Modified Planar Monopole Antenna for UWB Applications

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ABSTRACT
In this proposed paper, a planar monopole antenna with modified patch and truncated ground plane for Ultra wideband (UWB) applications is presented. The radiating element of the proposed antenna is fed by a 50 Ω microstrip line. Truncation in the ground plane is made for better impedance matching. It is found that by making steps in the ground plane, return loss characteristics and hence the VSWR is improved. The antenna parameters and performances have been investigated by using commercially available CST Microwave Studio 2012 software. Simulation and measurement results show that the proposed antenna provides an ultra wide bandwidth, completely covering the range set by the Federal Communication Commision (FCC) for UWB operations (3.1 GHz to 10.6 GHz).The antenna is of low profile and exhibits omnidirectional radiation pattern and high gain for the entire bandwidth.

General Terms
Microstrip antenna, Ultra-Wideband Characteristics

Keywords
UWB, planar monopole antenna, Microstrip fed, Truncated ground plane

1. INTRODUCTION
For future communication systems that requires high-speed data rate and excellent immunity to multi path interference, Ultra wide-Band (UWB) technology is one of the most promising solution .UWB technology enables the personal area networking industry leading to new innovations and greater quality of services to the end users. According to the Federal Communications Commission (FCC), the frequency band of the UWB should be between 3.1 and 10.6 GHz and it is a challenge to design the antenna to achieve such a wide bandwidth for many applications. To achieve high data rate, UWB antenna should radiate short pulse with duration of 0.3ns without time ranging. UWB antenna should cover the allocated 7500 MHz of spectrum so to fully utilize the spectrum. Printed monopole antennas have gained large attention recently as they offer large bandwidth, due their low profile and omni-directional radiation characteristics. To overcome the limitation of large ground plane used for the conventional printed monopole, the truncated ground plane has made the antenna low profile and suitable for integration into circuit board as tenninal antennas. In this report, the simulated and measured investigations towards the development of a UWB printed Monopole Antenna with the proposed geometry and truncated ground plane have been presented. The antenna is developed from printed circular disc monopole antenna and steps are designed and adjusted in ground plane to obtain UWB impedance matching.

2. ANTENNA DESIGN
Figure (1) shows the geometry of proposed monopole UWB antenna. As shown in figure (1), the proposed antenna is fabricated on one side of the substrate with the relative dielectric constant of ε_r=3.2 and the thickness of 0.762 mm (Gil GML 1000(loss free)) with length and width of 'l' and 'p' respectively. In this proposed antenna radiation element is fed by microstrip line. The width of the microstrip line is fixed at w_1 to achieve 50Ω characteristic impedance. On the other side of the substrate, the conducting ground plane with dimension l_1×w only covers the section of the microstrip feed line. Steps in the ground plane are there to adjust impedance matching as shown in figure (2). 'h' is the height of the feed gap between the feed point and the ground plane. Figure (3) is the photograph of the proposed antenna. The dimension of the proposed antenna is shown in Table 1.

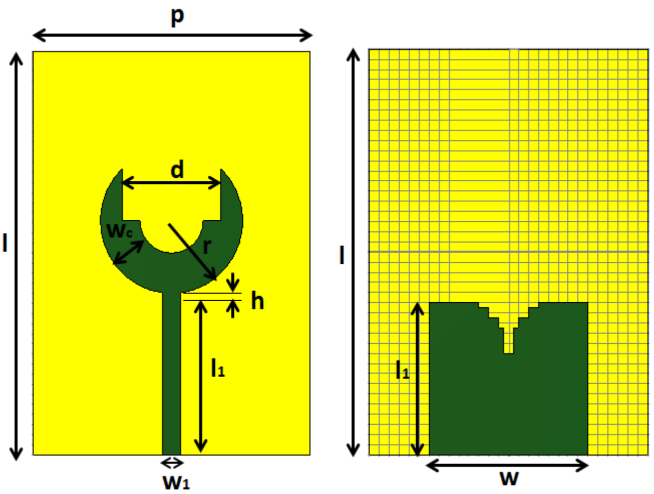

Figure1: Geometry of the proposed monopole UWB antenna

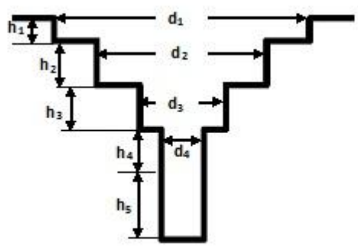

Figure 2: Geometry of the ground plane (steps in ground plane for better impedance matching

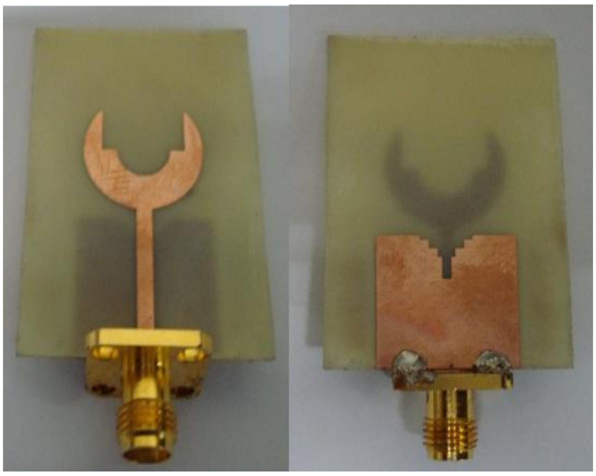

Figure 3: Fabricated UWB antenna

TABLE 1: Dimensions of the proposed monopole UWB antenna

Parameter	Value
l	40
p	28
l_1	15
w	16
w_1	1.83
h	1
r	7.2
d	10
w_c	4
d1	6
d2	4
d3	2
d4	1
h1	0.5
h2	1
h3	1
h4	1
h5	1.5

All dimensions are in millimeters.

3. RESULTS AND DISCUSSION

In this section, simulation and experimental results are presented. The proposed antenna is simulated using CST Microwave Studio 2012 software and the fabricated antenna is measured using ZVB 20 vector network analyzer.

3.1 Return Loss Characteristics:

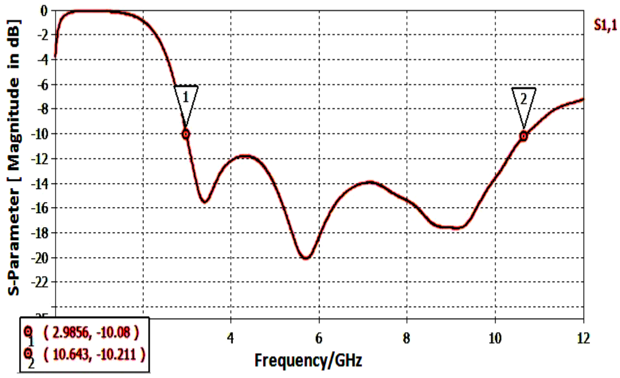

Figure 4: Simulated return loss of proposed antenna

Figure (4) shows that the designed antenna has UWB characteristics with impedance bandwidth covering from 2.98 GHz to 10.64 assuming a 10 dB return loss reference.

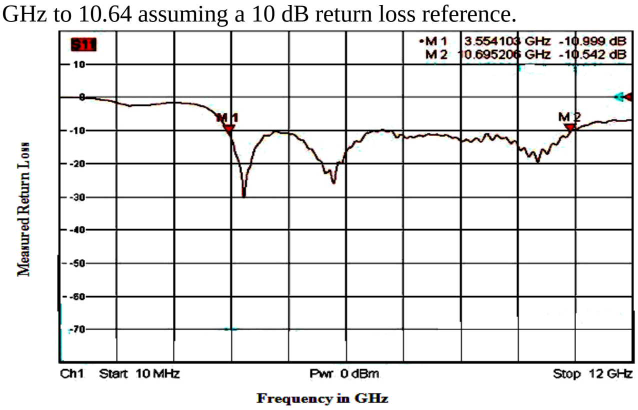

Figure 5: Measured return loss of the proposed antenna

Figure (5) shows that measured return loss of the proposed antenna is covering the frequency range from 3.55 GHz to 10.69 GHz satisfying the UWB requirement.

3.2 Voltage Standing Wave Ratio (VSWR):

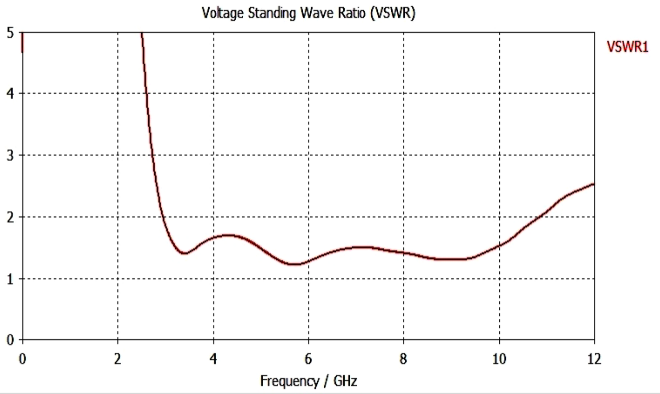

Figure 6: Simulated VSWR of proposed antenna

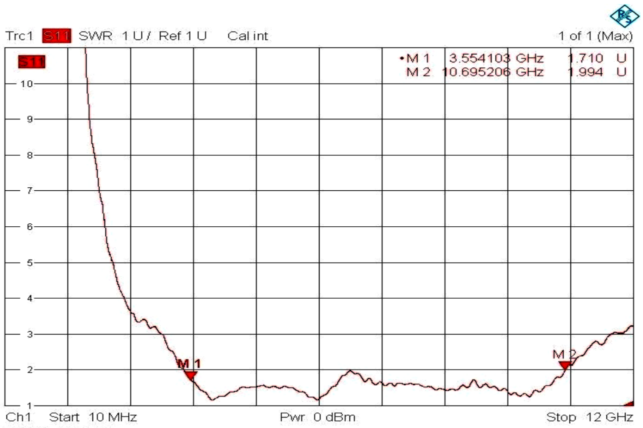

Figure 7: Measured VSWR of the proposed antenna

Figure (6) and (7) show the simulated and measured VSWR of the proposed antenna respectively which is < 2 for the entire UWB range (from 3.1 GHz to 10.6 GHz).

3.3 Effect of truncation in ground plane on VSWR:

For better impedance matching truncation in ground plane is done. It can be seen from the figure (8a-8b) that VSWR is strongly affected by the multi step ground, and the antenna can obtain impedance matching over the entire band by adjusting the steps.

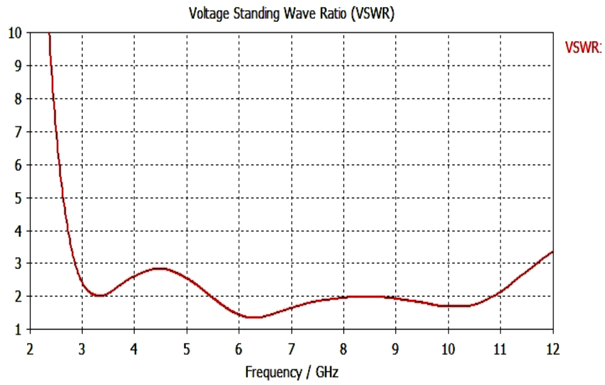

Figure 8a: Simulated VSWR with no step.

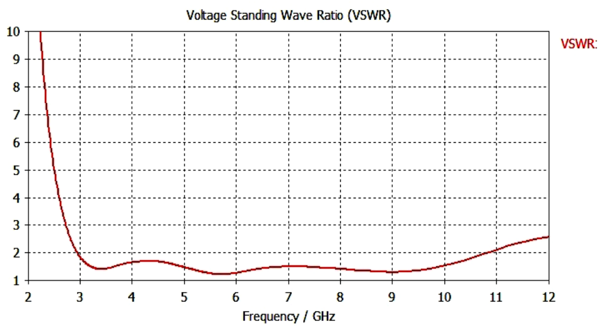

Figure 8b: Simulated VSWR with five steps.

Hence we choose five steps for the antenna to obtain the VSWR< 2 for wide impedance matching.

3.4 Radiation Pattern:

3.4.1 E-plane:

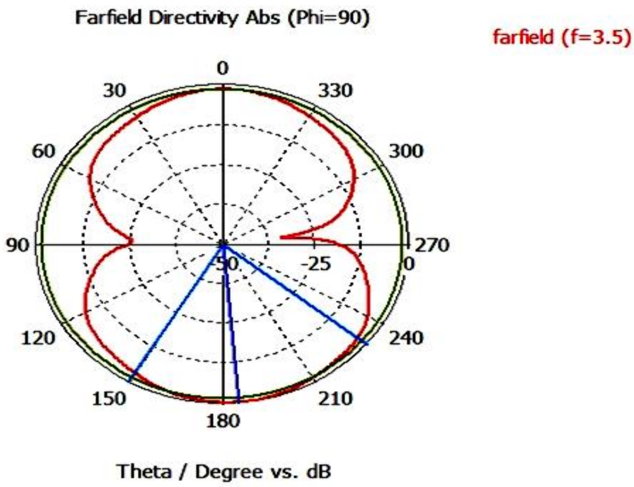

Figure 9(a): Simulated E-plane radiation pattern at 3.5 GHz

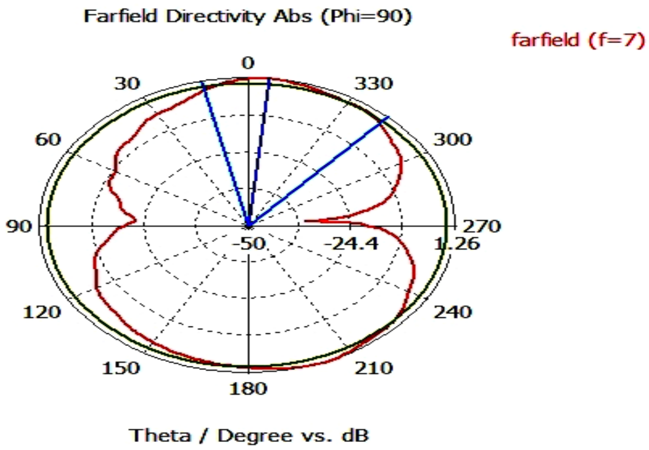

Figure 9(b): Simulated E-plane radiation pattern at 7 GHz

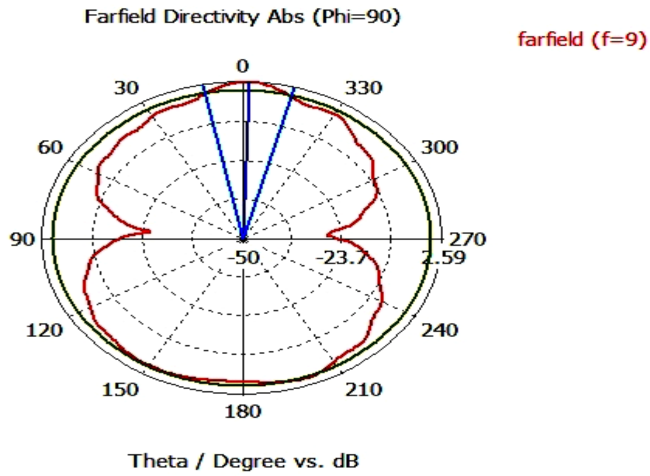

Figure 9(c): Simulated E-plane radiation pattern at 9 GHz

From figure (9a-9c) it can be seen that the proposed antenna exhibits almost the same radiation properties, and it is also nearly omni-directional over the entire bandwidth.

3.4.2 H-plane:

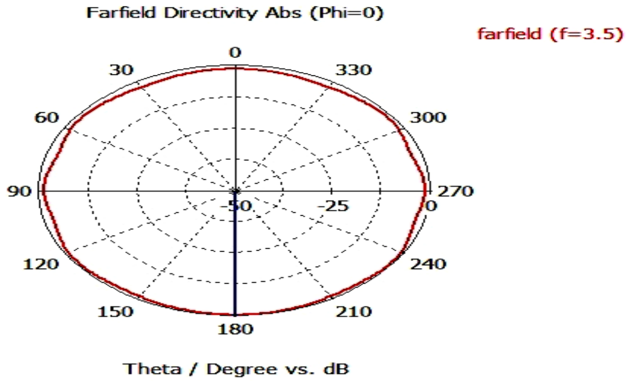

Figure 10(a): Simulated H-plane radiation pattern at 3.5 GHz

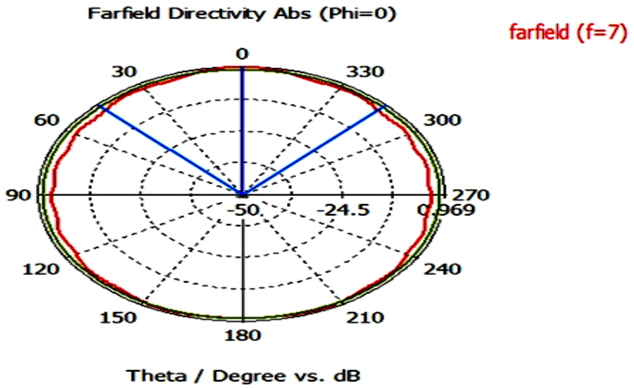

Figure 10(b): Simulated H-plane radiation pattern at 7 GHz

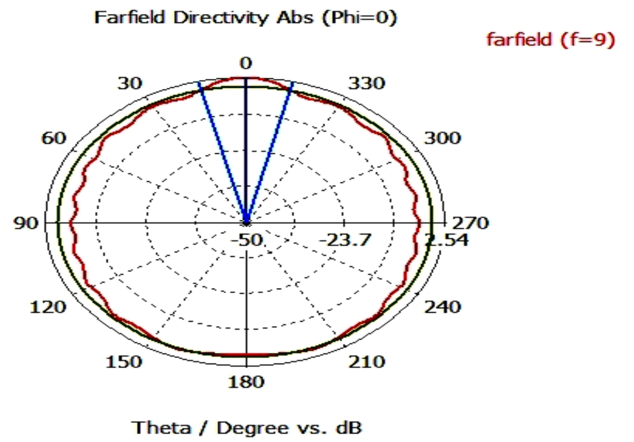

Figure 10(c): Simulated H-plane radiation pattern at 9 GHz

It can be seen from figure (10a-10c) that the H-plane radiation patterns are approximately omnidirectional and the variation is less than 10 dB over the entire operation frequencies, so the radiation is relatively stable in different frequencies.

4. CONCLUSION

A planar monopole antenna with modified structure which is developed from printed circular disc monopole antenna is proposed that easily satisfies the requirements for UWB applications. The results show that the impedance bandwidth of the proposed antenna is significantly improved with modified patch design. For better impedance matching steps in the ground is made. Simulation result shows that the proposed antenna provides an ultra wide bandwidth from 2.98 GHz to 10.64 GHz, completely covering the range set by FCC for UWB operations (3.1 GHz to 10.6 GHz).Measurement result shows that the proposed antenna has impedance bandwidth covering from 3.5 GHz to 10.6 GHz and Also the antenna exhibit omni-directional radiation pattern over the entire UWB range.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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