Design and simulation of folded printed dipole antenna with PBG structure for Ultra Wide Band (UWB) applications

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ABSTRACT

In this paper folded printed dipole antenna with PBG operating for Ultra wide band applications ,The geometry of the antenna is very simple for fabrication and printed circuit board integration that is only 42*36 mm, the proposed antenna are simplified structure with 50 Ω feed line .the PBG structure antenna working in the frequency at 3.2 GHz and 3.9GHz with the bandwidth 68% and 50 % respectively ,In this proposed antenna has maximum gain 4.664 dBi and 3.8 dBi at 3.2 GHz and 3.9 GHz respectively .The proposed radiation pattern is omnidirectional in the E-plane and H-plane due to the orthogonal configuration of the dipole strips. The folded printed dipole antenna with PBG structure antenna should be useful for the UWB applications, The radiation characteristics examined in further sections.

Introduction

Last 10 years UWB antennas developed for wide spectrum communications Ultra wide band communication technology used for large amount of digital data over a broad spectrum of frequency bands ,the Ultra wide band antennas for the so many applications such as ground penetrating radar ,medical imaging ,UWB communication ,vehicular radar systems ,surveillance systems etc.. because of their wide spectrum with data rate, Immunity multipath fading ,low loss[2][5].FCC has assigned frequency band for UWB antennas are 3.17 GHz to 10.7GHz in 2002 [4][10].

Recently ,several Ultra Wide band (UWB) dipole configuration such as square ,circular ,hexagonal have been proposed for Ultra wide band (UWB) applications .In dipole antenna many feeding method available such as CPW ,CPN and microstrip ,In order to reduce the size of the structure microstrip feeding proposed in dipole antennas [11].In this paper we proposed feeding structure is microstrip feeding to increase the performance and reduce the size ,many improved structure studied and reported such as special grounding structure [11] ,multi ground antenna array[12],wreath feed structure [12].In these structure are improved structure for Ultra wide band (UWB) antenna but this are need additional structure for the broad band working. In this reported structures are increase the geometry of the antenna, the proposed structure is simplified PBG structure ,It can improve the radiation characteristics such as gain, return loss, directivity, polarization etc..and it will operate at broad band [8].

Antenna Configuration

The geometry of the proposed folded dipole antenna with PBG structure with 50 Ω impedance matching feed shown in fig .1. In figure we using less expensive substrate FR4 with dielectric constant ε_r 4.4.The proposed antenna printed on the FR4 substrate with thickness 1.2 mm, The proposed antenna using PBG structure which is mainly used to achieves better impedance matching ,gain ,directivity and radiation pattern .In this proposed microstrip feeding using for better radiation

performance .The length and width of the proposed antenna calculated by using equation (1) and (2).In order achieve resonant frequencies 3.1GHz and 3.9 GHz by using this geometry given below ,

The length of the antenna calculated by using this equation given below

$$L_s = \frac{0.42*c}{f_r*\sqrt{\varepsilon_{eff}}}......... \qquad ....(1)$$

To find the width of the antenna is using this equation is

$$W = \frac{c}{2.fr\sqrt{\mu o.\varepsilon o}}\sqrt{\frac{2}{\varepsilon r + 1}}..... \qquad . (2)$$

Where,

fr = Resonant Frequency

ε r = Relative dielectric constant

ε o = $8.9x10^{-12}$ C^2 /Nm^2

$\mu_o = 4\pi.x10^{-7}$ Tm/A.

Width of the ground plane can be calculated by using this equation

$$W_e = \frac{1.38*c}{f_r + \sqrt{\varepsilon_{eff}}}......... \qquad ....(3)$$
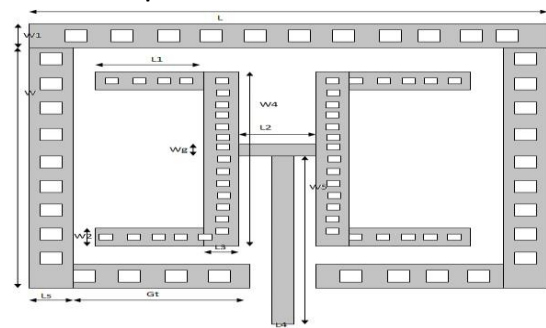

Fig.1 Antenna Configuration Of Proposed printed dipole antenna with PBG Structure

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Length of the ground plane can be calculated by using this equation

$$L_g = \frac{0.36 * c}{f_r * \sqrt{\varepsilon_{eff}}} \dots \dots$$ ....(4)

To calculate the feeding width is given below

$$Rin = \frac{1}{Gr + G12} \dots \dots \dots \dots \dots (5)$$

Where calculate the Rin using G_{12} given below

.............(6)

$$G_{12} = \frac{1}{120\pi^2} \int_0^\pi \left[\frac{\sin(K_0 \cos\theta)}{\cos\theta} \right] j_0 (K_0 . L \sin\theta) \sin^3 / \theta \, d\theta$$

To calculate the resonant frequency using this equation ,

...................(7)

$$f_r = \frac{14.4}{l + 2r} GHz$$

Where ,

$$r_1 = \frac{A_1}{2\pi d_1 \sqrt{\varepsilon_{ef}}} \; ,$$

$$r_2 = \frac{A_2}{2\pi d_2 \sqrt{\varepsilon_{ef}}}$$

From the above equations we find the geometry of the antenna given below L*W is 41 * 36 mm, length of the dipole arms is L1=9.5mm,L2=17mm ,L3=3mm, length of the micro strip feed line L4=2 mm, width of the micro strip feed line W_g=2mm ,width of the antenna is W1=3mm,W2=3 mm,W4=22 mm,W5=24mm , Gt=18mm ,Ls=3mm.

The total size of the antenna is 42*36mm, proposed antenna dimensions of the antenna designed by design equations for the patch antenna .The proposed antenna designed and simulated by using method of momentum(MOM) in ADS simulator software.

Result And Discussions

Based on the values of the proposed model of an antenna designed and simulated .The simulated return loss versus frequency for the proposed printed dipole PBG structure shown in fig .2.which indicate proposed antenna increase performance at 3.2 GHz and 3.9 GHz frequency range ,from simulated resonant frequencies covers the UWB frequency band 3.17 GHz to 10.7 GHz. The lower band frequency return loss is lower than that of the upper band frequency, proposed antenna simulated impedance bandwidth for the -20 dB for the lower band resonant frequency at 3.2 GHz (3.17 GHz to 4.76 GHz) and -14 dB for the upper band resonant frequency 3.9 GHz .
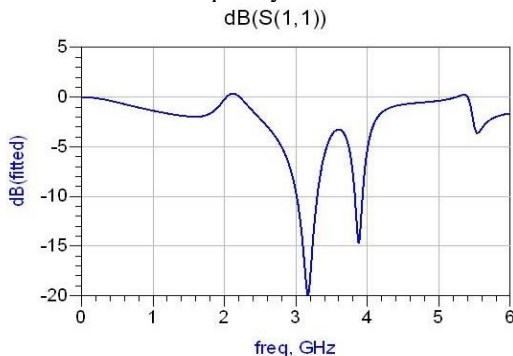

Fig 2. Return loss of the proposed printed dipole antenna with PBG structure.

It will covering the 3.17 GHz to 10.7 GHz UWB operation bands. Fig.4 Indicate exciting mechanism of the proposed antenna such as surface current of the folded printed dipole antenna are illustrated fig.4.(a)& 4.(b) at the frequencies 3.2 GHz and 3.9 GHz respectively .The current distribution along whole PBG structure ,In proposed antenna return loss gradually increase while increase the frequency.
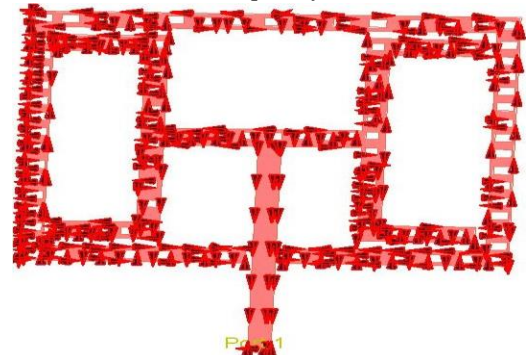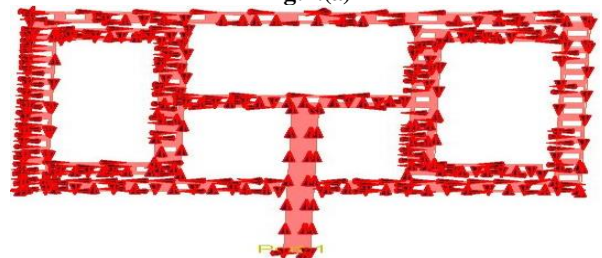

Fig.4.(a)

Fig.3.(a)

Fig 3. (a) &Fig 3(b) surface current distribution forward and reverse direction of the proposed printed dipole antenna with PBG structure.
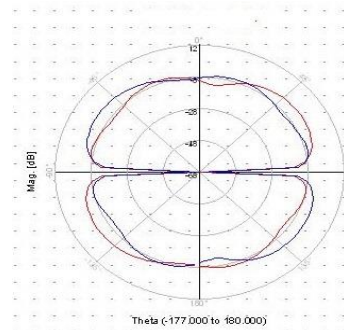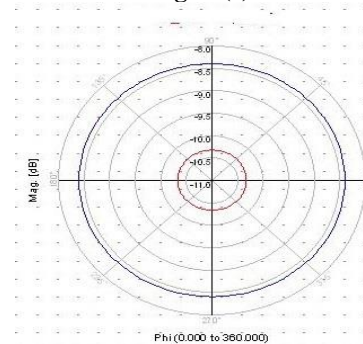

Fig .4.(a)

Fig .4.(b)

Fig 4.(a) and Fig 4.(b) E-plane radiation of the proposed printed dipole antenna with PBG structure at 3.2 GHz and 3.9GHz respectively

Fig.5 .(a)

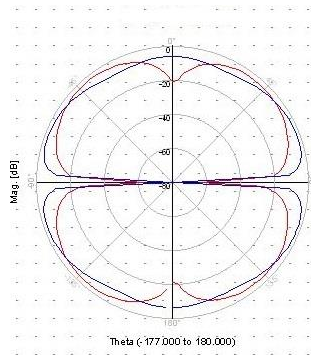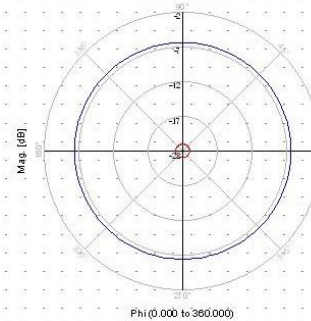**Fig .5.(b)**

Fig .5.(a) and Fig 5.(b) H-plane radiation of the proposed printed dipole antenna with PBG structure at 3.2 GHz and 3.9GHz respectively.
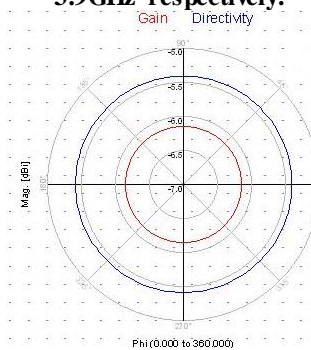

Fig .6 Gain and directivity of the proposed printed dipole antenna with PBG structure.

The proposed antenna simulated far field radiation pattern in H –plane and E- plane for resonant frequencies at 3.2 GHz and 3.9 GHz shown in fig .4.(a),fig .4.(b),fig .5.(a) and fig.5.(b).In this E-plane and H-plane radiation pattern indicates the proposed antenna fairly omnidirectional pattern which is shown from simulated results of the proposed printed dipole antenna with PBG structure. The gain and directivity of the proposed antenna shown in fig.6. Which is 4.66 dBi and 3.92 dBi gain and directivity respectively 3.2 GHz and 4.0 dBi and 3.6 dBi gain and directivity respectively at 3.9 GHz resonant frequency ,Hence simulated proposed antenna radiation characteristics clearly indicate perfectly suitable for the UWB applications .

Conclusion

Performance characteristics of a folded printed dipole antenna with PBG structure for Ultra wide band (UWB) application have been studied by design and simulation ,the proposed antenna is excited by microstrip feeding ,The printed dipole antenna PBG structures covers the UWB frequency 3.17

GHz to 10.7GHz such resonant frequencies 3.2 GHz and 3.9 GHz with return loss -20 dBi and -14 GHz .proposed is omnidirectional radiation pattern and its exhibits the perfect radiation characteristics ,such as perfect impedance matching , polarization.

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