Design of Circular Monopole Antenna for Ultra Wide Band Application

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Abstract: Now a days communication technology is constantly spreading in everyday life. The agile progress in wireless communication is increased accomplishment in ultra wideband antennas. This paper gives a simple design of ultra wideband circular monopole antenna. The parameters which are afflicted on the performance of the antenna are researched. The parameters are affected on antenna results are radius of monopole, feed gap which is a distance between feed point of circular monopole and transmission line and width of ground plane. This antenna is designed and simulated by using Ansoft High Frequency Structure Simulator (HFSS). The simulation of this antenna achieves good agreement with ultra wideband requirement.

***Key Words*: Ultra wideband, HFSS, Network Analyzer, Circular slit, Jeans, efficiency, return loss, textile material**

1. INTRODUCTION

The fast growing technology and development in wide band wireless technology system has increased the use of Ultra Wideband (UWB) antennas. After releasing a 10-dB bandwidth of 7.5 GHz (3.1-10.6 GHz) by Federal Communication Commission, UWB technology has quickly attracted the attention of academia and industries in the wireless technology [1]. A selected antenna is capable if it can give required efficiency and radiation properties over an ultra wideband bandwidth allocated by federal Communication Commission. [2-4]

UBW system has many advantages like it can transmit high data rate information, low power consumption and low interference and immunity to multipath fading. On top of this it has wide bandwidth and economics advantages and hence UWB system is widely used in biomedical system, radio communication and medical imaging [5-7]. Traditional UWB antennas having log periodic geometries or spiral radiate each frequency component from different part of antenna results in distortion to radiated signal and theses antenna are known as a dispersive. [9] Later on, UWB antennas with simple structure, fabrication and adequate radiation characteristics have been proposed [10,11]. These antennas are broadband dipoles with circular, pentagonal, elliptical, square and hexagonal configurations [12].

In this paper, a circular monopole antenna is proposed and investigated. The geometric antenna dimensions are maintained to obtain an ultra wide band width response with a bandwidth of 10 GHz and acceptable radiation pattern properties. In addition to these, the antenna can cover more application such that (GSM1900, PCS1900, DCS, 2.45/5.2/5.8-GHz-ISM, WCDMA/UMTS(3G), UWB (3.1 – 10.6 GHz) etc.

2. DESIGN OF ANTENNA

The recommended circular monopole antenna is depicted in Fig. 1. The radius of circular monopole is R=12.5 mm and a microstrip feed line are printed on same side of subtract with characteristics impedance of 50 Ω and the width of line is fixed at 2.6mm to achieve this impedance. In this design FR4 is used as a subtract with 1.6mm thickness and 4.4 relative permittivity. L is symbolised as a length of the dielectric subtract which is constant as 50mm and W is denoted as width of the dielectric substrate which is varied for the batter result. On the other side of the dielectric substrate, the partial conducting ground plane is designed, which only covered the section of microstip feed line, the length of ground plane is represented as Lg= 20mm as shown in Fig. 2. h is indicate the feed gap, it is a distance between the feed point of circular monopole and transmission line Here the width of the subtract and width of the ground plane are same.

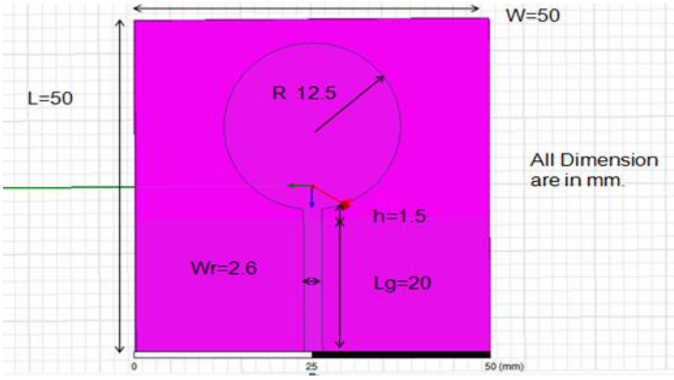

Fig -1: Geometry of proposed circular monopole antenna

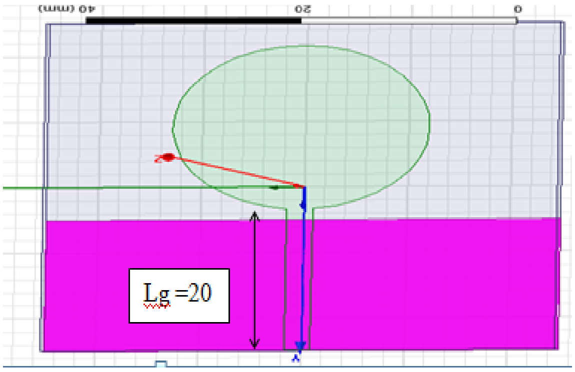

Fig.-2: Ground plane geometry

3. RESULTS AND DISCUSSION

The design parameters of antenna like radius of circular monopole, length of feed gap and width of ground plane are affected on the performance of antenna. So, for the optimum design of antenna these parameters are going to vary to get wider band. The process to achieve optimum design of UWB antenna is as below.

3.1 Effect of the Patch Radius(R)

The first step towards the optimization is to vary the radius of circular monopole as R=10, 11, 12, 12.5 mm. For that width of ground plane W is constant as 50 mm and feed gap (h) = 1.5 mm. The return losses simulated in HFSS at different radius shows in fig.-3.

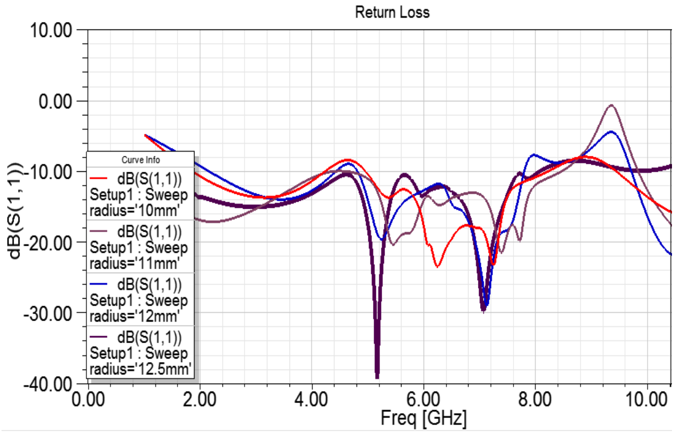

Fig.-3: Return loss due to variation of radius of patch

As seen from the previous figure, the radius of circular monopole set as R=12.5mm gives the wider bandwidth compare with the other radius. The other parameter which is affected on the performance of antenna is feed gap. To achieve the optimum value of it the feed gap is going to be changed.

3.2 Effect of Feedgap length (h)

Fig. 4 illustrates the simulated result of return loss with the different feed gaps as h= 0, 0.5, 1.5, and 2 mm when width of ground plane and dielectric subtract W is fixed at 50 mm. In Fig.-4 it is observed that when the feed gap is varied the bandwidth of antenna is also significantly changed. The reason of it is the effect of impedance matching on the feed gap [10]. When the feed gap is varied, the ground plane, serves as an impedance matching circuit, tunes the input impedance and the operating bandwidth. [11]. The optimised feed gap value is found h= 1.5 mm.

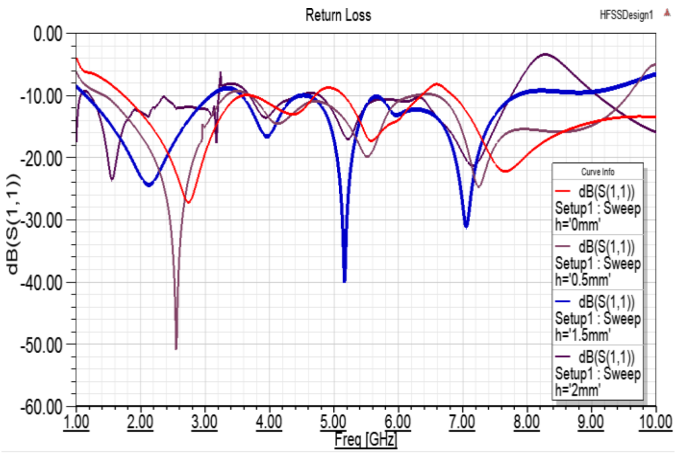

Fig.-4: Return loss due to variation of feed gap

3.3 Effect of the Width of Substact

One of the main parameter to design the natenna is width of ground plane and subtract. It is affected on the performance of the antenna To analyzed the effect the width of ground plane is varied. The different values of the width are: 30, 40, 50 and 60mm.

To enhance the bandwidth we varied the subtract width. The different values of the width are: 30, 40, 50 and 60mm.

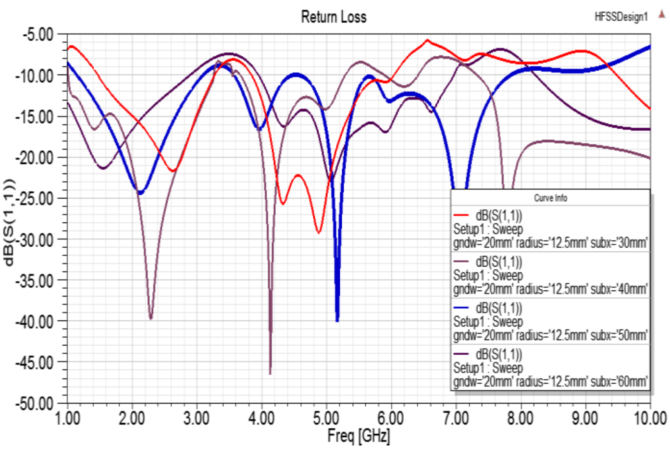

Fig.-5: Return loss due to variation of ground plane width

The simulation results depict that the performance of antenna is heavily depend on width of ground plane, because the current is mainly distributed and transmitted on the upper edge of the subtract along the y-direction. From the fig.-5 the widest bandwidth achieved at W=50mm. which is equivalent to double the diameter of the circular monopole.

Finally the optimum obtained dimensions are summarized in table 1.

Table -1: Dimension of Optimum design of Circular monopole UWB antenna

Optimized parameters	
Parameters	Dimensions
Subtract Height	1.6 mm
Width of Subtract	50 mm
Length of Subtract	50 mm
Radius of Patch	12.5 mm
Width of Transmission line	2.6 mm
Length of Ground plane	20 mm
Length of feed gap	1.5 mm

These simulations were performed using the Ansoft High Frequency Structure Simulation (HFSS), [13]. The return loss curve of the optimal design illustrate in Fig. 6. The proposed antenna design resonates from 1.2 GHz to 8.02 GHz, which gives bandwidth of 6.82GHz.

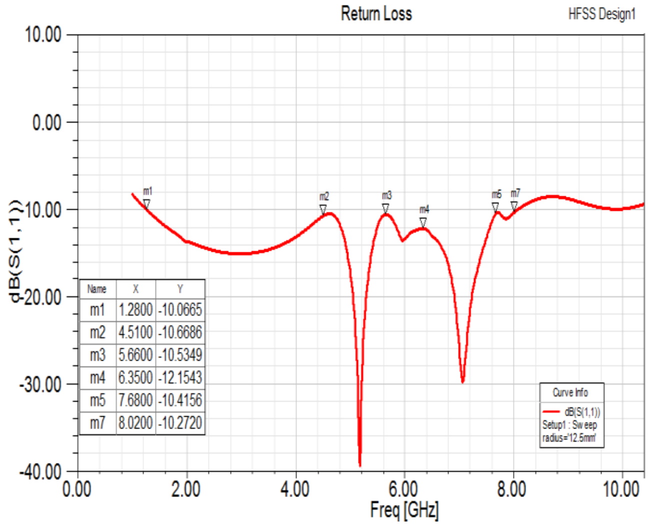

Fig.-6: Return loss of optimum design

The simulated radiation pattern at 2 GHz, 3 GHz, 5GHz and 7 GHz shown in fig 7 to 10.

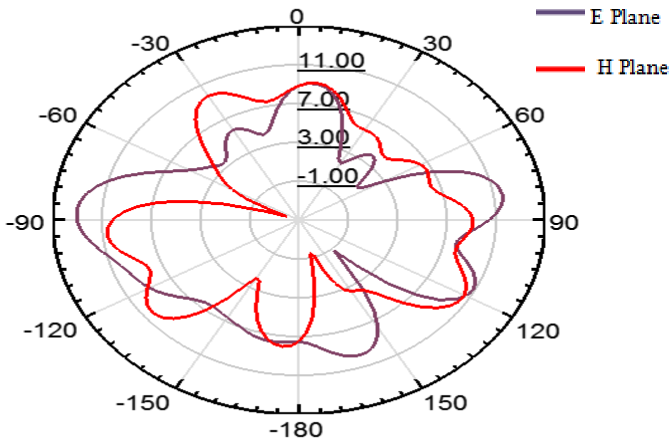

Fig.-7: Radiation Pattern at 2 GHz

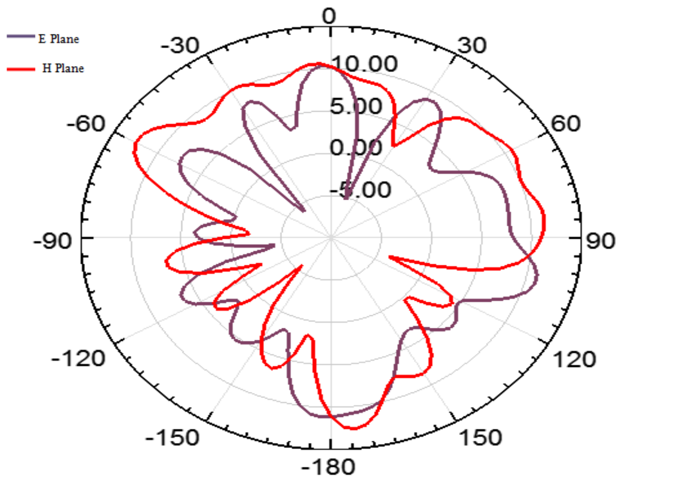

Fig.-8: Radiation Pattern at 3 GHz

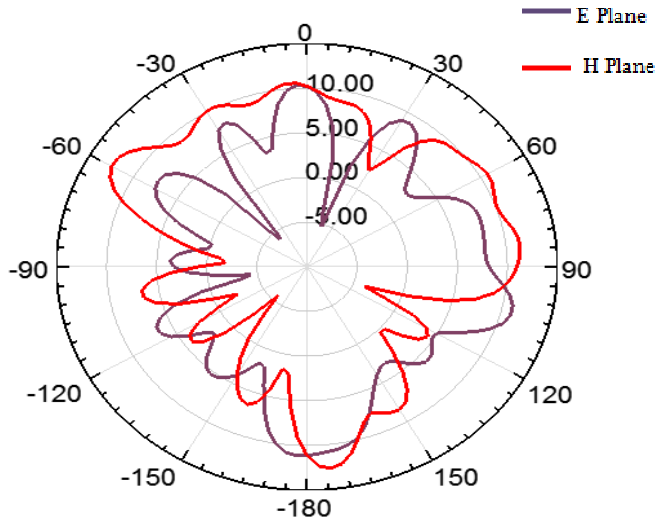

Fig -9: Radiation pattern at 5 GHz

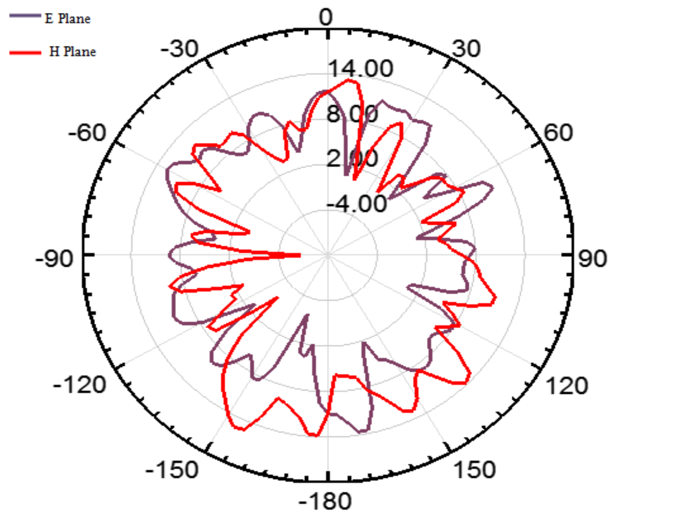

Fig.-10: Radiation pattern at 7 GHz

It is noticed that, the simulated H-plane patterns are nearly omni-directional. The simulated E-plane patterns show that as the frequency is increased, slightly notches. The Gain of the antenna presented in table 2.

Table -2: Gain of Circular monopole UWB Antenna

Frequency	Gain
2 GHz	1.6 mm
3 GHz	50 mm
5 Ghz	50 mm
7 GHz	12.5 mm

4. CONCLUSIONS

In this paper the different parameters of antenna are varied to check the effect of those parameters on the antenna. The width of ground plane, radius of patch and feed gap are varied to observe the response. By doing all this here can conclude that the bandwidth of the antenna is depending upon the width of ground plane, radius of circular monopole and feed gap. The optimum feed gap value is 1.5 mm and the width of ground plane should double of the diameter of circular monopole. The antenna gives the widest bandwidth with circular monopole radius dimension R=12.5mm and partial ground plane width dimension W= 50 mm. A circular monopole antenna was proposed having a bandwidth from 1.2 to 8.02 GHz, which is very large bandwidth, which is covered the S, C, and X bands. It has been shown that the performance of this antenna in terms of its frequency domain characteristics is mostly dependent on the circular monopole radius, ground plane width and feed gap. It is demonstrated by simulation that the proposed antennas can yield an ultra wide bandwidth, and that the radiation patterns are nearly omni-directional over the entire -10 dB return loss bandwidth. This antenna can be used in many application including 3G, Wi-Fi, Wi-MAX, as well as UWB applications.

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