DESIGN OF ELLIPTICAL SHAPED MICRO-STRIP PATCH ANTENNA FOR Ka BAND

Ch.Rama Krishna[1] & Naga Ganesh.A[2] & D. Durga Prasad[3]
[1]Associate Professor, [2,3]Assistant Professor
Department of ECE, Vishnu Institute of Technology, VIT, Bhimavaram, Andhra Pradesh, INDIA.

Received: June 08, 2018 Accepted: July 26, 2018

ABSTRACT *Nowadays wireless communication systems which have the high speed data rate such as Satellite Communications, Radar Systems as Synthetic Aperture Radar, Remote sensing radars, Shuttle Imaging Radar and other wireless communication systems operates in wide band frequencies. Here Micro-Strip Antennas are the first choice for these high frequency bands due to its light weight and have broad bandwidth. It is feasible to be structured conformal to the mounting hosts. Rectangular micro-strip patch antenna and E-shape Micro-Strip patch Antenna offers high Return loss and high VSWR value so it offers low gain at Ka band of frequencies. This paper presents the design of Elliptical shaped Micro-Strip Patch Antenna which is used to overcome the defects present in the Rectangular Micro-strip Patch Antenna and E-shaped micro-strip patch antenna at Ka band of frequencies. We propose the Elliptical shaped Micro-strip patch antenna, which provides better gain and less return loss and low VSWR value for high frequency band like Ka band when compared with E-shaped micro-strip patch antenna due to the Elliptical shape radiations are spread in all directions which is similar to the isotropic radiation pattern. The design and analysis of the Elliptical shaped antenna is carried out by using CST software.*

Keywords: *Micro-strip antennas, Rectangular micro-strip patch antenna (RMPA), E-shape micro-strip patch antenna, Return loss, VSWR, Ellipse shaped micro-strip patch antenna, CST software.*

I.INTRODUCTION

A Micro-strip patch antenna is one kind of radio antenna with a low profile. The design of micro-strip antenna was described by Howell in 1972. It mainly consists of a three parts one of them is a "patch" which is made up of metal like cooper or Gold. Next one is “Ground plane” which is large in size and made up of metal and finally “Substrate” plane is sandwiched between ground plane and patch plane. The two metal planes together form a resonant piece of micro-strip transmission line with a length of approximately one-half wave length of the radio waves.

The radiation mechanism arises due to discontinuities at each truncated edge of the micro-strip transmission line. The radiation at the edges causes the antenna to act slightly larger electrically than its physical dimensions, so in order to resonant the antenna, a length of micro-strip transmission line is slightly shorter than one-half the wavelength at the frequency is used. The patch antenna is mainly used at practical microwave frequency applications, at which wavelengths are short enough that the patches are conveniently small.

They are mostly used in portable wireless devices like Mobile phones and Hand held devices because of the ease of fabricating it on printed circuit boards. Multiple patch antennas on the same substrate called micro-strip antennas can be used to make high gain array antennas, and phased arrays in which the beam can be electronically steered.

II. METHODOLOGY ADAPTED

A. Antenna Shape

Common micro-strip antenna patch shapes are Rectangular, Square , Elliptical and Circular. Micro-strip patch antennas radiate mainly due to the fringing fields between the patch edge and the ground plane. The selection of a substrate material is very important. The Thickness of the substrate and height (h) has a large effect on the resonant frequency and bandwidth of the antenna. The bandwidth of the Micro-strip antenna will increase with an increase in height(h) and substrate thickness but with limits, otherwise the antenna will stop resonating.

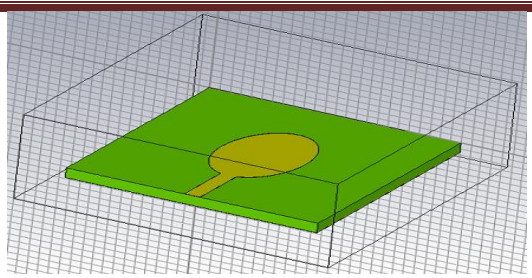

Fig.1. Micro-strip Patch Antenna

In its most basic form, a Micro-strip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 1. In this design an Elliptical shaped patch is used which is generally made up of conducting material such as copper or gold we mostly use Copper because of ease availability and low cost. The radiating patch and the Micro-strip line feed are usually photo etched on the dielectric substrate. Micro-strip patch antennas radiate mainly because of the fringing fields between the patch edge and the ground plane.

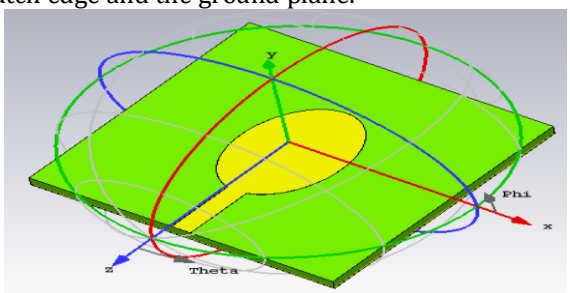

Fig.2. Structure of Micro-strip Patch Antenna

Consider Figure.2, which shows a Elliptical shaped micro-strip patch antenna of patch dimensions of large diameter of Ellipse A=6mm and small diameter of Ellipse B=4mm and height of the patch h= 0.0256mm and the patch is made up of copper material. The patch lies on a substrate plane whose dimensions are length L=24mm and width W=24mm and height h=1.59mm and substrate is made up of "Rogers Ro 3203(lossy)" material. The substrate lies on a Ground plane whose dimensions are length L=24mm and width W=24mm and Height h=0.0256 which is made up of copper. In this Design Micro-strip line feeding is used for exciting the Antenna. The co-ordinate axis is selected such that the length is along the x direction, width is along the Z direction and the height is along the y direction.

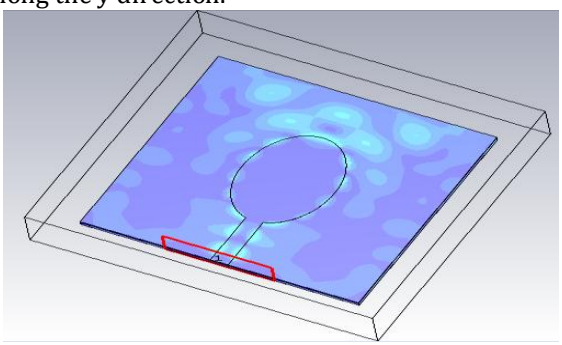

Fig.3. E-field pattern of Elliptical Shaped Micro-strip patch Antenna

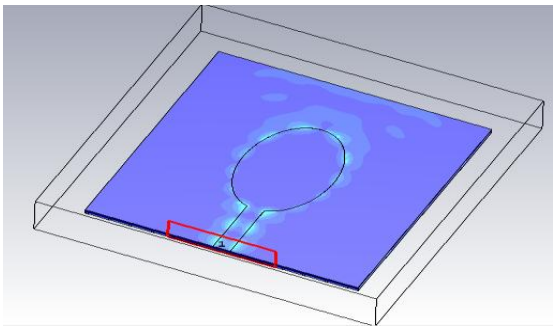

Fig.4. H-field pattern of Elliptical Shaped Micro-strip patch Antenna

The above figure.3 &4 shows the spread of E-field and H-field patterns of Elliptical Shaped Micro-strip patch Antenna.

III. RESULTS AND DISCUSSION

After completion of simulation to the 3D elliptical Antenna Model the results are obtained in the form of graphs. After analyzing these 2D & 3D wave forms, we can determine the performance characteristics of the antenna. Performance Parameters

1) Return loss
2) VSWR
3) Gain

1) Return loss

Return loss waveform is observed at 1D results folder followed by s11 Parameter as shown in fig.5.

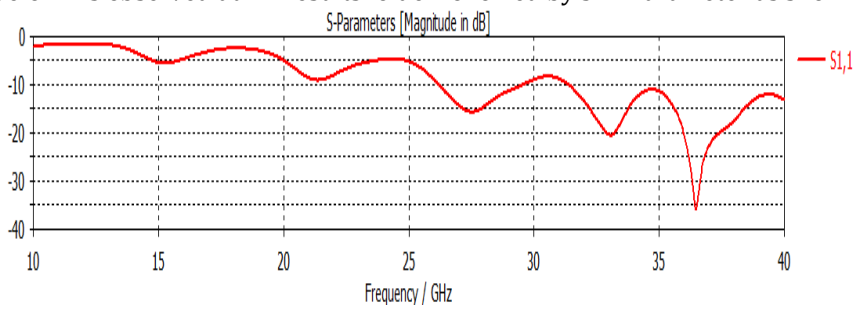

Fig.5. Return loss Graph of Elliptical Shaped Micro-strip patch Antenna

Table 1: Return loss value of Elliptical shaped Micro-strip patch Antenna at Ka band

Antenna parameter	Elliptical Shaped Micro-strip patch Antenna
Frequency(GHz)	36.5
Return loss(db)	-35.8

The above Table 1 shows Return loss value of Elliptical shaped Antenna at Ka band. Return loss value is -35.8 db at 36.5 GHz

2) VSWR

VSWR waveform is observed at 1D results folder followed by VSWR Parameter as shown in fig.6.

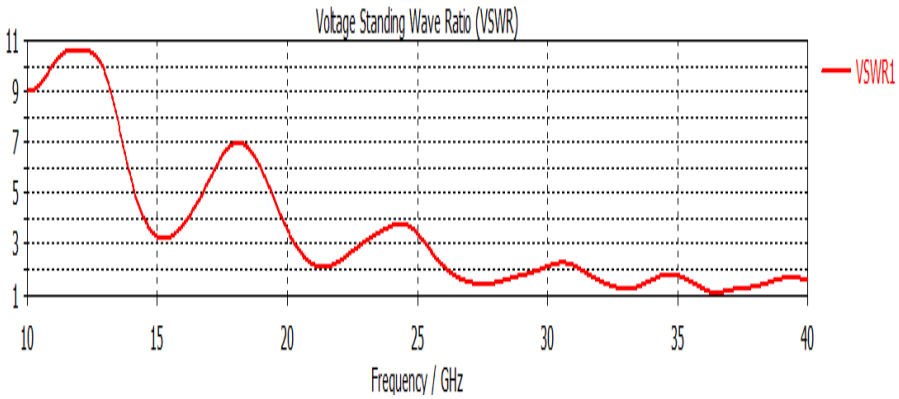

Fig.6. VSWR graph of Elliptical shaped Micro-strip patch Antenna

Table 2:VSWR Value of Elliptical Shaped Micro-strip patch antenna at Ka band

Antenna parameter	Elliptical Shaped Micro-strip patch Antenna
Frequency(GHz)	36.5
VSWR	1.0

The above Table 2 shows VSWR Value of Micro-strip patch antenna at Ka band. VSWR value is 1.0 at 36.5GHz.

3) Gain (db)

Gain is observed at particular frequency by applying field monitor and Gain of Elliptical shaped Micro-strip patch Antenna at Ka band as shown in fig .7.

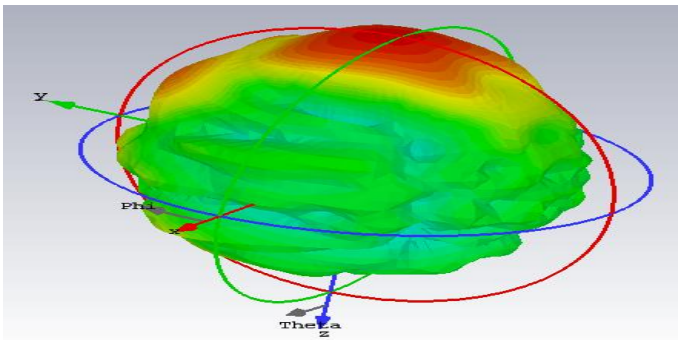

Fig.7. Gain of Elliptical shaped Micro-strip patch Antenna at Ka band

Table 3 : Gain Value of Elliptical Shaped Micro-strip patch antenna at Ka band

Type	Farfield
Approximation	enabled (kR >> 1)
Monitor	farfield (f=36.5) [1]
Component	Abs
Output	Gain
Frequency	36.5 GHz
Rad. effic.	-0.5195 dB
Tot. effic.	-0.5207 dB
Gain	7.173 dB

IV.COMPARISON BETWEEN DIFFERENT MICRO-STRIP PATCH ANTENNA DESIGNS

The comparison between Different Micro-strip Patch Antenna Designs in terms of different parameters is shown in Table 4.

After comparative analysis the low return loss, low VSWR and maximum gain is achieved in case of Elliptical Shaped Micro-strip patch Antenna.

Table 4: Comparison between Different Microstrip Patch Antenna Designs

Antenna Parameter	Rectangular Micro-strip Patch Antenna	E-Shaped Micro-strip Patch Antenna	Elliptical Shaped Micro-strip Patch Antenna
Frequencies (GHz)	36.5	36.5	36.5
Return Loss(db)	-14	-29	-35.8
VSWR	1.5	1.2	1
Gain(db)	3.9	2.8	7.17

V.CONCULSION

Finally, we conclude that Elliptical shaped antenna provides Low Return loss, Lowest VSWR value and high Gain operates in Ka band of Frequencies when compared with other Antenna's like Rectangular Micro-strip patch Antenna (RMPA) and E shaped Micro-strip patch antenna.

REFERENCES

[1] Pushpendra Singh, Swati Singh, "Ellipse Shaped Micro-Strip Patch Antenna For Ku, K And Ka Band Applications" International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 02 ,Feb-2016

[2] S. M. Rao, D. R. Wilton, and A.W. Glisson, "Electromagnetic scattering by surfaces ofarbitrary shape," IEEE Trans. Antennas Propagat., vol. AP-30, 1982, pp. 409–418.

[3] D. Peroulis, K. Sarabandi and L. B. P. Katehi. 2005. Design of reconfigurable slot antennas. IEEE Trans. Antennas Propag., vol. 53, no.7, pp. 645-654.

[4] H. Okabe and K. Takei. 2001. Tunable antenna system for 1.9 GHz PCS handsets. IEEE Antennas Propag. Int. Symp., vol. 1, pp. 166- 169

[5] K. C. Gupta, and A. B. Norwood, " Micro-strip Antenna Design," Norwood, MA: Artech House. 1988.

[6] X.-X. Zhang and F. Yang, "The study of slit cut on the micro-strip antenna and its applications," Microwave Opt. Technol. Lett., vol. 18(4), 1998.

[7] S. Rawat, and K..K. Sharma, " A compact broadband micro-strip patch antenna with defected ground structure for C-band applications," Central European Journal of Engineering, Springer, 2014, 287-292.
[8] Constantine A. Balanis. Antennas Theory - Analysis and Design. 3rd Edition. John Wiley&Sons, Inc, 1997.
[9] Punit S. Nakar. Design of a compact microstrip patch antenna for use in wireless/cellular devices. Master's thesis, The Florida State University, 2004.
[10] Supernec. http://www.supernec.com/.
[11] John D. Kraus. Antennas. 2nd Edition. McGraw Hill International, 1988.
[12] Lee,KaiFong,; LukKwaiMan (2011). Microstrip Patch Antennas. World Scientific. pp. 8–12. ISBN 184816453
[13] Di Nallo, C.; Faraone, A., "Multiband internal antenna for mobile phones," Electronics Letters, vol.41, no.9, pp. 514-515, 28 April 2005
[14] J. D. Joannopoulus, R. Meade, J. Winn, Photonic Crystals. Molding the Flow of Light, Pinceton Univ. Press, 1995.