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Design of Triangular and Modified E-Shape Antenna for UWB

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Abstract

The paper proposes a triangular design and modified E—shaped patch antenna fed by coaxial cable. The antenna characteristics are analysed by MOM method. From the simulation result based on MOM method, frequency characteristics of the structure are investigated. The aim of the designs is to reduce the size of antenna so that less substrate material is utilized and hence cost reduces. Initially square patch is simulated and modified to triangular shape which reduces the size by 50% and then it is further modified by using slot in slot to further reduce the area. The comparison of simulation is well within the acceptable limits. The designed triangular design antenna attains (VSWR<2) with resonance frequency of 5GHz. The proposed antenna can be used for 4G applications. The E—shaped patch antenna can be designed to provide Ultra Wide Band. The developed prototype may find its application in mobile networks, base antennas, IEEE 802.11 a and j standards

1. Introduction

We demonstrate design using slot in slot embedded in the triangular patch acting as side-slots. The main purpose of introducing the slot is to reduce the effective area and observing the results. In the present work two iteration has been performed and at the same time the structure is so modified which will not change the antenna characteristics but it will reduce the area eventually. Now with the loading some specific slot in the radiating patch of micro strip antennas, compact or reduced size micro strip antennas can be obtained. Loading the slots in the radiating patch can cause meandering of the excited patch surface current paths and result in lowering of the antenna's fundamental resonant frequency, which corresponds to the reduced antenna size for such an antenna. The patch is mounted on FR4 substrate (thickness = 1.5mm) above from ground plane with relative permittivity 4.35. It is found that proposed design can also cause significant lowering of antennas fundamental resonant frequency due to increased length of the probe feed.

The micro strip antenna are low profile, conformable to planar and non-planar surface, simple and inexpensive to fabricate using modern printed technology, compatible with MMIC design and very versatile in terms of resonant frequency, polarisation and impedance. However, the conventional type of patch antenna suffers from narrow bandwidth. Therefore, there are various broad banding techniques as illustrated [6] out of which reactively loading the antenna with slot is most preferred one.

This paper discusses about the design of an antenna that closely resembles "equilateral triangle", operating in the 2 to 8 GHz band of frequency that meets the various applications in wireless communication.

Resonant Frequency

The resonant frequency corresponding to the various modes can be given by [1]

$$fr = ck(mn)/(2*\sqrt{\varepsilon r} = \frac{2c\sqrt{m^2+mn+n^2}}{3a\sqrt{\varepsilon r}}$$

Where c is the velocity of the light in free space and K (mn) = wave number, given by

$$Kmn = \frac{4\Pi\sqrt{m^2+mn+n^2}}{3a}$$

a = effective side length

The resonant frequency may be determined with better accuracy if εr and 'a'in the above equation are replaced by effective dielectric constant ε (eff) and a (eff), which are given by

$$\varepsilon eff = 0.5(\varepsilon r+1)+0.25\frac{(\varepsilon r-1)}{\sqrt{1+(12h/a)}}$$

And

$$aeff = a + h/\sqrt{\varepsilon r}$$

Respectively. Hence

$$fr = \frac{2c}{3aeff\sqrt{\varepsilon eff}}$$

It is clear from the equations that for high dielectric constant substrate such as alumina, εr and a should be used in place of ε (eff) and a (eff), respectively.

1.1. ITERATION

The following iterations were performed to reduce the effective area without disturbing the antenna characteristics .It is found that even after incorporating the slots in the structure with a bounded limit , it does not affects the performance of the antenna. It may be noted that adding an additional slot may excite the second resonant mode. So with the loading of some specific slot in the radiating patch of TMSA, compact or reduced size micro strip antenna can be obtained. The loading slot in the radiating patch can cause meandering of the excited patch surface current paths and results in lowering of the antenna's fundamental frequency, which corresponds to the reduced antenna size for such an antenna , compared to conventional micro strip antenna at the same frequency.

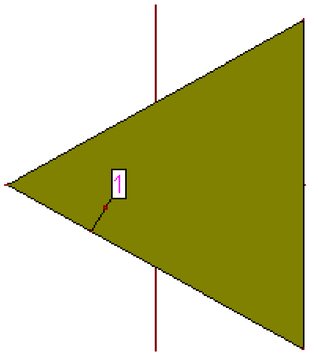

Fig.1. Basic antenna layout

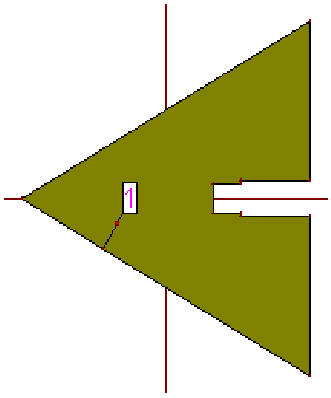

Fig.2. Iteration 1

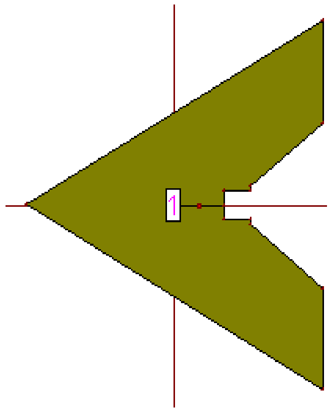

Fig.3. Iteration 2

2. Parametric Study

Table 1. Basic antenna

Parameters	Dimension (mm)
Length of patch (L)	16.47
Width of patch (W)	19.02
Dielectric material	Generic FR-4, h=1.5
Strength of dielectric	1.35

Table2. Iteration 1

Parameter	Dimension (mm)
Depth of slot 1	4
Width of slot 1	2
Depth of slot 2	0.8
Width of slot 2	1

Table 3. Iteration 2

Parameter	Dimension (mm)
Depth of slot 2	0.8
Width of slot 2	1
Inclination on length of slot 1	60 deg

2.2. Design Rules

. The antennas in the figs. 1, 2 and 3 have been simulated in IE3D software. This study was performed by considering that the length (L) define the appropriate resonant conditions of the patch and the width (W) influences the coupling and input impedance. The triangular patch is considered here for analysis. In the iteration 1 two slots have been introduced to reduce the substrate area without affecting the resonant frequency (f= 5GHz). The feed location is suitably chosen for impedance matching so that maximum power transfer can take place. Iteration 2 is further reduced in area by 6.108 % and requires less substrate material.

Simulation Results

Various antenna performance characteristics are shown below in the table 3

Table 3. Antenna characteristics

Characteristic	Iteration 1	Iteration 2
Return loss (db)	-16	-10.3
VSWR	1.5	1.8
Polarization	linear	Linear
Directivity (db)	6.6	6.6

The plot of slot in slot cut triangular micro strip antenna (iteration 1) and iteration 2 are shown in figures with fundamental frequency 5 GHz and 4.9 GHz. The return loss which indicates the amount of power being reflected as a radiation from antenna is -16 db and -10.3 db. The orientation of electric field for both the antennas is linear.

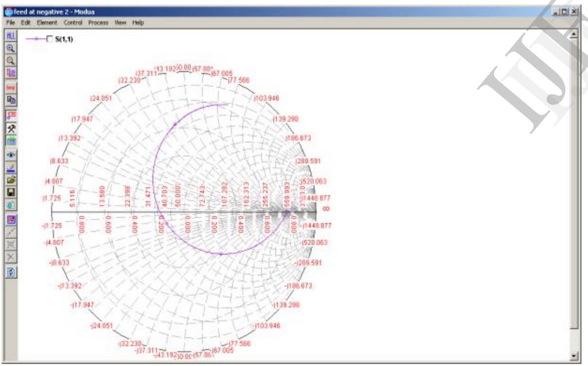
Figure4. Smith chart iteration1

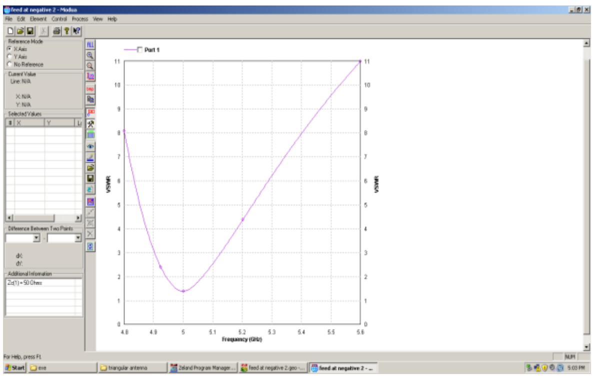
Figure5.VSWR iteration1

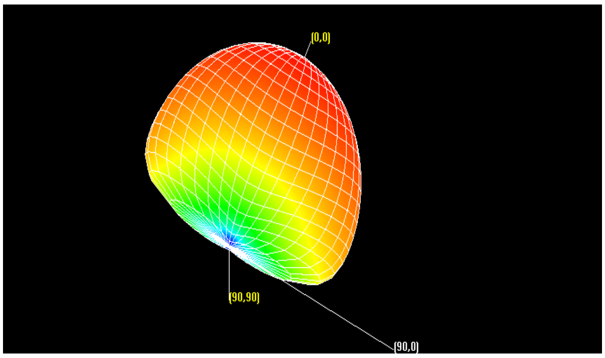

Figure6. 3D Radiation pattern iteration 1

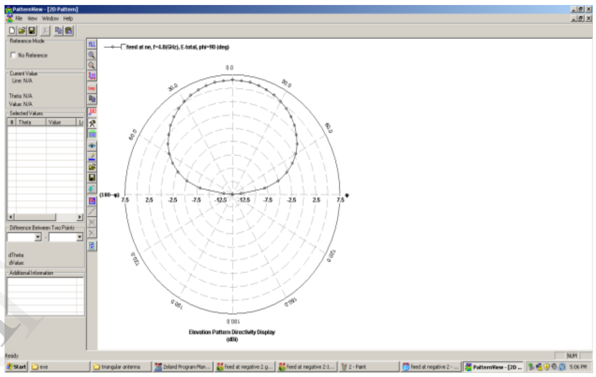
Figure7. 2D pattern iteration 1

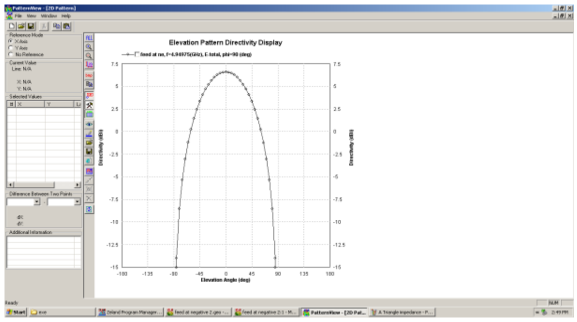

Figure8. Directivity iteration 2

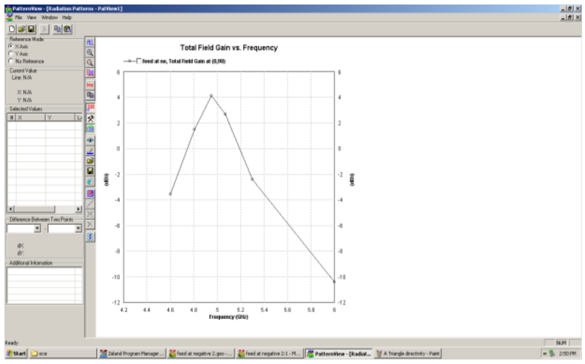

Figure9. Gain iteration 2

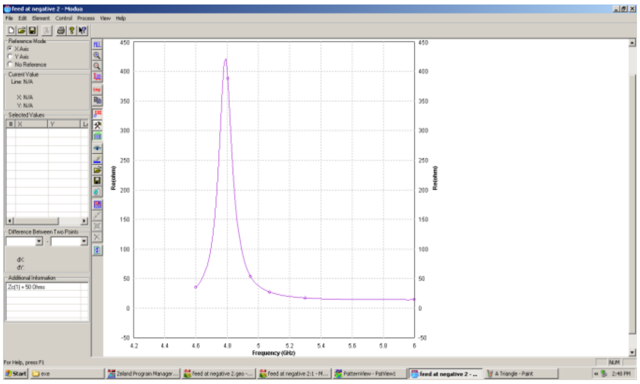

Figure10. Impedance iteration 2

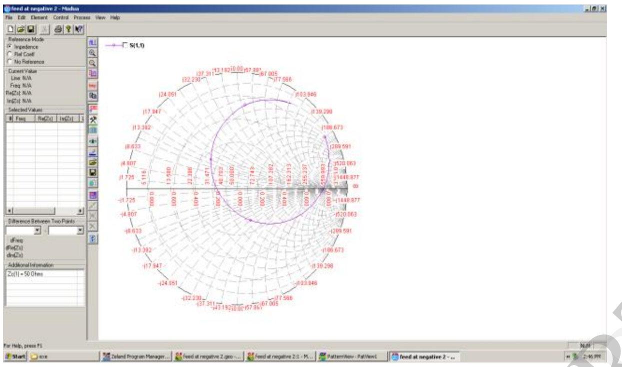

Figure11. Smith chart iteration 2

3. Modified E-Shape Antenna

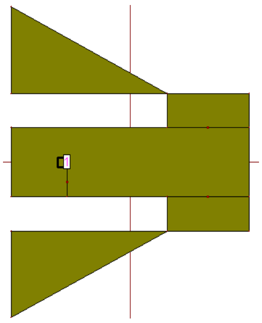

Figure12

Table 4 Parametric study

Parameters	Antenna 1
Length of patch (L)	17.5mm
Width of patch (W)	22.5mm
Length of slot (ls)	15mm
Width of slot (ws)	2.5
Substrate used- ho,h1	5

Table 5 Antenna characteristics

Parameters	Antenna 1
Return loss (db)	-23
VSWR	< 2
Polarization	linear
Resonant frequency GHz)	5.4 – 6.7
Directivity(db)	7.84

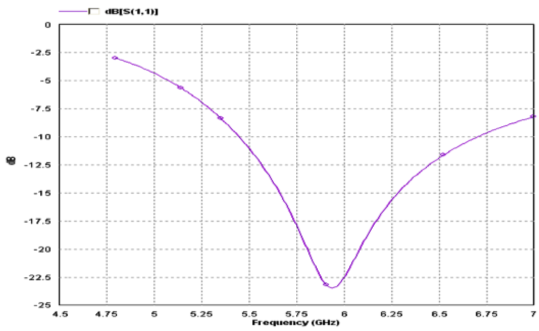

Figure13.Return loss for Modified E-Shape is -23db at frequency 5.9GHz

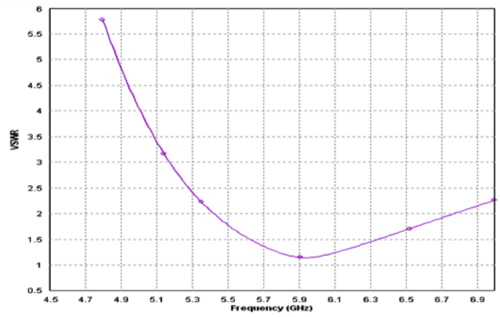

Figure14. VSWR for Modified E-Shape

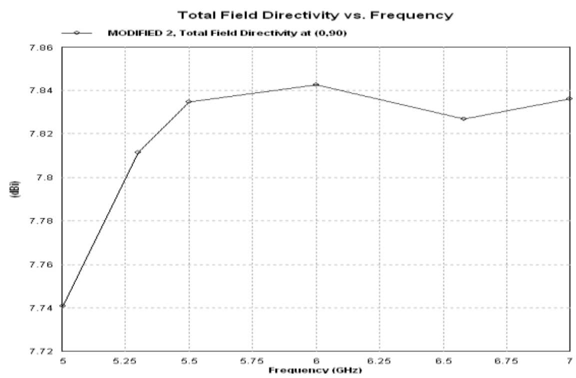

Figure15.The directivity for antenna-1 is 7.84 db at frequency 5.9GHz

In general, antenna is a resonant device and its input varies greatly with frequency. If the antenna input impedance can be matched to its feeding structure across a certain frequency range, that frequency range will define the antenna bandwidth (BW). The bandwidth can be specified in terms of the return loss or the voltage standing ratio (VSWR). The typical values for micro strip antennas are VSWR<2 or return loss (S_{11} in db) < -10db Furthermore, the BW is inversely proportional to the quality factor (Q) and given by

$$BW = \frac{VSWR-1}{Q\sqrt{VSWR}}$$

The minimum quality factor is given by

$$Q_{min} = \frac{1+3(koR)^2}{(koR)^3*[1+(koR)^2]}$$

Where R is the minimum sphere radius which completely encloses the antenna.

The technique to increase the bandwidth and to decrease the antenna dimensions generally employs, in combined way or not, high dielectric constant substrates, modification of patch shapes of the antennas.Also to reduce the area of the E antenna a technique of shorted pin between the patch and the ground plane may be applied in position where the higher frequency has major reduction in its value. As the bandwidth for wideband operation is due to interaction between close resonant frequencies, the first step is to vary than see how the frequency response is modified when feed is applied to various positions.

Conclusion

Modified E-shape micro strip patch antenna has been designed for wireless communication system. The bandwidth of antenna is 25.86% (from 5.3-6.8 GHz) while the antenna also maintains a thin thickness of 0.1λ at the centre frequency f= 5.8GHz, and for triangular antenna the bandwidth is narrow. Both the antennas are thin and compact with low dielectric constant substrate material. It should be noted that the performance of the proposed antennas are not further optimized using schemes like Powell or fasta optimization. By tuning the arms of the basic E-Shape antenna a wideband antenna has been obtained. Further enhancement on the antenna parameters can be done by implementing aperture coupling.

Application:

The proposed triangular antenna can be used for 4G applications. The E—shaped patch antenna can be designed to provide Ultra Wide Band**.** The developed prototype may find its application in mobile networks, base antennas, IEEE 802.11 a and j standards

References

[1]Ramesh Garg, Prakesh Bhartia ,Inder Bhal, Apisak Ittipiboon ,Micro strip Antenna design handbook, Boston, Artech House.

[2]J.R.James and P.S. Hall, Handbook of Micro strip Antenna London, Peter Perigrinus, 1989.

[3]Roger F. Harrington, Field computation by moment methods

[4]C.A. Balanis, Antenna Theory analysis and design, 2nd Edition

[5] K.L. Wong, "Compact and Broadband Micro strip Antenna", John Wiley & Sons, New York, USA, 2002

[6]G. Kumar and K.P. Ray, "Broadband Micro strip Antennas", First Edition, USA, Artech House, 2003

[7]Amit A. Deshmukh and K. P. Ray, "Compact Broadband Slotted Rectangular Micro strip Antenna", IEEE VOL antennas and wireless propagation letters, 8, 2009

[8]M. Albooyeh, N. Komjani, and M. Shobeyri, "A Novel Cross slot geometry to improve impedance bandwidth of Micro strip Antennas", Progress in Electromagnetic Research Letters, Vol. 4, 63–72, 2008.

[9]Zulkifli, F.Y. ; Halim, H. ; Rahardjo, E.T. "a compact multiband micro strip antenna using u slot ant s slot "Antennas and Propagation Society International Symposium, 2008. AP-S 2008. IEEE

[10]Rajan k Vishwakarma, J.A.Ansari."Equilateral triangle micro strip antenna for circular polarisation dual band operation". Indian Journal of radio and space physic vol35 aug2006 pp293-296.

[11]Yogesh Bhomia, Ashok Kajla, Dinesh Yadhav,"Slotted right angle triangle micro strip patch antenna". International journal of electronics engg and research ISSN0974-6450 vol. 2, no 3(2010) pp393-398.

[12]Wojeiech.J.Krzysztojik."Triangular micro strip antenna loaded by slots for GPS application".Proc.EuCAP 2006, Nice, France 6-10 Nov 2006.