Abstract—The article presents a compact double-sided printed omni-directional ultra wideband antenna operating within a band from 3.2 GHz to 12.2 GHz. The proposed antenna is fabricated on FR4 dielectric substrate and experimentally investigated. There is a good agreement between the measured return loss and the simulated one. The antenna gives symmetrical omni-directional patterns.

Keywords—Ultra wideband (UWB) antenna; Compact antenna; Omni-directional antenna; Printed monopole antenna

I. INTRODUCTION

RECENTLY printed ultra wideband antennas have great influence in communication fields. This influence comes from the several unique advantages of ultra wideband (UWB) antennas from wireless communications to radar applications. From the 1970's printed microstrip technology became admired. This type of antennas is considered compact, so they can be easily integrated with electrical elements. UWB technology has a bandwidth wider than 500 MHz or a 20% fractional bandwidth. 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]. 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 larger operating bandwidth compared to those obtained in [4]-[13].

II. 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 50mm × 50mm × 1.5mm. On the top layer, a rectangular patch of width $W_p$ and length $L_p$ 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 $L_g$. In the ground plane there are two inverted L-shaped slits depicted in figure 1. These slits are symmetrically cut from the ground resulting in symmetrical omni-directional far field radiation patterns.
The dimension of slits is a control parameter which gives 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. Inserting the right slit in figure 1 increases the bandwidth by pulling the upper limit to 12.2 GHz. The dimensions of the proposed antenna are listed in table 1.

III. RESULTS AND DISCUSSIONS

Initially, variations in the matching transformer dimensions \( L_m \) and \( W_m \) are studied and the results are shown in figures 4 and 5 respectively. The change in \( L_m \) affects the highest frequency more than the lowest one. On the contrary reduction in \( W_m \) has more effect on the lowest frequency than on the highest one. The variation in slit dimensions \( B4 \) and \( k=B1-B3 \) are also investigated and presented in figures 6 and 7. Obviously they do not affect the return loss curve significantly.
A. Return loss

The proposed antenna is simulated by Ansoft HFSS software and the results are shown in figure 8. The lowest frequency is 3.2 GHz and highest frequency is 12.2 GHz. Embedded in this bandwidth the rules of the FCC for indoor applications. In figure 8 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. The setup depicted in figure 9. It is very important to point out that the shift in return loss of measured result is due to fabrication. The antenna size is very small, soldering the SMA connector to the antenna may affect the measured result.

B. Radiation Patterns

Figures 10 and 11 show the radiation patterns of the proposed antenna at 4 GHz, 6 GHz and 8 GHz. Figure 10a depicts the 3D radiation pattern at 4 GHz. It is clear that the pattern is a symmetrical omni-directional one. Figure 11b illustrates the co and cross-polarization patterns in the plane $\phi = 90$ degrees at 4 GHz. Figure 11 depicts the co and cross-polarization patterns in the plane $\phi = 90$ degrees at 6 GHz and 8 GHz.
IV. CONCLUSION

The proposed antenna is achieving UWB conditions. It operates within a band from 3.2 GHz to 12.2 GHz. The variations in slit dimensions do not affect the return loss curve significantly. The experimental results and those of simulated are in a good agreement. The antenna gives symmetrical omni-directional patterns.

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REFERENCES