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Dual Band Patch Antenna for WLAN/Wi-Max Applications using Slot Loading

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Abstract

In this paper, the design of a coaxially fed single layer single patch wideband microstrip antenna in the form of slot loaded rectangular patch antenna for WLAN/Wi-Max applications is presented. The slot loaded patch antenna resonates at 2.43 GHz and 3.5 GHz frequencies. It has been developed to be used in future WLAN/Wi-Max technologies. The proposed antenna is simulated using Computer Simulation Technology (CST) Microwave Studio. The simulated results show that the designed patch antenna achieves impedance bandwidth of 4.1% and 14.8% for VSWR< 2, covering a frequency range from 2.39 GHz to 2.49 GHz and 3.33 GHz to 3.849 GHz respectively. The antenna exhibits the return loss (S11) below -10 dB for frequency ranges mentioned.

Keywords: Microstrip Antenna, WLAN/Wi-Max bands, Impedance Bandwidth, CST Microwave Studio

Introduction

Microstrip patch antennas are being used in communication systems due to their low profile. However in some systems, such as two way wireless communications, in order to have simply one antenna to transmit and receive the information, the antenna must be capable of operating in two distinct frequency ranges rather than just one. In addition, due to the miniaturization of portable communication devices, a small antenna is desirable. A new small dual-band rectangular patch antenna is presented in this paper.

It has been demonstrated that, by loading a rectangular microstrip patch antenna with a pair of narrow slots placed close to the radiating edges of the patch, a dual-frequency operation can be obtained [1, 3]. In such dual-frequency designs, the two operating frequencies are associated to the TM_{10} and TM_{30} modes of the unslotted rectangular patch. In addition, the two operating frequencies have the same polarisation planes and broadside radiation patterns, with a frequency ratio generally in the range of 1.6 to 2.0 for a single probe-feed case [l]. In this Letter, we demonstrate that, by placing the embedded slots close to the non-radiating edges of the patch instead of the radiating edges and replacing the narrow slots with properly-bent slots, a novel dual-frequency operation of the microstrip antenna can easily be achieved using a single probe feed. The two operating frequencies of the proposed antenna are also found to have the same polarisation planes and broadside radiation patterns. This makes the proposed antenna more suitable for dual-frequency applications where lower frequency ratio is required.

In this paper, a slot loaded double band microstrip patch antenna for WLAN/Wi-Max applications is designed and simulated using CST Microwave Studio. The proposed slot loaded patch antenna is suitable for the 2.39 GHz to 2.49 GHz WLAN applications and 3.33 GHz to 3.849 GHz Wi-Max applications.

Antenna Design

In this paper several parameters have been investigated using CST Microwave Studio software. The geometry of slot loaded microstrip patch antenna is shown in figure-1. The structure consists of a rectangular patch fed by co-axial probe of 50 Ω. The design specifications for patch antenna are:

Substrate permittivity (ε_r) = 2.33
Substrate thickness (h) = 8 mm.
Length of patch (L) = 30 mm.
Width of patch (W) = 26 mm.
Feed point location = (0, 2.5)
Dimension of ground (Lg x Wg) = 90x80 mm^2
The slot dimensions are:
a= 19 mm.
b= 20 mm.
c= 14 mm.
Where a, b and c are shown in figure-1.
The width of each slot is 2mm.

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The antenna structure is fed with a co-axial probe (50 Ω). The inner and outer radius of co-axial probe is 1.5 mm and 3 mm respectively.

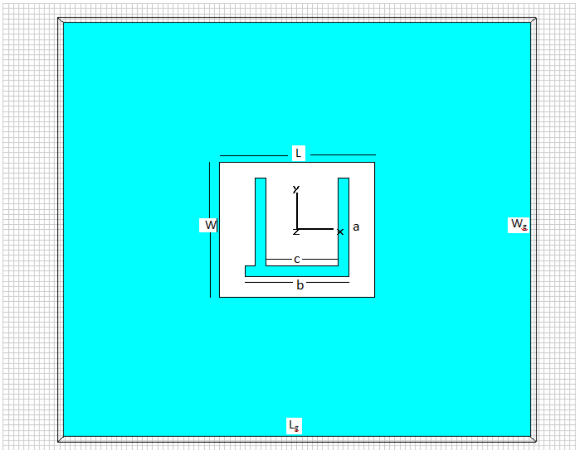

Figure 1(a)

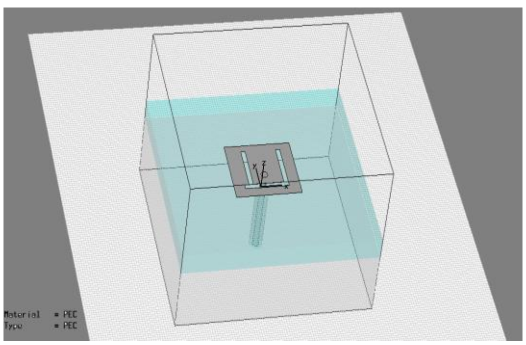

Figure 1(b)

Figure 1(a): Geometry of Slot Loaded Single Layer Patch Antenna
(b): Structural View of Patch Antenna

Result and Discussion

The dual band characteristics of proposed patch antenna are achieved by incorporating slots. The centre frequencies of these bands are decided by the electrical length of these slots. In addition to other factors, the thick multilayer substrate helps in achieving required bandwidth. The feed location is moved from the centre of geometry to get the best possible impedance match to the antenna [2]. Simulation studies of proposed antenna reported here are carried out using CST Microwave Studio.

A. ***Return loss characteristic***

The return loss of slot loaded patch antenna is shown in figure 2 which shows that it resonates at 2.43 GHz and 3.5GHz frequencies. These resonant frequencies give the measures of impedance bandwidth characteristics of the patch antenna [2]. The impedance bandwidth for the proposed antenna is 100 MHz (from 2.39 to 2.49 GHz) for the first band and 519 MHz (From 3.33 GHz to 3.849 GHz) for the second band. From the figure 2 the return loss values at the resonant frequencies f_{r1}= 2.43 GHz and f_{r2}= 3.5 GHz are -22.63 dB and -20.26 dB respectively. The achieved values of return loss are small enough and frequencies are closed enough to specified frequency bands for WLAN and Wi-Max applications. The return loss values suggest that there is good matching at the frequency point below the -10 dB region.

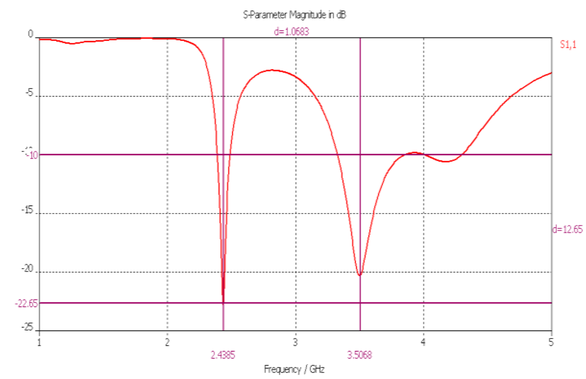

Figure 2: Return Loss verses Frequency Plot

B. ***Radiation pattern characteristics***

The simulated far field radiation patterns for the proposed antenna are different for all frequencies. Figure 3 shows the simulated radiation pattern at different frequencies (2.43 GHz and 3.5 GHz). It shows that proposed antenna radiates in broadside direction. Figure 3 also shows that the directivity of proposed antenna is 5.366 dBi at resonating frequency 2.43 GHz and 8.725 dBi at resonating frequency 3.5 GHz.

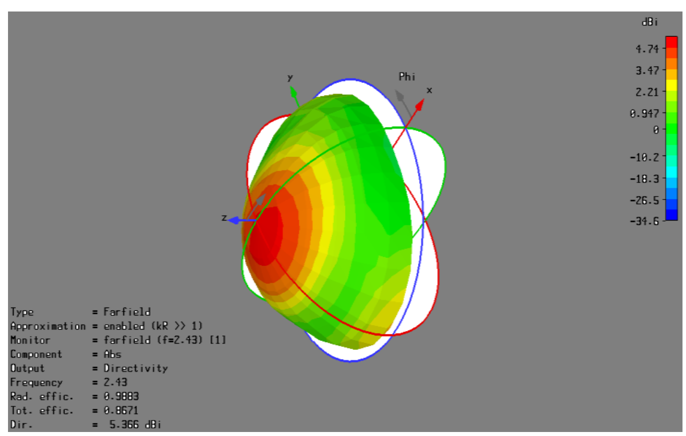

Figure 3(a)

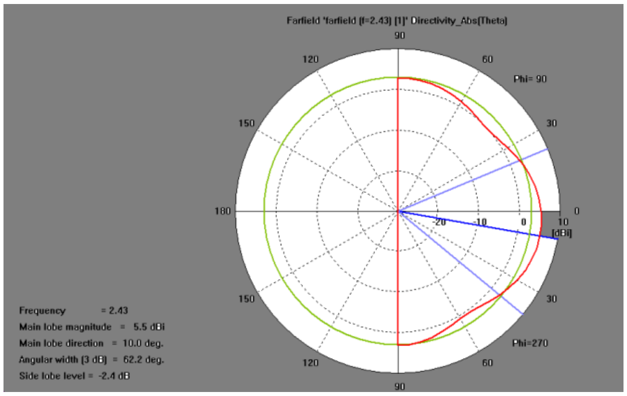

Figure 3(b)

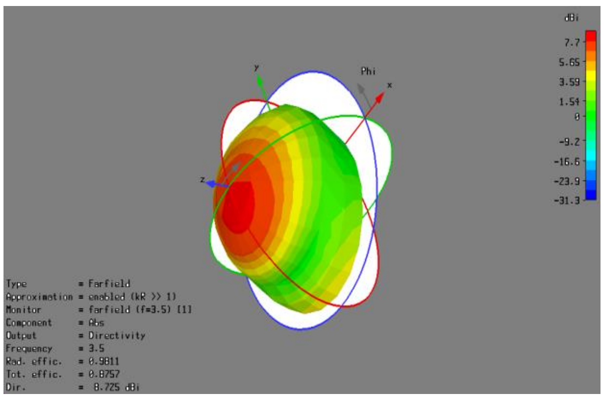

Figure 3(c)

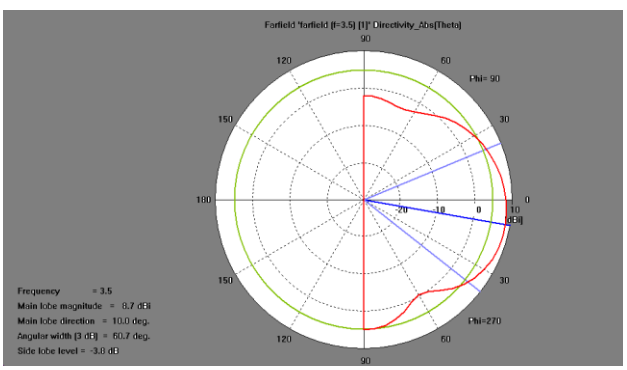

Figure 3(d)

Figure 3: (a):3D Radiation Pattern of Patch Antenna at 2.43GHz

(b): Polar Plot of Patch Antenna at 2.43 GHz

(c):3D Radiation Pattern of Patch Antenna at 3.5 GHz

(d): Polar plot of Patch Antenna at 3.5 GHz

The figure 4 shows the VSWR verses frequency graph for the proposed antenna. The value of VSWR at the two resonating frequencies f_{r1}=2.43 GHz and f_{r2}=3.5 GHz is 1.193 and 1.215 respectively which is below 2. The value of VSWR for both frequency bands is also less than 2 which shows better antenna impedance matching at these two frequency bands.

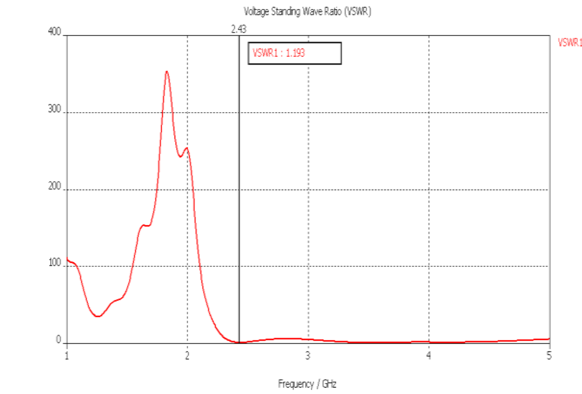

Figure 4(a)

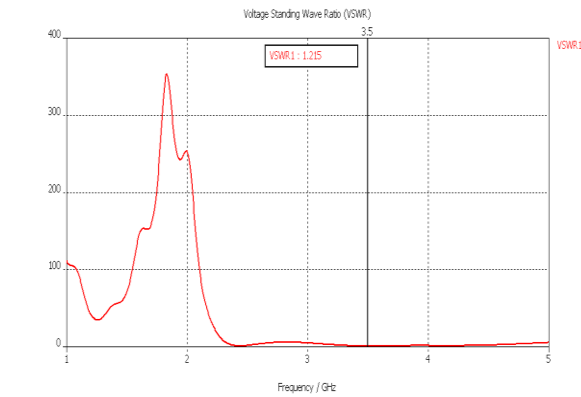

Figure 4(b)

Figure 4: VSWR verses Frequency Plot

Conclusion

A slot loaded patch antenna has been designed and simulated using CST Microwave Studio software. This is operating in two bands viz band I (2.39 GHz to 2.49 GHz) covering WLAN band and band II (3.33 GHz to 3.849 GHz) covering wi-max band. The return losses for these bands are -22.63 dB and -20.26 dB respectively. The measured impedance bandwidth of the proposed antenna is 4.1% and 14.8% over the entire frequency range from 2.39 GHz to 2.49 GHz and 3.33 GHz to 3.849 GHz respectively with stable broadside radiation patterns. A good radiation pattern results have been obtained which seems to be adequate for the envisaged applications.

References

*[1]. MACI, S., BIFFI GENTILI, G, PIAZZESI, P., and ALVADOR, C.: '**Dual band slot-loaded patch antenna**', IEE Proc., Microw. Antennas Propag, 1995, **142,** pp. 225-232.*

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[2]. *R.Garg, P.Bhartia, I.Bahl, A.Itipiboon, "***Microstrip antenna design handbook***", Artech House, Boston – London, 2000*

[3]. *James,J.R., and P.S.Hall, "***Handbook of Microstrip Antennas"***, Vol.1, London: Peter Peregrinus Ltd., 1989.*