

A Novel Design of a Low Cost CPW Fed Multiband Printed Antenna

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Abstract This work comes with a novel study on the design of a CPW-Fed multi band planar antenna. This structure can be integrated easily with passive and active elements. The antenna validated is suitable for GPS, UMTS and WiMAX bands. Its entire area is $70.4 \times 45 \text{ mm}^2$ and is printed on an FR-4 substrate. Simulation results show that the antenna has a good input impedance bandwidths for $S_{11} \leq -10 \text{ dB}$, covering the GPS, UMTS and WiMAX bands. This antenna is optimized, miniaturized and simulated by using ADS “Advanced Design System”, with a comparison with another software CST Microwave Studio.

Keywords Multi-band antenna · CPW-fed · GPS band · UMTS band · Wimax band

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1 Introduction

In recent years, we find a growing interest in the use of lightweight and compact dual band or multi band printed planar antennas for wireless communication systems. Among these bands we have the global system for mobile communication GSM [1], Digital Communication System DCS [2], Global Positioning System GPS [3], Universal Mobile Telecommunications System UMTS [4] and the Worldwide Interoperability for Microwave Access WiMAX [5]. For such applications, coplanar waveguide CPW-fed planar structures have many attractive features, such as having a low radiation loss, less dispersion, single metallic layer for the feed network and the antenna element has an easy integration with passive and active elements [6]. To achieve multiband antennas we can find the techniques using L-shaped shorted strip which is connected on both sides of the ground plane with CPW-fed [7–9], and tuning stub technique [10, 11]. The antenna validated in this study has a geometry structure composed from different arms of different lengths and an L-shaped shorted strip on the both sides of the ground plane. This antenna is designed and optimized for GPS, UMTS and WiMAX bands.

The following parts of this paper will present the antenna design and optimization with a comparison study between ADS and CST simulation results including radiation pattern and current distribution.

2 Antenna Design

The geometry of the proposed multi-band antenna is shown in Fig. 1. This antenna is printed on a low cost FR-4 substrate with a total area of $70.4 \times 45 \text{ mm}^2$ ($L_s \times W_s$), and a dielectric constant $\epsilon_r = 4.4$, a thickness $h = 1.6 \text{ mm}$, a loss tangent \tan

Fig. 1 Geometry of the proposed antenna

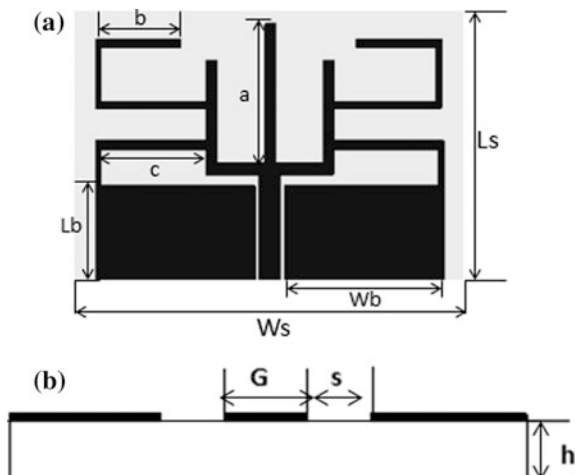


Table 1 Dimensions of the proposed antenna (unit: in mm)

Parameter	Value
Ls	45
Ws	70.4
Lb	15.5
Wb	30
a	23
b	16
c	19.7

(δ) = 0.025 and a metallization thickness $t = 0.035$ mm. The antenna is fed by a 50Ω CPW line with a fixed strip $G = 4$ mm and a gap $S = 0.7$ mm. The antenna structure and feeding CPW line are implemented on the same plane. Therefore, only one single sided layer metallization is used. The optimization of this antenna is done by using Momentum electromagnetic software integrated into ADS, which provides different techniques and calculation methods. After many series of optimization and miniaturizations by using ADS, the final dimensions of the proposed antenna are shown in Table 1. To compare the obtained results, we have conducted another study by using CST Microwave Studio where the numerical analysis is based on the Finite Integration Time Domain FITD.

To design the multiband antenna, we have studied some important parameters which can influence the input impedance bandwidth and the return loss of the antenna. Therefore we have found some important parameters such as the antenna shape, the feed line width and the dimensions of the ground plane that can give good return loss and good matching input impedance. As shown in Fig. 2, we can see that the length ‘a’ is a critical parameter which permits to adjust the desired frequency band. As depicted in Fig. 2, we have obtained an optimized antenna with the first resonant frequency of 1.274 GHz and a bandwidth (1.245–1.308 GHz), that can match to the GPS band, the second resonant mode occurs at the frequency of 2.097 GHz with a bandwidth (1.984–2.193 GHz), which is the UMTS band, and the third resonant occurs at 2.52 GHz with a bandwidth (2.464–2.591 GHz), that tends to the WiMAX band.

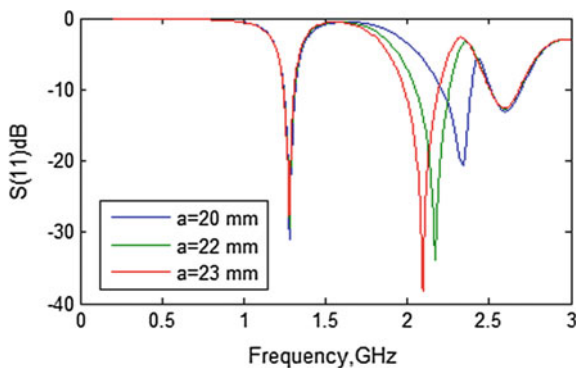
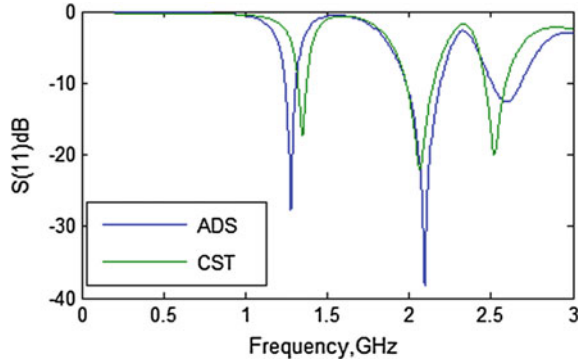
Fig. 2 Return loss (S11)/dB for different values of ‘a’ parameter on ADS

Fig. 3 Comparison of return loss (S11)/dB between ADS and CST-MW



To compare these results, we have used another electromagnetic software, CST-MW. As presented in Fig. 3, we can conclude that we have a good agreement between the simulation results obtained in ADS and CST-MW.

The simulated Far-field radiation patterns in CST-MW for the three resonant frequencies are shown in Fig. 4.

The current distributions of the proposed antenna for three resonant frequencies are shown in Fig. 5.

As we can see from Fig. 5. The current distribution affects different parts of the patch depending on the frequency level. When it reaches 1.274 GHz, the current distribution is concentrated in the L shape. When the frequency reaches 2.097 GHz,

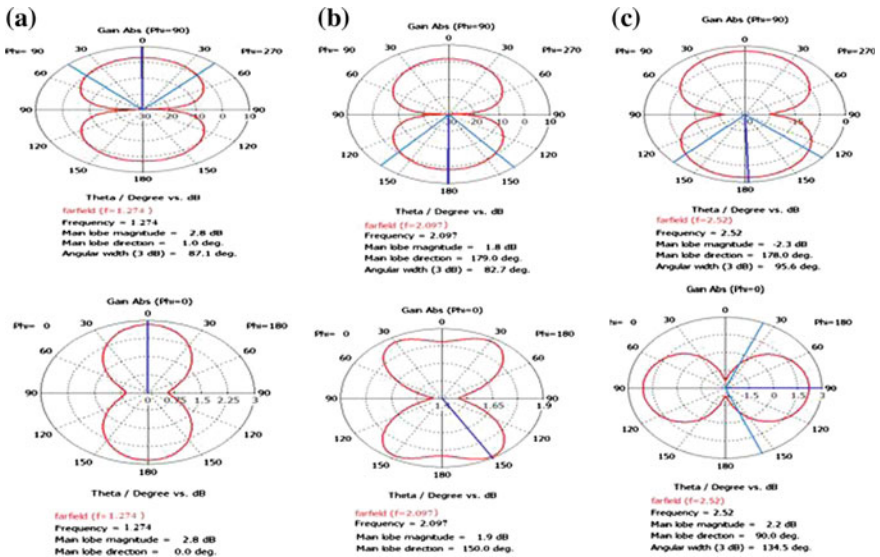


Fig. 4 Radiation pattern of the proposed antenna in CST: **a** @ 1.274 GHz, **b** @ 2.097 GHz, **c** @ 2.520 GHz

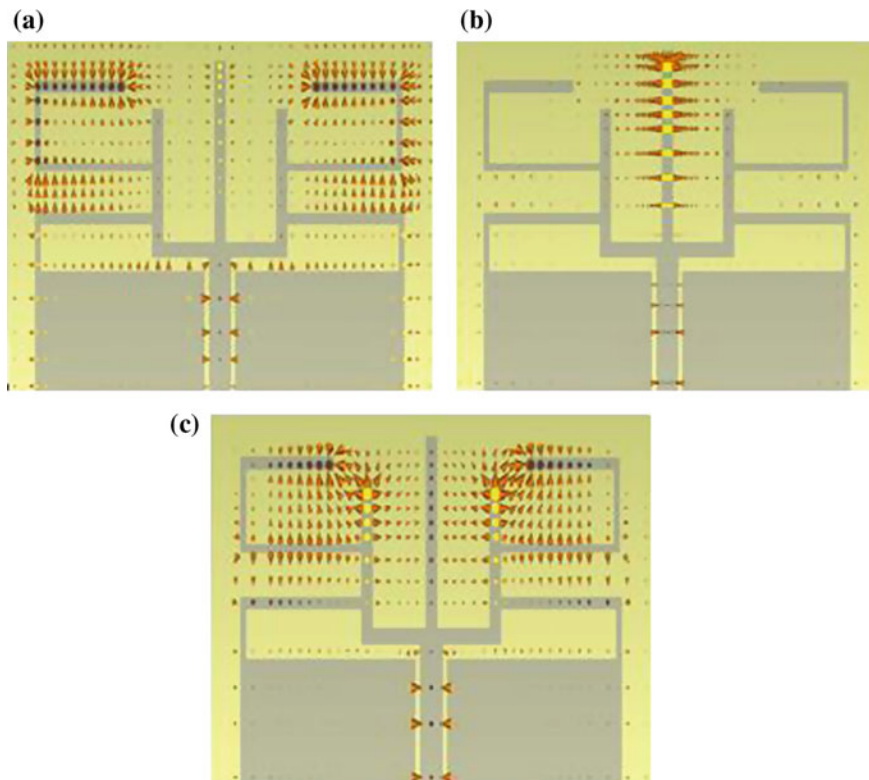


Fig. 5 Surface current distributions of the designed antenna: **a** @ 1.274 GHz, **b** @ 2.097 GHz, **c** @ 2.52 GHz

the density of the current distribution is in the middle of the patch along the feed line. At the frequency of 2.520 GHz the distribution of the current is concentrated between the feed line and on both L shapes.

3 Conclusion

In this study, a novel compact CPW-fed coplanar antenna has been successfully designed and optimized by using ADS “Advanced Design System” and CST Studio Suite Microwave Studio. This antenna has a Low cost and simple fabricated structure and a compact size of $70.4 \times 45 \text{ mm}^2$. The simulated results obtained show that the antenna structure is validated in three frequency bands (1.245–1.308 GHz), (1.984–2.193 GHz) and (2.464–2.591 GHz), which cover the GPS, the UMTS and the WiMAX bands. The use of a CPW Fed for this antenna structure permits it to be associated easily with passive and active microwave integrated circuits.

Acknowledgments We thank Mr. Mohamed Latrach Professor in ESEO, engineering institute in Angers, France, for allowing us to use all the equipments and electromagnetic solvers available in his laboratory.

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