ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

Design of Rectangular Microstrip Slot Antenna for Multi Band Application

K.Thamarairubini[1], V. Kiruthiga[2]

Assistant professor, Dept. of ECE, BIT College, Sathyamangalam, Tamilnadu, India [1]

PG Student [CO], Dept. of ECE, BITCollege, Sathyamangalam, Tamilnadu, India [2]

ABSTRACT: The aim this paper is to design a modified rectangular microstrip patch antenna for High band applications especially for Ku-band, and Ka-band applications. High band is achieved using inserting vertical slits in the rectangular patch. The result shows that thereturn loss as -5 dB is achieved at the first resonant frequency of 12 GHz in Ku-band.Return loss as -12 dB is achieved at the second resonant frequency of 31 GHz and return loss as -14 dB is achieved at the third resonant frequency of 39 GHz used in Ka-band application. Another aim to make operate the proposed antenna to give better performance in high band application

KEYWORDS: Antenna Design, BW Enhancement, Microstrip Patch Antenna, Rectangular Microstrip Patch Antenna, Return loss.

I. INTRODUCTION

Microstrip antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. This is relatively new area of antenna engineering. The radiation properties of micro strip structures have been known since the mid-1950.The application of this type of antennas started in early 1970 when conformal antennas were required for missilesA major contributing factor for recent advances of microstrip antennas is the current revolution in electronic circuit miniaturization brought about by developments in large scale integration. As conventional antennas are often bulky and costly part of an electronic system, micro strip antennas based on photolithographic technology are seen as an engineering breakthrough [1-2].

In this paper, compact design of microstrip patch element with microstrip feed line is proposed for Tri band (X-band, Ku-band and Kband)applications. The principal applications of X-band, Ku-band and K-band are radar, aircraft, spacecraft and mobile or satellite based communication system.

II. ANTENNA DESIGN AND GEOMETRY

A. DESIGN OF MICROSTRIP PATCH ANTENNA

The geometry of the existing antenna has been shown in Fig.1. The antenna comprises of circular and rectangular slots both on the radiating patch and ground plane. The design process begins with the radiating patch with substrate, ground plane and a feed line. It is printed on a 1.6 mm height FR4 substrate that contains dielectric loss tangent 0.02, permittivity 2.2.

The length and width of the microstrip patch antenna is calculated with the help of the following equations which is stated by the specified approximation [3-4].

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

i) To calculate width

$$w = \frac{1}{2f\sqrt{\mu_0 \varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

ii) To calculate Length

$$L = \frac{c}{2 f_o \sqrt{\varepsilon_r}} - 2\,l$$

$$\varepsilon_\varepsilon = \frac{1}{2}(\varepsilon_r + 1) + \frac{1}{2}(\varepsilon_r - 1)\ \left(1 + \frac{10h}{W}\right)$$

εr=dielectric constant of the substrate
h=height of the substrate

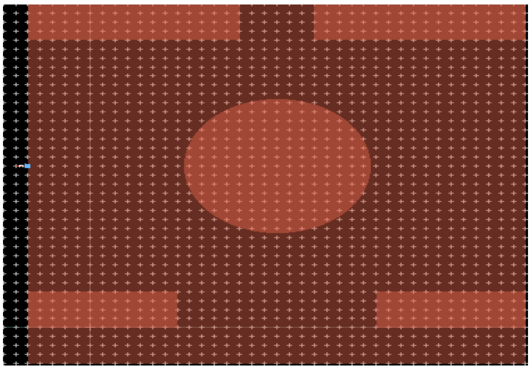


Fig.1. Existing Square shaped Microstrip Patch Antenna

In fig1, shows existing antenna is determined as 40 x 40 mm. The radius is 7.5mm. The path dimension is 17 x 10 mm.

B. Design of Proposed Rectangular Microstrip Patch antenna

The geometry of the proposed antenna has been shown in Fig.2. Basically, microstrip patch antenna consists of three layers: a metallic layer with antenna element pattern, dielectric substrate and another metallic layer as the ground plane[5-6].The antenna is designed by using FR-4 with permittivity ε_r =2.2 and height, h=1.588 mm. The antenna has a simple structure fed by 50Ω microstrip line.

i) To calculate Width

$$w = \frac{1}{2f_r\ \sqrt{\mu_0 \varepsilon_0}}\ .\ \sqrt{\frac{2}{\varepsilon_r + 1}}$$

ii) To calculate Length

$$L = \frac{1}{2fr\ \sqrt{\varepsilon_{eff}}\ \sqrt{\varepsilon 0\, \mu 0}} - 2\ \ L$$

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

Where,

$$L = 0.41h \frac{\varepsilon_{eff} + 0.3}{\varepsilon_{eff} - 0.258} * \frac{\frac{w}{h} + 0.264}{\frac{w}{h} + 0.8}$$

And

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + 12\frac{h}{w}}}$$

Where, λ is the wave length, f_r (in GHz) is the resonant frequency, L indicates the length and W indicates the width of the patch element and ε_r is the relative dielectric constant.

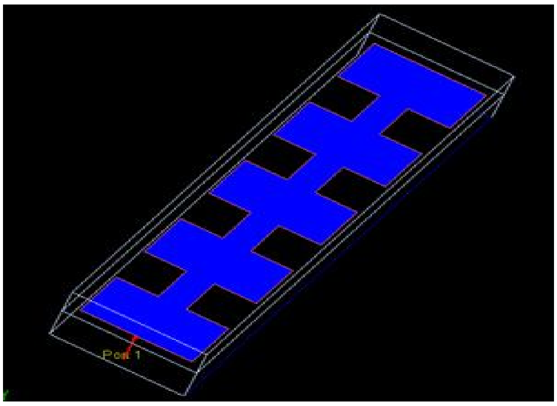


Fig.2.Proposed Antenna

In fig2, shows Proposed antenna is determined as 4 x 2.2 mm as first stub and 2 x 4.9mm as second stub with 3 array. The transmission line is 1.7 mm.

Step by step procedure to design the proposed antenna:

Step 1:

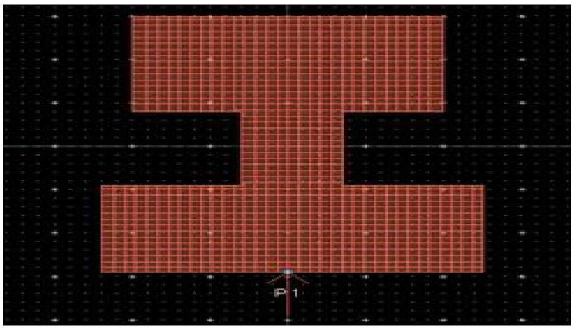


Fig.3 (a)

Step 2:

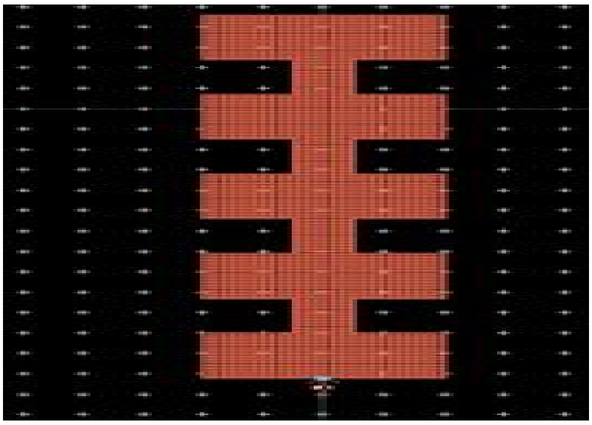


Fig.3 (b)

In fig 3 (a) (b) shows Proposedantenna design steps follows as step 1 and step 2.

III. RESULT AND DISCUSSION

It's easy to simulate the design through computer before real time implementation. The ADS software helps us to determine bandwidth, return loss, gain and directivity. This tool also helps to reduce the fabrication cost because only the antenna with the best performance can be fabricated. The simulation results of existingantenna and the proposed antenna design shown in figure 4 and figure 5.

A. RETURN LOSS AND BANDWIDTH:

In fig 4, shows the return loss of existing antenna as-20.9 dB is achieved at the first resonant frequency of 10.4 GHz.The return loss of -16 dB at the second resonant frequency of 13.9 GHz.

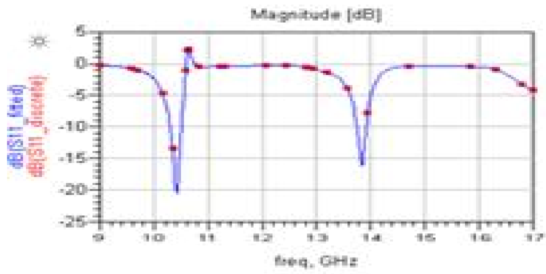


Fig.4. Return loss result for Microstrip Patch Antenna

For step 1:

In fig 5(a), shows the return loss for proposed antenna as -30 dB is achieved at the first resonant frequency of 30GHz used in Ka-band application.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

Fig.5 (a). Return loss result for step-1proposed antenna

For step 2:

In fig 5(b), shows the return loss as -5 dB is achieved at the first resonant frequency of 12 GHz in Ku-band .Return loss as -12 dB is achieved at the second resonant frequency of 31 GHz and return loss as -14 dB is achieved at the third resonant frequency of 39 GHz used in Ka-band application.

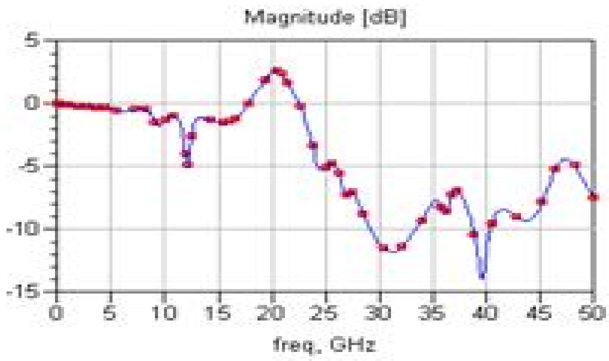
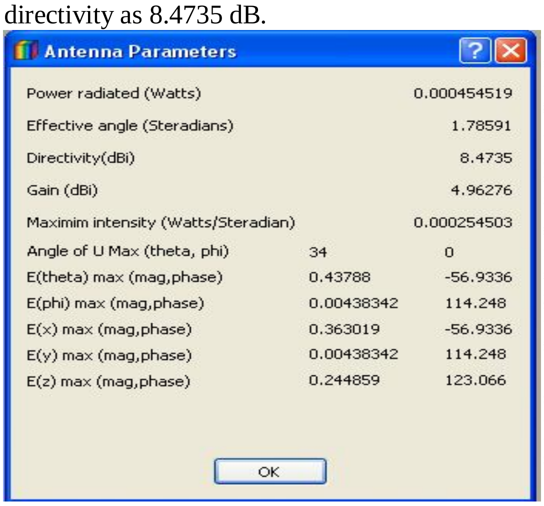


Fig.5 (b). Return loss result for step-2 proposed antenna

.

B. DIRECTIVITY AND GAIN

In Fig 6 (a) and (b), shows the result of gain and directivity where the existing antenna has gain as 4.96276 dB and directivity as 8.4735 dB.



Antenna Parameters

Power radiated (Watts)		0.000454519
Effective angle (Steradians)		1.78591
Directivity(dBi)		8.4735
Gain (dBi)		4.96276
Maximim intensity (Watts/Steradian)		0.000254503
Angle of U Max (theta, phi)	34	0
E(theta) max (mag,phase)	0.43788	-56.9336
E(phi) max (mag,phase)	0.00438342	114.248
E(x) max (mag,phase)	0.363019	-56.9336
E(y) max (mag,phase)	0.00438342	114.248
E(z) max (mag,phase)	0.244859	123.066

OK

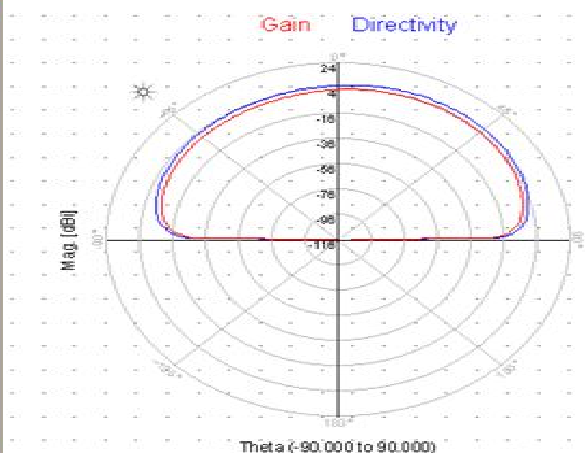


Fig.6 (a)Fig.6 (b)

Fig.6 (a) (b).Antenna Parameter for Existing antenna

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

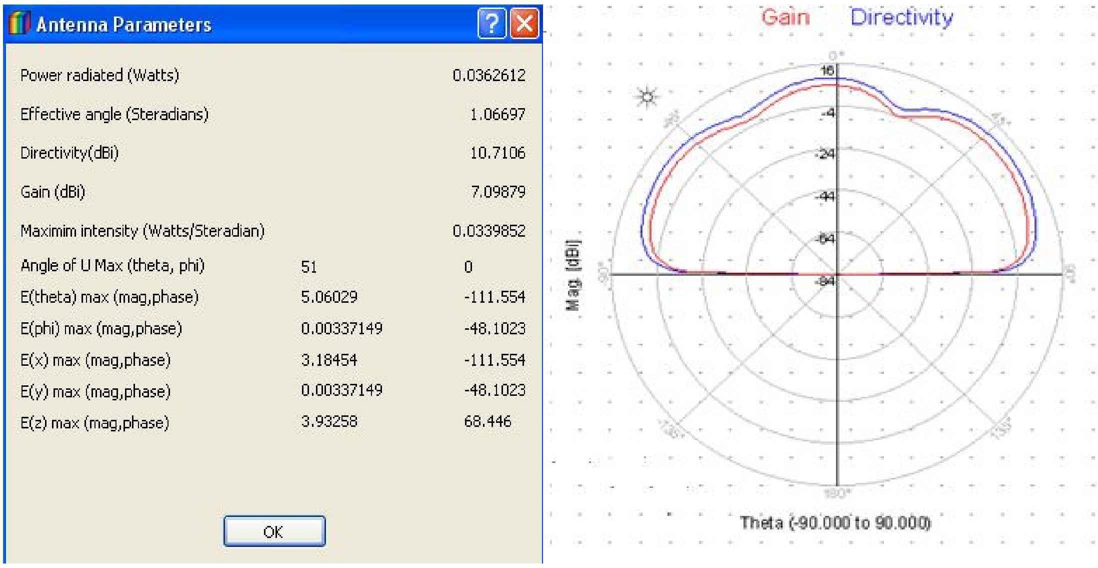


Fig.7(a)Fig.7(b)

Fig.7 (a) (b).Antenna Parameter for Proposed antenna

In fig 7 (a) and (b), shows the proposed antenna has gain value as 7.09879 dB dB and directivity as10.7106 dB.

C. RADIATION PATTERN

An antenna radiation pattern or antenna pattern is defined as a mathematical function or a graphical representation of the radiation properties of the antenna. Figure 8 and 9 shows the radiation pattern for existing antenna and proposed antenna.

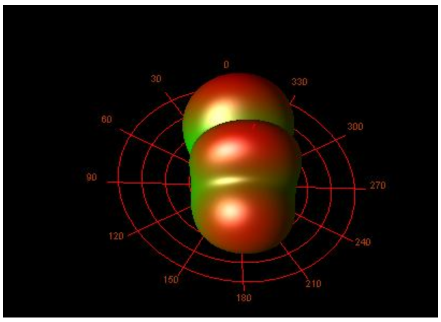


Fig.8. Radiation pattern for Existing method

In fig 8, shows the radiation pattern for existing antenna and it has side lobe with improper radiationeffect.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

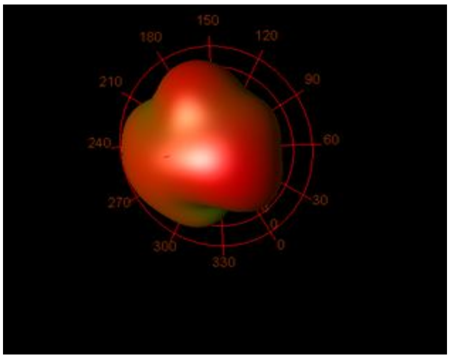


Fig.9. Radiation pattern for Proposed method

In fig 9, shows the radiation pattern for proposed antenna and it has no side lobe with proper radiation effect.

IV. CONCLUSION

Antenna plays a vital role in communication whether it an ISM band, C band, X-band, Ku-band or Ka-band. The proposed antenna delivers high return loss and bandwidth where a single antenna can used for Tri-band application.The proposed design has the capability to work in two different high band frequency such as, Ku-band, Ka-band whereas the existing method can be used only for two low band applications. The proposed method has reduced side lobes. Thus, Rectangular Microstrip Patch Antenna has much better result for satellite communication.

V. FUTURE WORK

The shape of the antenna can be changed in order to get more return loss and efficiency. Even the same antenna design can be used for Many band application.

REFERENCES

[1] M. Samsuzzaman, M. T. Islam, and M. R. I. Faruque, "Dual-band multislot patch antenna for wireless applications, "Journal of Telecommunications and Information Technology, vol. 2, pp. 19-23,2014.

[2] Muhammad MahfuzulAlam, Md. Mustafizur Rahman Sonchoy, andMd. Osman Goni, "Design and Performance Analysis of MicrostripArray Antenna", Progress In Electromagnetic ResearchSymposium Proceedings, Moscow, Russia, August 18-21, 2014

[3] A. Dastranj and H. Abiri, "Bandwidth enhancement of printed E-shaped slot antennas fed by CPW and Microstrip line," IEEE Trans. AntennasPropag., vol. 58, no. 4,pp. 1402-1407, 2013.

[4] K. Kiminami, H. Akimasa, and S. Toshiyuki, "Double-sided printedbow-tie antenna for UWB communications."*IEEE Antennas and Wireless Propagation Letters*, vol. 3, no. 1, pp. 152-153, 2013.

[5] J.-Y. Jan and J.-W.Su, "Bandwidth enhancement of a printed wide-slot antenna with a rotated slot," *IEEETrans. Antennas Propag*.vol. 53, no.6, pp. 2111-2114, 2013.