UWB Monopole Circular Patch Antenna With Parabolic Ground Plane

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Abstract—**Ultra Wide Band (UWB) wireless communication offers a radically different approach to wireless communication compared to conventional narrow band system. These paper reports on the design of an antenna structure composed of a circular patch with parabolic ground structure. The antenna has a dimension size of 26mmx 33mm. The antenna effectively covers the 3.1 to 10.6 GHz UWB frequency bands which has been approved by Federal Communication Commission for UWB unlicensed operation. Prototype of the antenna is design, fabricated and tested using Vector Network Analyzer (VNA). The antenna has a VSWR<2 over the UWB frequency band. The measure VSWR and radiation pattern indicate the suitability of this antenna for UWB application.**

Keyword – UWB, monopoleantenna, ground parabolic, slot

I. INTRODUCTION

Ultra-Wideband (UWB) technology brings the convenience and mobility of wireless communications to high-speed interconnects in devices throughout the digital home and office [1]. UWB is the leading technology for freeing people from wires, enabling wireless connection of multiple devices for transmission of video, audio and other high-bandwidth data.

UWB recently become populardue to their advantages, such as high speed data rate, extremely low power [2], high precision ranging, low complexity and low cost.

The authorization of theextremely wide spectrum of 3.1 GHz -10.6 GHzfor commercial applications has generated a lot ofinterest in the research and development of ultrawideband(UWB) technology for short rangewireless communications, imaging, radar, remote sensing, and localization application[3].

Various literature have reported on the design of UWB microstrip antennas[4].However there are still challenges to improve these designs in terms of return loss and antenna gain.Several researches indicated that these objectives are achievable by modifying the ground structure of the microstripantennas[5].

This research investigated on a parabolic ground plane,which will act as a reflector to increase the gain and radiation characteristics of the UWB antennas.This project also studies on the effects of size and dimension of parabolic ground, and the diameter of the circular patch on the performance of the antenna. The designed antenna is fabricated and measured using Vector Network Analyzer (VNA).

This project consist parametric simulations, fabrication and actual measurements. To fulfill the main objectives, simulation process and hardware process must be conducted. There are several steps to complete the project that include literature review, design model, simulation model, hardware model, result and discussion

In this technical paper, methodology of this research will be explained in section II and antenna design will be discussed in section III. The diameter effect, ground length effect, Voltage standing Wave Ratio (VSWR), and Radiation pattern will be discussed in section IV. The last section will be conclusion that will conclude the entire research finding.

II. METHODOLOGY

This section describes a flow chart from beginning until completing this project. Figure 1 show the flowchart of methodology employed in designing the proposed antenna. Literature review about the UWB was studied and the antenna topology was determined. The antenna was designed and simulated by using the CST software.

After the analysis of antenna characteristic, the antenna was fabricated on the FR4 printed circuit board (PCB) with overall size of 33× 26× 1.5mm3 and dielectric substrate εr = 4.3. The fabrication antenna design verified using Vector Network Analyzer (VNA) [6].

A. *Flow Chart*

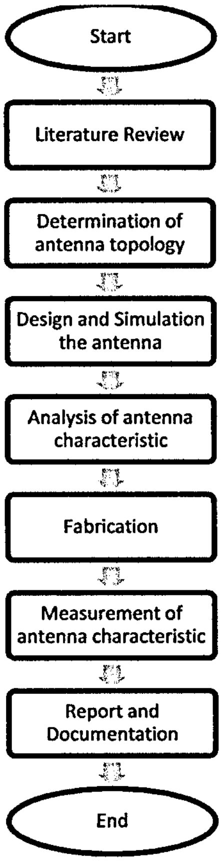


Fig.1: Flowchart

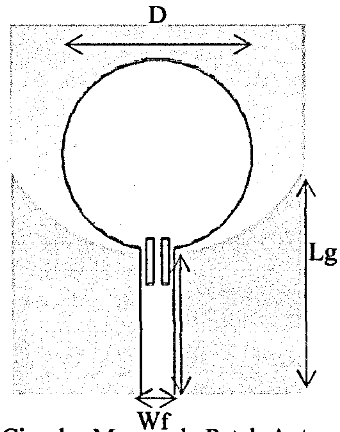


Fig.2: Circular Monopole Patch Antenna

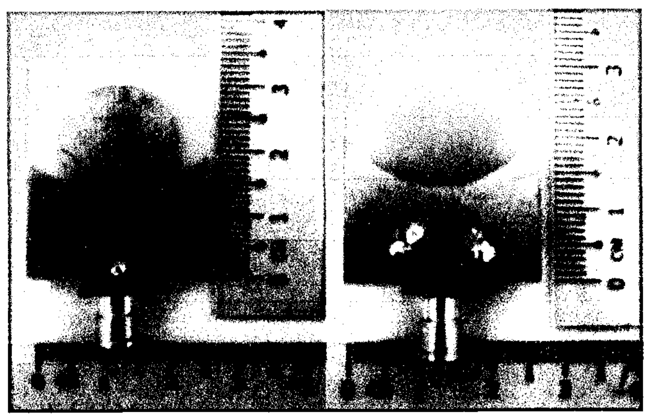


Fig.3: Fabricated microstrip antenna

III. ANTENNA DESIGN

The Monopole Circular Patch Antenna with Parabolic Ground Plane is showed in Fig.2. It consists of a printed circular patch antenna on FR4 substrate of thickness 1.5 mm and a relative permittivity 4.3. The substrate has a length of L=33 mm and the width of W=26 mm. The length of conducting ground is Lg=20 mm. The excitation is launched through a 50 Ohm microstrip feed line, which has the length 13mm with width, W_f= 3mm and patch diameter, D = 17mm.Fig.3 shows the actual fabricated antenna.

There is slot at the feed, first slot 0.7mm x4mm and the second slot 0.6mmx4mm.If a suitable combination of the shape of feed and slot is chosen and tuned perfectly, it gives an optimum impedance bandwidth with an improved radiation pattern [7]. All designs feature aparabolic-shaped ground plane to accomplish high directivity and gain. Moreover, in comparison with a simple corner-shapedground plane, the parabolic ground plane enhances bandwidthand improves input return loss [5]

IV. RESULTS AND DISCUSSION

The antenna has been optimized and analyzed using CST Microwave Studio. The antenna was subsequently prototyped for experimental verification. The return losses were measured using a vector network analyzer (VNA). Fig.4 shows the measured and simulated return loss.

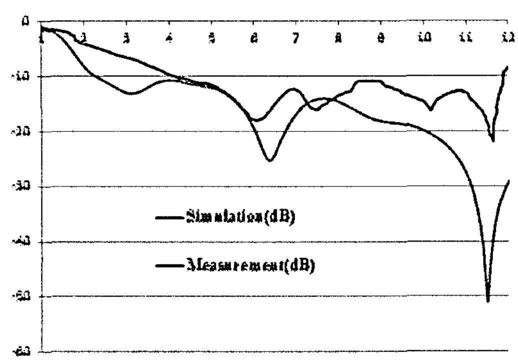


Fig.4: Simulated and Measured of Return Loss S_{11}

The plot show that the antenna has an impedance bandwidth 2.6 to 12GHz.The factor that effect different between measurement and simulation is substrate, if the substrate is replace with roger duroid 5880 which is permittivity is lower than FR4 the result might be better.Lower permittivity gives wider impedance bandwidth and reduced surface wave excitation and a thicker substrate results in wider bandwidth, but less coupling for a given aperture size. It is also may be due to the feeding cable, which is too long use in measurement and make losses.

Others factor caused the variations between simulated and an experimental result is the parasitic effect. Parasitic effect occurs when exceedingly solder the SMA connector. This can cause major effects at high frequencies, which can act as a feedback path, causing the circuit to oscillate.

A. Diameter, D effects

The diameter of the patch, D was simulated in three lengths which are 15mm (red), 17mm (blue), and 19mm (green) From the fig.5, at the length of 15mm give S_{11} is -10dB at 3.01 GHz. The result is getting better at the length of 17mm give S_{11} is below -10 at the bandwidth between 3GHz to12GHz.

Change the patch diameter techniques are aimed to change the distance between the lower part of the planar monopole antenna and the ground plane in order to tune the capacitive coupling between the antenna and the ground plane.

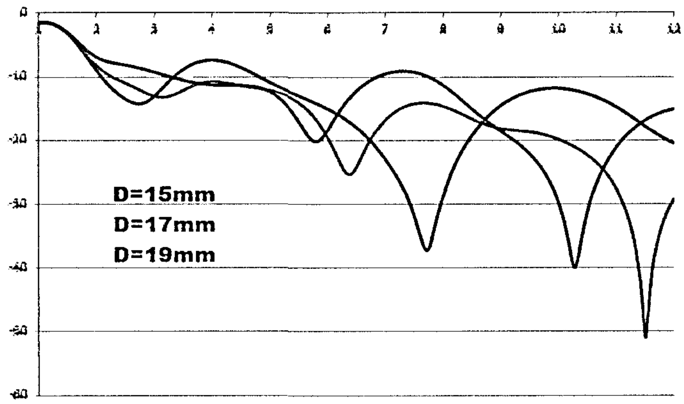


Fig.5: Diameter vs. Return Loss S_{11}

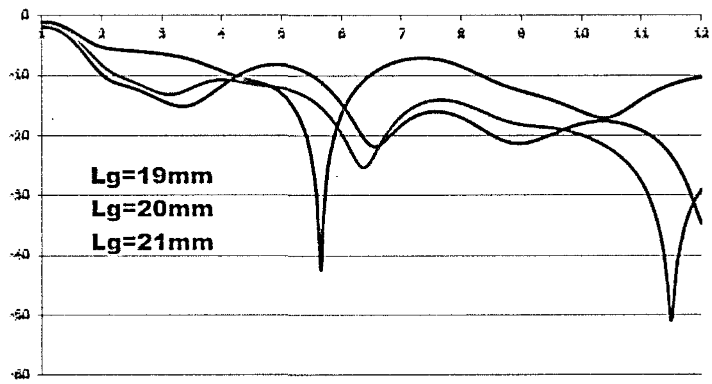


Fig.6: Ground Length vs. Return Loss S_{11}

B. Ground length, Lg effects

Fig.6 shows the variation of return loss with respect to the parabolic ground.Three lengths are simulated which are 19mm (red), 20mm (blue), and 21mm (green). It is found that at Lg=20mm the return loss is below -10 for the entire bandwidth.

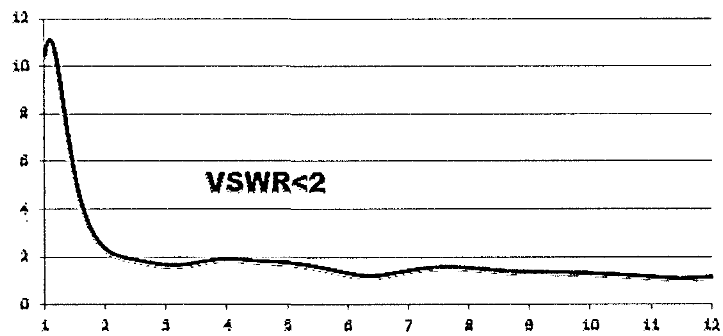


Fig.7: Voltage Standing Wave Ratio (VSWR)

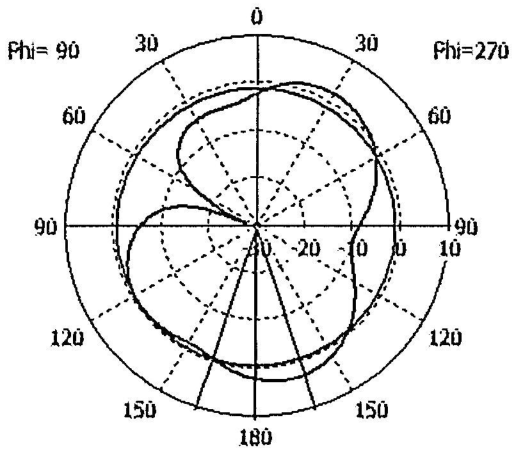
C. Voltage Standing Wave Ratio (VSWR)

Fig.7 shows that the result of simulated of ground length 20mm and diameter of circular patch antenna at 17mm.The simulation result indicates the maximum VSWR value is 1.82.It was found that the introduction of parabolic ground plane have greatly improved the value of VSWR in the operating frequency. The ground length also affected the VSWR value. However, relatively good agreement in between measurement for ground length of 20mm and simulation has been observed.

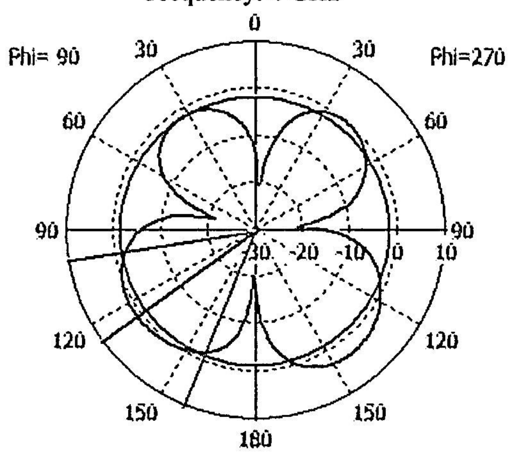
D. Radiation Pattern

The simulated radiation patterns of the antenna are plotted at several frequencies within this band. Fig. 8 plots the simulated radiation pattern for 4, 6 and 8 GHz. These results were compared with the partial ground. Its show that parabolic ground much better than partial ground because the gain is increase at parabolic ground

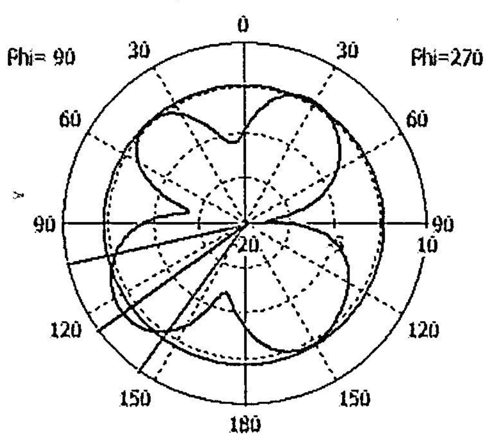
Figure 8(a): Parabolic Ground



Frequency: 4 GHz

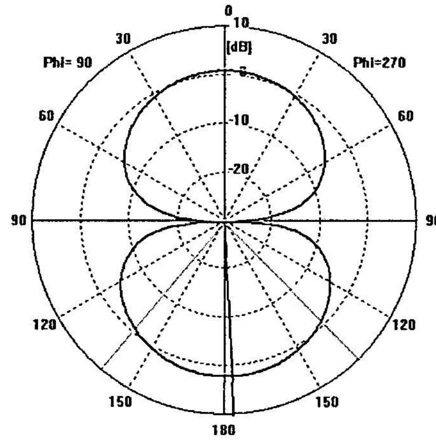


Frequency: 6GHz

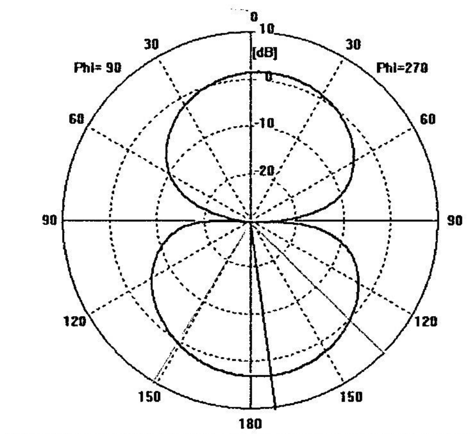


Frequency: 8GHz

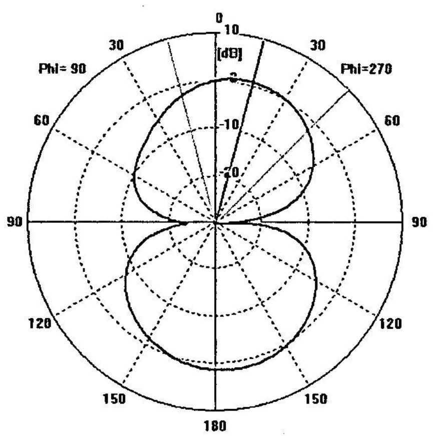
Figure 8(b): Partial Ground



Frequency: 4GHz



Frequency: 6GHz



Frequency: 8GHz

V. CONCLUSION

A UWB monopole circular patch with a parabolic ground plane have been designed and fabricated. The measurement results showed that the antenna fulfilled the requirements of UWB, which is having return loss of lower than -10 dB from 4.2 to 11 GHz frequency band. The parabolic ground plane demonstrated an improved antenna gain at 4 and 8 GHz. Future works will focus on the improvements of antenna performance, especially in the lower frequency region, by utilizing a better substrate, and improving the topology.

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