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Design & Simulation of TRI Band Microstrip Patch Antenna with Back To Back E Shape Slot

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Abstract
A conventional rectangular microstrip patch antenna is considered for this research and further cutting various notches in the conventional structure to make a back to back E-shape microstrip patch antenna structure. The designed antenna structure is further simulated and the simulation result in terms of bandwidth, gain, directivity and efficiency is observed. The observation includes the frequency bands in which the designed antenna can operate properly, the amount of gain in those frequency bands and their efficiency. The result shows that the designed antenna is suitable to work in three different frequency bands with a good amount of gain and efficiency. This whole task is performed over IE3D simulation software, a MoM based simulation software. The return losses obtained are -12.23dB at 3.95GHz, -22.90dB at 6.81GHz and -26.42dB at 7.87GHz of triple band back to back E-shape microstrip patch antenna.

1. Introduction

An antenna is generally a metallic object capable of transmitting and receiving radio waves. Antenna acts like a resonant circuit which converts electrostatic energy into electromagnetic energy and vice versa. On the basis of directional patterns antenna can be classified in two types namely directional and Omni-directional antenna. Yagi Uda, Log Periodic, Corner Reflector are some examples of directional antenna and whip antenna is example of Omni-directional antenna.

Different antennas used these days have high gain and bandwidth but a severe disadvantage of those antenna structures is their large size and complex 3D structure. As it is the era of wireless communication and antenna is one of the basic and most important requirements of any wireless communication system. As various technologies are used to scale the devices used in wireless communication system, we need to reduce the antenna size too. To fulfill this requirement microstrip patch antenna is a good alternative and is widely used.

Along with small size and simple structure microstrip antenna have some more advantages such as low cost, can be easily integrated in MMIC's etc., along with these advantages these antenna structures also have some disadvantages which make this antenna suffer in terms of bandwidth, gain, efficiency etc.

Improving the bandwidth, gain, efficiency of this antenna is a challenging task and different researches are in progress to rectify these problems. Different patch structures such as E shaped, H shaped, W shaped etc. are used for improved bandwidth of the antenna, some more techniques such as cutting notches and slots in conventional rectangular patch geometry also improves the antenna bandwidth and gain. A concept of using antenna array and the antenna having stacked configuration also provides good amount of improvement in terms of gain and bandwidth.

In this paper we are emphasizing on the back to back E-shaped patch geometry. This patch geometry is designed and simulated over IE3D simulation software and its simulated results are studied. An optimum result in terms of bandwidth and gain is presented in further sections.

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2. Theoretical Consideration

2.1 Analysis of Rectangular Micro strip Antenna

The width of the patch element (W) is given by.

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r + 1)}{2}}} \quad (1)$$

The effective of the dielectric constant (ε_{reff})

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left|\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right| \quad (2)$$

The effective length (L_{eff}) is given

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \quad (3)$$

The length extension (ΔL) is given by:-

$$\Delta L = 0.412h\,\frac{(\varepsilon_r + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (4)$$

The actual length (L) is obtained by:

$$L = L_{eff} - 2\Delta L \quad (5)$$

Calculation of the ground plane dimensions (L_g and W_g):

$L_g = 6h + L$ (6)

$W_g = 6h + W$ (7)

2.2 Analysis of Back to Back E-Shaped Patch Antenna

When two back to back E slots are incorporated into the rectangular microstrip patch antenna, it becomes a back to back E-shaped microstrip patch antenna. The back to back E-shaped microstrip patch antenna is simpler in construction. The geometry is shown in Figure (1). The back to back E-shaped microstrip patch antenna has width (W), two outer patch strips of length L. The frequency selected for microstrip patch antenna is 4GHz, the height of patch is 2 mm and the material used for this antenna is RT Duriod 5880 which has dielectric constant(ε_r)= 2.2.

f_0= 4 GHz
h= 2mm
ε_r = 2.2

The calculated parameters of back to back E shape slotted microstrip patch antenna are-

Parameter	Value
W	29.646mm
ε_{eff}	2.04
L_{eff}	26.21mm
ΔL	1.04mm
L	24.12mm
L_g	36.12 mm
W_g	41.64 mm.

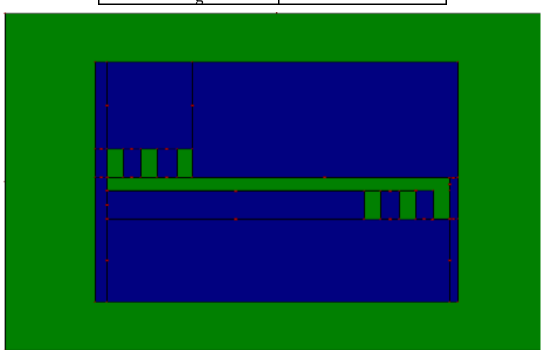

Fig: 1. Back-to-back E Shaped Patch Antenna

3. Results and Discussion

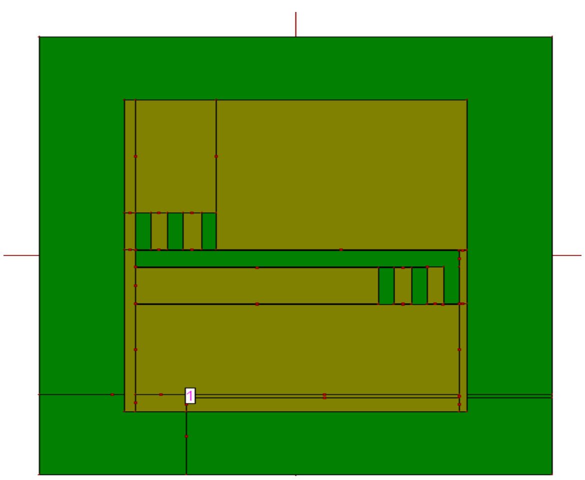

Fig: 2. Microstrip Patch Antenna with back to back E shape slots Feed at (-7.57, -13.35).

The area of ground layer is 36.12 x 41.64 sq mm and the area of patch is 24.12x 29.64 sq mm. The back to back E shape is slot is cut which is shown in figure (1). The design was then simulated on IE3D software. The model was designed to match 50 ohm of the probe feed. A glance at the model designed in IE3D software can be done in figure (1) given below. The method for feeding is probe feed to patch. The several feed points are taken in patch area, the tri band is achieved at feed point (-7.57, -13.35) which is shown in figure (2)

The return loss curve shown in figure (3) shows that the curve is crossing the -10dB line three times, hence the designed antenna can be operated in three different frequency bands. Due to this a single antenna structure can be used for three different types of applications.

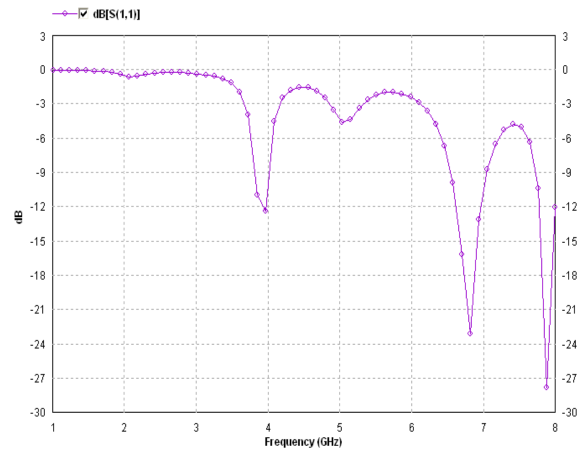

Fig: 3. Return loss Vs Frequency Curve of Microstrip Patch Antenna with back to back E Shape Slots Antenna

The return losses obtained are -12.23dB at 3.95GHz, -22.90dB at 6.81GHz and -26.42dB at 7.87GHz of triple band back to back E-shape microstrip patch antenna and this return losses are less than -10dB.

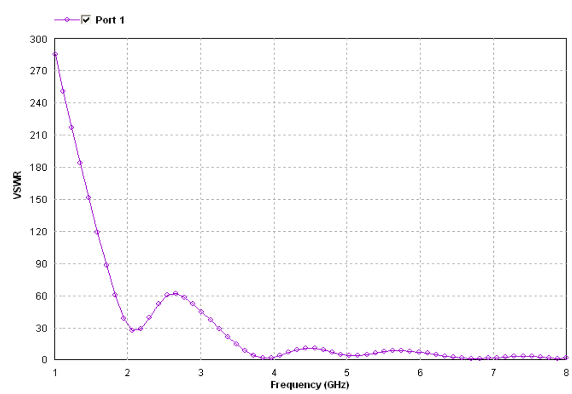

Fig: 4. VSWR Vs Frequency Curve

Another important parameter which is related to the return loss curve and bandwidth is the VSWR which determines if the bandwidth in the above said frequency bands are useful or not. According to theory the VSWR should be below 2dB for the entire frequency range in which antenna has to operate. The simulated VSWR curve is shown in figure (4)

The VSWR at frequency 3.96GHz is 1.633dB, at 6.81 GHz is 1.81dB and at 7.87 GHz is 1.14dB and all values are less than 2dB in the entire range of frequencies in which the bandwidth is observed. Another important parameter i.e. Antenna Gain is further calculated and is shown in figure (4). Analyzing the Total Field Gain Vs Frequency curve shown in figure (5) we can clearly say that the antenna gain is nearly 3dBi to 6dBi.Which is very useful for various applications including wireless application.

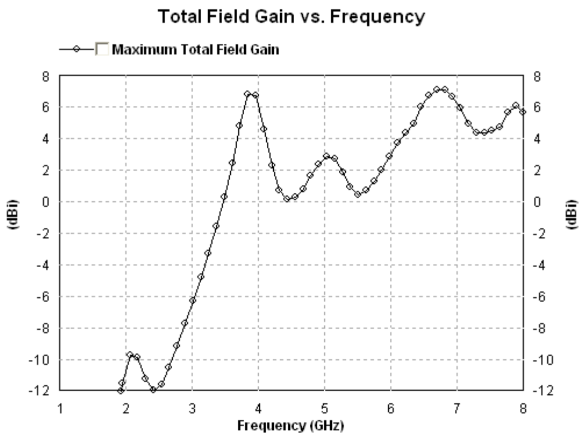

Fig: 5. Total Field Gain Vs Frequency Curve

Another important parameter related to the antenna gain is antenna directivity which is shown in figure (6)

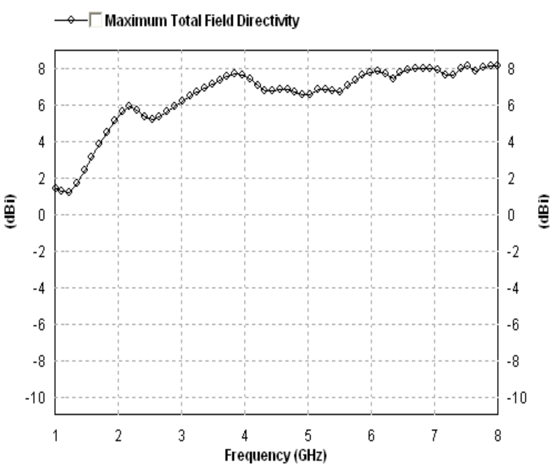

Fig: 6 Directivity Vs Frequency Curve

The efficiency is generally calculated in terms of antenna efficiency and radiation efficiency. The curve shown in figure (7) shows the relation between Antenna Efficiency and Frequency.

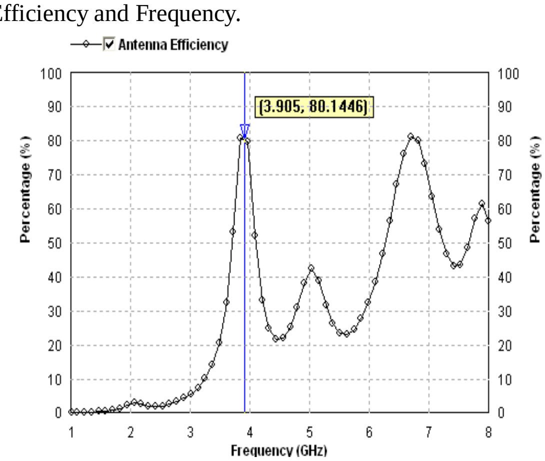

Fig: 7 Antenna Efficiency Vs Frequency Curve

Analyzing the efficiency curve shown in figure (7) it can be clearly observed that the designed antenna structure provides an antenna efficiency of 80%. Further radiation efficiency of the antenna structure is shown in figure (8).

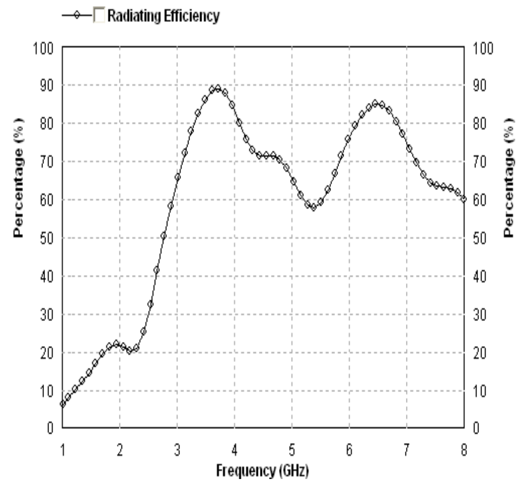

Fig: 8. Radiation Efficiency Vs Frequency Curve

Analyzing the radiation efficiency curve it can be clearly observed that the designed antenna structure provides a radiation efficiency of 90% for other bands which is much better in context of microstrip antenna can be achieved.

Another important parameter is radiation pattern shown in figure (9).

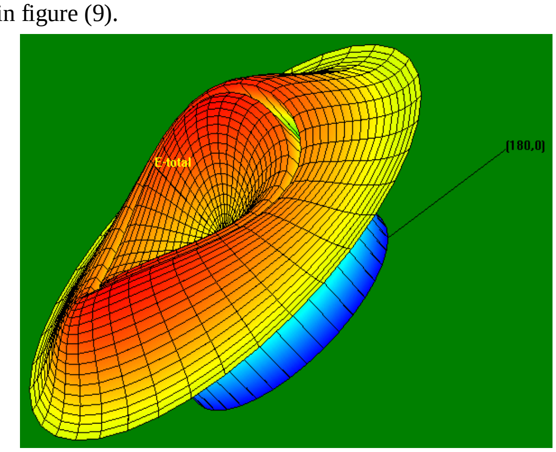

Fig: 9. 3d Radiation Pattern of back to back E shape Antenna

4. Conclusion

A rectangular microstrip patch antenna is designed and simulated over IE3D version 9.35. The designed antenna structure includes probe feeding method for the exciting the antenna. This antenna works in three different frequency bands as shown in the return loss curve, the bandwidth in all the three frequency bands are calculated and analyzed. The antenna structure also provides a good amount of gain i.e. 6dBi and directivity i.e. 7.85dBi. The antenna efficiency and the radiation efficiency of the designed antenna structure are about 90%, which is good enough.

Analyzing this type of structures we can further provide increment in the gain and bandwidth of the antenna.

References

[1] C. A. Balanis, Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, 1997
[2] G. Kumar, K. P. Ray, Broadband Microstrip Antennas, Artech House, Inc, 2003
[3] R. Garg, P. Bhartia, I. Bahl, A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, Inc, 2001
[4] W. L. Stutzman, G. A. Thiele, Antenna Theory and Design, John Wiley & Sons, Inc, 1998
[5] C. A. Balanis, Advanced Engineering Electromagnetics, John Wiley & Sons, New York, 1989
[6] I. J. Bahl, P. Bhartia, Microstrip Antennas, Artech House, Dedham, MA, 1980.
[7] F. T. Ulaby, Fundamentals of Applied Electromagnetics, Prentice Hall, 1999
[8] V. Harsha Ram Keerthi, N. Sri Pravallika, P. Srinivasulu, Design of C-Band Square Microstrip Patch Antenna with Dual Feed for Radar Applications Using ADS, International Journal of Engineering and Advanced Technology (IJEAT), 2(4), 2013
[9] A. Verma, Analysis and Design of E Shaped Patch Antenna in X Band. International Journal of Advanced Engineering Technology, III(I), 2012, 223-224
[10] A. Beno, D.S. Emmanuel, Diamond Shaped Symmetrical Slotted Miniaturized Microstrip Patch Antenna for Wireless Applications, Journal of Theoretical and Applied Information Technology, 2013
[11] S. Bhunia, Effects of Slot Loading on Microstrip Patch Antennas. International Journal of Wired and Wireless Communications, 1(1), 2012
[12] M. B. Kadu, R. P. Labade, A. B. Nandgaonkar, Analysis and Designing of E-Shape Micro strip Patch Antenna for MIMO Application. International Journal of Engineering and Innovative Technology (IJEIT), 1(2), 2012
[13] S. Das, P. P. Sarkar, S. K. Chowdhury, A Compact Novel Multi Frequency Slotted Microstrip Patch Antenna For Wimax And C Band Application. Journal of Engineering Research and Studies, III(II), 2012
[14] G. Immadi, K. Swetha, M. Venkata Narayana, M. Sowmya, R. Ranjana, Design of microstrip patch antenna for WLAN applications using Back to Back connection of Two E-Shapes. International Journal of Engineering Research and Applications (IJERA), 2(3), 2012, 319-323
[15] Zeland Software Inc. IE3D: MoM-Based EM Simulator. Web: http://www.zeland.com/
[16] Indu Bala Pauria, Sachin Kumar, Sandhya Sharma, Design and Simulation of E-Shape Microstrip Patch Antenna for Wideband Applications, International Journal of Soft Computing and Engineering 2(3), 2012