

# Microstrip Line Fed Fractal Monopole Antenna with Defected Ground Structure

S.S. Mohan Reddy<sup>1\*</sup>, M. Vinod Kumar<sup>1</sup>, B. Sanjay<sup>1</sup>, K. Aruna Kumari<sup>2</sup>, G. V. S. Padma Rao<sup>1</sup>

<sup>1</sup>Department of Electronics & Communication Engineering, SRKR Engineering College, Bhimavaram, Andhra Pradesh, India-534204

<sup>2</sup>Department of Computer Science & Engineering, SRKR Engineering College, Bhimavaram, Andhra Pradesh, India-534204

\*Corresponding author E-mail :rahulmohan720@gmail.com; Tel: +91-9849238118

## Abstract

This paper presents a wideband polarized antenna that is designed and analyzed for the cellular communication applications. The proposed antenna is designed with the coplanar wave guide feeding (CPW) by using the RT/ duroid 5880 material with a dielectric constant 2.2. It is observed that in the proposed model the return loss is -21.40dB for ungrounded CPW where as for the grounded CPW the loss is reduced to -39.13dB. The gain for the ungrounded CPW fed antenna is 2.95 dB and is enhanced to 3.2dB with grounded CPW structure. It is observed that there is an improvement in the bandwidth upto 6.03 GhZ for grounded CPW when DGS is applied. The antenna designing and simulation is done using ANSOFT HFSS software.

**Keywords:** CPW; feeding; DGS; grounded CPW.

## 1. Introduction

In the modern telecommunications systems Microstrip patch antenna has become more popular due to its compact size and simple to fabricate while the other antennas do not have this features [1]. The antenna with CPW feed consists of a substrate with a patch on it, the ground on either sides of the central conductor [2]. Wideband characteristics can be obtained with the CPW feeding antenna due to its zero cutoff frequency.

The microstrip patch antennas are widely used in the cellular communications, in Global Position Satellite and in satellite links [3][4][5]. The proposed antenna can be effectively used between 3 GHz to 9.24 GHz frequencies which is a wireless application range. It can cover the WIMAX and LTE42/43 systems [6]. The designed antenna operates in ultra-band with the bandwidth of 6.03 GHz by applying the Defective Ground Structure (DGS) for the grounded CPW fed antenna. The designed antenna is simulated and analyzed using the ANSOFT HFSS software [7].

## 2. FEEDING TECHNIQUE

There are several methods of feeding a microstrip patch antenna. The classification of these antennas is of two kind's namely contacting and non-contacting methods. The most popular feeding techniques are Line feeding, coaxial feeding, Aperture coupling and Proximity coupling

Here line feeding and coaxial feeding are a contacting method feeding techniques whereas aperture coupling and proximity coupling come under non-contacting schemes. In contacting method the RF power can be feed directly to the radiating patch using a connecting element, but in the non-contacting method the

with electromagnetic coupling the power gets transferred from the microstrip line to the radiating patch using.

In the line feeding the feed can be inscribed on the same substrate to provide a planar structure. The main advantage in the coaxial feeding is that feeding can be given at a point on the patch to provide better impedance matching. Generally aperture fed type consists of a two substrates. For the top substrate low dielectric material can be used whereas the bottom substrate can have material with high dielectric constant to optimize the better radiation from the patch. Proximity coupling improves the bandwidth by 13%.

## 3. ANTENNA DESIGN PARAMETERS

A circular patch antenna by using a coplanar wave guide feeding with an overall size of the substrate of 30\*30 mm<sup>2</sup> and the height of a substrate is 1.6mm has been designed. By cutting different slots with different shapes in the patch wide bandwidth is obtained with an improved Gain.

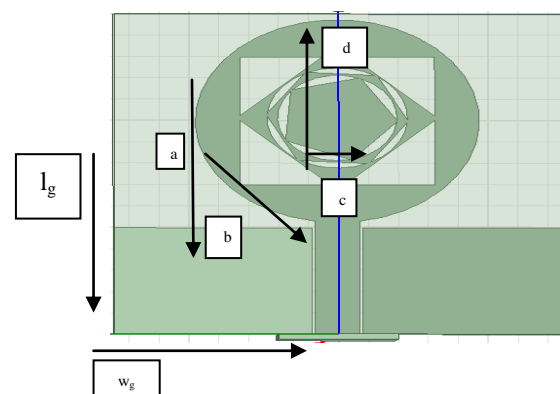


Fig. 1: Proposed antenna model

In the proposed circular patch antenna there are different shapes of slots such as square, rhombus, pentagon and hexagon. Here in this designed antenna different shapes of slots leads to enhance the bandwidth.

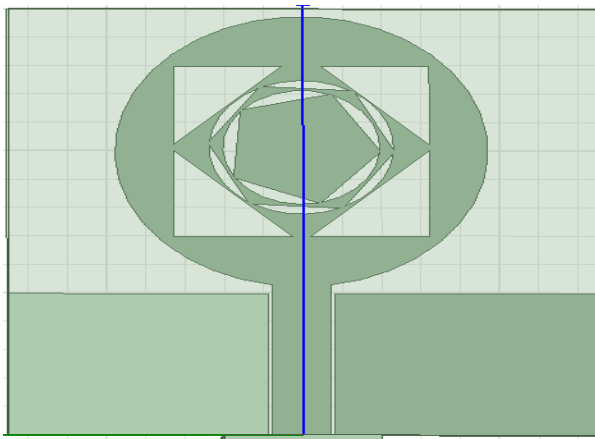
**Figure 1** shows the structure of the proposed antenna. For the stated variables in the designed antenna a, b, c, d, are the dimensions of the various geometrical shapes of slots on the patch and the dimensions are listed in the **Table 1**.

**Table 1:** Dimensions of the proposed antenna

Name of the parameter	Dimensions
Dimensions of the rectangle(a)	13*12mm <sup>2</sup>
Length of the rhombus(b)	9.5mm
Radius of the inner circle(c)	4.7mm
Radius of the outer circle(d)	9.5mm
Ground Length (l <sub>g</sub> )	10mm
Ground width (w <sub>g</sub> )	13.33mm
Length of the feed line	11.5mm
Width of the feed line	3mm
Substrate Length	30mm
Substrate width	30mm
Material	Rogers RT/duroid 5880

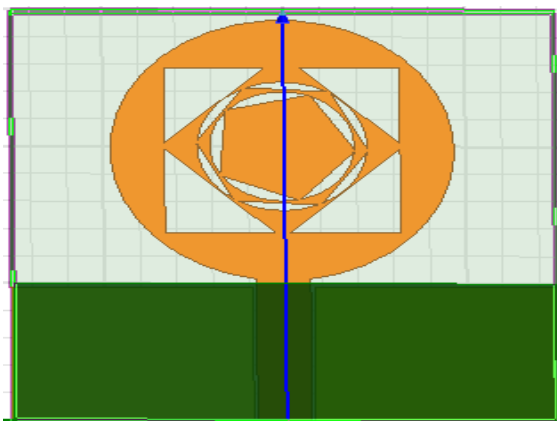
**4. Results and Discussions:**

This work mainly emphasizes on designing a circular patch by using CPW feeding with DGS (Defective ground structure). The material used in the proposed antenna is Rogers RT/duroid 5880 with the dielectric constant is 2.2. **Figure 2** displays the circular patch with ungrounded CPW.



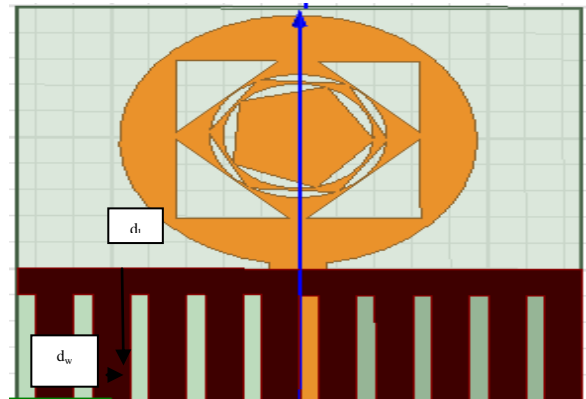
**Fig. 2:** Proposed antenna with the ungrounded CPW.

The designing of the circular patch with the grounded CPW feeding is displayed in the **Figure 3**.



**Fig. 3:** Proposed antenna with the grounded CPW.

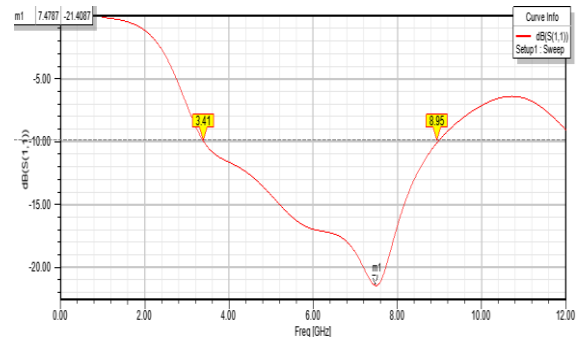
The designing of the proposed antenna with the grounded CPW with the DGS as shown in the **Figure 4**.



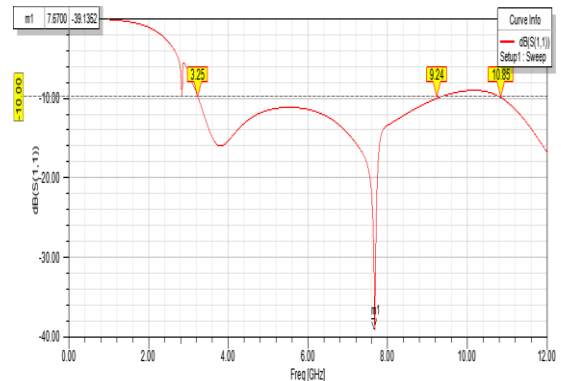
**Fig. 4:** Proposed antenna with the grounded CPW with DGS.

**Return loss plot:**

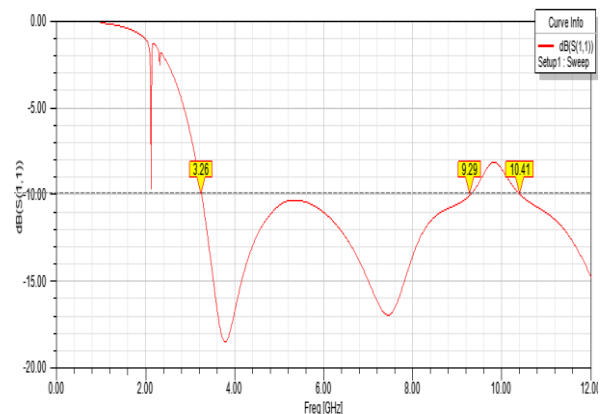
The s11 parameter indicates the amount of return loss. The plot represents the amount of reflected power from the antenna. To get excellent performance of the antenna the return loss should be less than -10db.



**Fig. 5:** Return loss vs. frequency for the ungrounded CPW.



**Fig. 6:** Return loss vs. frequency for the grounded CPW.



**Fig. 7:** Return loss vs. frequency for the grounded CPW with DGS.

Figure 5-7 show the s11 parameter for the proposed antenna. It was observed that the designed antenna operates in ultra-wide band (UWB) i.e., 5.54 GHZ for the ungrounded CPW feeding, a bandwidth of 5.99 GHZ for the grounded CPW and bandwidth of 6.03 GHZ for grounded CPW with DGS. The antenna has a return loss of -21.47dB with ungrounded CPW which considerably reduced to -39dB with grounded CPW and is found to have a return loss of -18.86dB when DGS is applied.

A. VSWR:

Figure 8-10 shows the VSWR for the proposed antenna without ground, with ground and with Defected Ground Structure.

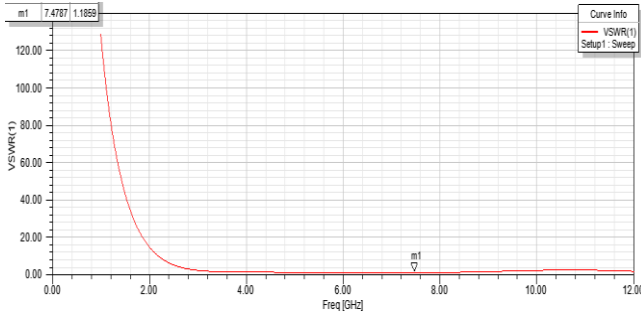


Fig. 8: VSWR for the circular shape patch for the ungrounded CPW

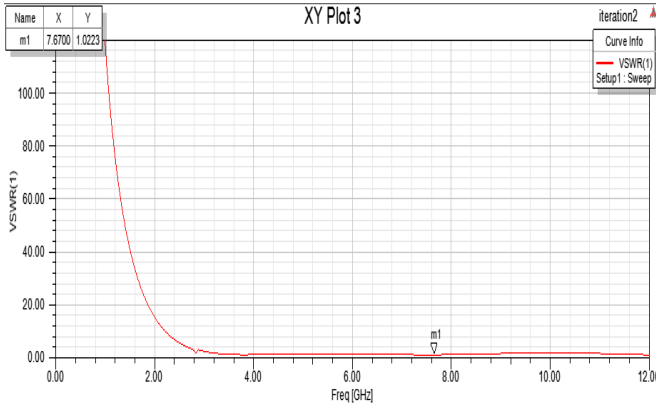


Fig. 9: VSWR for the circular shape patch for the grounded CPW

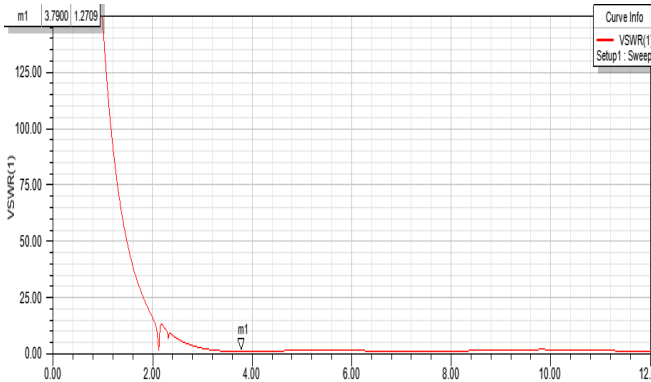


Fig. 10: VSWR for the circular shape patch for the grounded CPW with DGS

It was found that the VSWR for all the three designs is approximately equal to '1' which is the ideal condition.

B. Gain:

Figures 11-13 show the gain of the designed antenna for the ungrounded, grounded cpw without and with DGS respectively. It was observed that the antenna having the grounded CPW with and with out DGS is observed to have good gain around 3.25 dB .

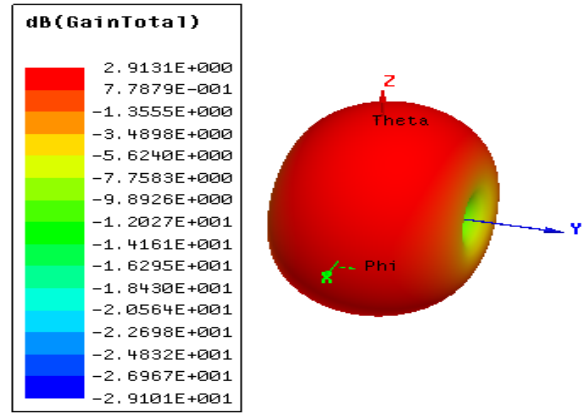


Fig. 11: Gain of the ungrounded CPW feed antenna

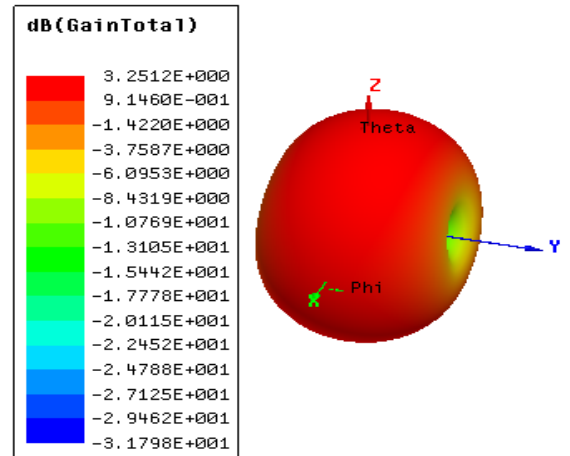


Fig. 12: Gain of the grounded CPW feed antenna

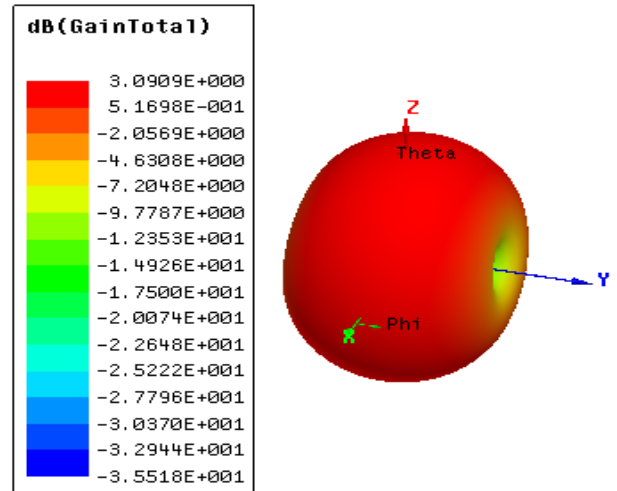


Fig. 13: Gain of the grounded CPW feed antenna with DGS

Parametric analysis:

The parametric analysis is done for the grounded CPW feeding with the DGS as listed in the below Table 2.

Table 2: Parametric analysis of the proposed antenna

parameter	Return loss	Bandwidth
D <sub>w</sub> = 1 mm	-46dB	1.8GHZ, 4.16 GHZ
D <sub>w</sub> = 1.4 mm	-20dB	5 GHZ
D <sub>w</sub> = 2 mm	-45dB	5.5 GHZ
D <sub>w</sub> = 2.4 mm	-27dB	5.4 GHZ
d <sub>1</sub> = 8 mm	-47 dB	5.55 GHZ
d <sub>x</sub> = 2.8mm	-40dB	5.6 GHZ
d <sub>x</sub> = 3mm	-18.86dB	6.03 GHZ

**Table 2** shows the parametric analysis results of the proposed antenna for the Defective ground structure. It was observed that the proposed antenna has better performance with  $d_x = 3\text{mm}$ . For this parameter the proposed antenna was observed to have a return loss of  $-18.86\text{dB}$  and a bandwidth of  $6.03\text{GHZ}$  which is ultra wide band and a good gain of  $3.0\text{dB}$ .

It was found that the proposed antenna operates in the frequency range of  $3.1\text{-}10\text{GHZ}$  with a wide bandwidth of about  $6.03\text{GHZ}$ . Table.3 shows the comparison of the simulated results.

**Table 3:** Simulated results of the proposed antenna

Parameter	Ungrounded CPW	Grounded CPW	Grounded CPW with DGS
Return loss	$-21.47\text{dB}$	$-39\text{dB}$	$-18.86$
VSWR	1.18	1.01	1.27
Gain	$2.91\text{dB}$	$3.25\text{dB}$	$3.01\text{dB}$
Bandwidth	$5.55\text{GHZ}$ ( $3.41\text{-}8.25$ )	$5.99\text{GHZ}$ ( $3.25\text{-}9.24$ )	$6.03\text{GHZ}$ ( $3.26\text{-}9.29$ )
No of bands	1(wide band)	1 (wide band)	1 (wide band)
Material used	RT/duroid 5880	RT/duroid 5880	RT/duroid 5880

The **Table 3** shows the simulated results of the proposed antenna. It was founded that the designed antenna has wide bandwidth with an acceptable gain.

## 5. Conclusion

The design and analysis of a Microstrip Line fed Fractal Monopole Antenna with DGS using a CPW feeding is presented in this paper. The designed antenna has a compact size ( $30*30*1.6\text{mm}^3$ ) with large operating bandwidth i.e.,  $6.03\text{GHZ}$  and a good gain around  $3\text{dB}$  is achieved. The return loss for the designed antenna with grounded CPW is  $-39\text{dB}$  which is very low when compare to the ungrounded CPW. This makes the antenna applicable for Wireless, Bluetooth and other UWB applications.

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