Research Article Impact Factor: 4.226 ISSN: 2319-507X
Milind Paraye, IJPRET, 2016; Volume 4 (9): 767-774 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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A TRIPLE BAND-NOTCHED UWB ANTENNA WITH DEFECTED GROUND STRUCTURE

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Accepted Date: 15/03/2016; Published Date: 01/05/2016

Abstract- A compact ultra-wideband (UWB) antenna with a triple band-notched characteristic with defected ground structure is proposed in this paper. The proposed antenna is fabricated on a dielectric substrate FR-4 with relative permittivity (εr) of 4.4 with thickness of 1.6 mm. In order to achieve ultra-wideband characteristic a partial ground plane with Defected Ground Structure is used. Proposed antenna has compact size of 30×25mm2, has an ultra-wide impedance bandwidth from 3.1 to 10.6 GHz for VSWR<2 except 5.15- 5.825GHz for WLAN system and 7.25–7.75 GHz for downlink X-band satellite communication systems and 4.5-4.8 GHz INSAT / Super-Extended C-Band. By creating a U-slot in transmission line first band notch 5.15–5.825 GHz for WLAN system is achieved. To reject the frequency band of 7.25–7.75 GHz two C-shaped slits are symmetrically placed besides the transmission line and to achieve band notch for 4.5-4.8 an open end ring is etched from patch. The influences on the characteristics of the proposed antenna are investigated when the slits length, width and position are modified.

Keywords: Band notched, planar antenna, ultra-wideband (UWB) antenna, partial ground plane.

PAPER-QR CODE

Corresponding Author: MR. MILIND PARAYE

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How to Cite This Article:

Milind Paraye, IJPRET, 2016; Volume 4 (9): 767-774

INTRODUCTION

Since the Federal Communications Commission (FCC) issued the ultra-wide band (UWB) from 3.1-10.6 GHz in 2002 for the use of indoor and hand-held systems, Ultra-wideband (UWB) antennas have gained so much of interest by the researchers. For identifying an antenna to be considered ultra wideband (UWB) or not there are two criteria available on the basis of fractional bandwidth. One definition (by Defence Advanced Research Projects Agency report) requires an antenna to have fractional bandwidth greater than 0.25. An alternate and more recent definition by Federal Communications Commission (FCC) places the limit at 0.2.

The major disadvantage of microstrip antenna is narrow bandwidth. For the enhancement of impedance bandwidth, several types of techniques such as surface meandering, coupled patches, using a pair of notches at the lower corner of patch inserting a slot in the tapered radiating element , using the notch structure in the ground plane [2], [3] and adding a narrow slit in one side of the monopole [4] have been reported. Here for broadening of impedance bandwidth defected ground plane strategy is used. Using a circular shape ground planewith elliptical notch results in drastically improvement in the bandwidth. However one of serious problem for UWB systems are electromagnetic interference (EMI) from existing frequency bands, because there are many other wireless narrowband that are allocated for different frequencies band in the UWB band, such as (WiMAX) operating in 3.3 - 3.7 GHz, wireless local area network (WLAN) for IEEE 802.11a operating in 5.15 - 5.825 GHz, and downlink of X-band satellite communication systems in 7.25 - 7.75 GHz, and 4.5-4.8 GHz INSAT / Super-Extended C-Band(Indian National Satellite systems). Therefore to overcome this interference problem UWB antennas should have band notches therefore they can reject the existing frequency bands within the ultrawide band. Recently different types of UWB antennas having the wide bandwidth and band notch characteristics have been developed for UWB applications [1-9].

The easiest and most common method to achieve a band notch is making a narrow slot of different shapes into the radiating patch of the antenna, will affect the current flow in the patch, as demonstrated in [5]–[7]. In [5] and [6], different type of shapes is used to make the slots (i.e., square ring and folded trapezoid, U-shape, C-shape) are used to get the band notched in the desired frequency band.

In this letter, a compact UWB antenna is proposed, which has a wide bandwidth from 2.8GHz to 10.6GHz with triple band notches for rejecting the WLAN, downlink X-band satellite communication and INSAT/Super Extended C-band application respectively. A U-shape slot in the radiating patch is made to achieve the notch band for INSAT/Super Extended C-band application an open end split ring slot is made in patch. For getting the band notch to reject the existing WLAN system two C-shaped slits are placed symmetrically besides the transmission line. To get the proper band rejection the length, width and the relative positions of the slits are optimized carefully. This proposed antenna structure's simulation is carried out using the CAD software Microwave Studio in Computer Simulation Technology Simulator (CST), one commercial 3-D full-wave electromagnetic simulation software. The Simulated results are presented, shows the usefulness of the proposed antenna structure for UWB applications. The simulation results indicate that the proposed antenna fulfils the excellent triple band notch characteristics for various frequency bands and showing the good return loss and radiation patters in the interested UWB.

I. UWB MONOPOLEANTENNA

Fig.1, shows the geometry of the proposed UWB antenna. The antenna is fabricated on an inexpensive dielectric material FR-4 substrate with dielectric constant of 4.4 with thickness of 1.6 mm. The radiating patch and microstrip feed line are printed on the top side of dielectric substrate and the ground plane on the other side. Elliptical shape ground plane is used to improve the bandwidth of the antenna. As a Ground Plane Structure an elliptical notch is created just below the feed line .The width of the microstrip feed line is chosen as 3.058mm to achieve the characteristic impedance of 50ohm. The dimensions of the proposed antenna after the manual optimization are as follows. r=9.5, a=6, X=1.6, y=3.1, Lf=10, Wf=3.058, Wsub=26.6, Lsub=29.3.

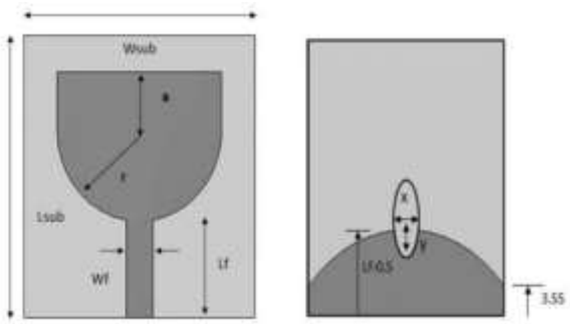

Figure 1. Front and back view of UWB antenna

Recently different types of methods are proposed for improving the antenna bandwidth. In this paper to enhance the impedance bandwidth defected ground plane is used. By making an elliptical notch in the ground plane a drastically improvement in the antenna bandwidth is seen.

The s11 vs frequency curve with the optimized values is shown below. This shows that the proposed antenna covers the entire UWB with good return loss.

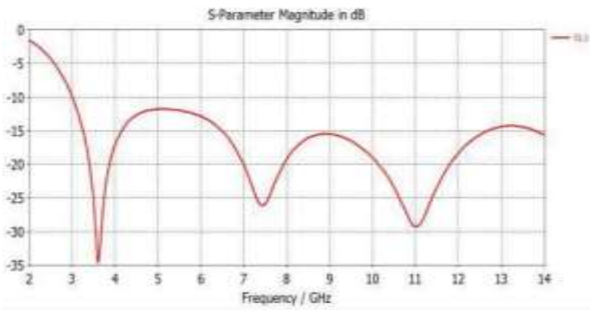

Figure 2 Return loss vs frequency curve of proposed antenna

III. UWB Monopole Antenna with Triple Notched Bands

A half circular extended patch antenna with triple band notch characteristic for WLAN 802.11a operating in 5.15-5.85 GHz, INSAT/Super Extended C-band application (Indian National Satellite System) 4.5 to 4.8 GHz and downlink X-band satellite communication 7.25-7.75 GHz is presented. The figure below shows the dimensions of the C-shape slit and the U-slot made in the microstrip transmission line. This C-shape slits are placed very nearer to microstrip lines, just 0.271 mm besides. The spacing between the feedline and slit affects the antenna performance.

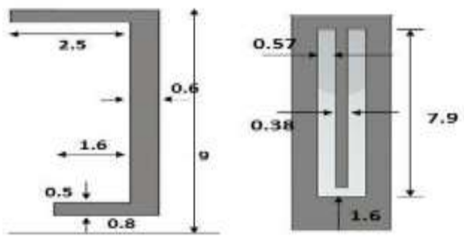

Figure 3. C-shape slit and the U-slot

As shown in figure for increasing the bandwidth of antenna a circular shape partial ground is used. An elliptical notch as a defected ground plane strategy is created in the ground plane. By creating a U-slot in transmission line first band notch 5.15–5.825 GHz for WLAN system is achieved. To reject the frequency band of 7.25–7.75 GHz two C-shaped slits are symmetrically placed besides the transmission line and to achieve band notch for 4.5-4.8 an open end ring is etched from patch. To get the band notch associated with the ring or U-slot or C-shape slit the dimensions and the relative positions has been carefully observed. Different antenna dimensions with their descriptions and optimized values are R=9.5, r=4.1, r1=0.6, a=6, X=1.6, y=3.1, Lf=10, Wf=3.058, Wsub=28.50, Lsub=30.25.

The vswrvs frequency curve for the proposed antenna with optimized parameters is shown below. We can observe from the plot that the antenna possesses three exact band notches or rejection of frequency band for three applications 4.5 to 4.8 GHz, 5.15 to 5.85 GHz and 7.25 to 7.75 GHz.

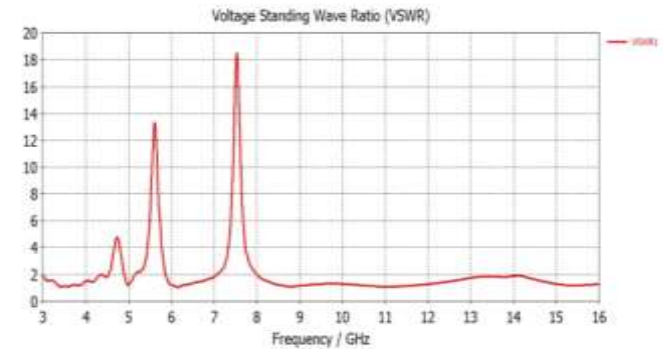

Figure 4. vswrvs frequency curve of Proposed Antenna.

The effect of the relative position of C-shape slit with respect to microstrip feed line is also observed. Below graph shows the comparison of differentvswr curves for different values of spacing s between slits and feedline.

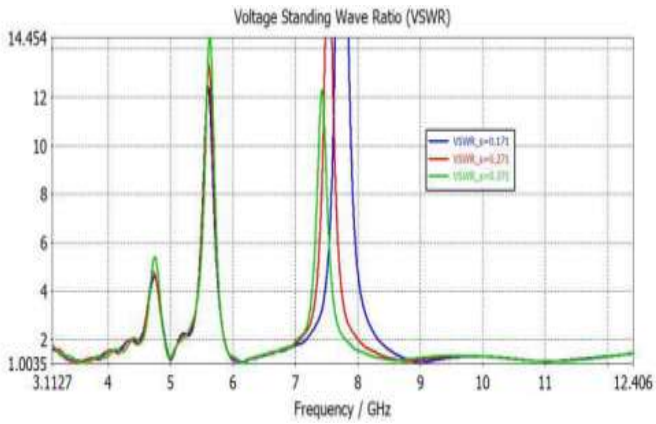

Figure 5. vswrvs frequency curve for different values of s spacing between slits and feed line

By plot we can conclude that the C-shape slits which responsible for band notch 7.25 to 7.75 GHz does not have so much effect on the notches created on the other two bands. Plot below shows vswr curve for the different radius of annular ring. It is observed that the effect of varying the radius of ring on other notches is negligible. It only shifts the notch frequencies that are introduce due to the annular ring notch.

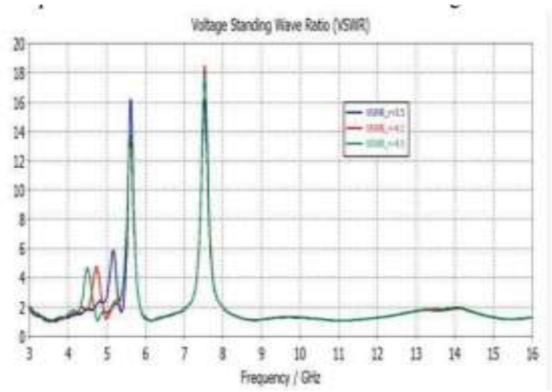

Figure 6. vswrvs frequency curve for different radius r of annular ring.

The plots below showing the effect of changing the dimensions length L1 and width w1 of U-shape notch on the vswr curve.

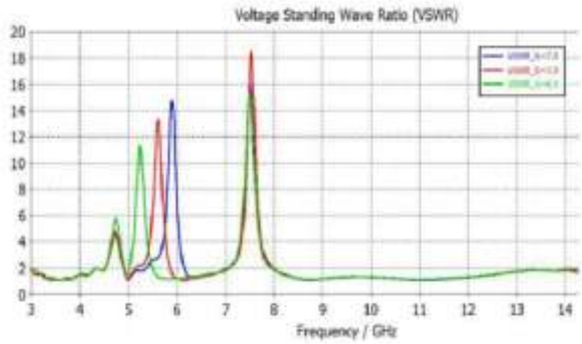

Figure 7. vswrvs frequency curve for different length L1 of Ushape notch.

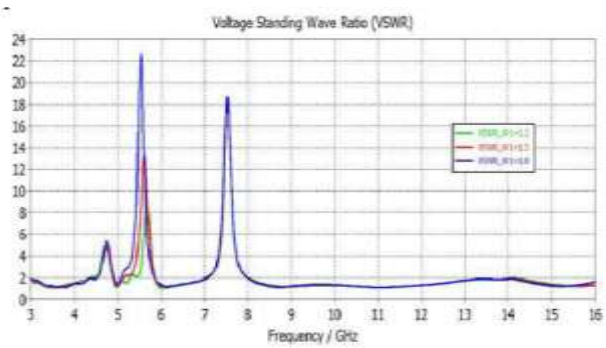

Figure 8. vswrvs frequency curve for different Width w1 of Ushape notch.

The radiation patterns and surface current distribution for different notch frequencies are shown in below figure.

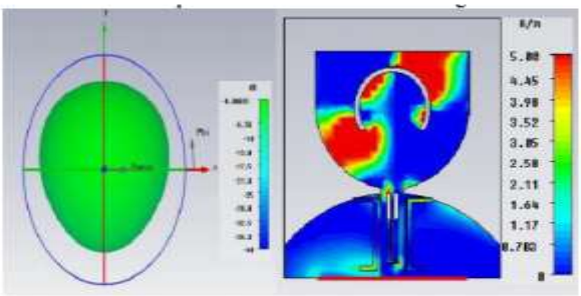

Figure 9. Radiation pattern and Surface current distribution at 4.7GHz

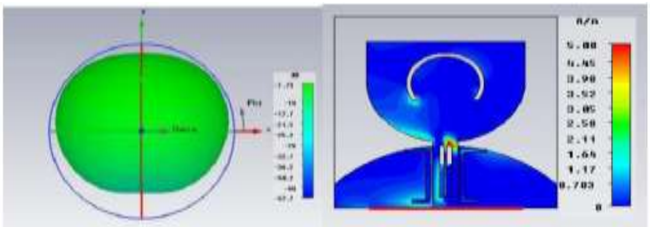

Figure 10. Radiation pattern and Surface current distribution at 5.6GHz

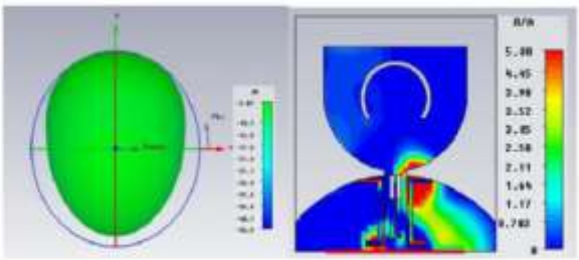

Figure 11. Radiation pattern and Surface current distribution at 7.5GHz

It can be observe from that the surface current is concentrated mainly on the notched that are responsible for band rejection at that frequency.Realized gain of designed antenna is shown in figure below.

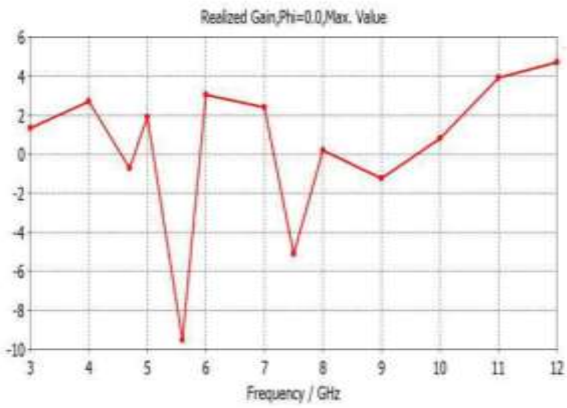

Figure 12. Realized Gain vs Frequency plot

The simulated gain of the antenna, from 3 to 12 GHz, is also plotted in Fig. 14. As expected, the gain decreases obviously in the notch frequencies of 3.6 and 5.5 GHz. Outside the notched band, antenna gain with a variation of less than 3 dB is achieved, indicating stable gain performances across the operation band and clearly confirms the positive effect of these notched bands in signal-rejection capability.

VI. CONCLUSION

The Simulated results are presented, shows the usefulness of the proposed antenna structure for UWB applications. The simulation results indicate that the proposed antenna fulfils the excellent triple band notch characteristics for various frequency bands and showing the good return loss and radiation patters in the interested UWB. To get the proper band rejection the length, width and the relative positions of the slits are optimized carefully.

REFERENCES

1. I. Oppermann, M. Hamalainen, and J. Iinatti, UWB Theory and Applications.

2. S. R. Branch, "Band-notched elliptical slot UWB microstrip antenna with elliptical stub filled by the H-shaped slot,'' J. Electromagn. WavesAppl., vol. 22, pp. 1993–2002, 2008..

3. C. Huang and W. Hsia, "Planar ultra-wideband antenna with a frequency notch characteristic" Microw. Opt. Technol. Lett., vol. 49, no. 2, pp. 316–320, Feb. 2007

4. J. Zhang, Y. Xu, and W. Wang, "Microstrip-fed semi-elliptical dipole antennas for ltra wideband communications" IEEE Trans. Antennas Propagat., vol. 56, no. 1, pp. 241–244, 2008.

5. Y. D. Dong, W. Hong, Z. Q. Kuai, and J. X. Chen, "Analysis of planar ultrawide band antennas with on-ground slot bandnotched structures," IEEE Transactions on Antennas and Propagation , vol. 57, no. 7, pp. 1886-1893, 2009.

6. M. J. Ammann, and Z. N. Chen, "Wideband monopole antennas for multiband wireless systems," Antennas and Propagation Magazine, vol. 45, no. 2, pp. 146-150, 2003

7. K. Yin, and J. P. Xu, "Compact ultra-wideband antenna with dual band-stop characteristic,'' Electronics Letters, vol. 44, no. 7, pp. 453-454, 2008.