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Study and Design Microstrip Patch Antenna for UWB Application

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Abstract- A design of compact size CPW fed microstrip antenna is studied and designed that have its applications in UWB, WiMAX, WLAN frequency range. In this paper, the antenna is fed by a CPW feeding technique and printed on a dielectric Fr4 substrate of dimension (23mm X 25.3 mm X 1.6mm) permittivity εr =4.4 and height h = 1.6 mm. The optimization on the microstrip has been done to accomplish an -10 dB return loss criterion. The antenna design parameters and performances have been investigated through a number of design simulations. Design parameters like slots variation, feed size which affect the performance of the antenna in terms of its frequency domain and time domain characteristics are investigated for UWB application. Proposed Antenna is designed using IE3D antenna design tool.

Key words:- Microstrip-feed, slot antenna, ultra wideband (UWB) antenna.

1. INTRODUCTION

Ultra-wideband (UWB) radio is an emerging technology with uniquely attractive features inviting major advances in wireless communications, networking, and radar, imaging and positioning systems [1]. In the U.S., the Federal Communications Commission (FCC) allocated the frequency band 3.1-10.6 GHz for UWB applications in 2002. In either conventional communication systems or UWB communication systems, an antenna plays a very crucial role. Owing to its wide bandwidth, high data rate, and short-range characteristics, ultra wideband (UWB) communicationhas been widely used in radar and miniature laptop applications [2]. It can also be used in a wireless body area network (WBAN) and a wireless personal area network (WPAN), in the future. Ultra Wideband Radio (UWB) is a potentially revolutionary approach to wireless communication in that it transmits and receives pulse based waveforms compressed in time rather than sinusoidal waveforms compressed in frequency [3]. In addition, for miniaturizing the wireless communication system, the antenna must also be small enough to be placed inside the system. To achieve this, planar monopole antennas are good candidates for wide-band applications, as they exhibit wide impedance bandwidth, compact and simple structure, and ease of construction. Moreover, the omnidirectional radiation properties of monopole antenna make them very suitable for base-station and for indoor applications [4].

Recently, there are various types of UWB antennas which have been designed to achieve the requirement for different applications. The compact size microstrip antenna is presented that have its applications in UWB frequency range is proposed [5]. Its bandwidth is impressive in view of its mechanical simplicity. However, it is not the most suitable for portable communication systems due to the size of the antenna. A new modified low profile small size UWB antenna is investigated. In this paper, a Microstrip-fed Planar UWB antenna with Defected ground plane is used to improve the bandwidth, radiation characteristics and overall performance of antenna [5].

2. ANTENNA GEOMETRY

2.1 Antenna 1

A design of compact size microstrip antenna is designed that have its applications in UWB frequency range is shown in figure 1. The antenna is fed by a microstrip feeding technique and printed on a dielectric Fr4 substrate of dimension (23mm X 23.5 mm X 1.6mm) permittivity =4.4 and height h = 1.6 mm. The optimization on the microstrip has been done to accomplish an -10 dB return loss criterion.

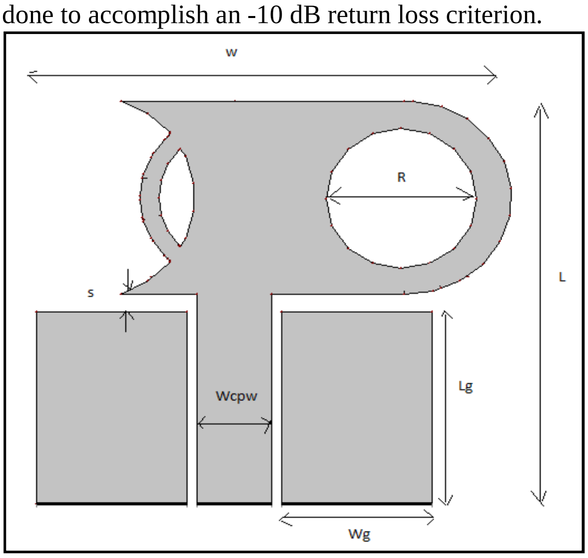

Figure 1: Antenna Geometry

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Table 1: Antenna Description

L	23mm
W	25.3mm
Lg	11mm
Wg	8mm
Wcpw	4mm
S	1mm
R	8mm

(a) Calculation of width of patch:
The width of the antenna is calculated by equation

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}} \times \sqrt{\frac{2}{\varepsilon_r+1}}$$

(b) **Calculation of effective dielectric constant**:
The effective dielectric is calculated by equation

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+12\frac{h}{W}}}$$

(c) **Calculation of the effective length:**
The effective length is calculated using equation

$$f_r = \frac{1}{2L\sqrt{\varepsilon_r\varepsilon_o\mu_o}} = \frac{v_o}{2L\sqrt{\varepsilon_r}}$$

3. RESULTS AND DISCUSSION

(a) S-Parameter
Figure 2 shows S-parameters which describe the input-output relationship between ports (or terminals) in an electrical system. For instance, if we have 2 ports (intelligently called Port 1 and Port 2), then S12 represents the power transferred from Port 1 to Port 2. S21 represents the power transferred from Port 2 to Port 1. The S-parameter of above designed is shown in figure 4.2. The antenna is resonate at 5.25 GHz . And its covers the high bands of UWB applications, which consists of eleven channels and occupies the spectrum from 6.0 GHz to 10.6 GHz. Total bandwidth of antenna is 6.8 GHz in the working frequency of 4.5 GHz to 11.3 GHz. The total gain of the antenna is 3.38894 dBi and the efficiency of the antenna is 87.32%. Radiation efficiency of the antenna is 88.41%.

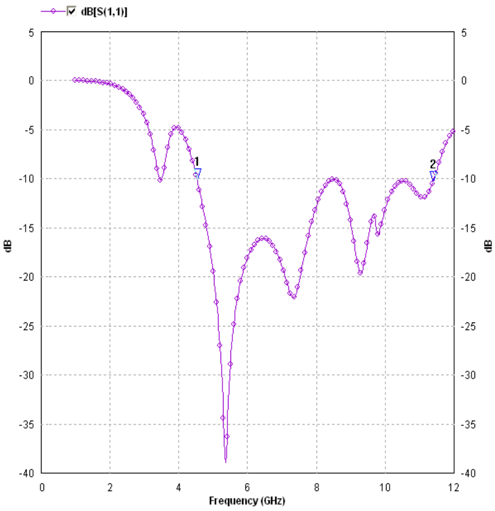

Figure 2:- S-Parameter

(b) ***VSWR***

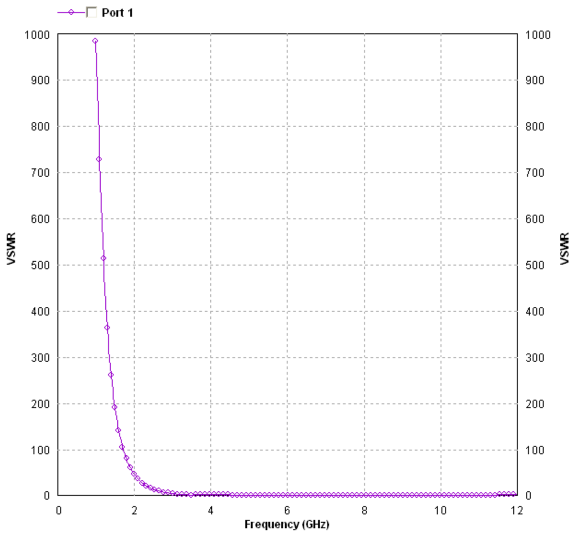

Figure 3:-Frequency (GHz) versus VSWR plot

VSWR graph is shown in figure 3 and it is defined in terms of the input reflection coefficient г as:

$$\text{VSWR} = \frac{1+|\Gamma|}{1-|\Gamma|}$$

 is defined in terms of input impedance *Z*in of the antenna and the characteristic impedance *Z*0 of the feed line as given below

$$\Gamma = \frac{Zin - Zo}{Zin + Zo}$$

c. Radiation Pattern
A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation as a function of the arrival angle is observed in the far

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field. In Figure 4, simulated 2D radiation pattern 3-D radiation patternis shown respectively. An antenna pattern is graphical representation or mathematical function which describes radiation property of antenna with respect to space coordinate.

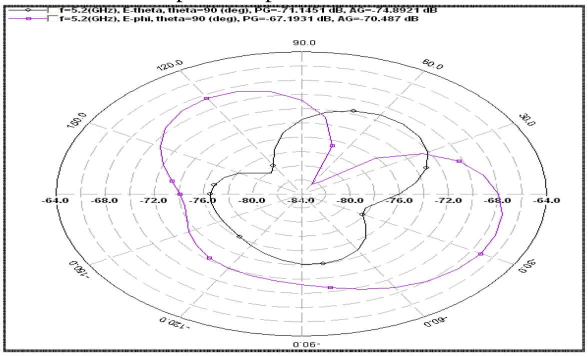

Figure 4 .1 2:-D Azimuth Radiation Pattern

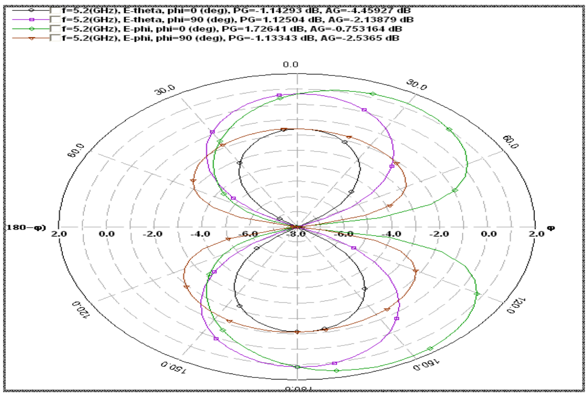

Figure 4.2 2:-D Elevation Radiation Pattern

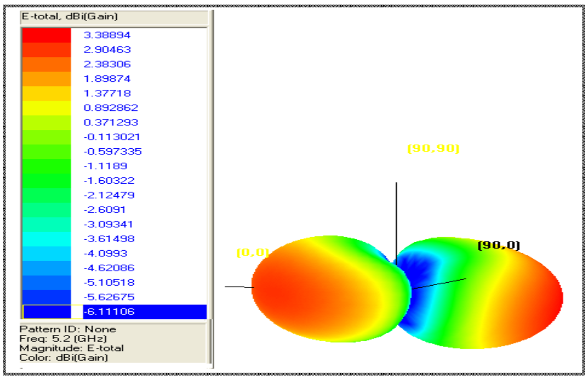

Figure 4.3 3:--D Radiation Pattern

4. CONCLUSION

In this paper, a microstrip-fed ultra-wideband planar monopole antenna is designed and studied. This antenna is low profile small size antenna. Antenna operates in the specified UWB, Wi MAX, WLAN range. The simulation results and other measurement results of the designed antenna show a good agreement in terms of the VSWR, S-Parameter, and Radiation Pattern.

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