

Compact Double-Sided Printed Omni-Directional Ultra Wideband Antenna

Introduction

Recently printed ultra wideband (UWB) antennas have great influence in communication fields. UWB antennas have a bandwidth wider than 500 MHz or a 20% fractional bandwidth. This influence of UWB antenna comes from the several unique advantages from wireless communications to radar applications. From the wireless communications view, the federal communication commission (FCC) allowed the use of unlicensed bandwidth from 3.1 GHz to 10.6 GHz [1], [2]. This means higher spectral efficiency than the typical narrowband and broadband technologies. Moreover as the bandwidth increases, the maximum capacity of a communication channel increases linearly, and not logarithmically increase as with the signal power, with a very low bit error rate. This gain in capacity is used in the transmission of high data rates in order of 1Gbps over very short distances less than 1m. The main characteristic in UWB technology is the integration of various kinds of passive and active elements for the sake of different applications [1]-[3]. From the 1970's printed microstrip technology became admired. The proposed antenna is compact, so it can be easily integrated with electrical elements. This article presents the design and fabrication of a compact double-sided printed omni-directional UWB antenna. The symmetry of the proposed design enhances the omni-directional properties of the antenna. Extensive modifications result in more compact antenna size compared to those obtained in [4]-[13].

Antenna Design

The proposed antenna is fed by a 50Ω microstrip line of width W_f and length L_f as shown in figure 1. The antenna is printed on FR4 substrate of thickness 1.5mm with relative permittivity 4.4 and dielectric loss tangent 0.02. The overall substrate dimensions are $22\text{mm} \times 22\text{mm} \times 1.5\text{mm}$. On the top layer, there is a stepped patch depicted in figure 1. It is connected to the feed line via a matching transformer of width W_m and length L_m . On the other side there is a ground plane with width W_g and length L_g . The proposed antenna design is symmetrical resulting in symmetrical omni-directional far field radiation patterns. The dimensions of the stepped patch are control parameters which give different antenna dimensions resonating at different central frequencies and bandwidths. The design is subjected to different enhancement steps for the sake of achieving UWB antenna. The dimensions of the proposed antenna are listed in table 1.

Table 1
The dimensions of proposed antenna

	W_f	L_f	W_m	L_m	W_g	L_g	W_1
Dimensions (mm)	3	3.3	2.4	5.005	7.15	22	6.6
	L_1	W_2	L_2	W_3	L_4	W_4	L_4
Dimensions (mm)	12.925	2	7	2	9	2	11

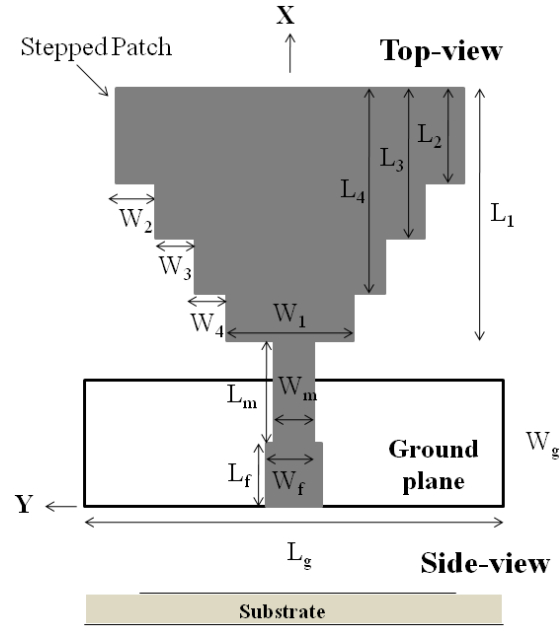


Figure1. Geometry of proposed antenna.

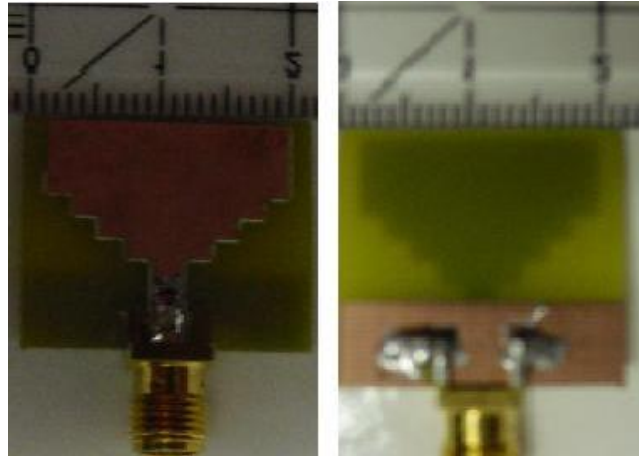


Figure2. Top and bottom layers of the fabricated antenna.

Results and Discussions

A. Return loss

The proposed antenna is simulated by Ansoft HFSS software and the results are shown in figures 3. The lowest frequency is 3.1 GHz and highest frequency is 10.6 GHz. Embedded in this bandwidth the rules of the FCC for indoor applications. In figure 3 the dashed curve, illustrates the measured return loss of the proposed antenna. It is clear the good agreement between the measured and simulated results. These measurements are done using the network analyzer. It is very important to point out that the shift in return loss of measured result is due to fabrication. Moreover there are results which are not

presented, illustrating the variation of the return loss with the dimensions of the patch. This is due to the limited number of allowed pages.

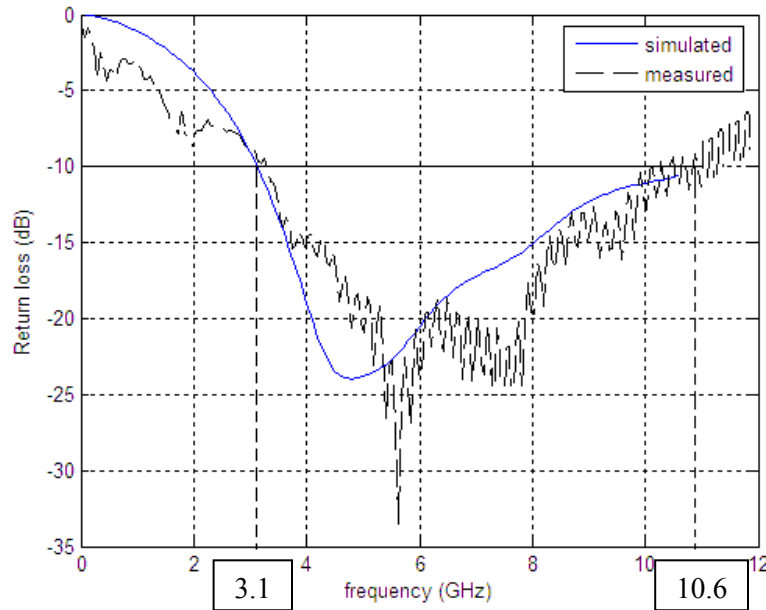


Figure3. Simulated and measured return loss of proposed antenna.

B. Radiation patterns

Figures 4 and 5 show the radiation patterns of the proposed antenna at 4 GHz, 6 GHz and 8 GHz. Figure 4a depicts the 3D radiation pattern at 4 GHz. It is clear that the pattern is a symmetrical omni-directional one. Figure 4b illustrates the co and cross-polarization patterns in the plane $\phi = 90$ degrees at 4 GHz. Figure 5 depicts the co and cross-polarization patterns in the plane $\phi = 90$ degrees at 6 GHz and 8 GHz

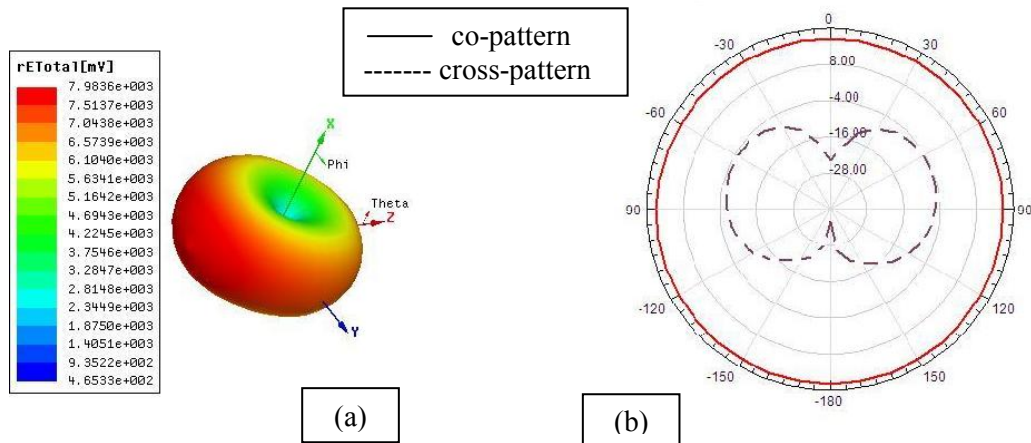


Figure4. Radiation patterns of the proposed antenna at4 GHz. (a) 3D polar plot. (b) 2D plot.

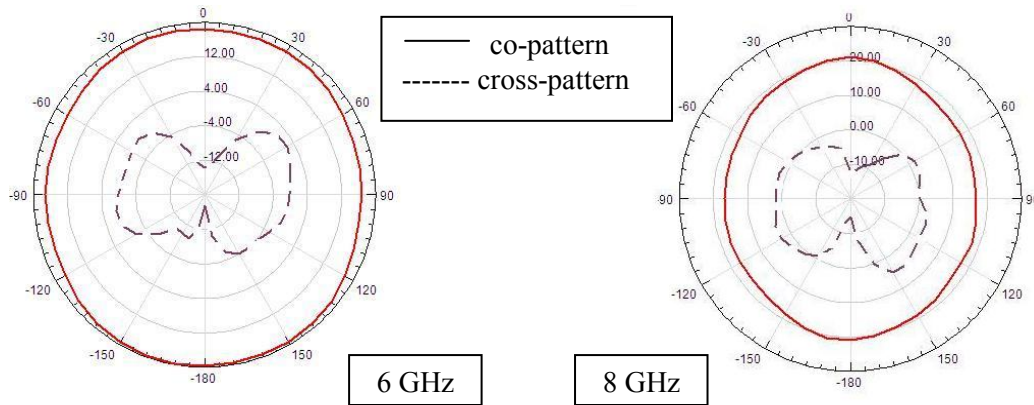


Figure5. Radiation patterns of the proposed antenna at 6 GHz and 8 GHz at $\phi = 90$ degrees.

Conclusion

The proposed compact antenna is achieving UWB conditions, it operates within a band from 3.1 GHz to 10.6 GHz. The variations in the patch dimensions affect the return loss curve significantly. The experimental results and those of simulated are in a good agreement. The proposed antenna is compact 2.2×2.2 cm² which is convenient for indoor systems and portable devices. In addition, it gives symmetrical omni-directional far field radiation patterns.

References

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