DESIGN AND IMPLEMENTATION OF MICROSTRIP ANTENNA FOR WIRELESS APPLICATION IN UWB REGION

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Abstract

A Ultra Wide Band Antenna (UWB) with notched band is proposed and to be analyzed. It consists of square radiating Patch and the grounded plane. The Notched band characteristics are analyzed using T-shaped stubs embedded in the square slot of the radiation patch and a pair of U-shaped parasitic strips beside the feed line. The results that are to be measure using the proposed notched-band planar antenna is the rejection of the bands,3.3-4.0 GHz (WiMAX),5.05-5.90 GHz (WLAN),5.5 GHz (DSRC) and 6.2-9.5 GHz (FIXED WIRELESS AND RADIO LOCATION) respectively. And to offer dedicated service in three bands. Both experimental and simulated results of the proposed antenna are to be analyzed indicating that the antenna is attracted for various UWB Applications.

Keywords: *riple notched bands, Ultrawide band (UWB) Antenna, Microstrip Antenna.*

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1. INTRODUCTION

In recent years, wireless communication is becoming more popular. The technologies for wireless communication are increasing day by day to satisfy higher resolution and data rate requirements. In recent years communication is carried out in ultra wideband (UWB) region, where high data transmission rates, low power consumption and simple hardware configuration is achieved. Radio frequency spectrum is spread from 3 KHz to 300 KHz. Federal Communications Commission (FCC) approved the rules for the commercial use of ultra wide band (UWB) in 2002. The frequency range of UWB region is 3.1-10.6 GHz.UWB pulses are very short. Hence the signal reflections does not overlap also multipath fading of narrow band signals does not **exsist.**

The Ultra wideband characteristics are suitable for short distance communication, such as PC peripherals. Hence UWB systems tend to be in short-range in indoor applications. Because of short duration of UWB pulses, it is easier to produce high data rates. Communication can be carried out using UWB region for radio frequency sensitive environment, in case of hospitals. Various antennas for wide band operation have been studied for communications and radar systems. The design of ultra wideband is complicated due to its size, cost and simplicity which is to be achieved.

One of the key issue in design of ultra wideband antenna is providing wide band characteristics over the whole operating band. Some of the wide band configurations of antenna are circular, rectangle, hexagonal, pentagonal have been proposed for UWB applications. Nowadays double notched and triple notched band antenna are gaining more importance. In this design, the microstrip UWB antenna with band notched characteristics is presented.

To achieve the band notched characteristics, a square slot is itched in the rectangular radiating patch. T-stubs and U-stubs are introduced in the patch and the feed line respectively. The notched bands are introduced at the following regions, DSRC [12], WiMAX, WLAN [13],FIXED WIRELESS AND RADIO LOCATION, in order to provide dedicated communication without overlapping with neighbouring regions. The antenna is designed and fabricated to demonstrate the proposed strategy. The proposed antenna is to be simulated using CST microwave studio, one commercial 3-D full-wave electromagnetic simulation software.

2. GEOMETRICAL CONSTRUCTION OF THE ANTENNA

The rectangular microstrip antenna is fabricated on FR4 substrate with dielectric constant of 4.5 and thickness of 0.1mm. The microstrip antenna has three layers. Top layer is the radiating patch, middle layer is the substrate and the bottom layer is the ground plane. The top patch and ground plane are made up of copper.

The middle layer is made up of FR 4 substrate [4]-[11]. In order to connect the transmitter and receiver, transmission line is a mandatory. Since antennas are high frequency components, transmission line effects are very important. The transmission line used here is microstrip transmission line to feed the antennas. Waveguide port is used for the propagation of power into the system from outside. The port construction is shown in figure 1.

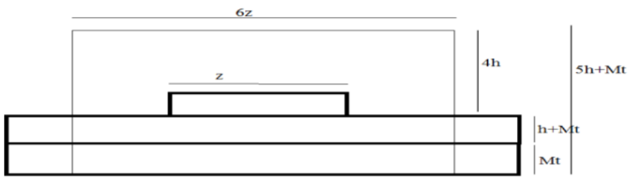

Fig-1: Port Construction of UWB Antenna

The frequency of operation of the antenna depends upon the length and width of the antenna. The length and width of the antenna can be calculated using equations given below.

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_o \varepsilon_r \mu_o}}$$

$$W = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where $c=3*10^8$ m/s,εr=4.5

3. MICROSTRIP ANTENNA WITH BAND NOTCHED STRUCTURES

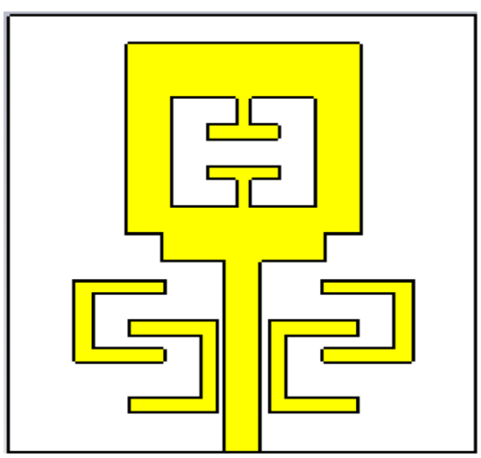

Fig-2: Configuration of Antenna with Notched Bands

The proposed microstrip UWB antenna with band notched structures is shown in figure 2. Notch bands are achieved by introduction of T-shaped stubs and U-shaped stubs. The T-stubs are introduced in the itched slot in the radiating patch.U-shaped slots are introduced near the feed line of the UWB antenna [13]. The antenna with central operating frequencies 6 GHz,8.4 GHz are obtained. The notched band and the operating frequency of the antenna are analysed using the return loss plot. The fabricated Antenna is shown in figure 3. Notched band is calculated using the formula given below

$$f_{notch} = \frac{C}{2L\sqrt{\varepsilon_r}}$$

Where L-Length of the stub (L1+2*L2) ;εr=4.5;c-speed of the light.

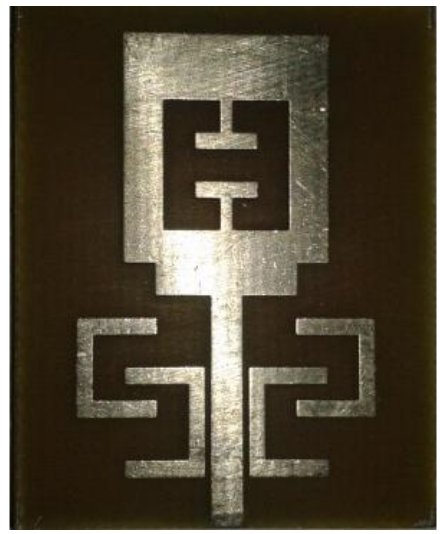

Fig-3: Fabricated Antenna

4. ANTENNA DIMENSIONS

Based on the frequency of operation and notched frequency the length and width of the antenna and the slots that is to be introduced are found. The dimensions of antenna are as follows, L=16; W=13; m=14; n=6.5; a=2; b=2; s=16; u=4;f=13.5;h=4.5;Mt=0.1;c=4;g=0.8;j=2;i=0.4;U_1=6.6;U_2=5.

5. RETURN LOSS PLOT

The Notched bands are found using the return loss plot. Return loss is the loss of signal power from the reflection from transmission line/optical fiber. The impedance matching can be measured from return loss plot. The device/load generates the waves, which interferes with the waves generated from other side. If both the waves interferes together, then standing waves are produced. If the return loss increases,the standing waves produced are minimized. The matching of devices and lines are analysed using return loss plot. Return loss is releated to standing wave ratio (SWR) and the reflection co-efficient.Return loss is found using the formula,

$$R_L\,(db) = 10log_{10}\,\frac{P_i}{P_r}$$

Pi - incident power
Pr - reflected power

Mathematically, return loss is calculated using,

$$RL_{input} = 20log_{10}|S_{11}|\ dB$$

Where S11 (complex number) here represents the input port (Scattering parameter of input port). Return loss is closely related to scattering parameter. This is used to model high frequency N-port liner electrical network. The S-parameter are arranged in the form of matrix. S-matrix consist of N^2elements of N-port networks.The designed antenna has only one input port, hence only one port S_{11} is considered here. The S_{11} is otherwise known as reflection co-efficient. When the magnitude of S_{11} expressed in decibel, it is known as return loss of input port.

Return loss plot is the plot of frequency (GHz) in x-axis and return loss (S_{11}) in y-axis. Using this plot we can conclude whether the antenna is single band or multi band antenna. The figure 4 below shows the return loss plot of designed antenna. The three peaks here shows the rejection of three frequencies 3.3-4.0 GHz (WiMAX) and 5.05-5.90GHz (WLAN),5.5GHz (DSRC),6.2-9.5 GHz (FIXED WIRELSS AND RADIO LOCATION) respectively. From the figure below we conclude the antenna is multi band antenna.

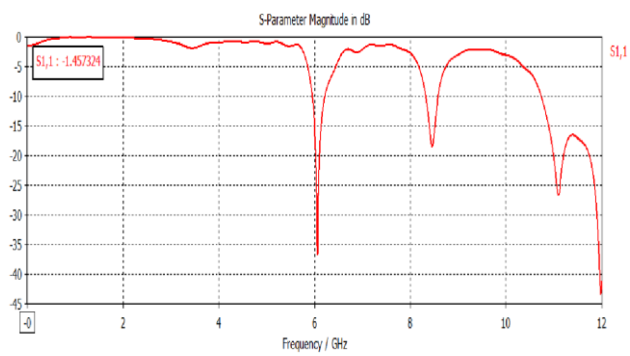

Fig-4: S11 (Return loss) plot. B and rejection characteristics of UWB Antenna

6. VSWR PLOT

VSWR stands for **Voltage Standing Wave Ratio.** VSWR is the reflection co-efficient, which describes the power reflected from the antenna. The VSWR is always real and positive. The antenna is well matched to the transmission line and the power delivered is high for smaller values of VSWR. No power is reflected from the antenna in the ideal case, when VSWR is 1.0. The value can range till 7.0. In our case the VSWR value is 2. Hence the designed antenna is efficient for UWB communication. The figure 5 below shows the VSWR plot of the designed antenna. Figure 6a and 6b shows the VSWR at the specific operating frequency.

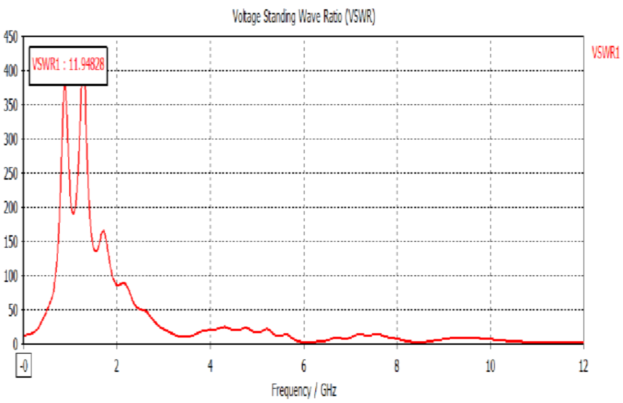

Fig-5: VSWR Plot

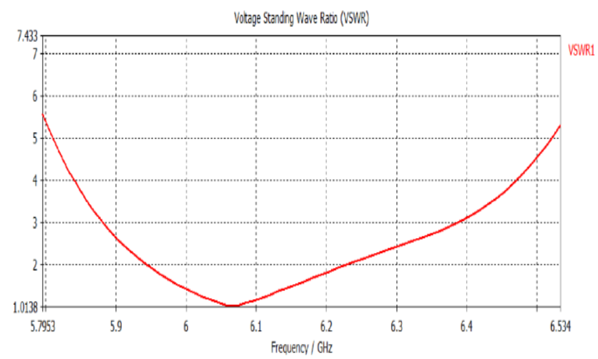

Fig-6a: VSWR plot at the operating frequency

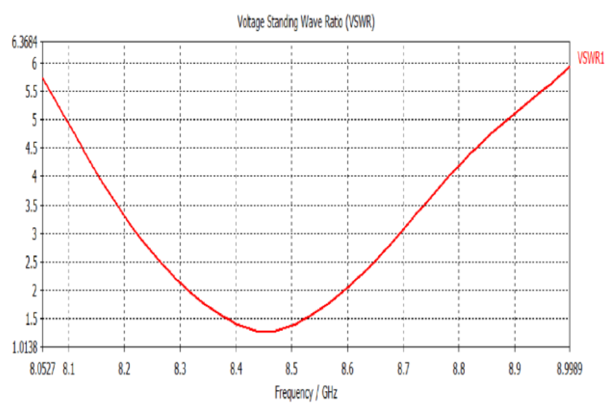

Fig-6b: VSWR plot at the operating frequency

7. GAIN

The term Gain in antenna refers to the directivity and electrical efficiency of the antenna. The antenna gain is usually measured in terms of dBi. The gain obtained at different frequency of operation is shown in figure 7.The variation of gain can be observed clearly. However the operating regions have positive gain. The entire gain variation is less than 3 dBi.

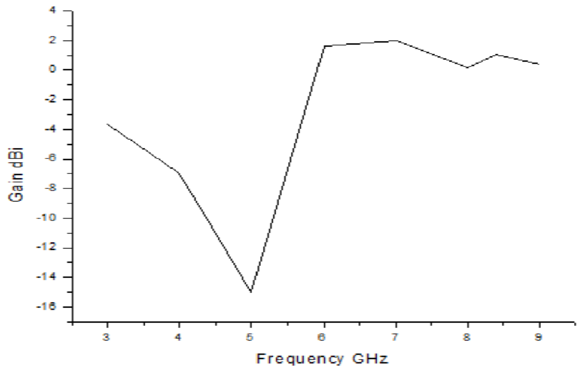

Fig-7: Gain of the Antenna

8. RADIATION PATTERN

The term radiation pattern is otherwise called as far-field pattern (farthest region away from antenna, irrespective of the distance).The distribution of field and power are independent of distance. It refers to the angular (directional) dependence of the strength of radio waves from the antenna (power radiated from the antenna).The radiation / farfield pattern of the designed UWB Antenna is shown in figure 8a and 8b.The polar plot of far-field at central operating frequency at 6 GHz and 8.4 GHz is shown in figure 9a and 9b respectively.

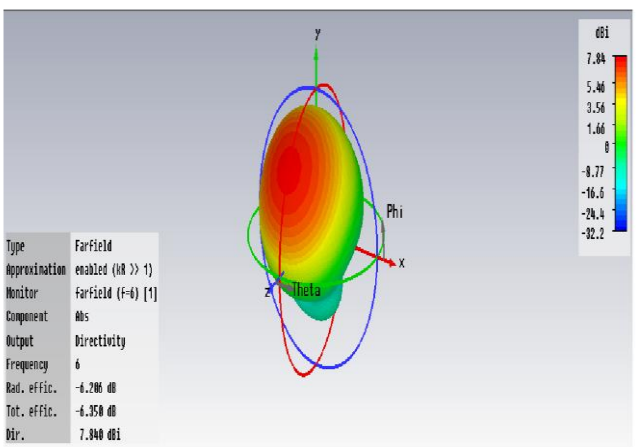

Fig-8a: Radiation Pattern at 6 GHz

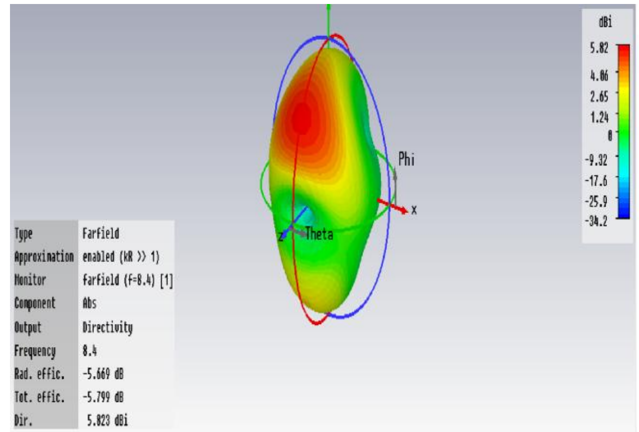

Fig-8b: Radiation pattern at 8.4 GHz

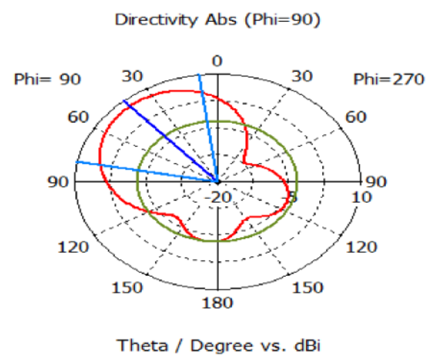

Fig-9a: Polar plot of the farfield at 6 GHz

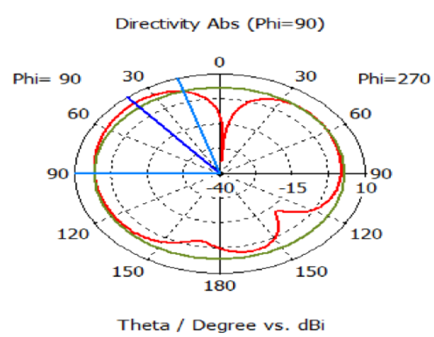

Fig-9b: Polar plot of the farfield at 8.4 GHz

9. CONCLUSIONS AND FUTURE WORK

In this paper UWB antenna with triple band notched characteristics used for UWB applications has been simulated. By introducing the T-shaped and U-shaped stubs in the radiating patch and near the feed line, stop bands for applications of WiMAX , WLAN, DSRC and FIXED WIRELESS AND RADIO LOCATION are created. This simulated UWB antenna has high rejection band in UWB region and it is converted into printed antenna by the process of fabrication. The printed antenna is to be tested under EMC (Electro-Magnetic Compatibility) region, in order to avoid interference. The designed and simulated antenna results are to be compared.

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