

DESIGN OF MULTIBAND CIRCULAR MICROSTRIP PATCH ANTENNA

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Abstract - In this paper design of a compact circular micro strip antenna with multiband characteristics has been proposed. The proposed antenna consists of circular radiating patch with a micro strip line type feed structure and employs a simple notch in feed line which gives multiple band of frequency. Maximum gain is 4.58 db. The crux of this design strategy is that a 'U' shaped slot has been embedded onto the patch antenna to achieve band stop filtering action at above mentioned frequency. Antenna has been designed on a FR4 substrate with dielectric constant $\epsilon_r = 4.4$, loss tangent ($\tan \delta$) = 0.02. The radiation pattern is omnidirectional. Simulation of the design is done with HFSS.

Key Words: Microstrip line feed, Multiband, Ultra Wide Band, Circular Patch, Notch, etc.

1. INTRODUCTION

A microstrip antenna is low profile and light weight device. Microstrip antenna widely used in the defense systems like missiles, aircraft, satellites and rockets. The large bandwidth of UWB antennas will improve the performance in the various applications of communication. 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]. UWB also have wide applications in short range and high speed wireless systems, such as ground penetrating radars, medical imaging system, high data rate wireless local area networks WLAN (5.15-5.35 and 5.725-5.825 GHz), downlink of X-band satellite communication systems (7.25-7.75 GHz) and ITU (8.025-8.4 GHz). Many techniques have already been applied to

design wide band antennas for different applications, one of which to increase the bandwidth. Since microstrip patch antennas inherently have narrow bandwidth characteristic, there have been numerous techniques developed for bandwidth enhancement in order to achieve the UWB characteristics [7]. Notch loading is a good solution to minimize and enhance the impedance mismatch and bandwidth [8-14] respectively.

2. ANTENNA DESIGN CONCEPTS

The proposed monopole antenna fig -1 is designed to work on FR-4 substrate having relative permittivity $\epsilon_r = 4.4$. To obtain impedance matching between the feeding and the radiation element, the signal strip width of the upper-side will be cut from radiating disk element. The antenna size is 50 mm * 64 mm and is separated from the ground plane by 1.6mm. The antenna is named "electrically small" as its largest dimension is 0.16λ .

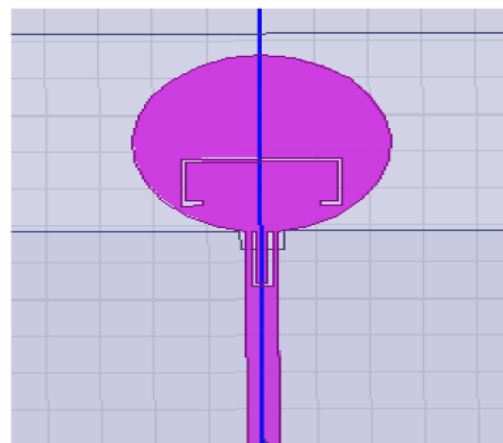


Fig -1 Design of Circular micro strip patch Antenna

The radiation element is a disk patch, where R denotes the radius of the circle with value of 12 mm & feed length is 34.6mm. The resonant frequency (f_r) can be calculated as:

$$f_r = \frac{c}{2L} \sqrt{\frac{2}{\epsilon_r + 1}}$$

Where c is the speed of light in free space and ϵ_r is the relative permittivity of the substrate material.

3. RESULT ANALYSIS

For proper transmission of signal by antenna the S11 parameter of antenna should be less than -10dB. It exhibits three band. Fig-2 shows simulated result of multiband characteristics from 1.5 GHz to 2.8 GHz, 3.3 GHz to 4.7 GHz & 6 GHz to 16.10 GHz with 10.10 GHz of bandwidth. This antenna can work well for multi-band applications viz digital communication system (DCS, 1710-1880MHz), personal communication System (PCS, 1850-1990MHz), universal mobile telecommunication system (UMTS, 1920-2170MHz), global positioning system (GPS), The frequency bands that are covered by this antenna is suitable for IMT (3400-3600 MHz), C-band (3400-4200 MHz) and WiMAX (3400-3690 MHz) also X band (8-12 GHz) wireless application.

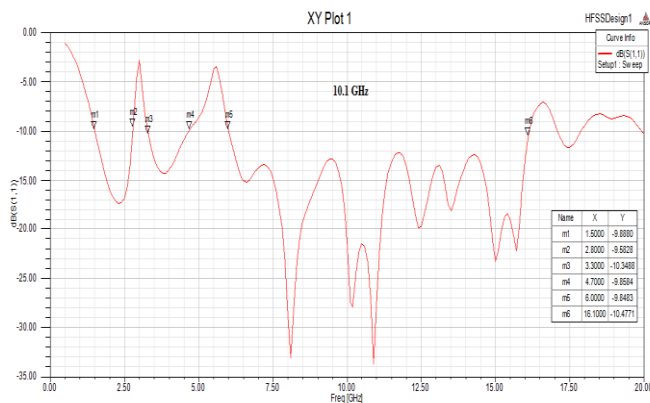


Fig -2 Return loss (dB) vs. frequency (GHz)

Fig-3 shows simulated result of VSWR. VSWR is less than 2 for multiband frequency which are shown in above figure.

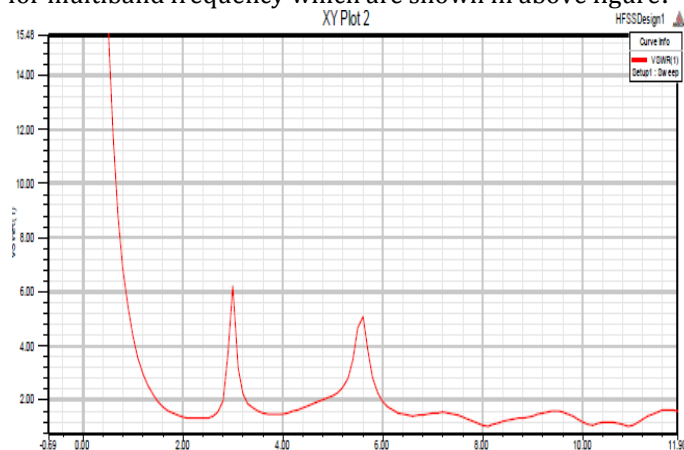


Fig -3 VSWR

This antenna gives maximum gain of 4.58 dB & efficiency is throughout above 80% for operating frequency band.

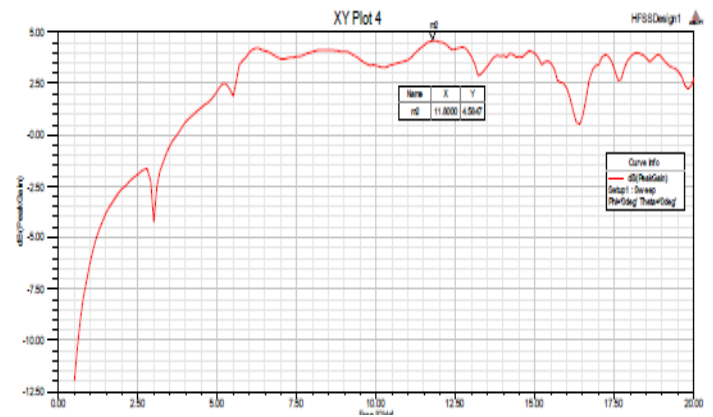


Fig - 4 Gain of antenna

4. CONCLUSIONS

The microstrip circular patch antenna for multiband applications has been simulated on FR4 substrate having thickness 1.6mm with dielectric constant of $\epsilon_r=4.4$. Final fabricated antenna exhibit UWB characteristic from 6 GHz to 16.10 GHz with VSWR value less than 2. It exhibit 10.10 GHz bandwidth and maximum return loss -42dB. Radiation efficiency of antenna is 86.17% throughout frequency band with maximum gain 4.58dB. It exhibits omnidirectional radiation pattern. It also provides an improved performance with respect to return loss, bandwidth, VSWR, gain. The design provides a flexible, reliable and cost effective approach for multiband application using notch on circular patch. The design structure of antenna can be used in L-band, C-band & X-band wireless application where antenna needs to have high bandwidth with moderate gain.

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