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Design of Multiband Linear Antenna for Wireless Applications

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Abstract: In remote correspondence frameworks, multiband reception apparatus has been assuming an essential part for remote administration prerequisites. Remote neighborhood (WLAN) and Worldwide Interoperability for Microwave Access (WiMAX) have been broadly connected in cell phones, for example, handheld PCs and astute telephones. These two procedures have been generally considered as a practical, feasible, and rapid information integration arrangement, empowering client portability. The proposed radio wire is intended for multiband via pair of planar patches and vertical shorted patches which brings about High proficiency of the reception apparatus and high gain. Double band and tri-band reception apparatus outline is made for 2.4–3.0GHz, 3.25–3.68GHz and 5.9–6.4GHz separately by drawing U-molded spaces in the ground plane. The reception apparatus is composed and mimicked utilizing HFSS with great radiation qualities and impedance matching in the three working operating bands.

Keywords: Multiband reception, high gain, wireless Local Area Network (WLAN), Worldwide Interoperability for Microwave Access (WiMAX).

I. INTRODUCTION

Using the quick advancement of open air and indoor remote correspondences, higher necessities for good execution of base-station receiving wires are certain in the terminal framework. Especially, requests for receiving wires utilized as a part of the region of remote neighborhood (WLAN) and Worldwide Interoperability for Microwave Access (WiMAX) correspondences have got gigantic consideration in the recent years. With a specific end goal to spread over the two working groups, a multiband receiving wire is exceptionally alluring due to its savvy answer for decreasing the number of reception apparatus units and minimizing the establishment region for the base station. Hence it is wanted to outline receiving wires that have the properties of multiband, high-pick up, and basic development. To outline a multiband receiving wire for multimode remote correspondence framework, different routines have been investigated. U-molded strip, E-formed monopole, and V-formed opening are decisions for double band outline. Fractal receiving wire is an alternate choice for multiband outline.

Dielectric resonator radio wires (DRAs) are prevalently used to give double band operation. Dipole clusters can be anticipated for multiband reception apparatus outline. Technology demands antennas which can operate on different wireless bands and should have different features like low cost, minimal weight, low profile and are capable of maintaining high performance over a large spectrum of frequencies.

In the proposed system, a tri-band unidirectional antenna with good radiation characteristics and impedance matching is designed which resonate at 2.4-2.48GHz, 3.7-4.2GHz, 5.9-6.4GHz and can be applied to wireless local area network (WLAN), Worldwide Interoperability for Microwave Access (WiMAX) and Satellite applications. The gain and bandwidth is increased up to a sufficient level by having U-shaped slots in the patches to satisfy the requirements of omnidirectional, high gain, and low back-lobe radiation. Different physical sizes of U-shaped slots can provide effective and flexible control on the positions of the working bands of the antenna. Efficiency of the antenna is also increased with good cross-polarization performance.

II. RELATED WORK

In this article, “Design of a Novel High-Gain Dual-Band Antenna for WLAN Applications” authors Xiaoxiang He, Sheng Hong, Huagang Xiong, Qishan Zhang discuss about a novel high-increase, double band WLAN receiving wire is intended for long-remove correspondence

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applications. The radio wire produces two different full modes to cover 2.4/5.2GHz WLAN groups. The lower resounding mode of the reception apparatus has an impedance transfer speed of 220MHz, which effortlessly covers the obliged transmission capacity of the 2.4GHz WLAN, and the upper thunderous mode has a transmission capacity of 380MHz, covering 5.2GHz WLAN band. Most extreme increase estimations of 6.2 and 10.4dBi in the lower and higher recurrence groups are obtained. The return misfortune, radiation design and the basic configuration parameters create great answers for the double band WLAN long-separate correspondence applications. In this article titled "Dual Band Microstrip Antenna for Wireless LAN Application", authors Asrokin A., M. K. A. Rahim, M. Z. A. Abd. Aziz, discusses about the outline of the multiband Microstrip receiving wire working at recurrence 2.4 GHz and 3.48 GHz. The point was to plan a double band Microstrip reception apparatus which will be working in the remote LAN band, IEEE 802.11 a/b/g. The measurements of the single components of the working frequencies were figured utilizing transmission line model. Two components of inset nourished Microstrip reception apparatus were utilized for every recurrence band. In this paper, there are four components to cover the recurrence band for WLAN application. The recreation methodology was carried out utilizing the Agilent ADS programming. The scaling element of 1.03 has been picked for the outline beginning from the most minimal resounding recurrence at 2.4 GHz band, while at5.2 GHz band, the scaling variable is 1.05. The distinction on the scaling components was contributed by the misfortunes that happened when joining both of the recieving wire components from both groups of recurrence. The recieving wire has been created on the FR4 micro strip board with ε= 4.5 and tan δ 0.019 utilizing the wet carving method.

III. Antenna Structure

3.1 Multiband Microstrip Antenna

With the quick improvement of open air and indoor remote interchanges, higher prerequisites for good execution of base-station receiving wires are unavoidable in the terminal framework. In the proposed framework, a tri-band unidirectional radio wire with great radiation attributes and impedance matching is composed which resound at 2.4-2.48GHz, 3.7-4.2GHz, and 5.9-6.4GHz can be connected to remote neighborhood (WLAN), Worldwide Interoperability for Microwave Access (WiMAX) and Satellite applications. The addition and data transfer capacity is expanded up to a sufficient level by having U-formed openings in the patches to fulfill the prerequisites of omnidirectional, high pick up, and low back-lobe radiation. Diverse physical sizes of U-formed openings can give successful and adaptable control on the positions of the working groups of the radio wire.

In this section, the outline parameters and results for a multiband microstrip patch reception apparatus in HFSS programming is clarified and the outcomes got from the reproductions are exhibited. The Microstrip patch outline is accomplished by utilizing coaxial feed procedure. To exchange electromagnetic vitality from the coaxial feed to the emanating component, one end of this nourishing line join with a SMA connector mounted on the ground plane, and the flip side is open-finished, which serves to couple vitality to the nearby radiator of the radio wire. For the estimations, the reception apparatus was composed utilizing a copper plate having a limited thickness.

3.2 Software Design Procedure

Three essential parameters for antenna design are:

a) Frequency of operation (f_r)

The resonant frequency of the antenna must be selected appropriately. The resonant frequencies selected for my design is 2 .4-2.48GHz, 3.7-4.2GHz, 5.9-6.4GHz for wireless applications.

b) Dielectric constant of the substrate (ε_r):

The dielectric constant of substrate material plays an important role in the patch antenna design. A substrate with a high dielectric constant reduces the dimensions of the antenna but it also affects the antenna performance. So, there is a trade-off between size and performance of patch antenna.

c) Height of dielectric substrate (h):

For the Microstrip patch antenna to be used in wireless communication systems, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate should be less. The design procedure of single band Microstrip patch antenna using rectangular patch is carried out step by step:

a) *Substrate Selectivity*
Selection of suitable substrate of appropriate thickness is the first step in the design procedure of any microstrip antenna.

b) *Calculation of width of patch*
The width of the antenna is calculated by equation,

$$W = \frac{1}{2f_r\sqrt{\mu_0 \in_0}}\sqrt{\frac{2}{(\in_r + 1)}}$$

c) *Calculation of effective dielectric constant*

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The effective dielectric is calculated by equation,

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

d) Calculation of the effective length

The effective length is calculated using equation,

$$L = \frac{1}{2f_r\sqrt{\epsilon_{eff}}\sqrt{\mu_0\,\epsilon_0}} - 2\Delta L$$

e) Calculation of the length extension

The length extension is calculated using equation,

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

f) Calculation of actual length of patch

The actual length is obtained by equation,

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

To have the antenna resonating at more than one frequency we go for multi-banding. One of the easy and efficient methods of achieving multi-banding is cutting slots in the patch. The length and position of the slots can be changed to obtain the microstrip patch antennas resonating at more than one frequency. In this way we can have the dual or triple band antennas.

g) Ground Plane:

Essentially the transmission line model is applicable to an infinite ground plane only. However, it has been shown that a finite ground plane can be used for if the ground plane is 6 times larger than the height of the dielectric substrate plus the used length or width. The ground plane can now be calculated as:

$$W_8 = 6.h + W$$
$$L_8 = 6.h + L$$

III. Experimental & Simulation Results

4.1 Triple-Band Antenna Design

Triple-band microstrip antenna is designed by cutting U-shaped slots on the patches for effective increase in gain, bandwidth and provides effective operations on the frequency bands. Comparing to the dual-band antennas, the triple-band antenna not only achieves triple bands simultaneously, but also has a rather simple structure that is easy to fabricate and satisfy the requirements of high gain and low back lobe radiation.

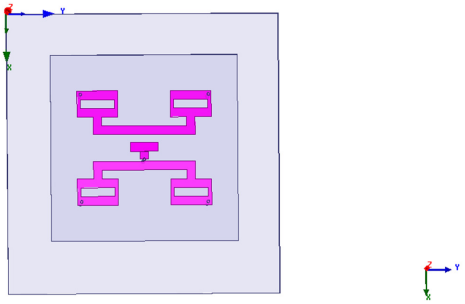

Fig 4.1 Triple-Band Microstrip Antenna

4.2 Return Loss of proposed antenna

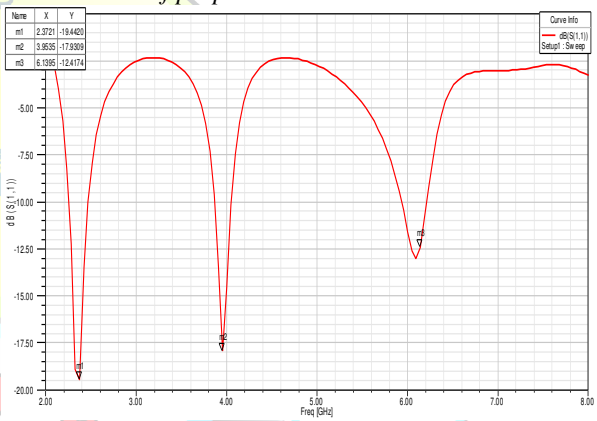

Fig 4.2 Return Loss vs Frequency

4.3 VSWR plot of proposed antenna

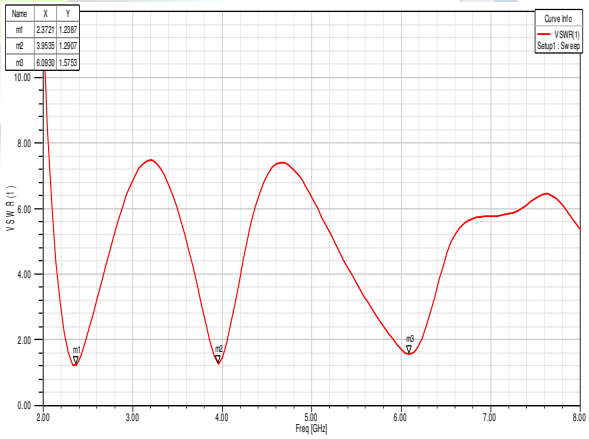

Fig 4.3 Voltage Standing Wave Ratio

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4.4 Gain of proposed antenna

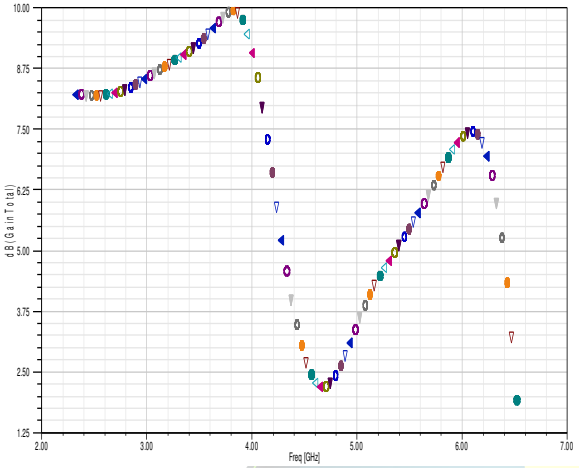

Fig 4.4 Gain vs Frequency

Triple-band antenna design produces return loss of -19dB at 2.4GHz, -17dB at 3.9GHz and -12dB at 6.1GHz with high gain of 8dB, 10dB and 7dB respectively.

IV. CONCLUSION

A minimal triple-band patch radio wire for WLAN/WiMAX and satellite applications is exhibited. Contrasted with numerous reception apparatuses proposed prior, this receiving wire is outlined taking into account a fairly basic structure and suitable for all recurrence groups of WLAN and WiMAX applications at the same time. The proposed reception apparatus is intended for multiband just through carving openings on the ground plane, so it can be much less demanding to manufacture. The measured results demonstrate that the acquired addition is 8dB (2.4–3.0 GHz), 10dB (3.25–3.68 GHz), and around 7dB (5.9–6.4 GHz), separately, sufficient for WLAN, WiMAX and satellite applications. The positions of three working groups can be independently controlled by changing the radio wire parameters. Moreover, the proposed reception apparatus has great radiation qualities and impedance matching in the three working groups. As Future Work the multiband direct fix radio wire reproduced utilizing HFSS will be created and their attributes like Return Loss, Smith Chart, Gain, VSWR, Radiation Pattern and Bandwidth are measured utilizing Network Analyzer.

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