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A Novel Dual Band Tree Shape Microstrip Patch Antenna for Bluetooth application

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Abstract

In this paper, A Novel Dual Band CPW fed Tree Shaped Microstrip Patch Antenna is designed using Ansoft HFSS software. The resonance frequencies of designed antenna are 1.3GHz and 2.4 GHz which makes it suitable for short range Bluetooth application. The Return losses of this antenna are -45dB and -30dB for two frequencies respectively. The Roger5880 is used as dielectric with value of dielectric loss tangent constant as 0.0009 and relative permittivity of 2.2. The antenna is fed by coplanar waveguide of 50Ω Microstrip line with ground plane and is excited by a coaxial SMA connector. This antenna is small size, cheap, compact and easy to fabricate, and achieve good radiation characteristics with higher return loss. This antenna can have wide application in a great variety of wireless communication such as Wide Band.

Keywords: Dual band, CPW, Resonance Frequency, HFSS, Return Loss, Patch Antenna

Introduction

In present era of technology Microstrip antennas are preferred mostly. These antennas have small size, light weight, low cost, easy to fabricate and installation. Because of its miniaturization it has great aspects in field of wireless communication. Nowadays Microstrip antennas are most preferred type of antenna, for communication in mobile phones, spacecrafts and industrial application and also for medical uses. But the main drawbacks of Microstrip antennas are the limitation of its impedance bandwidth and gain. So the various methods are used to improve its bandwidth like using material of low dielectric constants, using stacked structure with multilayer dielectric or metal, and designing of antennas using air gap method. Here the proposed antenna has the dual frequency bands which increase its range of applications. Here the dual-band resonance frequency can be used in short range Bluetooth application frequencies requires the antenna to operate equally well at both frequency bands. Frequency antenna consists of Single patched in Tree Shape. The patch is Feed by Coplanar Waveguide, So many other designs of the dual band antenna are proposed so far but the basic problem arising in these antennas is that these all designs are based on different feeding circuitry for different frequency gaining design but the design of dual band suggested in the paper is a Microstrip line designing which uses the concept of multiple resonance frequency and we are getting the two frequency bands for the same structure with same feeding circuitry.

Basic design

The proposed antenna is designed using substrate Roger 5880 with dimension of 90mm* 90mm*1.6mm and relative permittivity of 2.2. The patch is designed of with the length and width as 44.5mm and 60mm respectively of perfect electric conductor. The dimensions of ground plane are 90mm width and 90mm length.

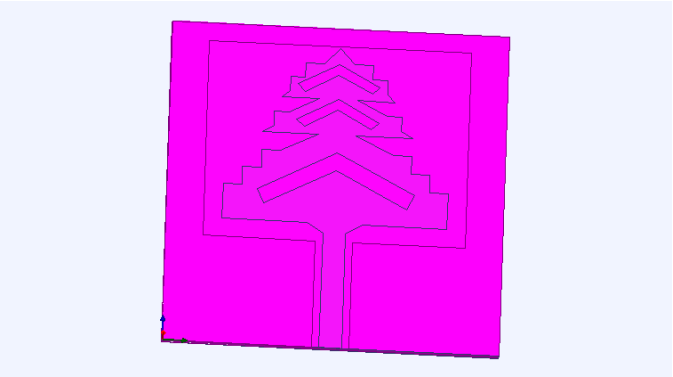

Figure 1: Design of Microstrip antenna (a) top view

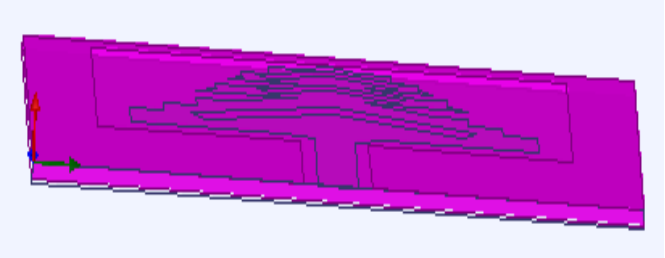

Figure 1(b): Side view

Simulation Results

The Microstrip patch antenna is simulated on Ansoft HFSS (high frequency structure simulator). It analyzes 3D and multilayer structures of general shapes with finite boundaries of air box which is the advantages of using Ansoft HFSS. Because antenna is designed for transmitting and receiving the signals within a definite boundary or range. Ansoft HFSS has been frequently used for the design of Microstrip patch antennas, wire antennas, and other RF/wireless antennas.

It can be used to calculate and plot VSWR curve, gain, data table, 3D polar plot, 2D rectangular curve and many other useful parameters. Here for the design of ladder shaped Microstrip patch antenna, the return loss is -29db and 13.8 db at two different frequencies 6.3GHz, 8.97 GHz which has been found very useful in UWB applications.

Design Consideration

The dimension of patch along its length have now have been extended on each end by a distance ΔL which is given by

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

Equation-1

For a rectangular Microstrip patch antenna the resonant frequency is given by

$$f_o = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2+\left(\frac{n}{W}\right)^2\right]^{\frac{1}{2}}$$

Equation-2

For efficient radiation the width is given by,

$$W = \frac{c}{2 f_o \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Equation no.3

Simulated results of return loss

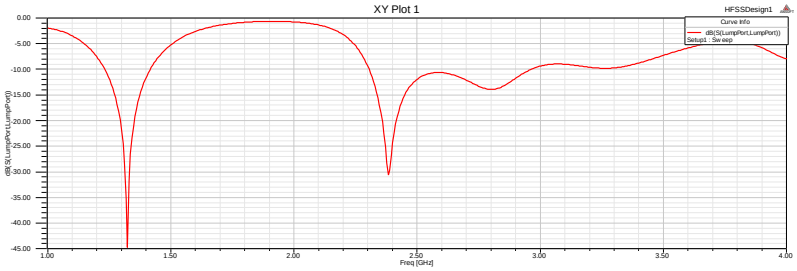

Figure 3: Simulated Return Loss S_{11} v/s Frequency Variation

Data Table 1 HFSSDesign1

	Freq [GHz]	dB(S(LumpPort,LumpPort)) Setup1 : Sweep
1	1.000000	-2.015010
2	1.006012	-2.057072
3	1.012024	-2.104548
4	1.018036	-2.157577
5	1.024048	-2.216302
6	1.030060	-2.280874
7	1.036072	-2.351449
8	1.042084	-2.428191
9	1.048096	-2.511272
10	1.054108	-2.600872
11	1.060120	-2.697182
12	1.066132	-2.800406
13	1.072144	-2.910758
14	1.078156	-3.028467
15	1.084168	-3.153780
16	1.090180	-3.286958
17	1.096192	-3.428287
18	1.102204	-3.578071
19	1.108216	-3.736642
20	1.114228	-3.904358
21	1.120240	-4.081610

Figure 4: 3D Polar Plot

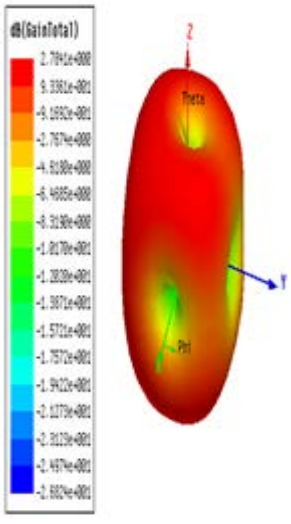

Figure 5: 3D polar plot or radiation pattern

VSWR of simulated field pattern

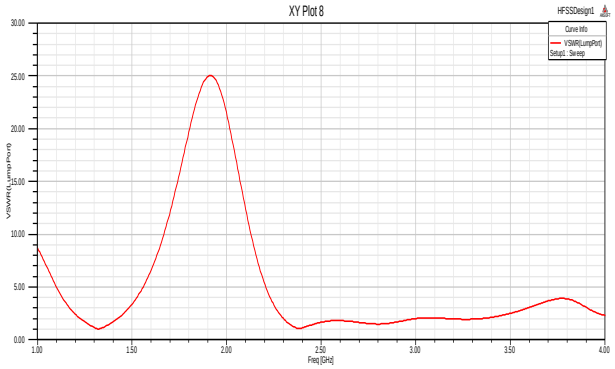

Figure 6: Smith chart of simulated field pattern

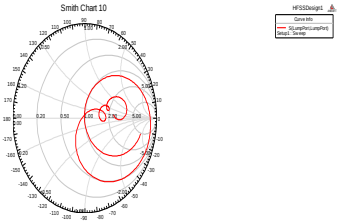

Figure **7:** Smith Chart

- The VSWR of the proposed antenna is less than 2.The return loss (Fig. 2), for the first resonance frequency is -45dB and second resonance frequency is -30 dB which has wider bandwidth .The Return losses of this antenna are good.
- The 3d polar plot has larger main lobe and very few side lobes that's why it has a high gain as well as lager bandwidth.

Conclusion

This proposed antenna has a new design with patch like a ladder shaped and is found to play a very important role over medical sciences such as short range medical sensor application. By using this shape we can obtain two resonant frequencies 1.3GHz, 2.4 GHz and hence can operate as dual band antenna and can be used in many places where the requirement of dual band frequencies such as in cellular concepts an also in WB application.

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