International Journal of Software & Hardware Research in Engineering
ISSN No: 2347-4890 Volume 2 Issue 6, June 2014

Design of Triangular Microstrip Patch Antenna Array for 4G (LTE) Applications

Mayank Mishra[1]; Joshua Madhukar Singh[2]

Teerthankar Mahaveer University, Moradabad[1]; Teerthankar Mahaveer University, Moradabad[2]

ABSTRACT

Various shapes of microstrip patch antenna had been designed in antenna field. This paper represents two patch element combined together and formed antenna array. The simulated results of this design using IE3D such as return loss of the antenna array, VSWR, gain, directivity and antenna efficiency. For this, the operating frequency 2.65 GHz, RT/Duroid material having dielectric constant 2.2, loss tangent 0.0004 chosen.

Keywords

Loss, VSWR, Gain, Directivity and Antenna efficiency.

1. INTRODUCTION

Antenna is a very interesting component in communication field. Antenna is responsible for converting sound waves into electromagnetic waves and vice-versa. Antenna also plays a very important role for transmission and reception process of signals from one place to another place. Due to the compactness the microstrip antennas are came into existence. Various shapes of microstrip patch are available for such as rectangular, square, circular, annular etc. The purpose of choosing triangular shape is the triangular waveforms can b easily calculated rather than other waveforms. Triangular microstrip patch antenna consists of a triangular shape radiating patch on one side of dielectric substrate which mounted on a ground plane. For getting the good performance of patch antenna we must careful about the height, dielectric constant of material and operating frequency.

2. DESIGN PARAMETERS AND SIDELENGTH CALCULATION

Three basic parameters are required for designing any shape of microstrip patch antenna. These parameters are described below:

2.1 Operating frequency (*fo*)

It is necessary the designed antenna must able to operate in the frequency range of communication system. So 2.65GHz operating frequency is selected for this antenna array system.

2.2 Dielectric constant of the material (ε_r)

Dielectric substrate must be designed with material which has a high dielectric constant which reduces the antenna size and compactness. In this paper RT/Duroid with 2.2 of dielectric constant used.

2.3 Height of the patch (*h*)

During the design of microstrip patch antenna we must try to minimize the antenna size. So 2 mm height of the triangular patch used in this paper. For designing the antenna array, first calculate the antenna dimensions. In case of equilateral triangular shape we need to calculate the sidelength of triangular patch. All of the paper based on the triangular shape is agree on the basic equation for the resonant frequency given by:

$$f_{m,n,l} = \frac{2c}{3a\sqrt{\varepsilon_r}}\sqrt{m^2 + mn + n^2} \quad \text{... (eqn. 2.1)}$$

For TM01, $m = 0, l = 0, n = 1$.

Resonant frequency f_o = 2.65 GHz, $c = 3x10^8$ m/s, $\varepsilon_r = 2.2$.

Calculated sidelength $a = 50.883$ mm.

Where m, n the mode integers due to the electric and magnetic boundary conditions and c is speed of light in free space, ε_r dielectric constant of substrate and a is the sidelength of the equilateral triangular patch. After the calculation design two triangular patches over the substrate which has ground plane on the other side and joined these two patches in series with each other. Atlas the probe feeding is done on specific location and get the simulated results.

3. SIMULATION RESULTS

For designing and simulation IE3D simulation tool is used which is very popular for antenna designing. Various simulated graphs such as return loss, VSWR, total directivity, antenna gain and antenna efficiency and radiation patterns (mapped 3D and true 3D view) are generated by the IE3D simulation tools shown in figures.

3.1 Return loss

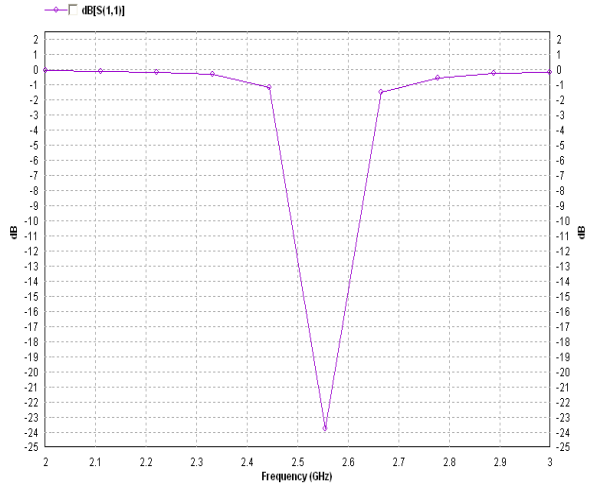

Fig.1. Return loss of two patch element antenna array

3.2 VSWR

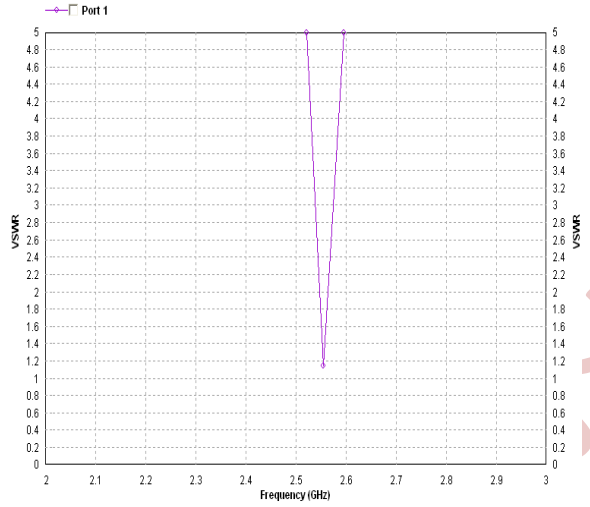

Fig.2. VSWR of two patch element antenna array

3.3 Directivity

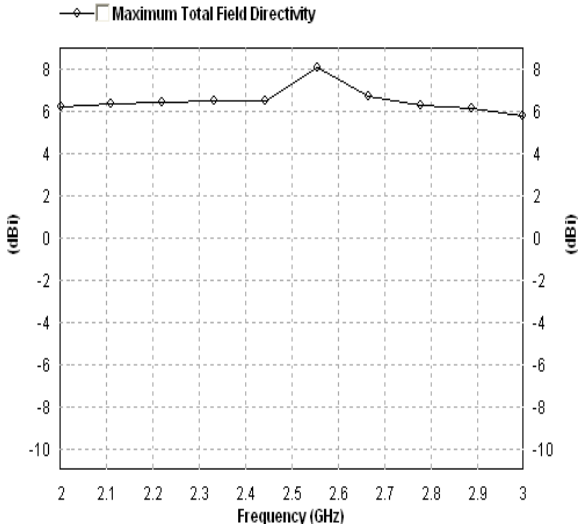

Fig.3. Total directivity of two patch element antenna array

3.4 Gain

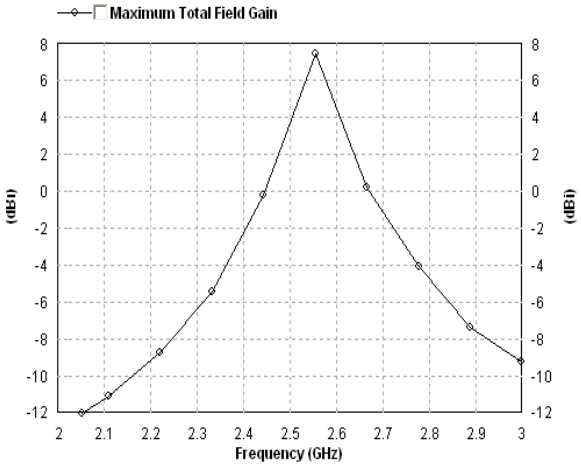

Fig.4. Gain of two patch element antenna array

3.5 Antenna Efficiency

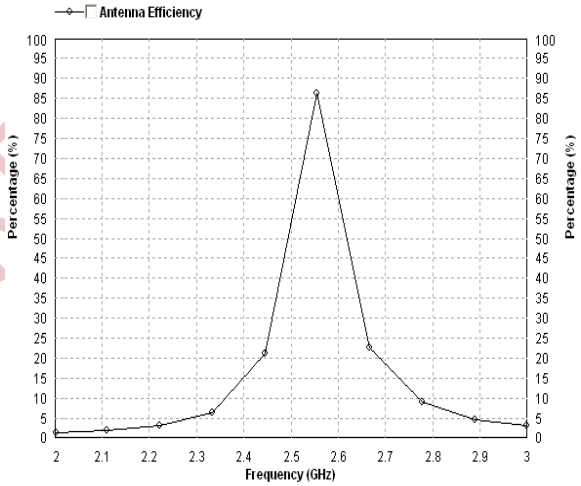

Fig.5. Antenna efficiency of two patch element antenna array

3.6 Radiation Pattern and Geometry

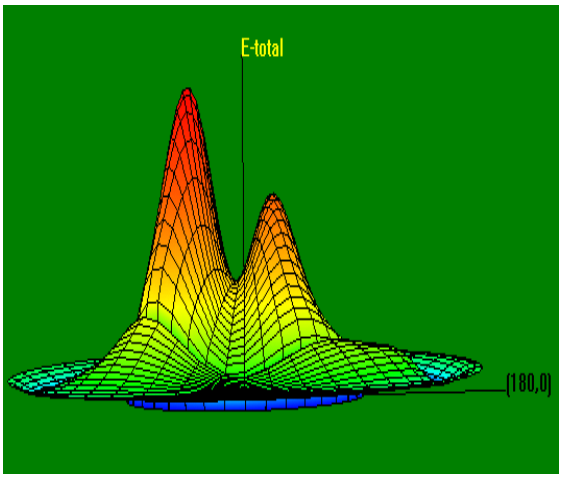

Fig.6. Radiation pattern two patch element antenna array (Mapped 3D view)

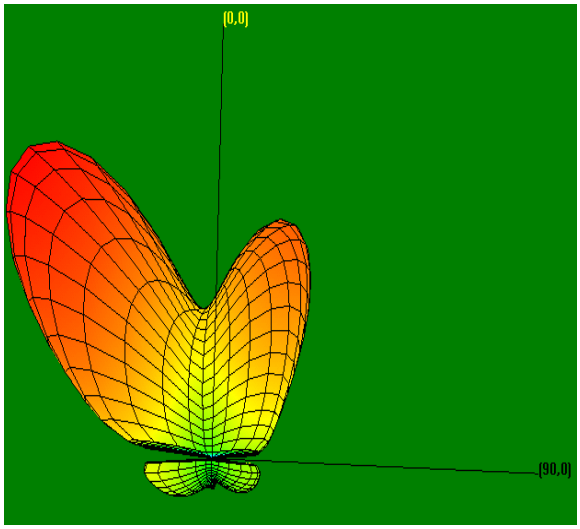

Fig.7. Radiation pattern of two patch element antenna array (True 3D view)

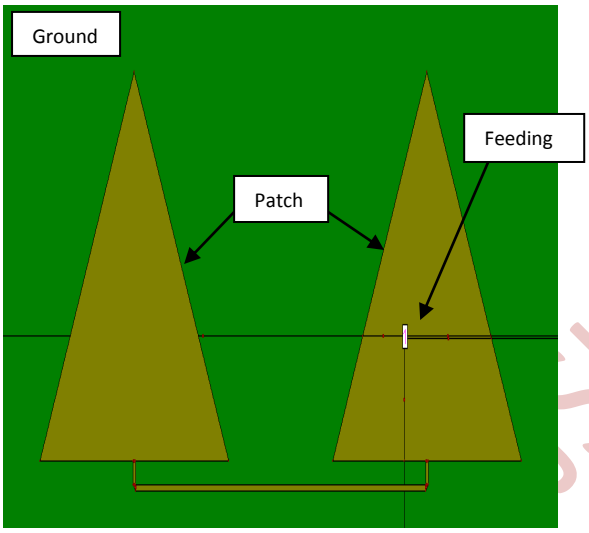

Fig.8. Two patch element antenna array geometry

4. Conclusion

Antenna array built by connecting two triangular shape microstrip patch antennas in series. The geometry of this array is designed using IE3D Ver. 9.35 simulation tools. The return loss of the array is -24 dB, VSWR is 1.139 which is very close to 1, and the ideal value of VSWR is 1. Total directivity of array is 8.0225dBi, gain of antenna array is equal to 7.37dBi and antenna efficiency is equal to 86.18%.

5. REFERENCES

[1] Jhon S. Thompson, Peter M. Grant, and Bernard Mulgrew, "Smart Antenna Array for CDMA Systems" IEEE Personal Communications, October, 1996.

[2] M. Mouhamadou, P. Vaudon and M. Rammal, "Smart Antenna Array Patterns Synthesis: Null Steering and Multi-User Beamforming By Phase Control" Progress In Electromagnetics Research, PIER 60, 95–106, 2006.

[3] P. Yadav, A. Khare, P. Kumar and K.P. Gowd, "Design and Optimazation of Triangular Shape Dual Band Microstrip Antenna for SAR Applications" International Journal on Emerging Technologies **2**(1): 39-41, ISSN : 0975-8364, 8 June, 2011.

[4] M. M. Olaimat and N. I. Dib, "A Study Of 15^{o}-75^{o}-90^{o} Angles Triangular Patch Antenna" Progress In Electromagnetics Research Letters, Vol. 21, 1, September 2011.

[5] Yahya S. H. Khraisat, "Design of 4 Elements Rectangular Microstrip Patch Antenna with High Gain for 2.4 GHz Applications" Modern Applied Science, Vol. 6, No.1, ISSN:1913-1844, 1, January, 2012.

[6] Yahya S. H. Khraisat, Melad M. Olaimat & Sharief N. Abdel-Razeq, "Comparison between Rectangular and Triangular Patch Antennas Arrays" Applied Physics Research, Vol. 4, No. 2, 1, May, 2012.

[7] V.Ratna Bhargavi, P.Poorna Priya, K.Pavan Kumar, Dr.Habibulla Khan, "Gain Enhancement Of V-Slotted Triangular Shape Microstrip Patch Antenna For WIMAX Applications" International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 3, May-Jun 2012.

[8] Anzar Khan, Rajesh Nema, Puran Gour, "Investigation Of Triangular Microstrip Patch Antenna On Six Different Substrates For X –Band Applications" International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 5, September- October 2012.

[9] Bilal Ahmed, Ilyas Saleem, H. Zahra, Hunaina Khurshid and S. Muzahir Abbas, " Analytical Study on Effects of Substrate Properties on the Performance of Microstrip Patch Antenna" International Journal of Future Generation Communication and Networking, Vol. 5, No. 4, December 2012.