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# Design of Band Notch UWB Circular Microstrip Antenna

Dr. V. Rajya Lakshmi

***Abstract*— Design of a compact circular micro strip antenna with band notched Ultra-Wide Band (UWB) characteristics has been proposed. The proposed antenna consists of circular radiating patch with a micro strip line type feed structure and employs a simple defected ground structure (DGS) in a rectangular shape to achieve UWB operation. A notch is also designed to avoid the function of the antenna at 5.5 GHz to reject WLAN2 band from 5.15 to 5.825 GHz. The crux of this design strategy is that a 'C' shaped slot has been embedded onto the patch antenna to achieve band-stop filtering action at above mentioned frequency. Simulation of the design is done with CST MW Studio 2012 Electromagnetic Simulator.**

**Keywords— Circular Microstrip antenna, Ultra wide band antenna, Defected ground structure, Notch.**

## I. INTRODUCTION

A Micro Strip Antenna consists of a tiny metallic patch etched on a dielectric substrate [1]. These antennas are mechanically rugged, compact, conformable to planar and non-planar surfaces and relatively cheap to manufacture with the latest printed circuit technology. Apart from the rectangular micro strip antennas, circular micro strip antennas are also more popular due to their convenient shape. Various methods are proposed to design circular Microstrip antennas [2-3]. Antennas with broad bandwidths are always in demand so that various applications are covered by a single antenna. Antenna design is one of the primary challenges in the development of UWB systems especially when low cost, compact and radiation efficient structures are required for UWB and radar systems [4-6].

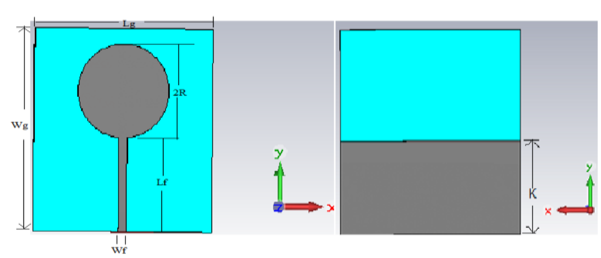
Since micro strip patch antennas inherently have narrow bandwidth characteristics, numerous methods have been reported in literature [7-12] and DGS is one of the popular techniques to achieve ultra - wide band width. It is a defect etched in the ground of a planar antenna and changes characteristics like inductance and capacitance of the transmission line. The equivalent circuit for a DGS is considered as parallel tuned circuit in series with the line to which it is coupled. The effective values of L, C and R are decided by the dimensions of the DGS structure and its position relative to the transmission line.

Dr. V. Rajyalakshmi, Associate professor, dept of ECE
Anil Nerukonda institute of technology and sciences
India

Ultra-wideband from 3.1 GHz to 10.6 GHz has been approved by FCC (Federal Communication Commission). But WLAN (Worldwide Local Area Network) which is operated in the range of 5.1 GHz to 5.8 GHz may interferes with UWB devices. Many researchers worked with rectangular Microstrip antennas for achieving UWB characteristics and employed very complex Defected ground structures leads to complexity in design as well as in fabrication. It is always desirable to avoid the interference between the UWB system and the other narrow band systems. So, one has to opt for band stop filters and it further increases complexity and cost of the system. Keeping in view of this, the above said design has been proposed which incorporates a very convenient rectangular DGS for a circular Microstrip antenna for UWB and a 'C' shaped slot for band notch characteristics at 5.5GHz.

## II. ANTENNA DESIGN

The proposed antenna consists of a circular patch with trimmed ground plane to achieve ultra-wideband performance and also this arrangement increases the flow of surface current through the feed-line and concentrates the surface current around the bottom of the radiating patch. First a circular patch with normal ground plane is designed using CST microwave StudioTM suite 2012 and then the ground plane is trimmed by removing rectangular shaped part using the extrude feature. Radiating patch and ground plane are made using PEC (Perfect Electrical Conductor) material. Dielectric material used here has relative permittivity= 2.2(Rogers RT 5880).Thickness of substrate= 0.79 mm, Length of substrate=35 mm, Width of substrate= 35 mm. The parametric study of the length of the ground plane is conducted to achieve the good ultra-wide band characteristics. The ground plane is trimmed in the dimension (17.8X35mm) to get the good UWB characteristics. The top and bottom views of the antenna are shown in Fig.1.The optimized dimensions along with description of every parameter is listed in Table.1




(a) Top view (b) Bottom view

Fig.1. Top view and bottom view of antenna with DGS.

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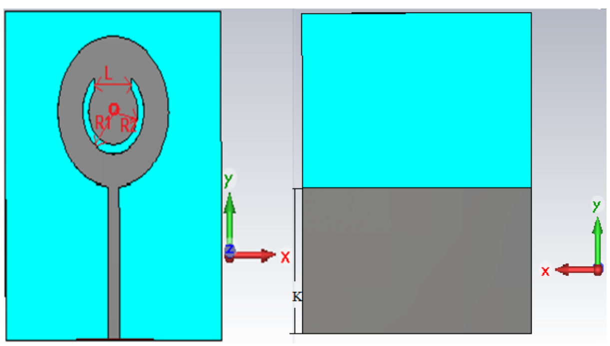
TABLE I. DIMENSIONS OF ANTENNA

| Parameter | Description | Value(mm) |
|---|---|---|
| $L_g$ | Length of substrate & ground | 35 |
| $W_g$ | Width of substrate & ground | 35 |
| $L_f$ | Length of feed line | 18 |
| $W_f$ | width of feed line | 1.8 |
| R | Radius of patch | 9 |
| K | Length of un defected ground | 17.8 |

To achieve notch characteristics, a 'C' shaped slot has been introduced. Antenna with slot dimensions are listed in Table.2 and the geometry is shown in Fig.2.The dimensions are obtained by optimizing different parameters like length between slot ends, inner and outer radii. It is found that by adjusting the total length of the slot, tuning of the notch Centre frequency is possible.




(a) Top view (b) Bottom view

Fig.2. Geometry of antenna with 'C' shaped slot.

TABLE II. DIMENSIONS OF 'C' SHAPED SLOT.

| Parameter | Description | Value(mm) |
|---|---|---|
| L | Length between ends of slot | 3 |
| R1 | Outer radius of 'C' shaped slot | 5 |
| R2 | Inner radius of 'C' shaped slot | 4 |

## III. RESULTS

The proposed antenna design is simulated with the CST Microwave Studio™ suite 2012 .In order to verify the performance of an antenna, parameters like VSWR vs. Frequency, Gain vs. Frequency and return loss vs. frequency plots are obtained.

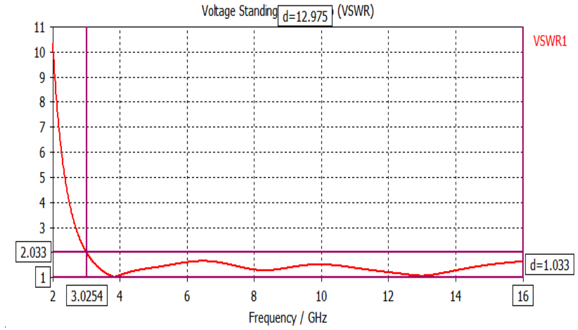



Fig.3. VSWR vs. frequency of the basic antenna

The VSWR vs. Frequency plot of the basic antenna is shown in Fig.3.The Voltage Standing Wave Ratio (VSWR) provides information related to the mismatch between an antenna and the feed line connecting to it. VSWR less than two is preferable for many applications. The antenna exhibits this value from 3 to 12 GHz. Fig.4 shows the VSWR characteristics of antenna with a slot. A band notch is observed in the frequency range of 5.1-5.9 GHz.

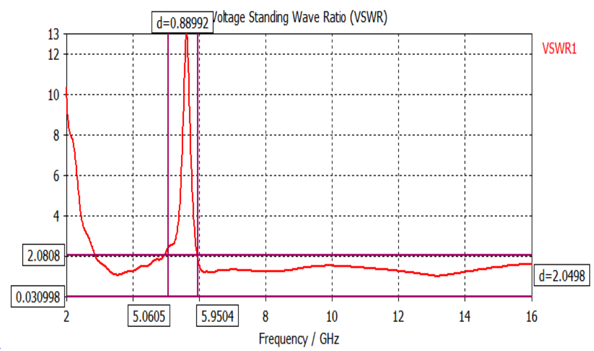
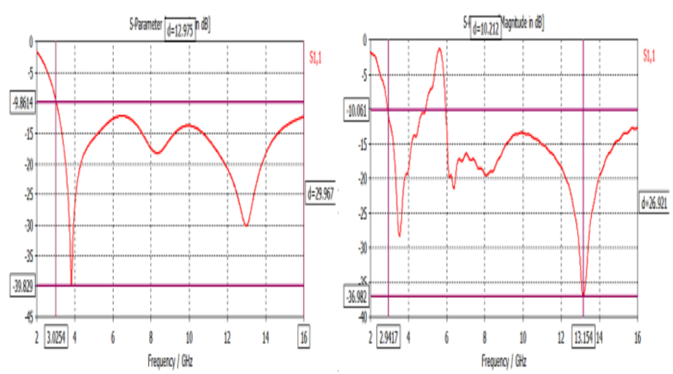



Fig.4. VSWR vs. frequency graph for the antenna with band notch at 5.5 GHz.



a) $S_{11}$ without band notch b) $S_{11}$ with band notch

Fig.5. Return loss vs. frequency of with and without 'C' shaped slot.

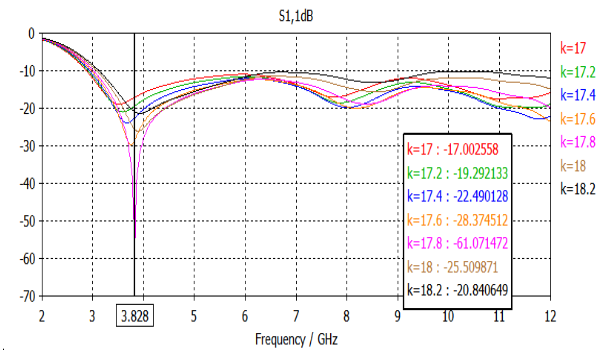



Fig.6. Return loss graph showing the effect of variation of length of ground plane.

Figures 5(a), 5(b) show the simulated Return loss plots of UWB characteristics without band notch and with band notch as -10dB as reference. Result of the parametric study on the length of ground plane is shown in Figure 6.and the optimum length found is 17.8mm in the range from 17 to 18.2 mm. From the surface current plot shown in Fig.7, it is clear that flow of surface current concentrates at the slot at 5.5GHz.

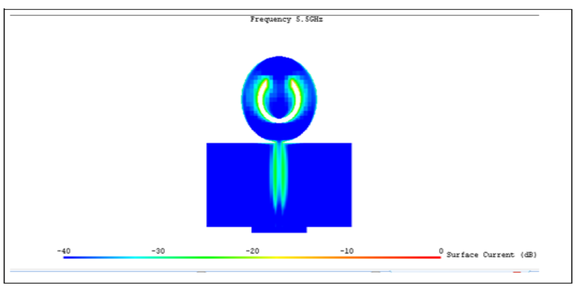


Fig.7. Surface Current distributions for band notch antenna at 5.5 GHz.

## CONCLUSION

Circular Microstrip antenna is designed to operate in 3.1-10.6 GHz range with rectangular Defected ground structure. Parametric study of length of ground plane on Return loss variation is conducted. To reduce the potential interferences between the UWB system and the narrow band system, i.e. WLAN2, a compact Microstrip line-fed planar UWB antenna with band rejection features at 5.1-5.9GHz is also designed.

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About Author:

Dr. Rajyalakshmi obtained her M.E and Ph.D from Andhra University in 2007 and 2012 respectively. At present she is working as associate professor in Anil Neerukonda institute of technology and sciences, vishakapatnam, India. She published more than 30 research papers in international conferences / journals. Her area of specialization is anteenas and microwaves