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A Multiband Handset Antenna Designing with High gain for UMTS/WiMAX/WLAN Applications

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ABSTRACT: This paper presents a novel design of a Triband Antenna for wireless communications. Presently many research groups are working on LTE/4G/5G mobile communications technologies and proposed various types of antenna designs. We have proposed an antenna which not only operates at three resonant frequencies but also having high gain. This antenna also fulfills the requirement of low cost, less weight, small size for wireless mobile devices. The design and simulation of proposed triband mobile antenna carried out with Flame Retardant 4 (FR-4) substrate and dimension of antenna substrate is 95mm × 50mm. Performance parameters of this antenna is investigated in terms of Gain , Return Loss , VSWR, radiation pattern. 2.45 GHz, 5.09 GHz and 7.65GHz are the resonant frequencies of the proposed antenna. For more accuracy and better results, High Frequency Structure Simulator software HFSS's optometric is utilized. The proposed antenna provides an operating bands, covering the (UMTS) Universal Mobile Telecommunications System bands (2300-2400 MHz), (WLAN) Wireless Local Area Network bands (2400-2497 MHz), and (WiMAX) World Interoperability for Microwave Access system bands (3300-3790 MHz) simultaneously. It is easy to fabricate and its simple configuration made it easy to suitable for the application in the UMTS/WiMAX/WLAN and satellite communications.

KEYWORDS: UMTS ,WiMax ,WLAN, Triband Antenna, 4G.

I.INTRODUCTION

In recent years, wireless communication system provides a great interest in an antenna with multiband characteristics for research work. Antennas with small size, low-cost fabrication, light weight, conformability, ease of installation and integration with feed networks have many applications over the broad frequency ranges. This system is having data transfer rate of around 10 times faster than the 3G mobile communication. Now a days due to increasing demand of high spectral efficiency to transfer data in form of video & multimedia it is required to develop such antenna which operates in wide range of frequencies. As per the recent demand, a Triband antenna, for the next generation wireless communication system, is presented in this paper. The proposed antenna provides operating bands, covering the (UMTS) Universal Mobile Telecommunications System bands (2300-2400 MHz), (WLAN) Wireless Local Area Network bands (2400-2497 MHz), and (WiMAX) World Interoperability for Microwave Access system bands (3300-3790 MHz) simultaneously[1,2].

II.ANTENNA STRUCTURE

Our Main objective is to design an antenna which are having small size and multiband performance characteristics. To Design an antenna essential parameters are required they are- dielectric constant of the substrate (ε_r), resonant frequency (f_r), loss tangent(δ) and the height of substrate *h*. Width and Length of a patch antenna is calculated using standard formulas for the design of microstrip patch antenna[2,3].
(1) Calculation of the width *W* of antenna, which is given by:

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$$W = \frac{vo}{2fr}\sqrt{\frac{2}{\varepsilon r+1}} \quad (1)$$

Where v_o is the free-space velocity of light.

(2) Calculation of effective dielectric constant, ε_{reff}, which is given by:

$$\varepsilon_{reff}=\frac{\varepsilon r+1}{2}+\frac{\varepsilon r-1}{2}[1+12\frac{h}{W}]^{-\frac{1}{2}} \quad (2)$$

(3) Calculation of the effective length, L_{eff}, which is given by:

$$L_{eff}=\frac{c}{2fr\sqrt{\varepsilon reff}} \quad (3)$$

(4) Calculation of the length extension ΔL, which is given by:

$$\Delta L=0.412h\frac{(\varepsilon reff+0.3)(\frac{W}{h}+0.264)}{(\varepsilon reff-0.258)(\frac{W}{h}+0.8)} \quad (4)$$

(5) Calculation of actual length of patch, L which is given by:

$$L=Leff-2\Delta L \quad (5)$$

Design of triband antenna based on the basic parameters of resonant frequency f_r=2.4GHz, dielectric constant of FR4 Substrate i.e. 4.4, loss tangent of 0.0002 and thickness of substrate 1.6mm. The design has been simulated by using high frequency structure simulator software (HFSS) which is a full-wave electromagnetic field simulation package with the criterion of return loss S_{11} less than -10dB. The total size of the substrate is 95mm×50mm including ground plane with 65mm×50mm and height of 1.6mm and the size of the radiated patch is 30mm× 28mm is fed by a microstrip line. Rectangular patch has been investigated for the triple band antennas in the wireless communication systems[4,5].

Design Structure of the proposed antenna is shown in Figure 1. Ground plane is kept on the same plane of antenna. The antenna is fed by 50 Ω microstrip line[6,7].
Following are the design specifications for the triband antenna with antenna patch and ground structure:

Patch width (W) =28mm
Patch length (L) =30mm
Ground plane width (Wg) = 50mm
Ground plane Length (Lg) =65mm
Dielectric constant 4.4
Height of substrate (h) = 1.6mm

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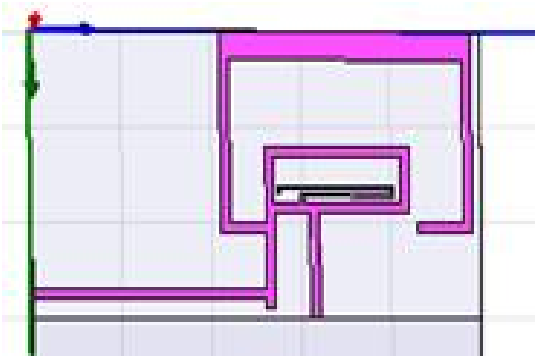

Figure 1 (a)

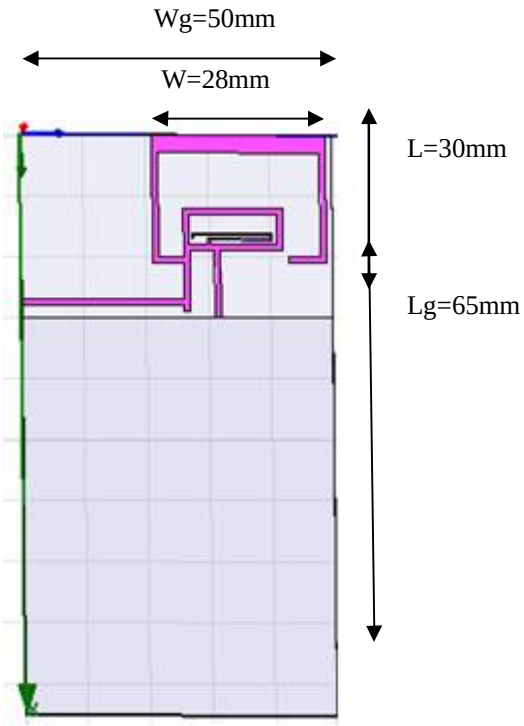

Figure 1 (b)

Figure 1: Geometry Of Microstrip Patch Antenna

III.RESULTS AND DISCUSSION

The proposed antenna generates three bands at center frequency of 2.45, 5.09 and 7.65 GHz with simulated impedance bandwidth of 0.51, 0.32 and 0.32 GHz respectively. With reference to the simulation results, we can see that antenna achieve good results as shown in Figure 2.

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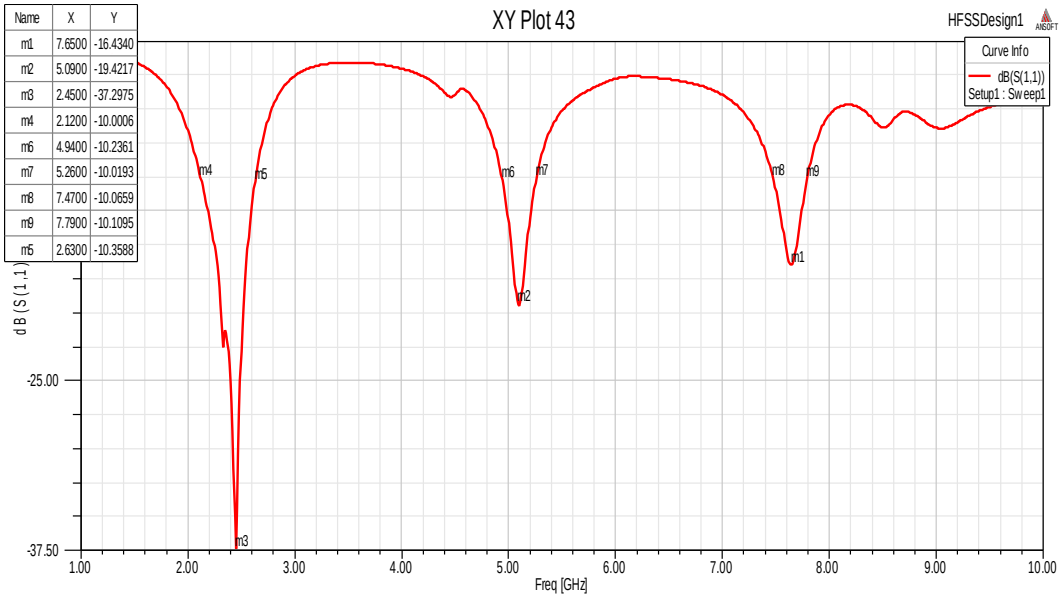

Figure 2: Frequency Response Of An Antenna

As it can be seen from the Figure 2, triband antenna exhibits wideband characteristic from 2.12GHz to 2.63GHz , 4.94GHz to 5.26GHz and 7.47GHz to 7.79GHz for S11 ≤ -10dB threshold level and used for mobile handsets.

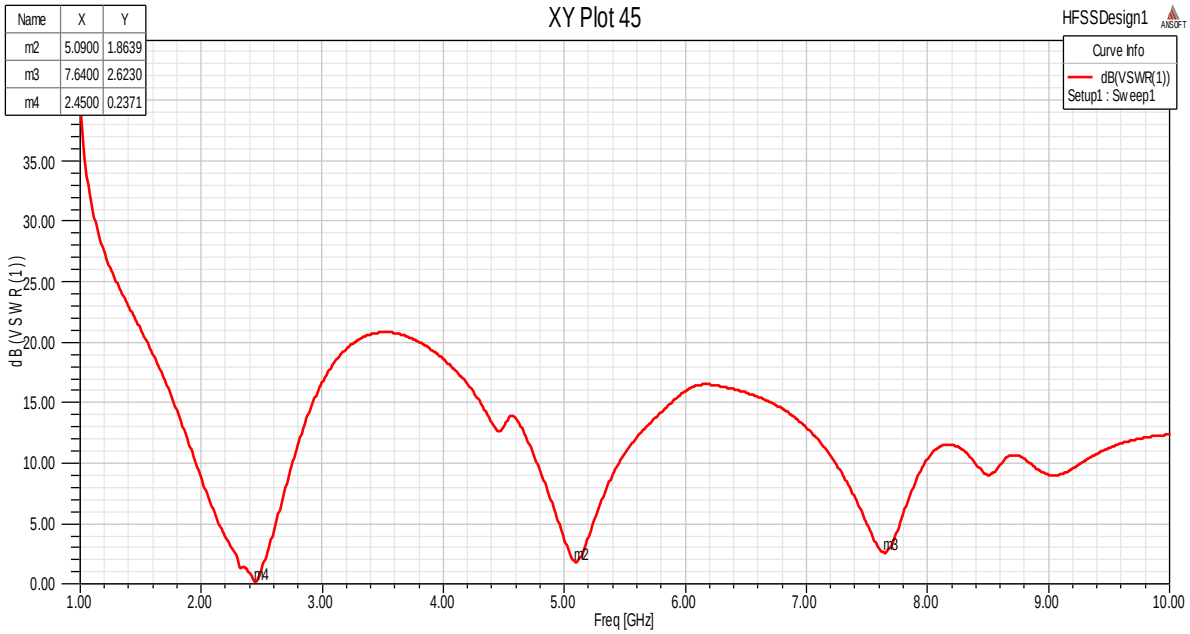

Figure 3: VSWR Response Of An Antenna

This antenna is able to achieve the desired value of the VSWR of 0.23db for 2.4GHz, 1.86db for 5.09GHz and 2.62db for 7.64GHz as shown in Figure 3.

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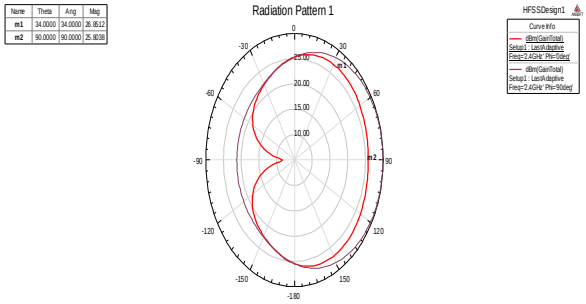


Figure 4 : Radiation Pattern Of An Antenna At Fc=2.4GHz

In Figure 4, the simulated radiation patterns at the center frequency fc =2.4GHz are plotted. According to this figure, patch antennas produces a good broadside radiation pattern at 2.4GHz and the peak gain is obtained to be around 26.85dBm.

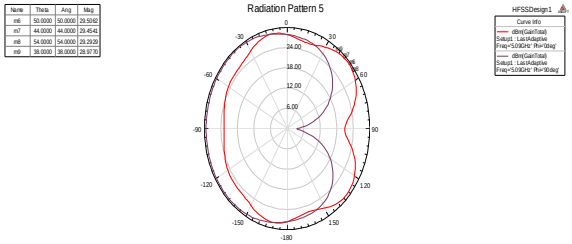


Figure 5 : Radiation Pattern Of An Antenna At Fc=5.09GHz

Similarly In Figure 5, the simulated radiation patterns at the center frequency, fc = 5.09GHz is plotted and the peak gain is obtained to be around 29.50dBm.

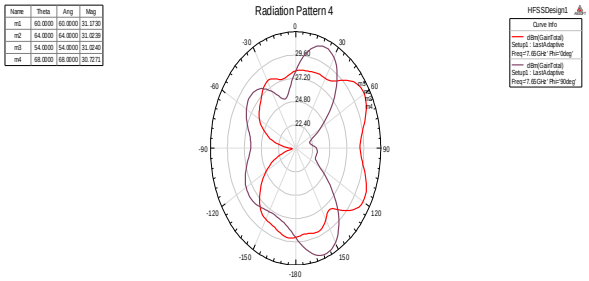
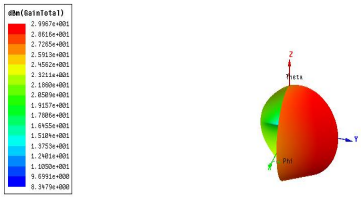


Figure 6 : Radiation Pattern Of An Antenna At Fc=7.65GHz

As shown above in Figure 6, at frequency fc = 7.65GHz,we have obtained gain is around 31.17dB.



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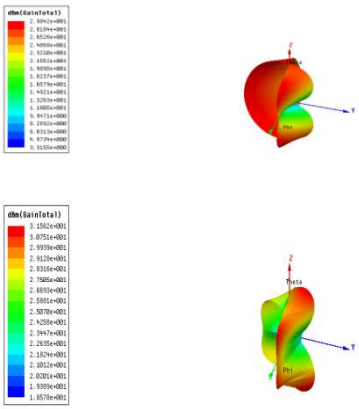

Figure 7 : 3D Polar Plots Of Radiation Patterns Obtained of an Antenna

3D Polar Plots of radiation patterns at Fc=2.4GHz, 5.09GHz and 7.65GHz is shown above.

IV.CONCLUSION

A Triband antenna for wireless communications designed have exhibited a high gain of 26.85dbm,29.50dbm and 31.17dbm for the resonant frequencies of 2.4GHz ,5.09GHz and 7.65GHz respectively. Besides, size of antenna is kept small considering its use in hand held mobile devices. Likewise, the VSWR value of 0.23db,1.86db and 2.62db is obtained.

This antenna thus is suitable to be used in mobile communication application of (UMTS) (2300-2400MHz), (WLAN) (2400-2497 MHz), and (WiMAX) (3300-3790 MHz) simultaneously.

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