



SUPER WIDE BAND CIRCULAR SHAPED ANTENNA WITH A SLIT ON THE TRAPEZOIDAL GROUND PLANE

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ABSTRACT

In this paper, a microstrip fed circular monopole antenna with a trapezoid shaped ground plane is designed and fabricated for super wide band applications. In order to achieve ratio bandwidth greater than 10:1, a semi elliptical slit is introduced on the ground plane, along with the difference in length of microstrip line feed and length of ground plane. The measured reflection coefficient, VSWR, radiation pattern and peak gain are presented to validate the performance of antenna.

Keywords: super wide band, circular patch, modified ground plane.

1. INTRODUCTION

In modern wireless communications, it is required to design antenna with wide band characteristics. Microstrip antennas are frequently used in wireless communication systems because of light weight, low cost and small in size. These microstrip antennas had a disadvantage of having narrow bandwidth [1]. So many researchers attempted to design wide band antennas [2-4].

Microstrip antennas with a defect introduced in the ground plane improves its performance in terms of various parameters [5,6]. Several Super Wide Band (SWB) microstrip antennas are available in the open literature. Super wide band antenna is one, in which the bandwidth ratio is greater than 10:1 at 10dB return loss [7-9]. A SWB printed antenna is designed for a band of frequencies from 400MHz to 16GHz with very large dimensions of 150×150mm²[10]. A dual branch excited asymmetrical monopole SWB antenna is designed for a band of frequencies from 1.05GHz to 32.7GHz with large dimensions of 74×80mm²[11]. Modified rectangular SWB antenna is designed with dimensions of 52×42mm² has a wide band from 0.96GHz to 13.98GHz [12]. In this paper a circular monopole with super wide band (SWB) characteristics is designed, fabricated and measured for reflection coefficient, VSWR, radiation pattern and gain.

2. GROUND PLANE DESIGN

The proposed antenna is a microstrip fed circular shaped monopole with a trapezoid shaped ground plane. The radius of the circular patch is chosen based on the equation 1 [1]

$$a = \frac{F}{\left\{ \frac{2h}{\pi F \epsilon_r} \left[\ln \left(\frac{\pi F}{2h} \right) + 1.7726 \right] + 1 \right\}^{\frac{1}{2}}} \quad (1)$$

where

$$F = \frac{8.791 \times 10^9}{f_r \sqrt{\epsilon_r}}$$

A semi elliptical shaped slit is introduced on the ground plane. Epoxy FR4 material is used as a substrate with 1.6mm thickness, loss tangent 0.02 and relative dielectric constant of 4.4. The geometry of the proposed antenna is shown in Figure-1 and its dimensions are mentioned in Table-1. To obtain wide band characteristics ground plane is modified to a trapezoid shape with a slit exactly below the microstrip feed line and a gap or difference in length between microstrip line feed and length of ground plane. The rear view and front view of the proposed antenna are shown in Figure-2.

Table-1. Design parameters of the proposed antenna.

S. No.	Parameters	Dimensions
1	Radius of circular patch, r_p	10mm
2	Length of microstrip line feed, L_f	20.128mm
3	Width of microstrip line feed, W_f	3.2mm
4	Height of trapezoid, L_1	20mm
5	Base of trapezoid, L_2	36.95mm
6	Major radius of semi ellipse, L_{s1}	2.8
7	Minor radius of semi ellipse, W_{s1}	3mm
8	Length of substrate, L_s	45mm
9	Width of substrate, W_s	60mm
10	Gap ($L_f - L_1$), g	0.12mm
11	Thickness of substrate	1.6mm
12	Dielectric constant of substrate	4.4

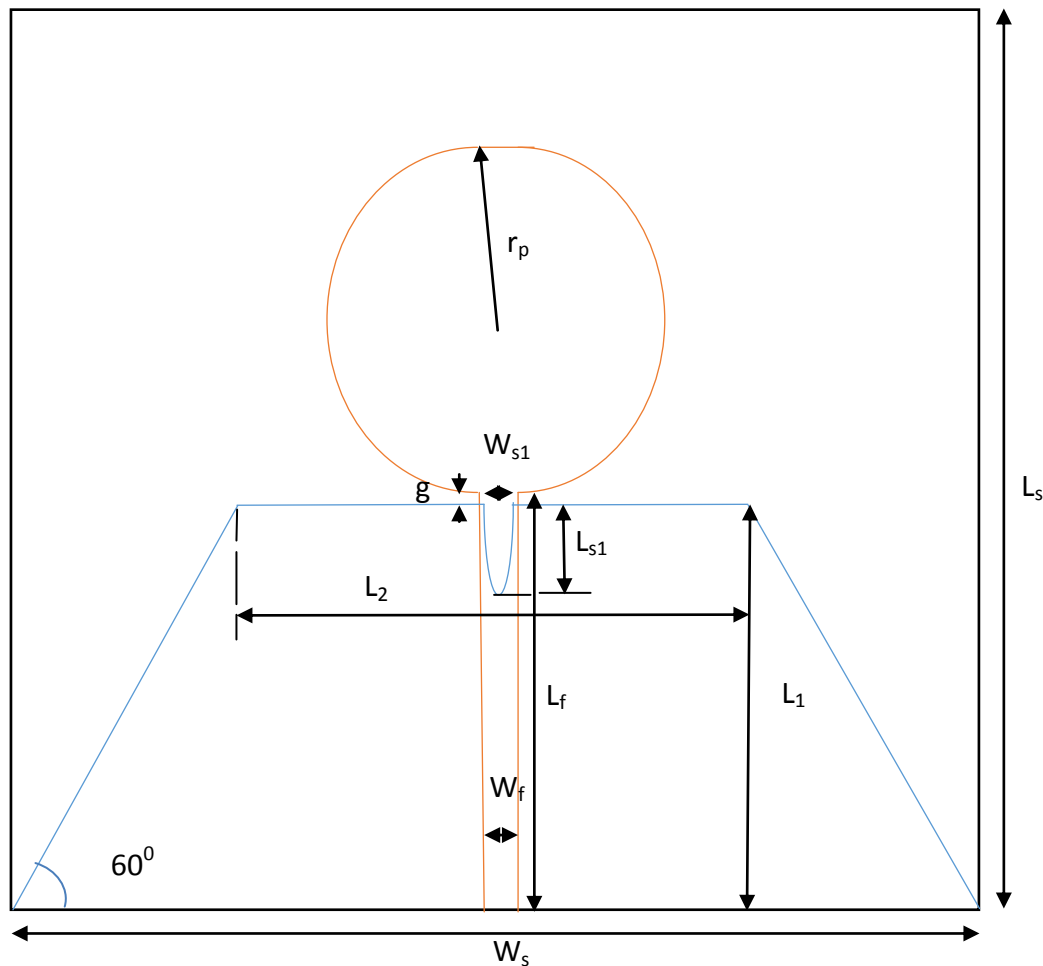


Figure-1. Geometry of the proposed antenna.

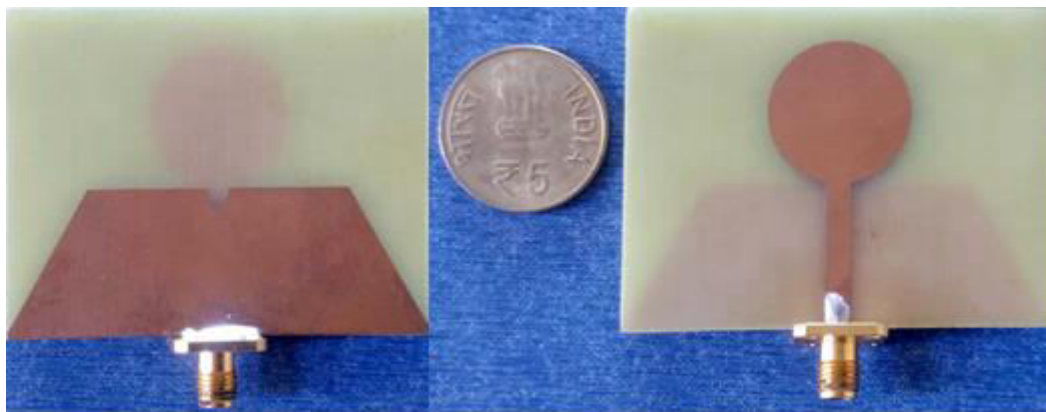


Figure-2. Rear view and front view of the proposed antenna.

3. RESULT ANALYSIS

Simulation of the proposed antenna is done in HFSS software. Measured and simulated values are plotted using Matlab software. Reflection coefficient versus frequency of the proposed antenna is shown in Figure-3. The measured and simulated results show that it has super wide band characteristics. VSWR versus frequency is presented in Figure-4 shows that it has wide band characteristics. Figure-5 presents measured

normalized far field radiation pattern at 3GHz, 6GHz, 9GHz, 12GHz, 15GHz and 18GHz frequencies. They indicate that the proposed antenna has nearly directional radiation pattern in E-plane and nearly omni-directional pattern in H-plane. At high frequencies there is a deviation in the radiation pattern due to higher order modes. Figure-6 displays the measured and simulated gain of the proposed antenna.



4. CONCLUSIONS

A simple circular monopole with a trapezoid shaped ground plane is designed. Introducing a slit on the ground plane exactly below the feed line with a difference

in length between feed line and ground plane, exhibits super wide band characteristics from 2.36GHz to 71.6GHz with a significant gain. Thus the proposed antenna can be used for ultra wide band and super wide band applications.

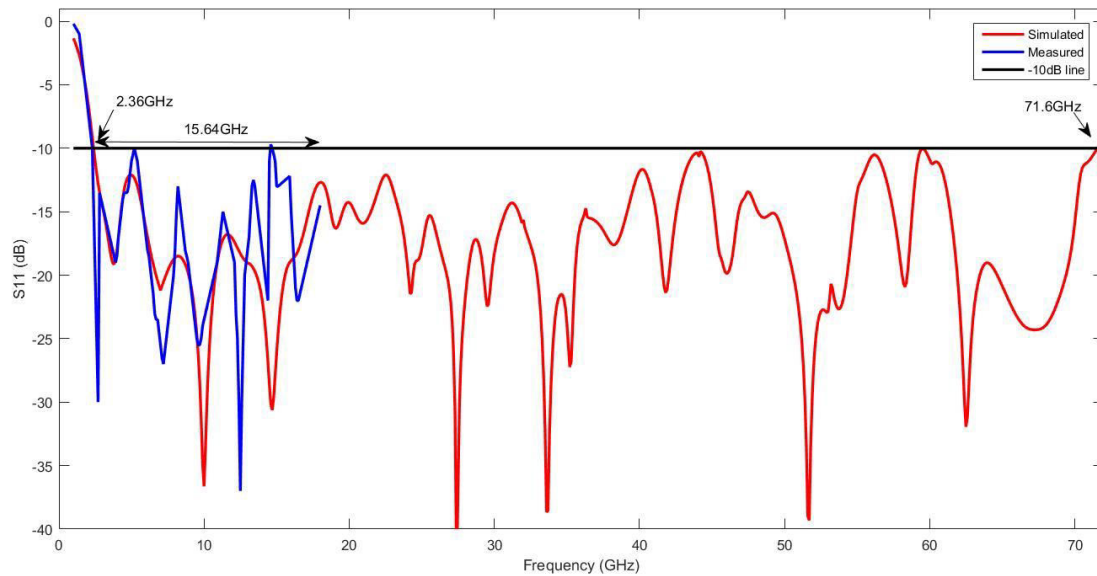


Figure-3. S_{11} versus frequency of the proposed antenna.

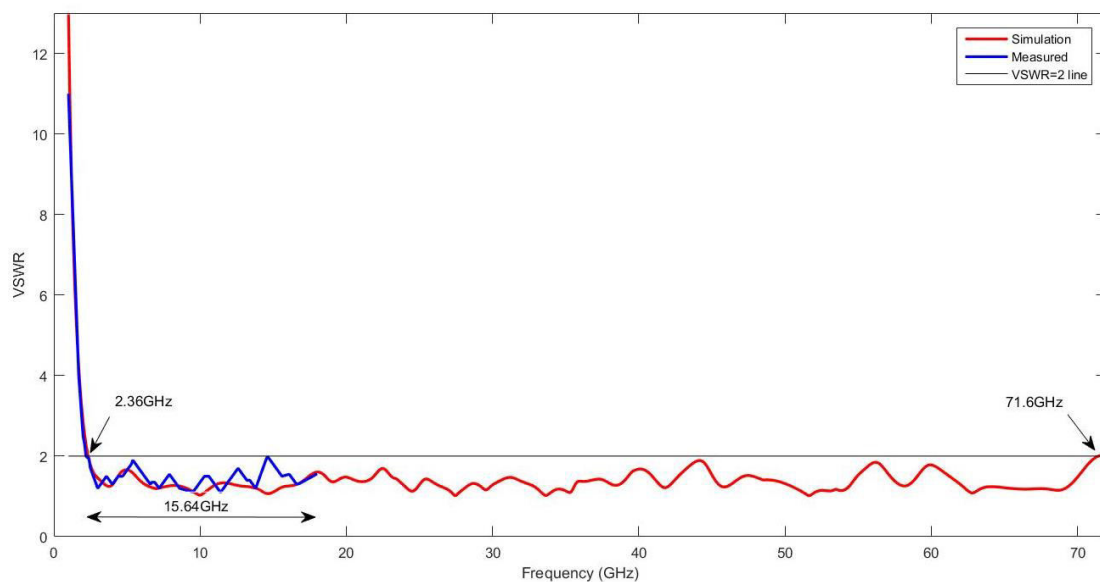


Figure-4. VSWR versus frequency of the proposed antenna.

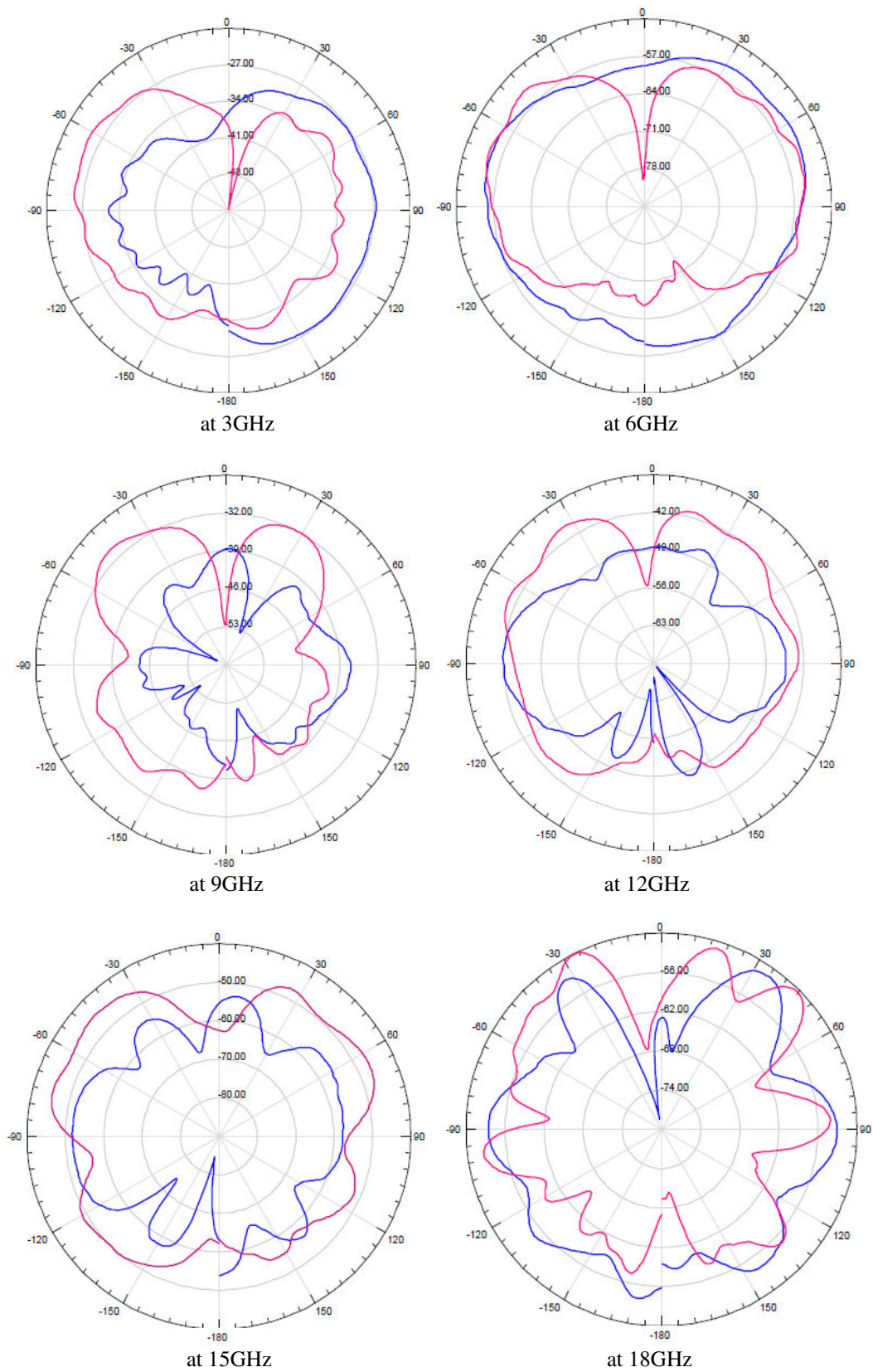


Figure-5. Measured E-plane (red colour) & H-plane (blue colour) radiation patterns.

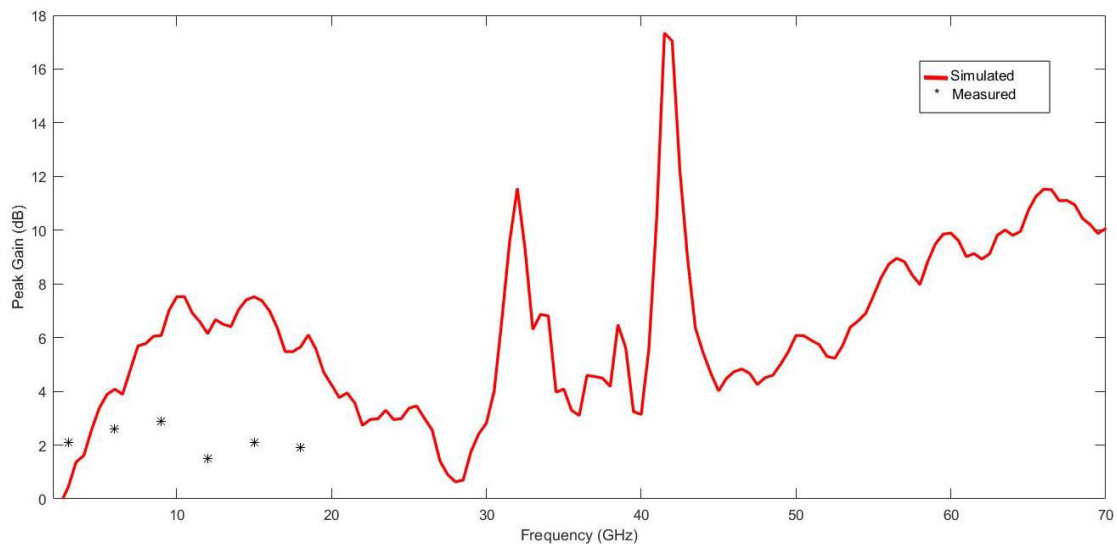


Figure-6. Measured and simulated gain versus frequency.

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