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Development of an omni-directional, multi-band antenna for Wireless Access Point

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1. Introduction

Wireless access point become one of the inevitable component for the wireless networking industry which facilitates wireless communication between Laptops, Wireless routers, print servers and other modern wireless communication systems. IEEE has standardised Industrial, Scientific, and medical (ISM) bands: 2.4 – 2.4835 GHz and 5.15 – 5.825 GHz. There for the development of a multiband antenna with omnidirectional radiation characteristics has great demand for the wireless networking industry. The standard monopole is probably the most widely used antenna on existing wireless network systems because of its simple structure and omnidirectional radiation behaviour. Some printed triangular monopole antennas [1,2,3,4] with reduced size and broadband operation are reported. For such printed triangular monopoles, the antenna length is reduced many times than that of a strip monopole.

In this paper we demonstrate the development of a triangular patch loaded monopole antenna with omni directional radiation behaviour suitable for the wireless access point. The proposed antenna consists of a strip monopole and a triangular patch to facilitate multiband operation. The design parameters are optimized using Ansoft High Frequency Structure Simulator (HFSS v 10.1) and experimentally verified using Agilent E8362B Performance Network Analyzer. Details of the design considerations of the proposed antenna with the experimental and simulated results are presented and discussed.

2. Antenna Configuration

Fig. 1 shows the proposed triangular patch loaded monopole antenna fabricated on an FR4 substrate of thickness 1.6 mm , relative permittivity 4.6 and size W x L = (50 x 65) mm. The antenna consists of a strip monopole of dimension M_w x M_L = (3 x 10) mm on Layer 1 which act as a radiator and excitation element for the triangular patch on layer 2. Dual band operation is achieved by loading the strip monopole with a triangular patch of dimension TP_L = 25mm and is made offset from the ground plane of dimension G_W x G_L = (50 x 35)mm by an amount O_G = 1mm for optimum performance. Also note that an SMA connector, attached to 50 Ω transmission line, is used to feed the antenna. It is found that two resonant bands with similar radiation characteristics can be excited at frequencies corresponds to the length of the monopole (M_L) and dimension of the triangular patch (TP_L). These operating modes are tuned for the Wireless Access Point by optimizing various design parameters.

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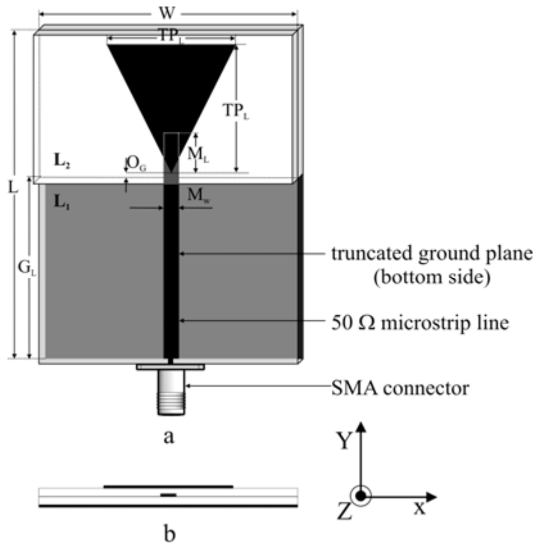


Fig 1. Geometry and dimensions of the proposed antenna a. Top View b. Cross-sectional View. Dimensions : W = 50 mm, L = 65 mm, G_L = 35 mm, O_G = 1 mm , M_L = 10 mm, M_w = 3mm, TP_L = 25mm

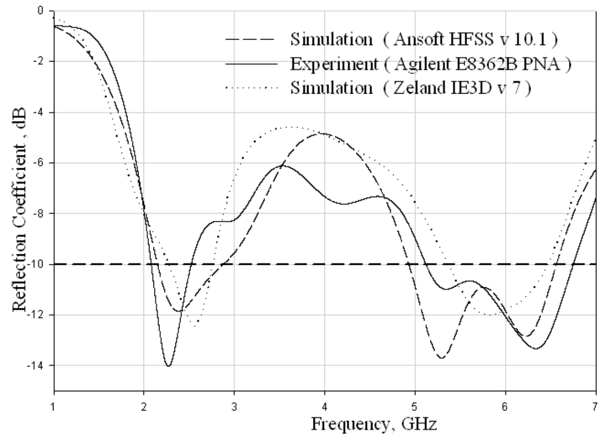


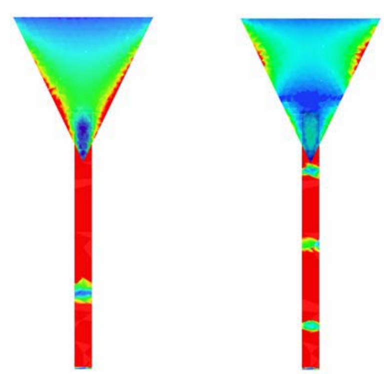
Fig 2: Comparison of measured and simulated reflection coefficients of the TPLMA for Wireless Access Point

3. Experimental Studies and Discussion

Fig. 2 shows the measured and simulated reflection coefficient of the proposed Triangular Path Loaded monopole antenna (TPLMA). Good agreements between simulated and measured results are observed. It is seen from the Experimental results that the proposed antenna has an impedance bandwidth of 19.2 % in the 2.1 – 2.5 GHz band and 27.5% in the 5.1 – 6.8 GHz band. This meets the bandwidth requirement for IEEE 801.11 WLAN applications.

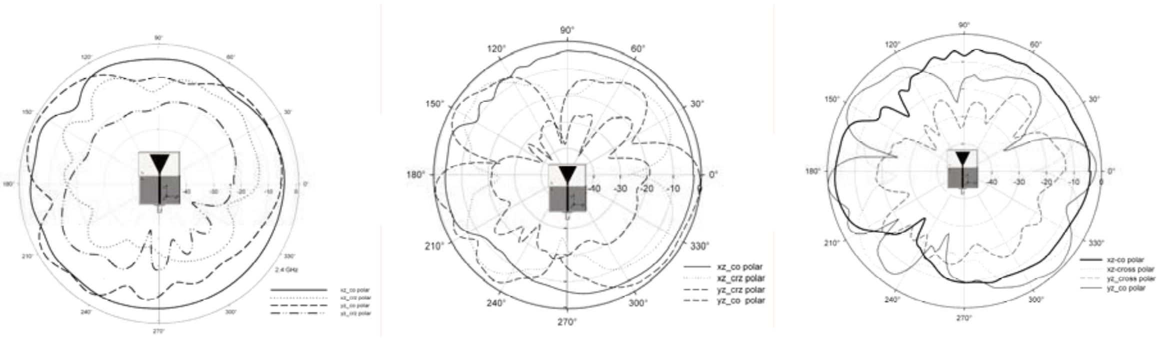
The simulated surface current distributions for the proposed antenna at 2.4 GHz and 5.8 GHz are presented in Fig 3. It can be seen that the triangular patch is excited more at lower resonant band while the strip monopole contributes to the second resonant band.

The radiation characteristics of the proposed antenna are also investigated, and the measured radiation patterns in x-y and y-z planes at 2.4 GHz, 5.35 GHz and 5.8 GHz are depicted in Fig 4. It is observed that almost omni directional radiation characteristics are observed in the first two bands while the radiation behaviour of the antenna at 5.8 GHz is slightly disturbed. The measured average gains at three bands listed above are 1.8, 1.4 and 1.2 dBi respectively.



a b

Fig 3: simulated surface current distributions for the proposed antenna a) 2.4 GHz b) 5.2 GHz



a. 2.4 GHz   b. 5.2 GHz   c. 5.8 GHz

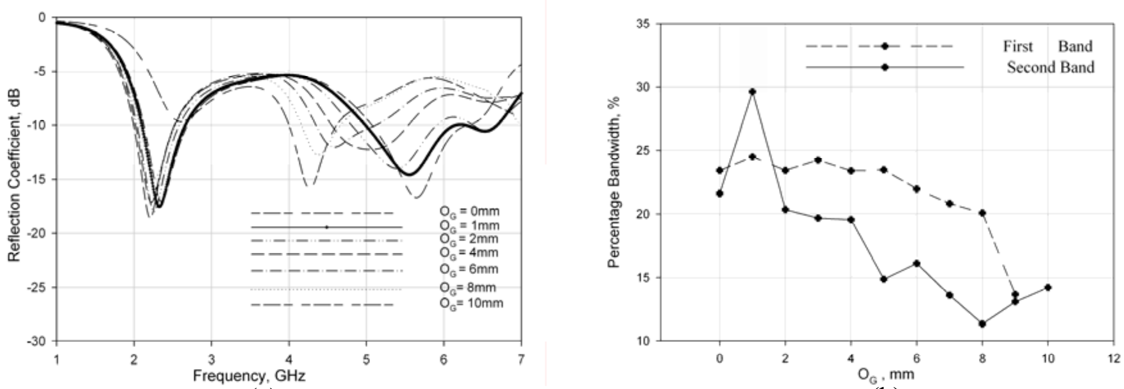
Fig 4. Measured radiation patterns of the proposed antenna (a) 2.4 GHz (b) 5.2 GHz (c) 5.8 GHz

3.1 The effects of the key parameters

A parametric study is being done for the proposed antenna using Ansoft HFSS in order to investigate the effect of various design parameters.

A. Offset position of triangular patch from ground (O_G)

The amount of offset for the triangular patch over the monopole is studied and optimized for maximum bandwidth. Figure 5 depicts the variation of reflection coefficient for different values of O_G and it is observed that peak value of percentage bandwidth is obtained for O_G = 1mm.

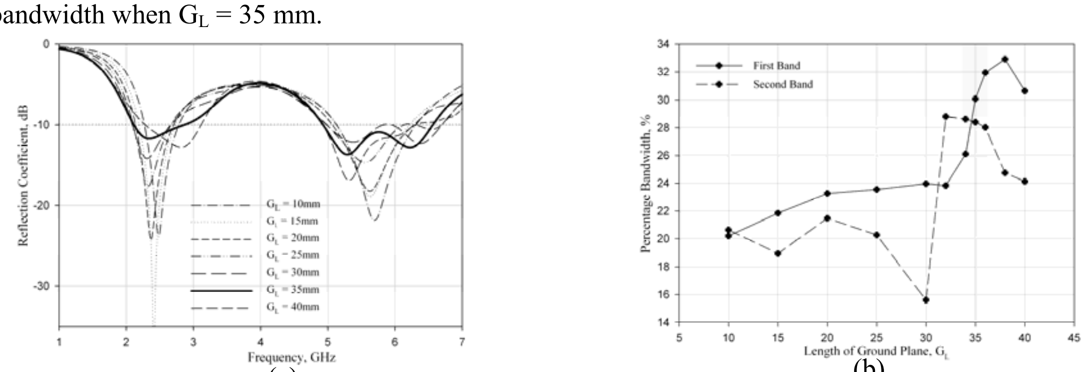


(a)   (b)

Fig 5: Variation of percentage bandwidth first and second resonant bands with offset position , O_G (a) Effect on reflection coefficient (b) Effect on percentage Bandwidth

B. Truncated ground plane Length, G_L

Length of truncated ground plane is also studied while keeping the offset distance, O_G = 1mm and optimized for maximum bandwidth. Fig 6. Shows the variation of percentage bandwidth for different values of G_L. It is observed that the proposed geometry offers peak percentage of bandwidth when G_L = 35 mm.

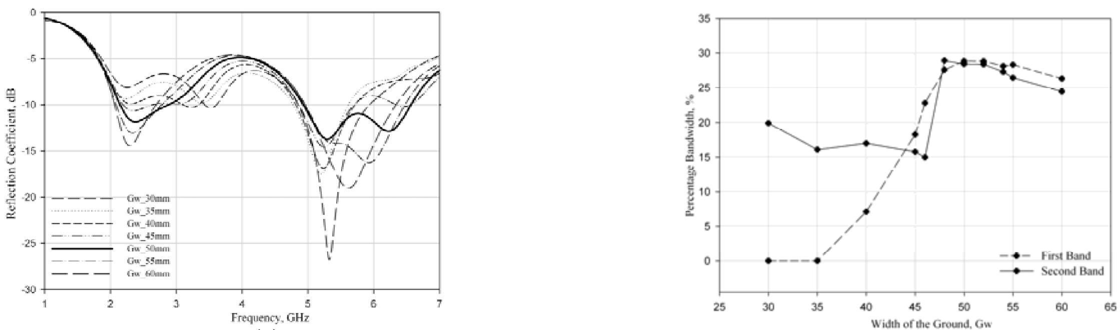


(a)   (b)

Fig 6: Effect of Reflection characteristics and percentage bandwidth over the parameter, G_L (a) Effect on reflection coefficient (b) Effect on percentage bandwidth

C. Truncated ground plane Width, G_W

Now the parameter G_W is optimized while keeping other two parameters in its optimum value – that is O_G = 1 mm and G_L = 35 mm. Fig 7 depicts the optimization of G_W for optimum bandwidth. It is clear from the analysis that maximum band width is obtained for G_w = 35 mm.



(a) (b)

Fig 7: Optimization of the antenna parameter, $G_{L,}$, for optimum bandwidth in both the resonant bands. (a) Effect on reflection coefficient (b) Effect on percentage bandwidth

4. Conclusion

We have presented an omni directional triangular patch loaded monopole antenna suitable for IEEE 802.11 WLAN applications in wireless access point. The key parameters of the proposed antenna is studied, optimized and experimentally verified. It is found that the antenna exhibit omni directional radiation behaviour with moderate gain.

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