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Design of Dual Band U-Slots Circular Patch Antenna on Fr4 Substrate

D. Rama Devi[1*] and E. Kusuma Kumari[2]

[1]Dept. of ECE, MVGR College of Engineering, Vizianagaram, Andhrapradesh, India.
[2]Department of ECE, Sri Vasavi Engineering College, Tadepalligudem, Andhrapradesh, India

ABSRACT

This paper presents design andanalysis of probe fed dual U-shape slots antenna. The proposed antenna has simple structure consisting two U-shape slot on a circular patch of radius 13.1mm.The patch is designed on circular shape FR4 substrate material of radius 13.2mm,with height of 5mm and whose permittivity is 4.4.By using only single patch a high impedance bandwidth and dual bands are achieved. Simulated results shows that the return loss is - 24.65dB at the center frequency of exactly 7GHz and the simulated impedance bandwidth (VSWR<2) is 24% .The antenna is designed and simulated using HFSS software and theoretical results gives good agreement with simulated results. Return loss, 3D gain, radiation pattern are simulated for the proposed designed antenna was presented.

KEYWORDS: U-slot micro strip patch antenna,circular patch, FR4 substrate.

***Corresponding author**

Dr. D. Rama Devi

Professor

Department of Electronics and communications engineering,

MVGR College of Engineering,

Vizianagaram, A.P. INDIA.

Email: rama@mvgrce.edu.in, Mob No – 9440578334

INTRODUCTION

Microstrip patch antenna in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. Radiation from microstrip antennas occurs from the fringing fields between the edge of the microstrip antenna conductor and the ground plane.Extensive research and development of microstrip antennas and arrays, exploiting the numerous advantages such as light weight, low volume, low cost, planarconfiguration, compatibility with integrated circuits have led to develop the proposed design model. The proposed antenna design operates at 7.1GHz finds applications in the S-band which includes Microwave Device communications, wireless, LAN, communications satellites, WLAN(Wi-F), wimax, Radars.

The disadvantage of MSPA is narrow bandwidth. To improve the bandwidth recent research efforts have been devoted. A high permittivity substrate could be used but this approach increases the coupling between the antenna and the ground plane. Embedding a suitable U-shaped slot in circular shape radiating patch is a very effective method for achieving a wide bandwidth. Several U-slot patch antennas has been reported recently to improve bandwidth [4,5,6]. In this paper U-slot is designed on circular patch to achieve more compactness and high impedance bandwidth.

Conventional Microstrip patch antenna designs with thick substrate layer causes major problem associated with impedance matching. The proposed antenna is designed on FR4 substrate material which is low density, less weight material for high performance weight sensitive applications. The very low dielectric constant of FR4 laminates is uniform from panel to panel and is constant over a wide frequency range. Applications include airborne antenna system, light weight feed network, military radar systems, missile guidance system and point to point digital radio antennas.

The proposed antenna is designed using HFSS software. It is a state of the art system for high frequency structure simulation. The main components are modeler, quickwave simulator, quickwave2D, CLASP, SOPRANO/EV and post processor. This provides a complete tool chain for RF and microwave electromagnetic design for use on 32 or 64 bit windows platform. Modeler is used to generate data and models for electromagnetic simulation

ANTENNA DESIGN

In this part, the antenna design steps of microstrip slot antenna are presented. Substrate selection is the first practical step in designing a patch antenna. The structure of the proposed microstrip slot antenna in this paper utilizes dielectric material FR4 with dielectric constant of 4 as the substrate with the dielectric loss of 0.02.

$$F_{=} 8.791\times10^{9} \qquad 1$$

$$\frac{}{f_r \sqrt{\varepsilon_r}}$$

ANTENNA DESIGN SPECIFICATION

The geometrical configuration of the proposed U shape slot circular micro-strip patch antenna shown, gives dimensions of each element used to design the patch.

DESIGN DIMENSIONS OF U-SLOT CIRCULR PATCH ANTENNA

Table.1 Optimized dimensions of Proposed Antenna

S No	Parameters	Size (mm)
1	Patch circular Radius	13.1
2	Height	0.05
3	U-slot1length	15
4	U-slot1 width	0.2
5	U-slot2length	13
6	U-slot2 width	0.2
7	Distance between patch and U-slot	4.5
8	Substrate circular Radius	13.2
9	Substrate height	5
10	Feed inner radius	0.7
11	Feed outer radius	1.6

DESIGIN OF CIRCULAR PATCH ANTENNA WITHOUTU-SLOT

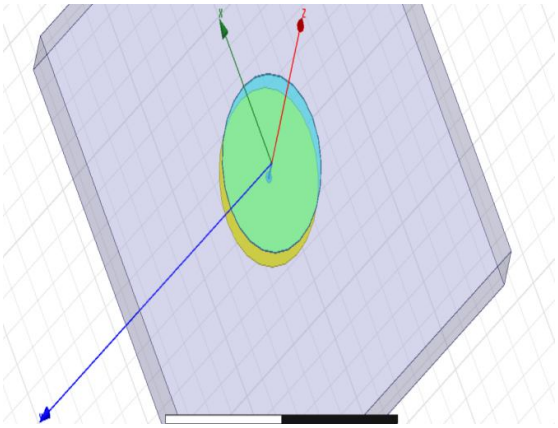

Figure 1.Simple structure of circular patch without U-slot with operating frequency of 7.1GHZ

DESIGIN OF CIRCULAR PATCH ANTENNA WITH U-SLOT

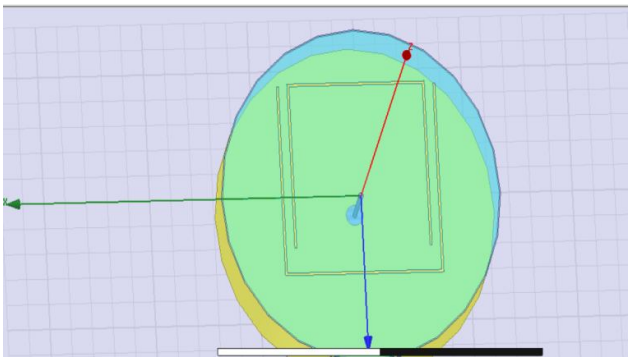

Figure2. Simple structure of circular patch with dual U-slots with operating frequency of 7.1GHZ.
By comparing fig 1 and 2 the U-slot was introduced in the patch. It can be observed that adding U-slots with certain dimensions in the patch, there has been observed that triple bands of frequencies are obtained.

RESULTS AND ANALYSIS

Return loss:

It is the measure of the reflected energy from a transmitted signal. It is commonly expressed in positive dB. The larger the value the less energy that is reflected**.**A good antenna might have a value of -10dB return loss as 90 % of the signal is absorbed and 10% is reflected back.

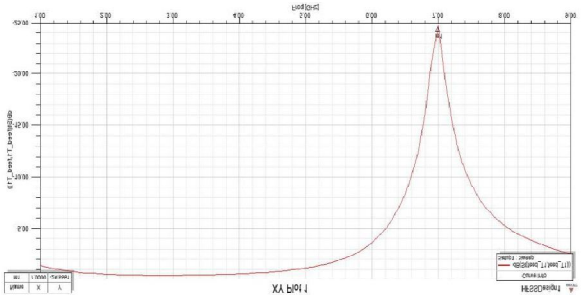

Figure 3.Return loss of circular patch without U-slot is 24.65 at 7GHZ

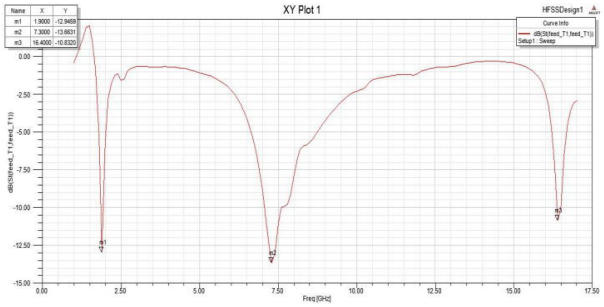

Figure 4. Return loss of circular patch double U-slot shows tri band

1. At 1.9GHZ the return loss is 12.94dB.
2. At 7.3GHZ the return loss is 13.66dB.
3. At 16.4GHZ the return loss is 10.63dB.

3D GAIN

The term antenna gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source.

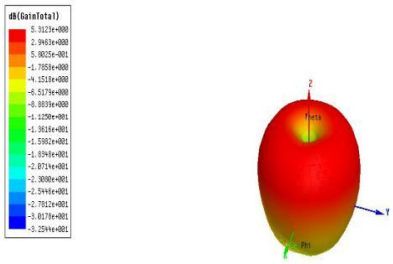

Figure 5. Gain of circular patch without slot is 5.312dBi at 7GHZ.

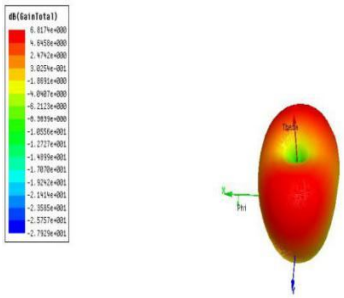

Figure 6. Gain of circular patch double U- slot is 13.1dBi at 1.9GHZ.

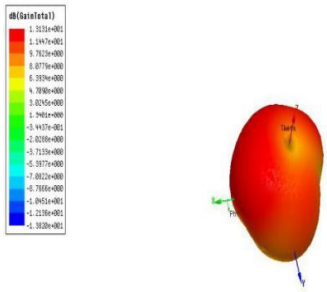

Figure7. Gain of circular patch double slot is 6.81dBi at 7.3GHZ.

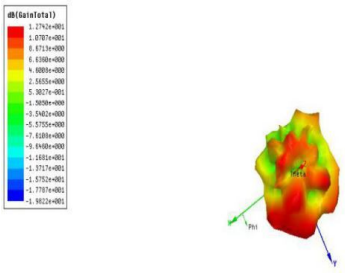

Figure 8. Gain of circular patch double slot is 12.74dBi at 7.3GHZ.

VSWR

The VSWR is a measure of the impedance mismatch between the transmitter and the antenna. The higher the VSWR the greater is the mismatch VSWR which corresponds to a perfect match is unity.

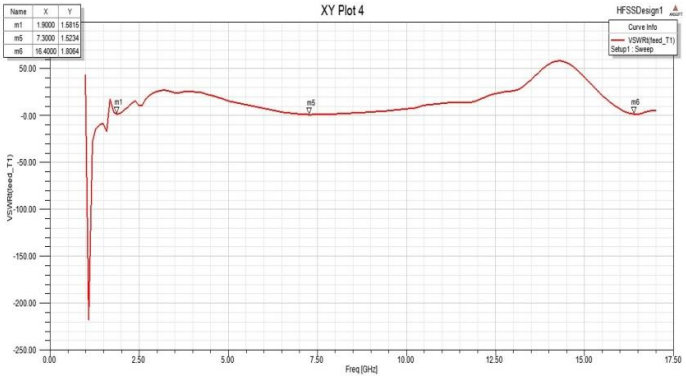

Figure 9. VSWR of circular patch with double U-slot

CONCLUSIONS

In the present work, double u-slot circular antenna is designed by using coaxial probe feed.For triple-band dual U-slots patch antenna the resonantfrequency that we achieved is7GHZ, without U-slot at an operating frequency of 7.1 GHZ.The resonant frequencies are 1.9GHz, 7.3GHz, 16.4GHz.The proposed antenna can be considered to achieve multi-band just through etching U-slot on the circularpatch, so it can be much easier to fabricate.These bands are extensively used for wireless applications.All antennas simulated results of return loss, gain, and radiation patterns have been analyzed using Ansoft HFSS simulation software.

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