ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Design of UWB Microstrip antenna with band-notch for interference avoidance.

Pol Shalini Ashokrao[1], Prof. Hate S.G[2] ,Rakshit S.M[3]

1. ME(VLSI & Embedded System GHRCOEM, Ahmednagar, India
2. Department of E&TC GHRIET, Pune, India.
3. ME(VLSI & Embedded System . GHRCOEM, Ahmednagar, India

Manuscript Info

Manuscript History:

Received: 12 March 2015
Final Accepted: 22 April 2015
Published Online: May 2015

Key words:

Microstrip antenna, UWB, Satellite Receiver.

***Corresponding Author**

Pol Shalini Ashokrao

Abstract

In wireless communication we mainly utilize the Electromagnetic Spectrum. In Previous era systems were narrowband long range systems but if wanting to use of available spectrum, we are now using UWB (ultra-wide band) short range systems which consume low power and these are built using cheaper/inexpensive digital components. Again Microstrip antenna is used for implementing UWB systems as it shows good broadband characteristics.
In this paper I am going to design the UWB Microstrip patch antenna printed on FR-4 substrate for satellite receiver, aircraft, space craft, missile application etc.

INTRODUCTION

Microstrip antennas are the correct option for several wireless applications(Wi-MAX, RFID, GSM etc) because of their several advantages including easy design & fabrication procedure[1].These antennas are low profile, conformable to planar & nonplanar surfaces, simple & inexpensive to manufacture using modern printed- circuit design technology, they are very flexible in terms of polarization, pattern , resonant frequency & impedance[2]. Microstrip antenna is used for building UWB systems as to shows good broadband characteristics. Now a day, UWB communication system is appealing more & more attention because of its benefits such as high data rate transmission as in the multimedia communication, low power consumption, high degree of reliability & robustness against jamming. In communication systems, one of the main purposes of UWB technology is to design of a compact antenna which provides wideband characteristics over the entire operating band. Recently, demanding research works are carried out on UWB antenna design. The various paper include set of numerous technique to increase the impedance bandwidth[3].Difficulty of using the UWB in public sector application is that the frequency range varies from 3.1 GHz to 10.6 GHz for UWB systems and it will cause disturbance to the present wireless communication systems, such as the IEEE 802.11a standard for WLAN system at 5.5 GHz (5.15- 5.825 GHz), IEEE 802.16 standard for WiMAX system at 3.5 GHz (3.3-3.69 GHz) & C-band at 4GHz (3.7-4.2GHZ). In order to avoid such disturbances along these bands a UWB antenna with diversified stop band characteristics is required. So, the UWB antenna with a single & dual band-stop performance is used up till now. Various shapes of the slits (i.e. T-shaped, rectangular) are used to obtain the specific band notched characteristics [4].

In this paper , I am going to design UWB microstrip antenna to achieve all of the above purposes such as notched band characteristics(to avoid the interference between UWB & WLAN/WiMAX) & frequency range for UWB system with respect to the multiresonance performance.

Microstrip Antennas:

A microstrip antenna, also called as a patch antenna. In a most basic form a microstrip antenna comprises of two thin metallic layers ($t<<\lambda_0$ where λ_0 is wavelength in free space) one as radiating patch and second as ground plane and a dielectric substrate sandwiched between them. The conductor patch is placed on the dielectric substrate and used as radiating element. On the other side of the substrate there is a conductive layer used as ground plane. Copper and gold is used normally as a metallic layer. Radiating patch can be of any shape but simple shapes are used to design a patch because patches basic shapes are easy to analysis by the available theoretical models and it is easy to predict the performance. Square, rectangular, dipole, triangular, elliptical, circular are some basic shapes. Circular, rectangular and dipole are the most often used shapes because of easy of analysis and fabrication. A variety of dielectric materials are available for the substrate with dielectric constants $2.2\leq\varepsilon_r\geq 12$. The height of substrate plays an important role in antenna characteristics generally are in the range $0.003\lambda_0\leq h\geq 0.05\lambda_0$.

Microstrip antenna is a low profile antenna that has light weight and is very easy to installation due to which it is very popular in handheld wireless devices such as cell phones, pagers and in some high performance communication systems such as in satellite, missile, spacecraft, aircraft etc. Some of the major advantages of **microstrip** antenna as discussed by Randy Bancroft and Garg are given below:

- Inexpensive and easy to fabricate.
- Can be planted easily on any surface.
- Can easily get reconfigurable characteristics.
- Can easily design antenna with desired polarization.
- Mechanically robust, Resistant against vibration and shock.
- Suitable to microwave integrated circuits (MICs).
- For high gain and directivity Array of antennas can be easily formed.

In this section a rectangular patch antenna is chosen as an example for investigation, since it is the most popular printed antenna. We are going to examine the operational principles, major characteristics and design procedures.
A design example will be given at the end of the section.

The field variation across the length of the patch is shown in figure 1(b). The normalized impedance along the length of the patch is shown in figure 2, maximum resistance at the edges is typically 150 – 300 ohms and the centre is a short circuit.
What is UWB?

UWB (Ultra Wide-Band) is a radio communication technology that uses very low energy pulses & it is intended for short-range-cum-high-bandwidth communications by using a huge chunk of the radio spectrum (in GHz Range)
UWB is becoming more attractive for low cost consumer communications applications. ULTRA-WIDEBAND communications involves the transmission of short pulses with a relatively large fractional bandwidth and more specifically, these pulses possess a −10 dB bandwidth which exceeds 500 MHz or 20% of their center frequency and is typically on the order of one to several gigahertz. The Federal Communications Commission's Report and Order (R&O), issued on Feb. 2002, defines UWB as any signal that occupies more than 500 MHz in the 3.1–10.6 GHz band [6].

UWB Spectrum:-

II. ANTENNA DESIGN

The basic design considerations for a rectangular patch were considered for the design. The length L of the patch is usually $0.3333\ \lambda_0< L< 0.5\ \lambda_0$, where λ_0 is the free space wavelength. The patch is selected to be very thin such that $t<< \lambda_0$ (where t is a patch thickness). The height of the dielectric substrate is usually $0.003\ \lambda_0 \leq h \leq 0.05\ \lambda_0$. The dielectric constant of the substrate (ε_r) is typically in the range $2.2 \leq \varepsilon_r \leq 12$.
Formulas used for the patch design is explain in [2, 7]

1. Calculate the width of the patch as

$$W=\left(\frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}}=\frac{\vartheta_0}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}}\right)$$

Where υ_0 is the free space velocity of light.

2. Calculate the effective dielectric constant

For (W/h > 1)

$$\epsilon_{reff}=\frac{\epsilon_r+1}{2}+\frac{\epsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$$

3. Calculate the length correction due to fringing

$$\frac{\Delta L}{h}=0.412\frac{(\epsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{reff}-0.28)\left(\frac{W}{h}+0.8\right)}$$

4. Calculation of effective length.

$L_{eff.} = L+2\Delta L$

5. The length of the patch can now be calculated as

$L= L_{eff.} - 2\Delta L$

6. Calculation of resonant frequency(f_r)

$f_r=\frac{\upsilon 0}{2L\sqrt{\varepsilon r}}$

7. Ground length

$L_g =6h + L$

8. Ground width

$W_g = 6h + W$

9. The feed point position for 50 Ohms can be calculated using the following expression

$$R_{in}(y=y_0)=R_{in}(y=0)\cos^2\left(\frac{\pi}{L}y_0\right)$$

Where R_{in} (y=y0) is 50 Ohms and R_{in} (y=0) is roughly given as (Neglecting the mutual coupling of the slots)

$$Z_{in}=\frac{1}{Y_{in}}=R_{in}=\frac{1}{2G_1}$$

$$G_1=\begin{cases}\frac{1}{90}\left(\frac{W}{\lambda_0}\right)^2 & W\ll\lambda_0\\ \frac{1}{120}\left(\frac{W}{\lambda_0}\right) & W\gg\lambda_0\end{cases}$$

Alternatively the patch can also be fed using a quarter wave microstrip lines as an impedance transformer, or using an inset feed, proximity fed etc

With the help of above data a rectangular patch antenna dimensions are calculated. The antenna are printed on a FR-4 substrate having the thickness h=1.6mm, permittivity ε_r =4.4, and loss tangent 0.02 with center frequency 4.2 GHz. And fed by a 50Ω Microstrip line.

In this work we start by choosing the dimension of design antenna, these parameters including substrate, is $W_{sub}\times L_{sub}$=12mm×18mm at 4.2 GHz.

The final value of proposed antenna design parameters are as follows:

W_{sub}=12mm, L_{sub}=18mm, W_f=2mm, L_f=7mm, W=10mm, L=10mm, Ws=4.5mm, L_s=2.5, W_{s1}=3.5, L_{s1}=3.5, W_x1=5.5mm, L_{x1}=0.25mm, W_x=0.6mm, W_{x2}=0.2mm and L_{gnd}=3.5mm.

III. RESULT AND DISCUSSION

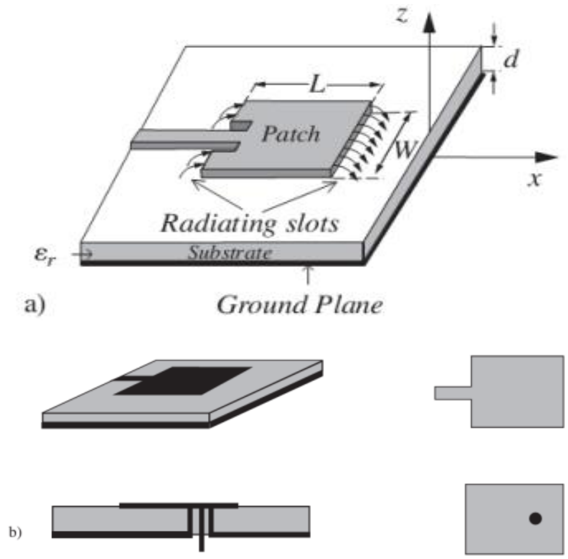

Fig.1: Microstrip patch antennas with their feeds (a) a microstrip antenna with its coordinates; (b) two feeding way: microstrip feed and coaxial feed

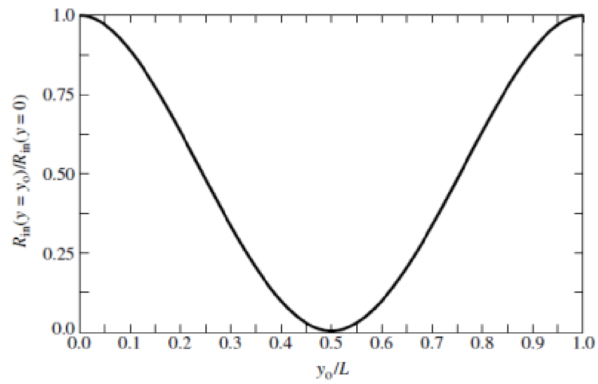

Fig.2 Normalized Impedance along the length of the patch

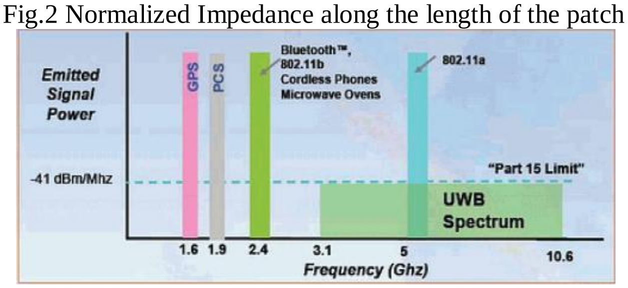

Fig.3: Comparison of various communication standards.

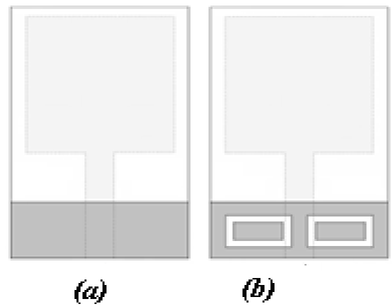

Fig.4 a) Simple UWB Microstrip Antenna b)Antenna with two rectangular ring slot in the ground plane.

Above Fig.4 shows the structure of numerous antennas for simulation studies. Return loss characteristics and VSWR for a) Simple UWB Microstrip Antenna b) Antenna with two rectangular ring slot in the ground plane. Are compared in figure.

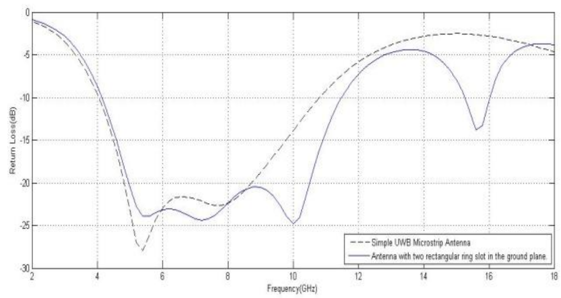

Fig.5: Return loss characteristics

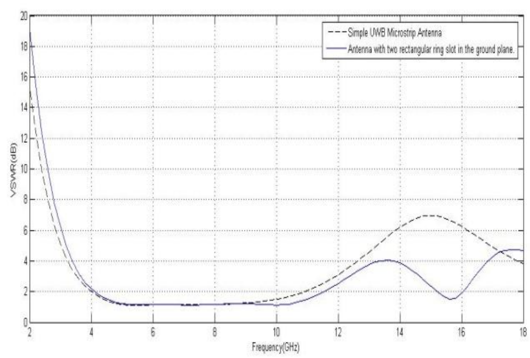

Fig.6: VSWR characteristics

The proposed microstrip antenna with simple microstrip patch and second antenna with patch and ground consists of two ring slot. The parameter of this antenna are presented and discussed below.

Return Loss (S11):

Fig.5 shows the simulated return loss against frequency of antenna. Based on the simulated result antenna displays resonant frequency at 4.2.GHzwith S11 of -11.14 dB and 11.4 GHz with -10.22 dB.

VSWR:

The VSWR values ranges from 1 to 2 at frequencies 4Gz with 2 dB and 16GHz with 2dB. The frequency region from 4 GHz to 11.6 GHz, the VSWR values is in the range of 1 to 2 dB.

IV. CONCLUSION

The propose UWB antenna with band-notched function. fabrication of prototype antenna will be carried out in future and measured results will be compared with simulated results.

ACKNOWLEDGMENT

I would like to express my special thanks of gratitude to my guide Prof. Hate S. G, for their valuable comments and suggestions to improve the quality of the paper. I am also grateful to our ME Coordinator Prof. Bhope V.P & Principal Dr. Vinod Chowdhary, for nice cooperation & time to time supports.

REFERENCES

[1]. Veeresh G. Kasabegoudar and Ajit Kumar," Dual band coplanar capacitive coupled microstrip antennas with and without air gap for wireless applications", Progress In Electromagnetics Research C, Vol. 36, 105–117, 2013.

[2].Balanis, C. A., Antenna Theory Analysis and Design, 3rd Edition, John Wiley, 2011

[3]. Mohammad A. , Meghdad K. ,Saman Z., & Reza G. , "A simple UWB antenna with dual stop-band performance using rectangular slot & strip line ended up shorting pin", Progress In Electromagnetics Research C, vol.42, 83-92,2013.

[4]. Nasser Ojaroudi and Mouhammad Ojaroudi, "Dual band-notched monopole antenna with multi-resonance characteristic for UWB wireless communications", Progress In Electromagnetics Research C, Vol. 40, 187–199, 2013

[5]. Syed Saadullah Hussaini," Design and Fabrication of a Microstrip Patch Antenna", Lab Manual

[6]. Yashar Zehforoosh, Changiz Ghobadi, and Javad Nourinia," Antenna Design for Ultra Wideband Application Using a New Multilayer Structure", PIERS ONLINE, VOL. 2, NO. 6, 2006.

[7] Lalitha K., Dr. Rajya L.V., & Dr. GSN Raju, "Optimization of Geometry of microstrip patch antenna for Broadband application", International Journal of Advanced Research in Electrical, Electronics & Instrumentation Engg.vol.2,Issue 7,july 2013.