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A Compact Monopole Antenna for Wireless Applications

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ORIGINAL ARTICLE
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Abstract *–A tiny wideband microstrip-fed monopole antenna which includes of a radiating patch with two L-shaped notches and stubs at the lower corners and truncated ground plane, is suggested for various mobile communication services such as WiBro, WLAN, DMB, and UWB applications. This antenna which is presented here is designed to function over 2.3 to 10.7 GHz for S11<-10dB. In this paper, numerical analysis using Ansoft HFSS and details of the proposed antenna design approach and measured results are also presented and discussed.*

Keywords: *Microstrip Antenna, Monopole, Wireless.*

INTRODUCTION

Recently wireless communication systems are becoming increasingly popular. Despite the fact that the wireless communications systems have recently become increasingly popular, the technology used in wireless communications still need to get better to answer the demand for higher resolution and data rate requirements. These days wideband monopole antenna has been showing great potentiality to be used in mobile wireless devices such as intelligent mobile phones and smart tablets. [1-6]. In this paper, a compact wideband microstrip-fed monopole antenna is designed to satisfy the entire system requirement for WiBro (Wireless Broadband) (2.30-2.39 GHz) for broadband wireless internet, WLAN (Wireless Local Area Network) (2.400-2.483 GHz), DMB (Digital Mobile Broadcasting) (2.605-2.655 GHz) and UWB (Ultra Wideband) (3.1-10.6 GHz) simultaneously [7-11].Since there is a trade off between size, cost and simplicity .The design of wideband antenna is very difficult to deal with, particularly for hand-held terminals.

The shame of compact antenna in wideband communications systems in wideband communication systems is the main concern to provide wideband characteristics over the range of operating band which is because of their appealing features of wide bandwidth, omni directional and simple structure.

Square, circular, elliptical, pentagonal and hexagonal configurations are among the suggested monopole configurations for UWB applications which are very popular for radiation pattern and ease of construction [12-15].

A microstrip-fed monopole antenna is preferable over the UWB applications because they don't have planar structures and suitable for integration with printed circuit boards. Low profile, low cost and light weight are other advantages of microstrip-fed monopole antenna.

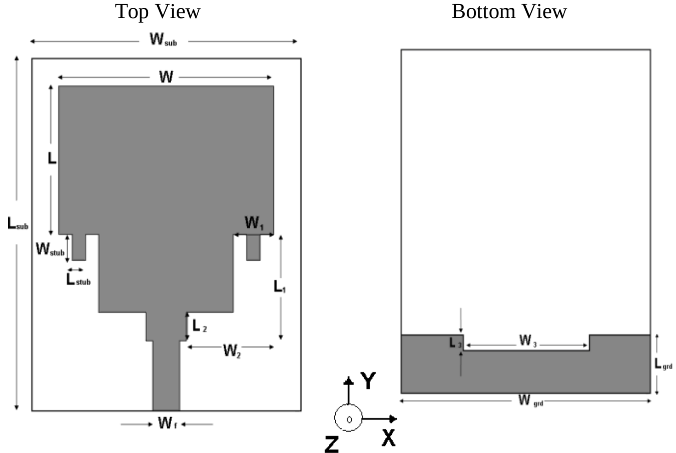

Figure 1. Geometry of the proposed antenna

ANTENNA DESIGN AND PARAMETERS

The configuration of the suggested wideband monopole antenna which consists of a radiating patch with two L-shaped notches and stubs at the two lower corners in the top layer and a truncated ground plane with the notch structure in the bottom layer is related in figure no.1 [16-19]. The suggested antenna which has tiny dimension of 20mm × 25mm (Wsub× Lsub), is constructed on FR4 substrate with thickness of 2.4 mm and relative dielectric constant of 4.4. The width Wf of the microstrip feedline is fixed at 2 mm. On the front surface of the substrate, a rectangular patch with size of W×L is printed. A wideband traits of the suggested antenna is simply achieved by cutting two L-shaped notches and attaching two stubs to the radiating patch as shown in Figure no.1.The L-shaped notches of suitable dimensions (W1,L1,W2,L2) elevate impedance matching performance at middle frequencies within the bandwidth of interest.

This happens because of the notches impact the electromagnetic coupling between the lower edge of the rectangular patch and the truncated ground plane [20]. To better impedance matching at higher frequencies, two stubs (Wstub, Lstub) are added to the radiating patch. The slightly changed truncated ground plane acts as an impedance matching element to control impedance bandwidth of a square monopole. The suggest antenna has the dimension which are as fallows: Wsub=20mm, Lsub=25mm, Wgrd=20mm, Lgrd=4mm, W=16mm, L=10.5mm, W1=3mm, L1=7.5mm, W2=7.5mm, L2=2mm, W3=10mm, L3=0.6mm, Wstub=1mm, Lstub=1.8mm, Wf=2mm. The suggested antenna is designed to work over the frequency band ranging from 2.3 to 10.7 GHz.

RESULTS

Referring to design dimensions presented in Figure no.1, the suggested antenna was made and its characteristics were analyzed. The simulated results were obtained using Ansoft simulation software High Frequency Structure Simulator (HFSS) [21].

Figure no. 2 presents the photograph of a realized printed microstrip-fed monopole antenna on an FR-4 substrate with SMA connector.

The simulated return loss curves for the suggested antenna with its L-shaped notches and stubs, and truncated ground plane are presented in figure no.3. As shown in Figure no. 3, the fabricated antenna satisfies 10dB return loss requirement from 2.3 to 10.7 GHz. For comparison point of view, the measured return loss of the antenna without L-shaped notches and stubs, and truncated ground plane are also shown in Figure no.3. The result for both measurement and simulation process presented in Figure no.4. The results from simulation and measurement process are matching. There is a VSWR of lower than 2 (S11<-10dB) for the antenna from 2.3 to 10.7 GHz.

Figures no. 5 and 6 demonstrate the measured co- and cross polarized radiation patterns over the entire frequency band in the H-plane (xz-plane) and the E-plane (yz-plane). The E-plane pattern of radiations is more preferable than the H-plane pattern if we want to make use of the antenna as a linearly polarized. The cross-polar radiation in the E-plane is at least -10dB less than the co-polar radiation. But changes, the radiation in high frequencies and demonstrate the higher directivities in other directions.

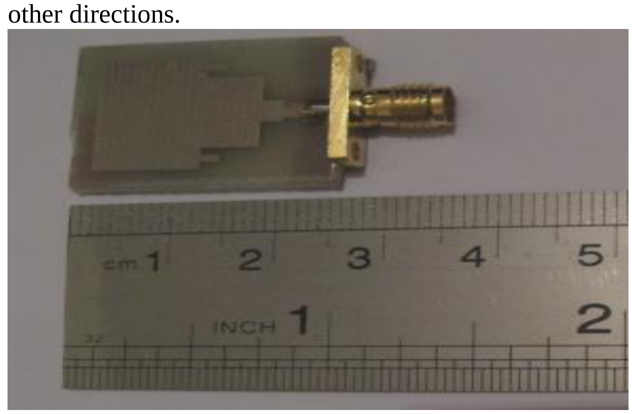

Figure2. Photograph of the realized printed microstrip-fed monopole antenna.

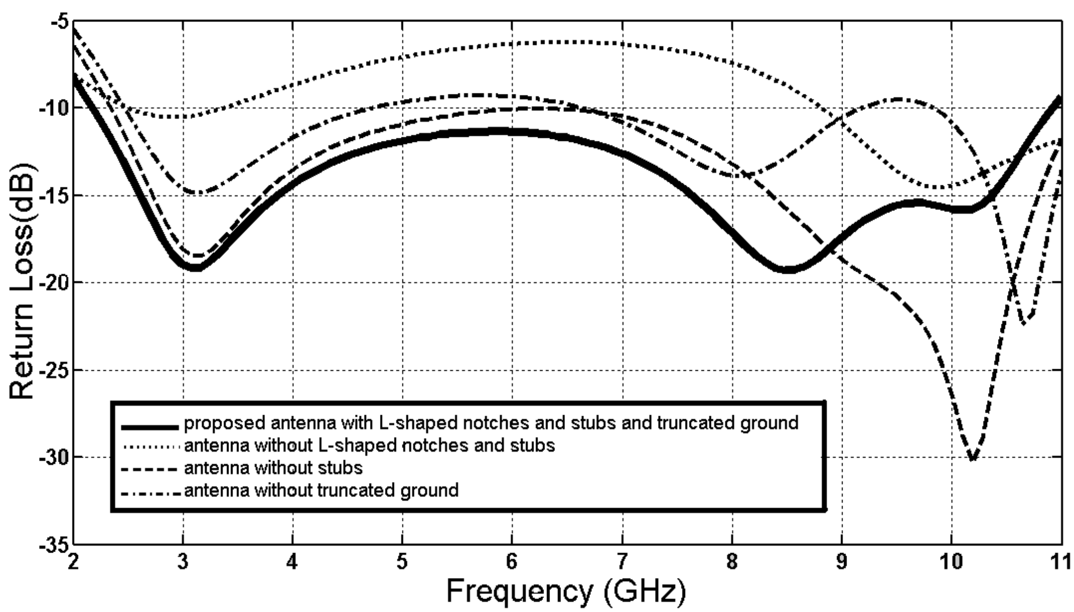

Figure 3. Simulated return loss characteristics for proposed antenna

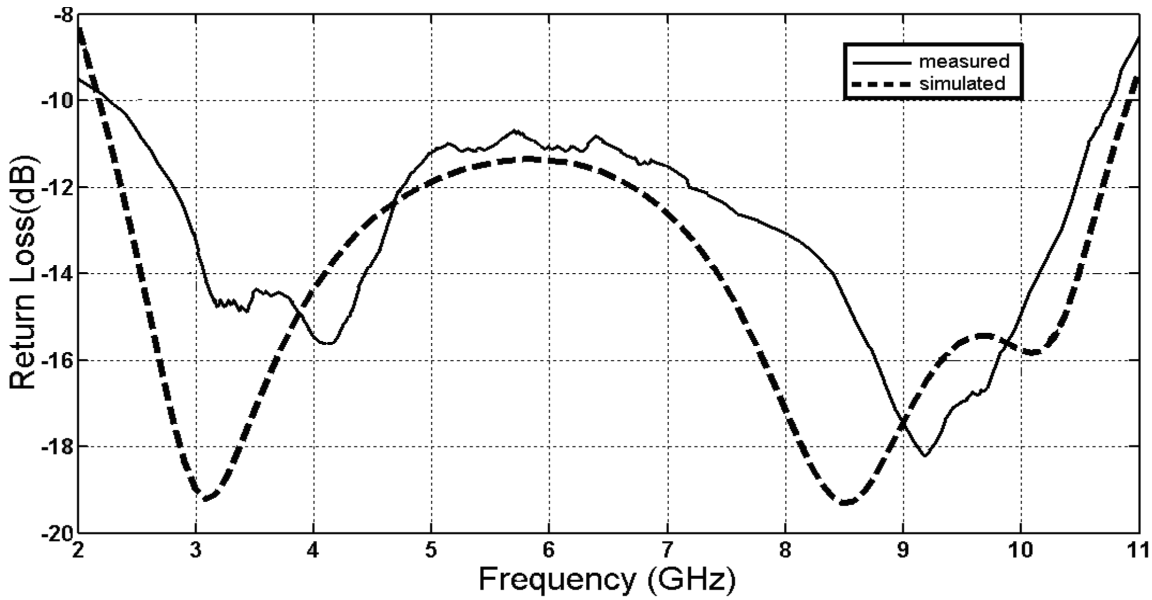

Figure 4. Measured and Simulated return loss for a proposed antenna.

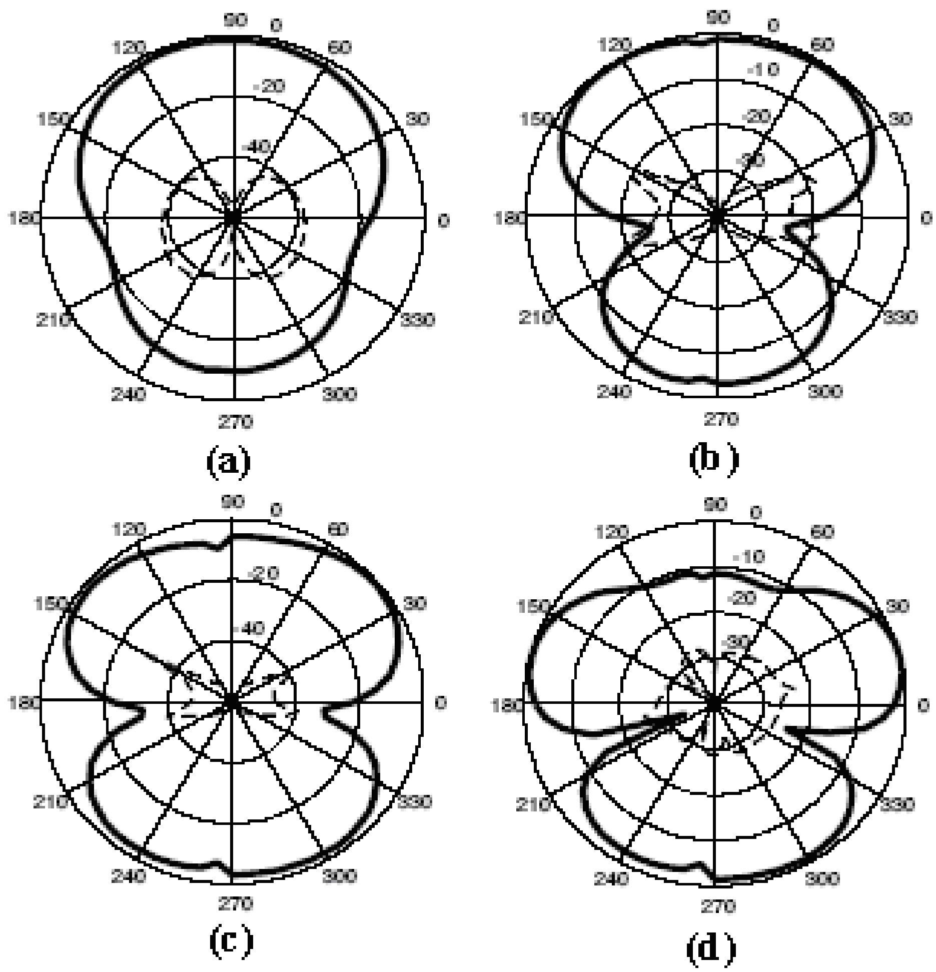

Figure no. 5 measured radiation pattern of proposed antenna in E-plane
EMBED Equation.3 at (a) 3.5 GHz, (b) 5 GHz, (c) 8.2 GHz and (d) 10 GHz. We used the solid line for co-polar and the dash line for cross-polarization.

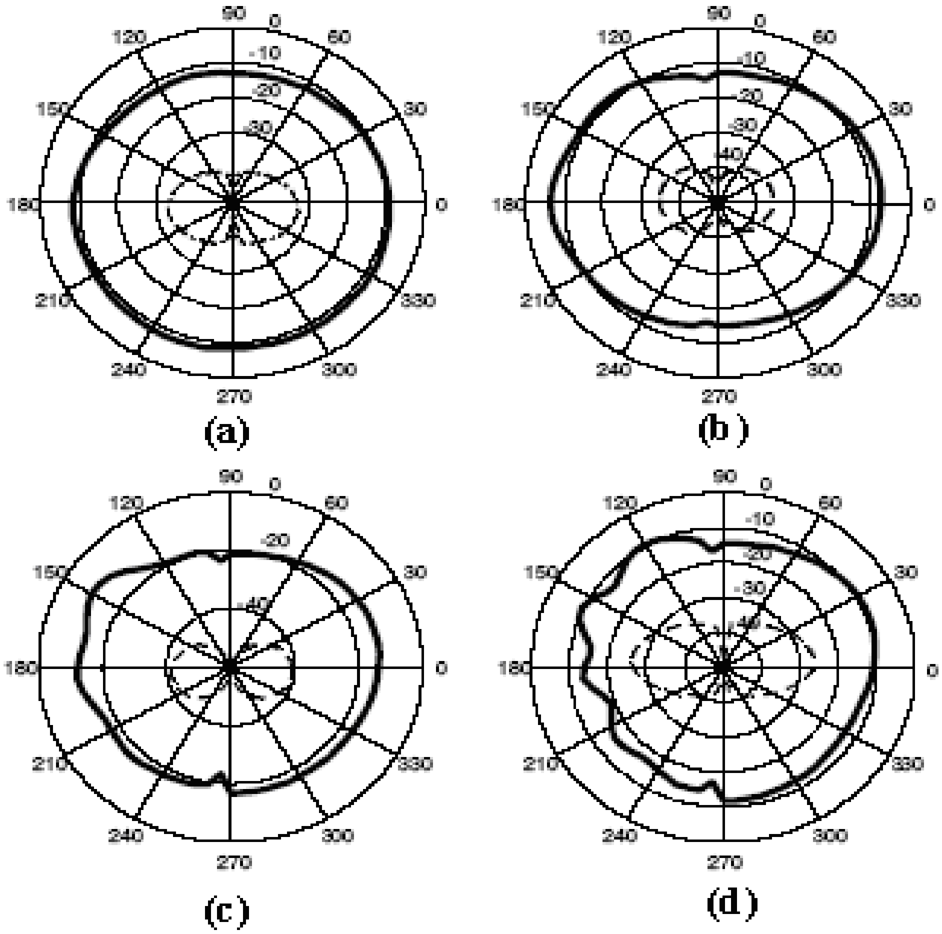

Figure no. 6 measured radiation pattern of proposed antenna in H-plane EMBED Equation.3 at (a) 3.5 GHz, (b) 5 GHz, (c) 8.2 GHz and (d) 10 GHz. As used previously the solid lines are for co-polar and the dashed lines are for cross-polar.

The measured antenna gain in different frequencies is listed in Table 1. As it is seen in the table the maximum gain value is 3.9 dBi and the variation of the gain is less than 2.5 dB over the entire band.

Table 1. The measured antenna gains

frequency, GHz	2	3	4	5	6	7	8	9	10
Antenna gain, dBi	1.4	2.9	3.1	3.4	3.6	3.9	3.7	3.5	3.3

CONCLUSIONS

A novel wideband compact microstrip-fed monopole antenna has been proposed and implemented for various mobile communication applications. It is easy to fabricate the suggested antenna since it has a single structure. It is capable of covering the existing WiBro, WLAN, DMB and UWB bands. The suggested antenna provided the 10dB return loss requirement from 2.3 to 10.7 GHz and gives better radiation patterns. To obtain the wide bandwidth, the sizes of the two L-shaped notches and stubs at the lower corners and truncated ground plane have been optimized by parametric analysis. Considering the results from above we reach to the conclusion that the suggested antenna can be a better choice for hand-held wideband applications.

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