good operation of the antenna.This antenna has been able to achieved the desired value of 1.2.The simulated results of 3D is shown in figure 3.The proposed antenna can cover WLAN application.

In order to investigate slots size on the influence of the working frequencies, a simulated result of return loss of various lengths (G1, W1, W2, W3) is shown in Fig. 2.The simulated far field radiation patterns in E-plane and H-plane of the opreating frequencies are obtained.The radiation patterns show a good performance.

It is possible for a rectangular patch antenna working in dual bands by putting the feed point at the position near a right angle of the rectangular patch, and Selecting proper long and wide of the rectangular. In this paper, we put the probe feed point at the position near the right angle of the patch and then slotting on the patch to change the current path, we can obtain an simple structure antenna operates in multi bands 1.66/2.41/4.95 GHz.

Antenna designed in HFSS

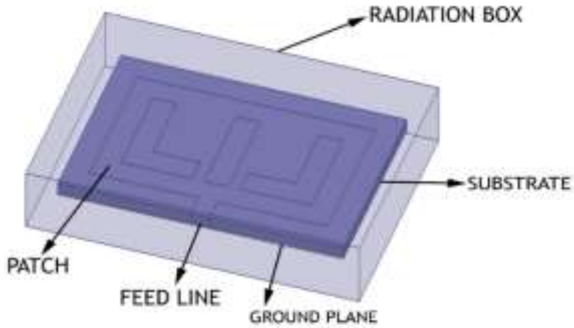


Fig 3.Three-Dimensional view of the simulated antenna

Fig 4. The simulated Return loss of the antenna

Generally, the return loss measured at the input of the feed connected to the antenna, for maximum power transfer the return loss should be a small as possible, this means return loss should be large negative number as possible. The below desired antenna shows a good return loss of approximately -14 dB at 2.4GHz

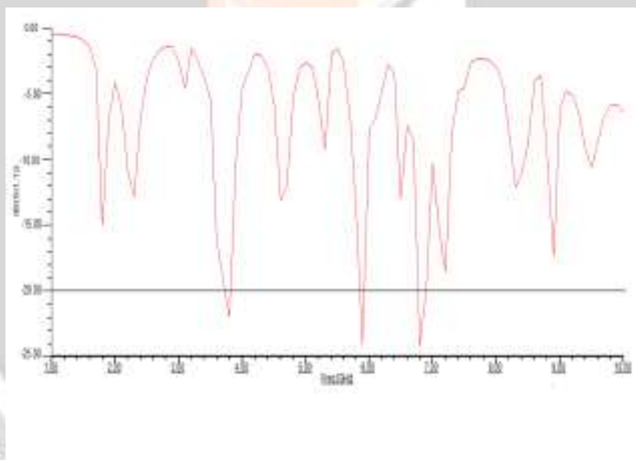


Fig 5. VSWR measurement

The VSWR parameter is matching and tuning of the transmitting antenna. For practical applications the value of the VSWR lies between the value of 1 and 2. The VSWR value varies from 1.2 to 1.8 throughout the frequency from 2 to 5 GHz.This plot shows the value of VSWR of 1.2.

V. CONCLUSION

The simulation of the Recatngular Microstrip Patch Antenna that operates in UWB frequencies was successfully designed. From observing the Return loss and VSWR , it is very clear that this antenna works on the designed UWB frequency range.These antennas are simulated using the HFSS version S11=-20dB. The proposed antenna is very compact, very easy to fabricate, and itis fed by 50Ω microstrip line which makes it very attractive for current and future WLAN applications.

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