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A Compact Microstrip-Fed Ultrawideband Slotted Antenna with Resonance of WiMAX Band

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ABSTRACT

This is a presentation of microstrip-fed monopole with a compact dome-shaped wide-slot antenna for ultrawideband application with band notched characteristics. The rectangular radiator and dome-shaped ground plane of an antenna are etched on FR4 substrate with permittivity 4.4 and loss tangent 0.02 with an overall size of 35× 36.5×1.6mm3.For notching WiMAX inverted U-shaped slot is cut from the patch. Simulation and optimization carried out using CADFEKO suite 7.0.Dome-shaped slot provide a wide usable bandwidth from 2.718GHz to 13.5GHz. The average efficiency is 75%, and stable VSWR (1.0-2.0) achieve over entire range except WiMAX band in simulated and measured results. The radiation pattern of E-plane and H-plane are directional and omnidirectional respectively with a stable gain.

Keywords: UWB (Ultra Wide Band); VSWR (Voltage Standing Wave Ratio); MoM (Method of Moment); band notch; printed monopole.

1.INTRODUCTION

Regarding to the allocation and permits of the 3.1 GHz to 10.6 GHz unlicensed frequency band with 7.5 GHz wide bandwidth by the FCC,for the commercial use as a UWB.This UWB system holds the attention of all researchers day by day increases due to its advantages such as small size, light in weight, low cost, and high radiation efficiency. These all advantages of UWB antenna fullfiill with different geometries in Small planar monopole antenna [2-9]. The antenna consists of a rectangular aperture on a printed circuit board ground plane and a T-shaped exciting stub .In [2],the proposed planar coplanar waveguide fed antenna is easy to be integrated with radio-frequency/microwave circuitry for low manufacturing cost. In [3], two novel designs of planar elliptical slot antennas are presented. Printed on a dielectric substrate and fed by either microstrip line or coplanar waveguide with U-shaped tuning stub, the elliptical/circular slots have been demonstrated to exhibit an ultrawideband characteristic. In [4], two new low-cost, compact antennas, which operate in the upper half of the direct sequence spread spectrum UWB (DS-UWB) band, are presented. One L-slot antenna has a planar ground plane and the other modified L-slot antenna has a ground plane consisting of a planar section and two sidewalls.

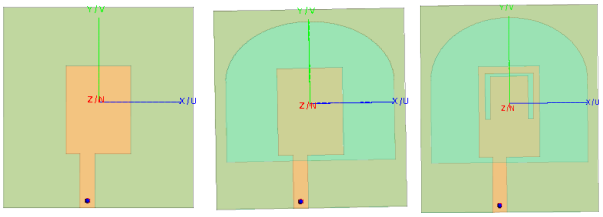
Reference [7] employed a hexagonal wide slot with microstrip fed gives the impedance bandwidth from 2.9 GHz to 18 GHz.

In this letter, dome shaped slotted ground along with rectangular patch consists of inverted u-shaped slot which filter WiMAX band. The proposed antenna has dimensions of 35×36.5×1.6 mm^3. Antenna consists of a substrate with a relative permittivity of 4.4 and dielectric loss tangent of 0.02.

2. ANTENNA DESIGN

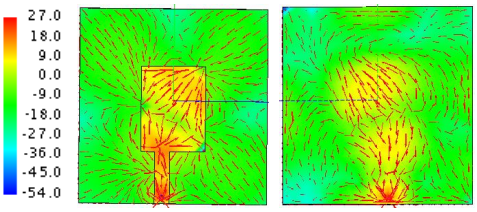
A. Development of printed monopole antenna

Figure 1 shows the development of monopole antenna in which first figure Shows the radiating patch and back side with full ground then in next fig shows to improve the bandwidth wide dome shape slot cut from the ground plane For achieving the UWB range cut slot from the ground plane exactly back side of radiating patch due to maximum current concentration which is shown in figure 2. In figure 3 VSWR graph of evolution of notched UWB monopole antenna.

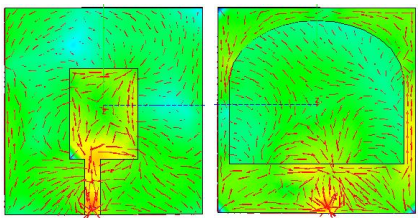


a) Rectangular monopole b) Slotted monopole UWB antenna c) Band-notched antenna

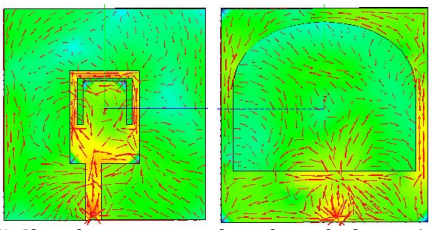
Figure 1: Development of printed monopole antenna



a) Rectangular monopole



b) Slotted UWB monopole



C) Slotted UWB monopole with notched WiMAX

Figure 2:.Current distribution at 6.8GHz

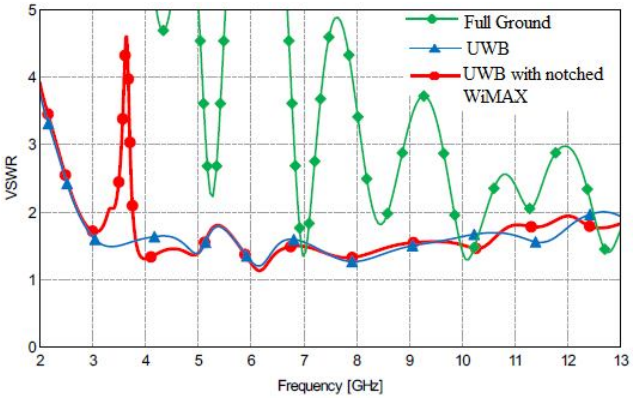


Figure.3: Development of monopole antenna VSWR

B.Parametric study releted to UWB:

a. Slot related study*:*

Figure 4 and Figure 5 shows effect of varying width and length of slot. The width of slot varying from 10mm to 32 mm.This width determines the wideband characteristics of antenna. It is seen that as width of slot increases, it has noticeable impact on the impedance matching at higher operating frequencies. Moreover Figure 5 shows antenna VSWR for different dimensions of length of slot. It is clearly seen from the figure that the length of the slot has a significant effect on the impedance matching. At higher operating frequency impedance matching affected by the high length of slot. The slot dimensions are important for matching the impedance of antenna.

b. Feed related study:

Figure 6 demonstrate the effect of varying the position of feed line on impedance matching. By changing the feed position like as at center, left side and right side. We were getting desired results at feed shift to the left side.

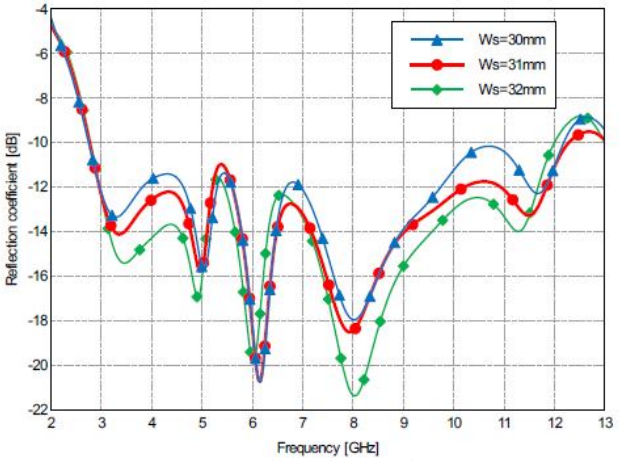


Figure.4: Effect of width of slot

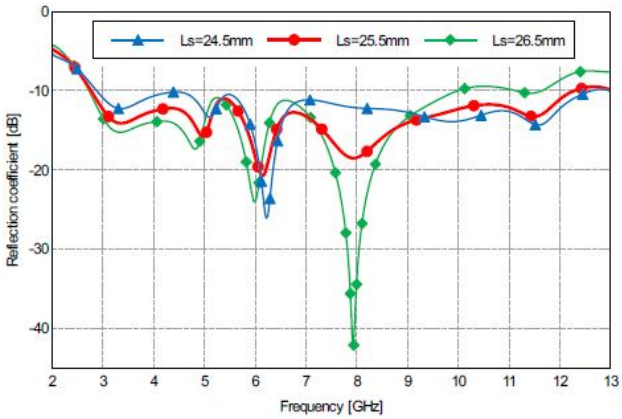


Figure.5: Effect of length of slot

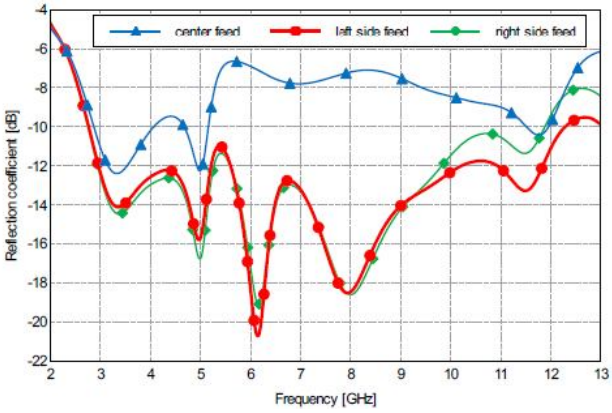


Figure.6: Effect of position of feed line.

C.Parametric study releted to WiMAX band-notch:

For notching WiMAx band, we used inverted U-shaped slot on rectangular radiating patch [8] [9].By choosing proper dimensions and position of slot, we got notching of desired frequency band from 3.3-3.7GHz.So we select the U-shaped slot parameters as a=8mm, b=9.5mm, c=1mm and d=0.5mm.

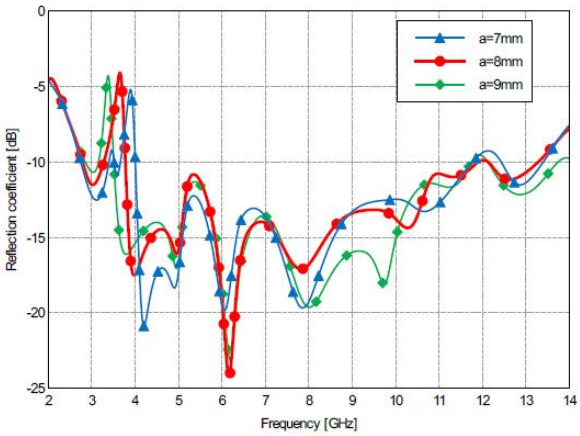


Figure.7: Effect of parameter a.

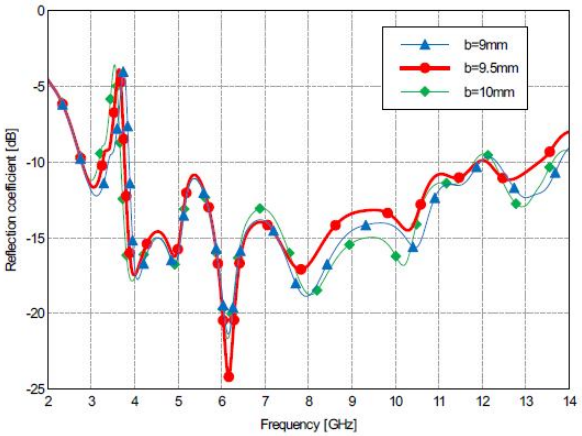


Figure.8: Effect of parameter b.

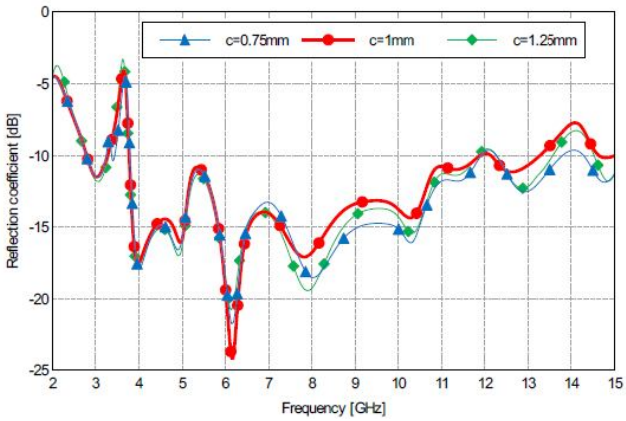


Figure.9: Effect of parameter c.

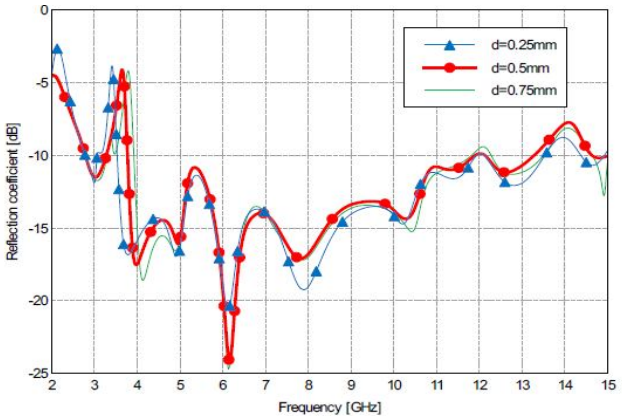


Figure.10: Effect of parameter d.

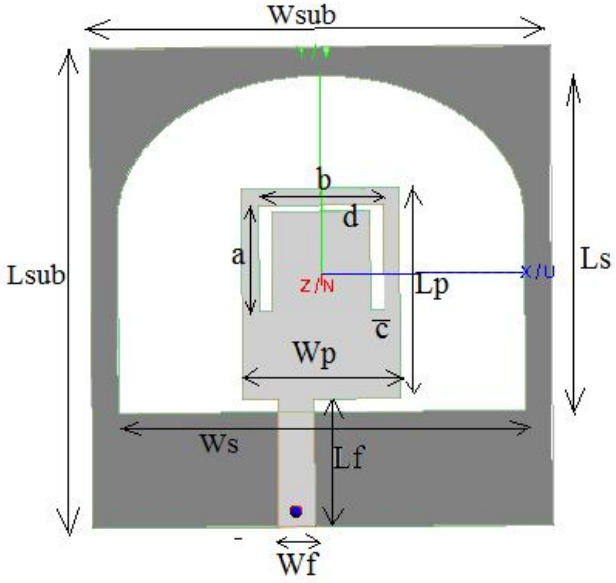


Figure.11: Geometry of rectangular monopole band notch antenna. Ws = 35mm, Ls = 36.5mm, Wp = 12mm, Lp = 16mm, Wf = 2.8mm, Lf = 8.8mm, Wslot = 31mm, Lslot = 35.5mm, a = 8mm, b = 9.5mm, c = 1mm, d = 0.5mm.

3. RESULTS AND DISCUSSION

The simulated and measured VSWR of the proposed antenna are shown in figure 12 and figure 13. The simulated bandwidth of the proposed antenna covers 2.718 GHz to 13.5 GHz for VSWR > 2:1 and return loss below -10 dB except WiMAX band. Measured VSWR follows the simulated VSWR.

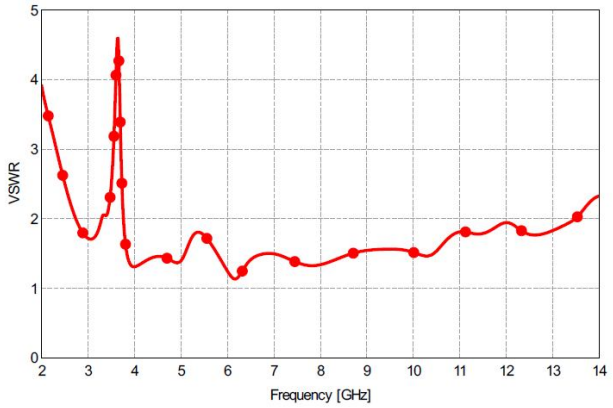


Figure12: VSWR of proposed antenna

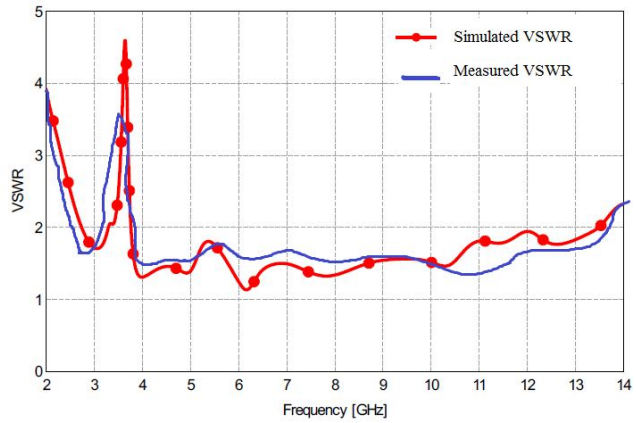


Figure.13: Simulated and Measured VSWR of proposed antenna.

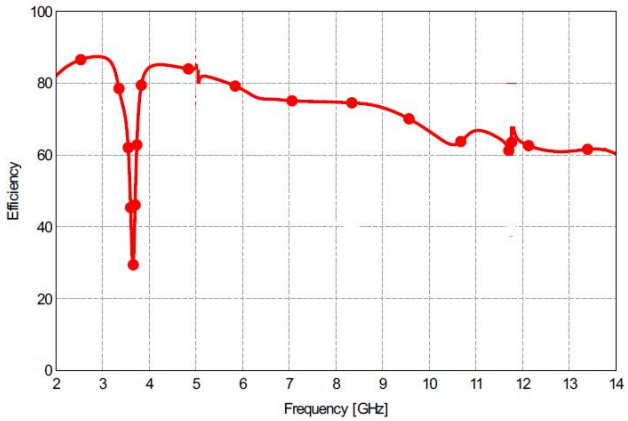


Figure.14: Efficiency vs. frequency of proposed antenna

Figure 14 shows the efficiency of proposed notched slotted UWB antenna.Efficiency decreases as frequency increases because dielectric loss of FR4 increases with increase in frequency.So for entire UWB the efficiency is greater than 75%which satisfies UWB requirements.Efficiency suddenly dropped at WiMAX band.

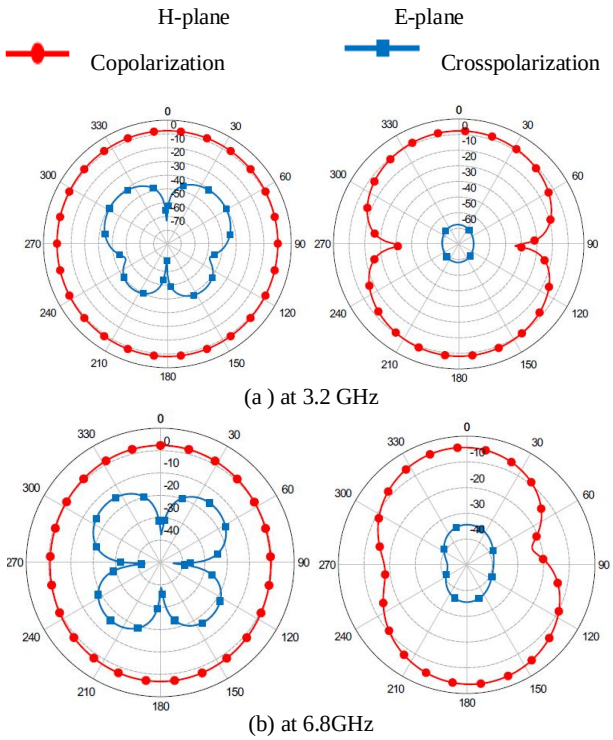


Figure.15: H-field and E-field radiation patterns of optimized UWB slot antenna.

Figure 15 shows the simulated 2-D normalized radiation in both H-plane and E-plane for co-polarization and cross-polarization component at two different frequencies. It is seen that for all the frequency, E-plane radiations have almost bidirectional and dipole like radiation pattern and H-plane radiations have nearly omnidirectional pattern.

4.CONCLUSION

The proposed antenna is fully planar, simple and small in size. Dome-shaped slot enhanced impedance bandwidth by 129%.The antenna covers whole UWB from 3.1-10.6 GHz.Antenna notched WiMAX band from 3.3-3.7 GHz.The antenna shows stable radiation pattern and efficiency over entire UWB.

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