Dual Band Notched Monopole Antenna For UWB Applications

Zahoor Ul Nazir*,
*School of Electronics Engineering, VIT University, Chennai
Email: zahoor.parray@gmail.com

ABSTRACT

In this paper, we propose a design novel ultra wideband monopole antenna with dual frequency band-stop performance. In the proposed antenna consisting of an ordinary square radiating patch with a rotated T-shaped slot on the patch and a ground plane of modified geometry consists an inverted Ω and a pair of rectangular ring slots. By cutting a pair of rectangular-ring slots in ground plane of the present structure additional resonances gets excited and due to which there is produced much wider impedance bandwidth. For the generation of single band notched characteristics pair of rotated T-shaped slots in the radiating patch are cut. Finally by the insertion of the inverted Ω-shaped slot in the ground plane, dual band notched function is achieved. The designed antenna has small size of 12 x 18mm². simulated results are presented for the validation of proposed antenna for UWB application.

Keywords - rectangular ring-slot, rotated T-slot, inverted Ω slot, square monopole antenna.

I. INTRODUCTION

In UWB systems, the design of compact antenna is one of the key problems in providing, wideband characteristic over the whole operating band. Experimentally the characterizations of a number of microstrip antennas with different shapes have been done. Moreover it has been investigated that to improve the impedance bandwidth with different strategies, the planar antenna geometry does not involve modification.

The Federal Communication Commission (FCC) has allocated the frequency band of 7.5GHz ranging from 3.1-10.6GHz causes interference to the available wireless communication system, such as, WIMAX 3.3-3.6GHz, C-band 3.7-4.2GHz and wireless local area networks (WLAN) for IEEE 802.11a with operation range of 5.15-5.35GHz and5.725-5.825GHz bands, so there is requirement of UWB antenna with single and dual-band stop performance. In [1,2], for obtaining the desired band notched characteristics the different types of slits (ie, rectangular and Γ shaped) are used. For generating the single and multiple notched functions ground plane is embedded with a conductor-backed plane structure.

In this paper, for achieving the multi-resonance performance and dual band notched characteristics in the frequency range of UWB systems (for reducing interference between UWB and WLAN/WIMAX). For the design the first step is in the ground plane is cutted a pair of rectangular-ring slots. Production of much wider impedance bandwidth and excitation of additional resonances, due to which there is the improvement of bandwidth and UWB frequency with complete coverage. The next step is for generation of single band notched characteristics in the square radiating patch a pair of rotated T-shaped slots are cut. Lastly in the ground plane by the insertion of an inverted Ω-shaped slot we can achieve a dual band notched function. The design of proposed antenna for devices with UWB is mounted on satellite receiver as wireless systems. The size of the proposed antenna is small 12x18mm², or at 4.2GHz 0.15λ x 0.25λ, due to which there is the reduction of size with respect to the previous antenna. In the frequency band of interest there is obtained good antenna gain and VSWR characteristics.

II. ANTENNA DESIGN

A small monopole antenna is shown in fig 1 which is fed by the microstrip line, which is embedded on the FR4 substrate of thickness of 1.6mm with permittivity of 4.4 and loss tangent of 0.018. In the basic monopole antenna structure there is present a square radiating patch, a feed line and a ground plane. The width of the square radiating patch is W. The radiating patch is connected with a feed line of length Lf and width Wf. The feed line width is fixed at 2mm, as shown in fig1. On substrates other side there is placed a modified
structure of conducting ground plane. For signal transmission there is connection of proposed antenna with a 50Ω SMA connector.

Fig.1 geometry of proposed micro strip feed monopole antenna.

Here we start the design by choosing the dimensions of the antenna. The substrate parameters are Wsub x Lsub are 12mm x 18mm or 0.15λ x 0.25λ at 4.2GHz. For choosing the width of the radiating patch there is a lot of flexibility. The antenna bandwidth is mostly affected by this parameter. The antenna bandwidth gets decreased as W is decreased and vice versa. Next step is for determining the length of the radiating patch L. This parameter corresponds to λlower/4, where λlower represents the lower bandwidth frequency wavelength. There are several parameters on which λlower depends such as thickness as well as width of the radiating patch and substrates dielectric constant on which the antenna is fabricated. One of the important step for the design is choosing Lresonance (resonators length) Lnotch (filter length). At 0.25λg of resonance Lthird resonance is set, where Lthird resonance =Ws+Ls and Lfourth resonance = 0.5Ls+Ws, where λg represents frequency wavelength of new resonance.

The design parameters of final values of the proposed antenna are as given: Wsub=12mm, Lsub=18mm, Wf=2mm, Lf=7mm, W=10mm, Ws=4.5mm, Ls=2.5mm, Ws1=3.5mm, Ls1=1.5mm, Wx=0.6mm, Lx=2.75mm, Lx1=0.25mm, Wx1=5.5mm, Wx2=0.2mm, WT=4.25mm, LT=8mm, WT1=0.25mm, LT1=0.5mm, Ld=4.75mm and Lgnd=3.5mm

III. RESULTS AND DISCUSSION

The construction of various design parameters of a proposed microstrip monopole antenna was done, and the input impedance and radiation characteristics numerical and experimental results are presented and discussed. By changing one parameter at a time and fixing the other the parameters of the proposed antenna can be studied. Optimization of the design and agreement between the simulation and measurement is done by Ansoft HFSS Simulator.

(A) Multi Resonance Characteristic of UWB Antenna

In figure 2 the simulation studies of various antenna structures for multi resonance are done. In fig 2a the return loss characteristic of ordinary square patch antenna, fig 2b shows the single rectangular-ring slots in ground plane. As shown in fig 3 by using these modified structures it is observed that in the ground plane third and fourth resonances are excited so there is the increase in the bandwidth.
As in fig 3 in the proposed antenna, the ordinary square monopole antenna provides the fundamental and next higher resonant radiation band. By using a pair of rectangular-ring slots in the ground plane the upper frequency bandwidth gets significantly affected. This behavior occurs due to the change in the dimensions of a pair of rectangular slits there is the change in the surface current path.

It is observed that current gets concentrated on the edges of the interior and exterior of inverted coupled U shaped plane, the concentration of current is mainly on the interior and exterior edges of rectangular ring slots.

For the investigation of the effects of the rectangular ring slots on the impedance matching and bandwidth of the proposed antenna the VSWR characteristic is analyzed. It is found that by inserting rectangular slots in the ground plane, there is the excitation of additional resonances and also the production of much wider impedance bandwidth and multi resonance characteristics.

(B) Dual Band Notched Function of UWB Antenna

For designing a novel antenna with dual band notched characteristics, a pair of rotated T-shaped slits on the square shaped radiating patch and also insertion of an inverted Ω-shaped slot in the ground plane, as displaced in fig 4. The geometry of the antenna consisting in a ground plane a pair of rectangular-ring slots and on the square shaped radiating patch a pair of rotated T shaped slots and the proposed antenna structure.
Fig 4 (a) antenna with a pair of rectangular-ring slots in ground plane (b) pair of rotated T-shaped slots in radiating patch (c) proposed antenna structure

For the generation of single band notched characteristics (for C-band and WIMAX) a pair of rotated T-shaped slots in the square shaped radiating patch. Also in the ground plane on addition of the inverted Ω-shaped slots, achievement of the dual band notched function covering bands for WLAN, WIMAX and C-band.

Fig 5 illustrates the measurement of the radiation pattern, including co-polarization and cross-polarization in H-plane and E-plane. It can be seen that for the three frequencies the radiation pattern in x-z plane in nearly omnidirectional.

Fig 5(a) measured radiation pattern of proposed antenna at 4.6 GHz in E and H plane with values 16.629dB
Fig 5(B) measured radiation pattern of proposed antenna at 5.2 GHz in E and H plane with values 0.441 dB.

Fig 5(c) measured radiation pattern of proposed antenna at 9.1 GHz in E and H plane with values 1.442 dB.
IV CONCLUSION

Here presentation of compact novel UWB monopole antenna with dual band notched-function. The basic structure of monopole antenna consists of a square radiating patch, feed line and a ground plane. By cutting a pair of rectangular –ring slots and also rotated T-shaped slots also there is embedded an inverted Ω-shaped slot in the antenna configuration. Additional resonances are excited with two band-stop characteristics due to which much wider impedance bandwidth is produced. Simulated results show that the proposed antenna can be good option for UWB application.

REFERENCES


