Exponentially Shaped monopol antenna Antenna with high efficiency

For UWB Applications

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Abstract— **In this paper, we introduce a novel printed monopole antenna for ultra-wideband (UWB) applications. The antenna geometry is based on exponential outlines. The designed antenna operates over impedance bandwidth (3.15 to 12.5GHz) for return loss S11< -10dB. The antenna also shows omni-directional radiation patterns and good gain flatness over the frequency range of interest. The proposed antenna performance is suitable for UWB applications.**

Keywords-component; Ultra Wideband Antennas (UWB); Planar Monopole Antenna; Finite Integrate Technique (FIT)

I. Introduction

The allocation of the 3.1 GHz – 10.6 GHz band by the FCC [5] has initiated a lot of research activity for UWB antennas such as wireless communications, medical imaging, radar and indoor positioning. This is due to its ability to enable high data transmission rate and low power consumption.

Microstrip patch antenna is frequently used in UWB antenna designs due to its advantages such as lightweight, ease of integration, small size and compact [6]

Geometries of recent UWB antennas are based on simple geometric elements, such as rectangles [1], circles [2] or ellipses [3], or a combination of these [4].The geometry of this antenna is based on an exponential curve; for ease of optimization of the shape of the antenna.

The antenna is printed on microstrip substrate with a curved shape of the patch, which operates in the range of 3.15 – 12 GHz, thus achieving the UWB bandwidth enhancement. This research focused mainly on miniature antennas with high efficiency and omnidirectional radiation patterns [7].

The next section presents the geometry of this antenna design and materials used, whereas Section three discusses a simulated result of the antenna performances. Lastly, the findings of the simulated results are summarized in the conclusion.

II. Antenna Geometry

Figure.1 shows the geometry of the proposed planar antenna whose parameters have been obtained using commercially available simulations software CST Microwave Studio [8] which contains different techniques and calculation methods.

The antenna is designed on Gil GML1034 substrate of thickness high 1.524 mm and $\varepsilon_r = 3.38$. The substrate has a size of W=40 mm by L=32 mm .A 50 Ω microstrip line is printed on the front of the substrate together with the patch element, The feed line is denoted by *Wf*.

The rear consists of the ground plane; the curved edges of the patch elements and the top edge of the ground plane are described by an exponential curve profile. The curved shape of the patch is given by the *y1* and *y2* and the ground plane by y3 (see Fig.1).

The design parameters such as the patch shape, the feed line

$$y_1 = a_1 e^{-x/k_1} + a_0 \quad (1)$$

a_0	a_1	k_1
115,63	6,12E-51	-3,378

$$y_2 = a_2 - a_2 \cdot e^{k_2 x} \quad (2)$$

a_2	a_3	k_2
132,45	5,8E-55	-0,32

$$y_3 = a_4 - a_5 \cdot e^{-k_3 x} \quad (3)$$

a_4	a_5	k_3
115,37	1,96E58	0,36

width and shape of partial ground plane are optimized to obtain the best return loss (|S11|≤ -15dB) and high Gain over the operating frequency range.

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The design parameters such as the patch shape, the feed line width and shape of partial ground plane are optimized to obtain the best return loss (|S11|≤ -15dB) and high Gain over the operating frequency range.

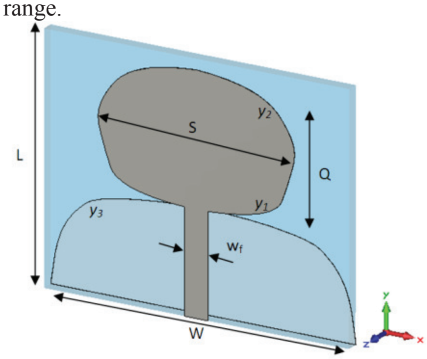

Figure 1. Geometry of Patch Antenna

Tableau I. Critical Antenna Dimensions

Parameters	Dimensions (*mm*)
W	40
L	32
h	1.524
S	25
Q	15
Wf	2.7

III. Results And Discussions

CST Microwave tool [8], which is based on Finite integral technique (FIT), is used to optimize and analyze the tag. This tool is used as main platform to design and come up with certain antenna performance parameters such as return loss, gain, directivity, radiation pattern…

A. Return Loss, S11

Performance of the proposed antenna when used in the UWB systems was verified by using the commercial software package, CST Microwave Studio.

Figure 2 shows the simulated return loss of the antenna given by finite integrate technique (FIT). As can be seen from this figure, the 10 dB return loss bandwidth extends from 3.15 GHz to more than 12 GHz equivalent to 116.83% calculated by using relation (4)

$$BW\% = 2 \times \frac{f_h - f_l}{f_h + f_l} \times 100 \qquad (4)$$

B. Voltage Standing Wave Ratio (VSWR)

Figure 3 illustrates the simulated voltage standing wave ratio (VSWR) against frequency of the antenna. Based on the simulated result, the VSWR value ranges from 1 to 2 throughout the frequency range.

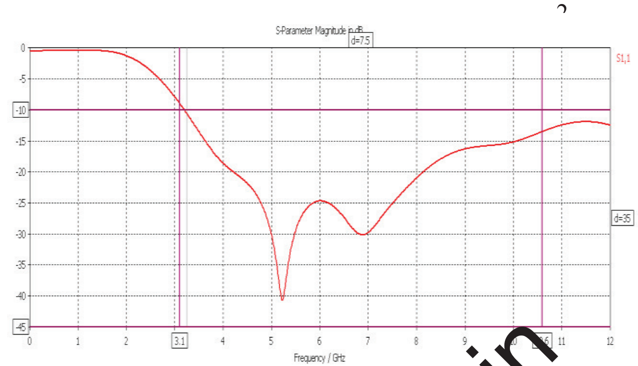

Figure 2. Return loss of the antenna S|11| (dB) against frequency (GHz).

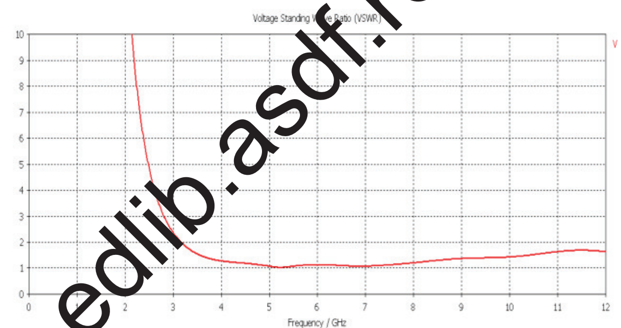

Figure 3. Simulated results of voltage standing wave ratio (VSWR) against frequency (GHz).

Overall, this antenna exhibits good UWB characteristics in terms of impedance bandwidth and return loss.

C. Current Distribution

For better visualize the radiating parts of the antenna, and the influence of the curved shape, we visualize the current distribution of central frequency (at 6 GHz) in Fig 4. It seems that the edges of the antenna are most active at this frequency.

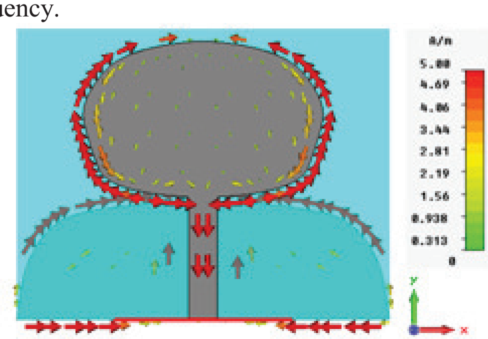

Figure 4. Current distribution at 6 GHz

D. Radiation Pattern

The simulated gain versus frequency result of the antenna forms 1 to 12 GHz (Fig 5); shows that the gain increases with frequency and is around 5 dB at 10 GHz. The gain is up of 3 dB overall the frequency range.

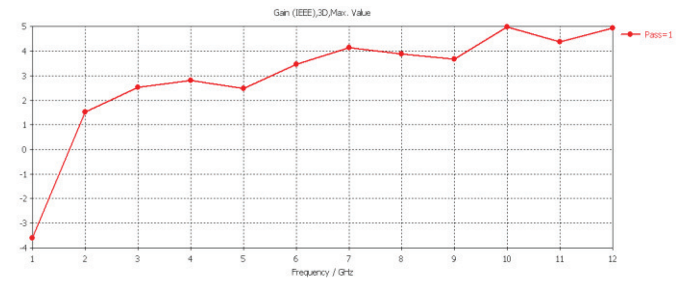

Figure 5. Simulated results of gain vs. Frequency

Figure 6 shows two dimensional radiation patterns of the proposed antenna at different frequencies (3, 6, 9 and 12 GHz) the antenna presents an omnidirectional (doughnut-shaped) radiation patterns.

IV. CONCLUSIONS

The shape of this antenna based on exponential curves designed to eliminate spurious radiation, and to keep the characteristic impedance of the antenna constant in the entire operating band. The proposed antenna exhibits good UWB characteristics, with its simulated result operating from 3.15 GHz to 12.5 GHz, having fractional bandwidth of more than 116.83%.Besides, it complies with the VSWR range from 1 to 2 throughout the impedance bandwidth, whereas the radiation patterns with stable radiation characteristics. The proposed antenna, with good UWB characteristics and geometrically small nature, easily integrated into a network, is suitable for wireless communication systems and microwave imaging. Several perspectives seen from this work, trying to increase the operating band and radiation characteristics of the antenna, and our results will be validated with a practical realization.

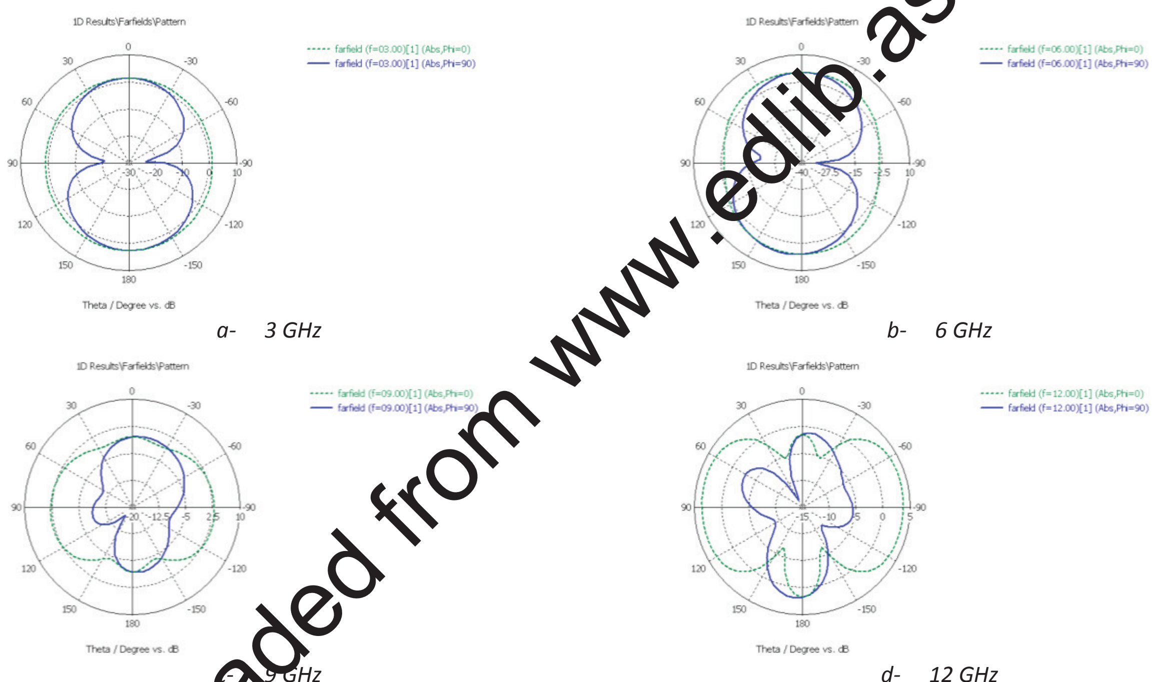

Figure 6. Radiation Patterns At Different Frequencies (3, 6, 9 and 12 GHz)

V. REFERENCES

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