Dual Band Monopole Antenna for Wireless Communications

A.Bharathi
CVR College of Engineering, Department of ECE, Ibrahimpatan, R.R.District, A.P., India
Email: bharathig8@gmail.com

Abstract—**Dual band antennas are used in many applications like in cellular phones, in laptop for wireless printer and modem connections. This paper discusses a dual monopole Microstrip antenna configuration for dual frequency coverage at 1800MHz for mobile communication and at 2400MHz for wireless LAN applications. The antenna consists of two monopoles of different stems printed on a FR4 substrate (1.6 mm thickness) which has a dielectric constant of 4.4. More than 1500 iterations have been carried out during simulation stage to yield the optimized performance characteristics for resonant frequency and return loss at both the above frequencies. Fairly good return losses and radiation pattern response of the proposed dual monopole dual frequency antenna indicates that this antenna is well suited for the applications intended.**

Index Terms—**Microstrip antenna, dual band, impedance bandwidth, monopole antenna, mobile communication.**

I. Introduction

Dual band antenna designs are gaining much interest due to the rapid developments in wireless communication industry. Wire antennas are the oldest and in many case the most versatile antennas from a practical point of view [1]. In modern personal wireless applications, it is desirable to integrate the antenna on a circuit board for low cost, low profile, and conformability. **In the recent years, printed circuit antennas have been receiving much attention owing to their low profile, light weight, low cost, small size, design flexibility, and ease of installation [2]. Applications in the present day mobile communication systems usually require smaller antenna size in order to meet the miniaturization requirements of mobile units. Thus size reduction is becoming major design consideration for practical applications of printed circuit antenna.** In applications in which the increased bandwidth is needed for operating at two separate sub-bands, a valid alternative to the broadening of total bandwidth is represented by dual-frequency patch antennas. **Various types of antennas are available to meet these requirements. Among these, the Dual Monopole Microstrip antenna for Dual Frequency Mobile communication and Wireless LAN Applications has gained great prominence because of simplicity [3]. Dual-frequency antennas exhibit a dual-resonant behavior in a single radiating structure. The antennas designed to operate at 900MHz and 1800MHz are available in literature[4,5,6,7]. This paper discusses the dual frequency antenna operating at 1800MHz and 2400MHz.All the corresponding details of antenna specifications, simulation details and design parameters are clearly presented and discussed.**

II. Antenna Design

The geometry of the microstrip fed uniplanar monopole antenna is shown in Fig. 1, it consists of two printed strip monopoles of different dimensions. The longer one (i.e., Monopole 1) is for a lower frequency band while the shorter one (i.e., Monopole 2) is dominant at the higher frequency. The two monopoles are combined at their lower ends and fed by a single microstrip line with a tuning stub. This structure is printed on a dielectric substrate of dielectric constant 4.4. and thickness 1.6 mm. The design is based on [8].

A. Steps for antenna design

1 Calculate the design parameters and generate the model using HFSS Simulation software.
2 Simulate the antenna by varying one parameter at a time for obtaining desired response.
3 Gather simulated hybrid response data using the return loss plot and radiation pattern with Ansoft HFSS software.
4 Analyze simulated results and verify with manufacturing and fabrication tolerances.
5 Fabricate the proposed design using FR4 with dielectric constant of 4.4.
6 Obtain the measured Return Loss response using vector network analyzer and radiation pattern response in Anachoic chamber.

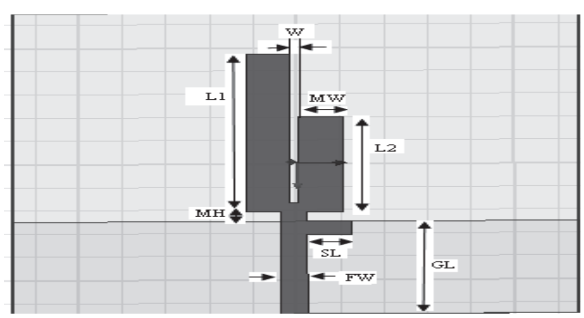

Figure1. Geometry of dual monopole antenna.

DOI: 10.32377/cvrjst0305

7 Compare the simulated and measured results of antenna and analyse the deviations if any.
8 Optimize the antenna performance for aimed specifications.

A microstrip monopole is formed by making one side length of the patch resonant(fraction of wavelength) and other patch dimension very thin. Both the monopoles are chosen to have same width**. The design parameters are calculated using design equations[9].**

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

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

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (3)$$

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}} \quad (4)$$

$$L_{eff} = L + 2\Delta L \quad (5)$$

Where W is the width of the patch, ε_r is the dielectric constant of the medium, h is the substrate thickness, f_0 is the resonant frequency of antenna, ε_{reff} is the effective dielectric constant of the medium, h is the height of the substrate, ΔL is the incremental length, L_{eff} is the effective length of the patch. L is the resonant length of the patch.

The width of microstrip line is calculated using the equation,

$$Z_c = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\frac{W_0}{h} + 1.393 + 0.667\ln\left(\frac{W_0}{h} + 1.444\right)\right]} \quad (6)$$

Initially two monopoles are designed separately and the resonance at corresponding frequencies is verified. Both the monopoles are then combined, as for a multiband operation, a multi element monopole is needed [4]. **A dual-band uniplanar monopole antenna operating at 1800 MHz and 2400 MHz has been designed using HFSS Simulation Software. The parametric analysis is carried out with respect to several design parameters of the antenna to the obtain the best design with best radiation characteristics. Optimal design is obtained by choosing the following design parameters. Length of larger monopole as L1=34mm, length of small monopole as L2=20.5mm, feed width FW=3mm, monopole width MW=5mm which is same for both monopoles, the gap between monopoles is W=1mm, SL= 5mm is used for good impedance matching at both the frequencies, ground plane length chosen as 20mm.**

III. RESULTS

The return loss plot determines the resonant frequency and impedance bandwidth of the antenna. It is seen from the return loss plot depicted in Figure 2.that the antenna resonates effectively at both the frequencies and has good impedance bandwidth. The minimum return loss of -19.8dB and -15.8dB are obtained at 1798MHz and 2409MHz respectively. The -10dB return loss bandwidth at lower resonant frequency is 401MHz (1553MHz-1952MHz) and at higher resonant frequency is 404MHz (2421MHz-2825MHz). The impedance characteristics at two resonances is clearly depicted in Fig.3. The radiation patterns of the antenna in E-plane and H-plane at 1800MHz is shown in Fig. 4. It is seen that E plane pattern is bidirectional and H plane pattern is non directional. Fig.5 shows the principal plane patterns at 2450MHz which is also omnidirectional.

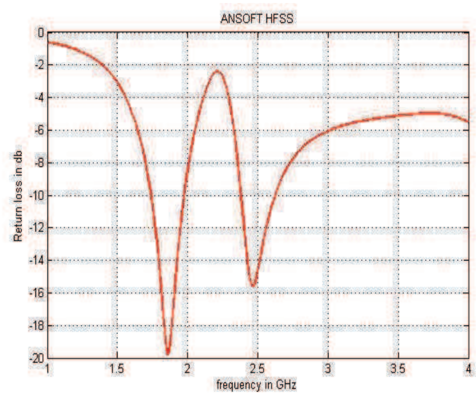

Figure2. Simulated return loss for dual monopole antenna.

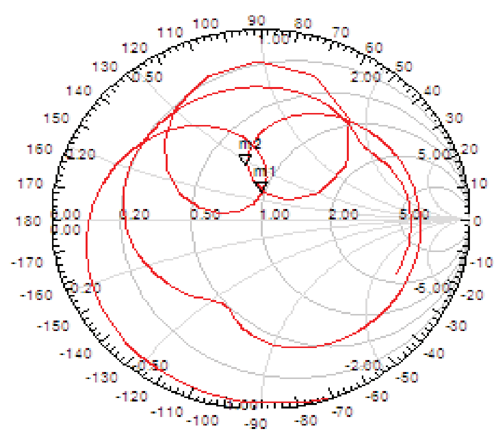

Figure3. Impedance characteristics of the antenna.

DOI: 10.32377/cvrjst0305

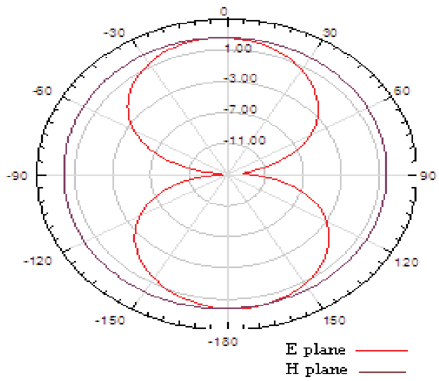

Figure4. Simulated radiation patterns for 1800MHz.

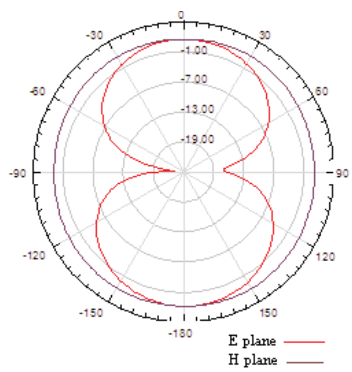

Figure5. Simulated radiation patterns for 2450MHz.

CONCLUSIONS

The monopole antenna is very compact and is easily fed at center of two monopoles by a 50 ohm microstrip line. The simulation results of radiation patterns and return loss are presented. The antenna operating characteristics are very good at both the frequencies and are suitable for wireless communication. This simple structure has performance characteristics such as pure vertical polarization and horizontal omnidirectional coverage which makes its extensive use possible in variety of wireless applications.

REFERENCES

[1] Multiband Integrated Antennas for 4G Terminals by David A.Sánchez-Hernández Universidad Politécnica de Cartagena, Artech House.

[2] Broadband microstrip antennas by Girish kumar and K .P Ray, Artech House.

[3] Microstrip antennas by I.J. Bahl and P.Bhartia , Artech House.

[4] Chen, H.-M., et al., “A Compact Dual-Band Microstrip-Fed Monopole Antenna,” Proc. IEEE Antennas and Propagation Society Int. Symposium, July 2001, Vol. 2, pp. 124–127.

[5] B. Winter and V. Stoiljkovic, "A novel dual antenna for mobile communications," in 1998.

[6] I.Egorov and Z. Ying, "A non-uniform helical antenna for dual-band cellular phones," in 2000 IEEE Antennas Propagat. Soc. Int. Symp. Dig., Salt Lake City, UT, July 2000, pp. 652-655.

[7] S. Tarvas and A. Isohatala, "An internal dual-band mobile phone antenna," in 2000 IEEE Antennas Propagat. Soc. Int. Symp. Dig., Salt Lake City, UT, July 2000, pp. 266-269.

[8] M. Ali, M. 0. Wski, M. A. Stuchly and S. S. Stuchly, "A dual-frequency strip-sleeve monopole antenna for a laptop computer," in 1998 IEEE Antennas Propagat. Soc. Int. Symp. Dig., Atlanta, GA, June 1998, pp. 794-797.

[9] Balanis, C. A., Antenna Theory: Analysis and Design, New York: John Wiley & Sons, 2005.

[10] Nakano, H., et al., “An Inverted FL Antenna for Dual-Frequency Operation,” IEEE Transactions on Antennas and Propagation, Vol. 53, No. 8, August 2005, pp. 2417– 2421.

DOI: 10.32377/cvrjst0305