International Journal of Electrical & Electronics Research (IJEER)
Volume 3 issue 2, Pages 15-18, June 2015, ISSN: 2347-470X

Array of Rectangular Patch Antenna with Asymmetric Slot for L-Band Applications

Sarbar Khan
Department of Electronics and Communication
RJIT, Tekanpur, Gwalior, M.P., India
sarbarkhan8@gmail.com

ABSTRACT- In this paper, array of microstrip patch antenna is designed for communication in wireless application in L-BAND. Single element and 2x1 array of rectangular microstrip patch antenna is designed and simulated by a full wave simulator (IE3D). Two rectangles of length 42mm and width 38.9mm with asymmetric slots is simulated. The design is fabricated on ground with relative permittivity (€r) of 2.2 and thickness 1.6mm. This design has a resonance frequency of 2.44 GHz and achieved a return loss of -41.4176dB. Coaxial feeding is used in this antenna design. Some other important parameters of simulated results of the proposed antenna such as Return loss, Smith chart, directivity, gain are also mentioned and discussed. The proposed design finds application in L-BAND especially in BLUETOOTH devices.

General Terms- Array of rectangular Microstrip patch antenna.

Keywords- Microstrip patch antenna (MPA), Rectangular microstrip patch antenna (RMPA), Array of Rectangular Microstrip patch antenna (ARMPA), L – Band Applications.

1. INTRODUCTION

The microstrip patch antennas (MPA) are most widely used in microwave applications for the last few years due to their attractive features such as light weight, low volume, ease in fabrication, good return loss and low cost, easy and simple structure and high gain [4]. However, the major disadvantage associated with MPA is their narrow bandwidth which restricts their many useful applications [4-5]. Microstrip antenna is good when its typical gain is about 6 dB [5]. High performance antenna is very important in any type of wireless applications as transceivers. Some observations are being pursued for improving the performance of the particular antenna with the help of the array techniques [6]. Among different shapes of radiating patches such as square, rectangular, triangular, circular, ellipse etc., the rectangular radiating patch was found to exhibit good radiation characteristics, simple to design and compact in size when compared to other microstrip patch shapes [4-6]. RMPA are the most common and basically used microstrip antenna, these all type of patches are mostly used for the highly demanding applications. The analysis of rectangular shape antennas was simple and separable [9]. RMPA covers all the applications which lie in L-band frequency range but this design is specifically for Bluetooth application.

Some rectangular patch antenna designs are presented in this paper which are single element and 2x1 arrays and which are simulated in Full wave Simulator (IE3D). This paper consists of (1) Single element Rectangular Patch design, (2) Co-axial feeding, (3) Symmetrical Rectangle design, (4) Microstrip line, (5) Asymmetrical slotting. The proposed antenna achieves high return loss and high gain. Its simulation bandwidth is 208MHz and it is very suitable for Bluetooth devices because it works on 2.4 GHz.

Formulas:

Width (W) = $(1/2F_r\,(\mu_0\varepsilon_0)^{1/2}) \times (2/(\varepsilon_r+1))^{1/2}$

Effective length (E_{ff}) = $[(\varepsilon_r+1)/2] + [[(\varepsilon_r-1)/2] \times [1 + 12(h/w)]^{-1/2}]$; $w/h>1$

Change in length (ΔL) = $[0.412 \times [(E_{ff}+0.3) \times (w/h + 0.264)/ (E_{ff} - 0.258) \times (w/h + 0.8)]] \times h$

Length (L) = $[[1/ (2F_r(E_{ff})^{1/2}x(\mu_o\,\varepsilon_o)^{1/2})] - 2\Delta L]$

2. ANTENNA DESIGN

ARMPA with slots is design on the ground plane which has a dielectric constant of 2.2. The ARMPA have length of 42mm and width of 38.9mm which have coaxial feed on the substrate which is connected to an ARMPA. In this ARMPA, there are some asymmetric slots which help to improve its return loss. In this paper, L-band rectangular MPA with microstrip line and a ground plane is presented which is actually a single band antenna in the 2-3 GHz frequency band. Two symmetrical rectangles of length 42mm and width 38.9mm are designed and these two rectangles are connected to each other with a microstrip line of thickness 4.82mm. Asymmetrical slots of same length and width is cut at various coordinates with length of 1mm and width of 5mm. Another two slots of length 0.5mm and width of 1mm are also cut at different coordinates. In this paper co-axial feeding of pentagon shape is placed at a point whose radius is 5mm and division angle is 10^0. The proposed antenna design with asymmetric slots is designed on IE3D is shown in the figure 1. The dimensions of lengths and widths of the ARMPA are shown in tabulated form in Table 1.

Table 1: Dimensions of ARMPA

Component	Length (mm)	Width (mm)
Patch	42	38.9
Feed Point (co-ordinates)	3	11
Microstrip Line	4.82	45.2
Slots	5	2

2.1 Single Element

In this design, ground is made at point (0, 0, 1.6) whose dielectric constant (€r) of 2.2, loss tangent for €r is 0.01 with relative permeability (μ_r) of 1. On ground a rectangular shaped Patch is made with a length of 42mm and width of 38.9mm and centred at (0,0). Now a pentagon shaped co-axial feeding is done at point (3, 11) with a radius of 5mm and division angle of 10^0.

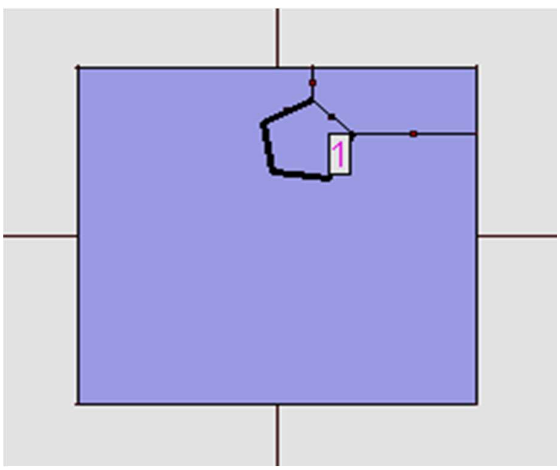


Figure (1): Single element RMPA

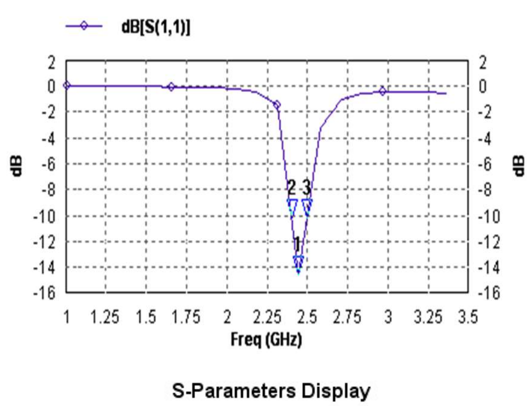


Figure (2): Simulated Return loss of single element RMPA

2.2 Array Formation:

Symmetrical rectangular microstrip patch antenna is designed and these two rectangles are connected to each other with a microstrip of thickness 4.82mm.

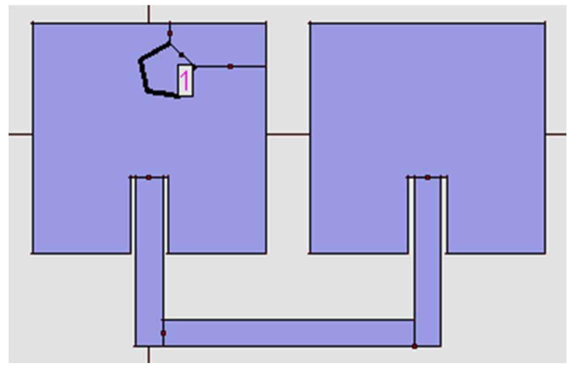


Figure (3): 2x1 ARMPA

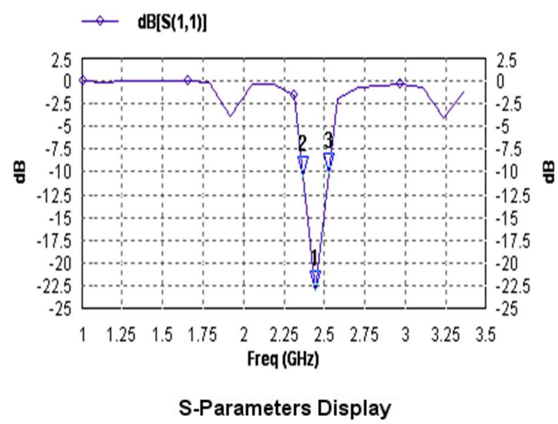
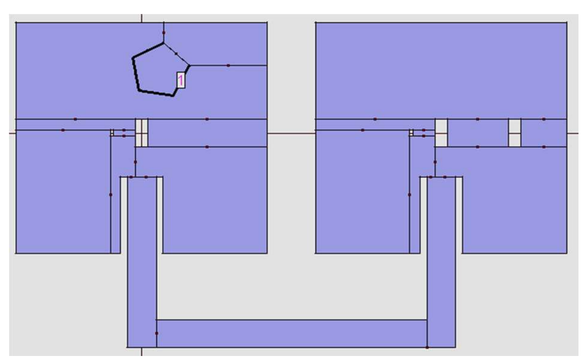
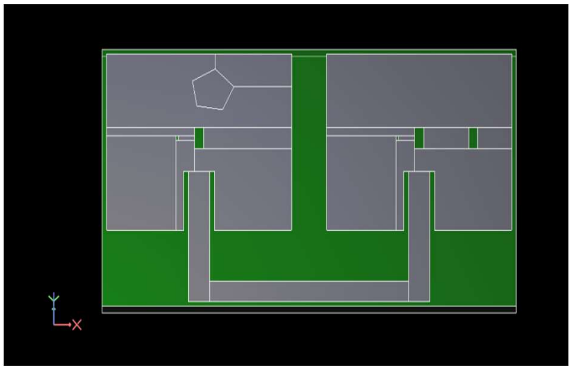


Figure (4): Simulated Return loss of 2x1 ARMPA

Three asymmetrical slots of length 1mm and width 5mm is done at coordinates (0,0), (50,0) and (62,0) respectively. Another two asymmetrical slots of length 0.5mm and width 1mm is done at coordinates (-5, 0) and (45, 0).



(a) Front View of proposed ARMPA



(b) 3D geometric view

Figure (5): 2x1 array structure of the ARMPA with asymmetric slots (showing in (a) and (b))

3. SIMULATION AND EXPERIMENTAL RESULTS

The ARMPA with asymmetric slots is simulated using the IE3D Software. Figure 2 shows the simulated return loss of the proposed antenna from 1 to 3.5 GHz. using a 50Ω SMA (Sub Miniature version A) connector at the port 1. The achieved simulated return loss of the proposed ARMPA is -41.41dB at a centre frequency of 2.44 GHz having the lower frequency (f_L) and higher frequency (f_H) of 2.34GHz and 2.55GHz respectively, obtain a bandwidth of 208MHz as shown in figure (6). Smith chart is shown in figure (7). The maximum directivity at centre frequency is 9 of the proposed antenna is shown in figure (8) and the maximum gain at centre frequency is about 6 of the proposed antenna is shown in figure (9).

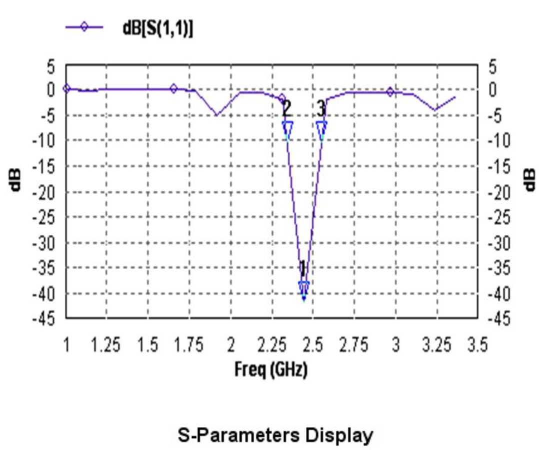


Figure (6): Simulated result of the proposed ARMPA.

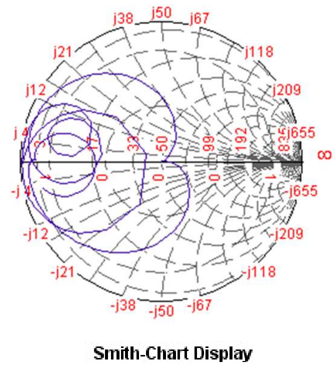


Figure (7): Simulated Smith Chart result of the proposed ARMPA.

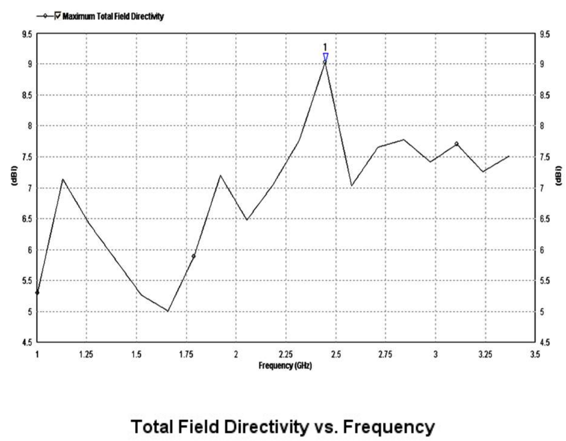


Figure (8): Simulated Directivity vs. Frequency result of the proposed ARMPA.

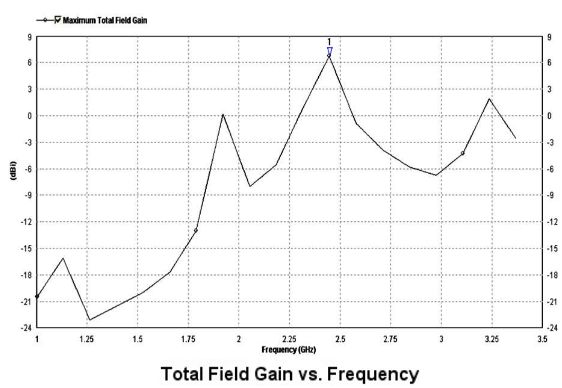


Figure (9): Simulated gain vs. Frequency result of the proposed ARMPA

4. CONCLUSION

In this paper, rectangular patch antenna arrays are studied. Rectangular shape is taken; specifically simple rectangle element and 2x1 array element, all the shapes of designs are compatible with L-BAND applications. This design is specifically for Bluetooth application. In result, both gain and directivity is improved because of the implementation of the technique of array. This paper is using array techniques with asymmetric slots in both the symmetrical rectangular patch antennas which provide more improved return loss in the proposed antenna. With the proposed coordinates for the asymmetric slots, it is been observed that the resulting parameters improved successfully. This antenna is designed for wireless communication in L-BAND especially for the Bluetooth application.

REFERENCES

[1]. Ali M., Seyyed H. Mohseni A., and Ali R. E., "Millimeter-Wave Energy Harvesting Using 4 x 4 Microstrip Patch Antenna Array", IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 14, 2015.

[2]. Rajkumar R., Pankaj G., Aashi R., Anjali P., " Development of Trapezium Cut Shape Rectangular Microstrip Patch Antenna & Compare with Normal Microstrip Patch Antenna", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 6, June 2014.

[3]. Md. Amirul I., Sohag K. S., Md. Masudur R., "Dual U-Shape Microstrip Patch Antenna Design for WiMAX Applications", International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 2, February 2013.

[4]. Yahya S. H. K., Melad M. O. & Sharief N. A., "Comparison between Rectangular and Triangular Patch Antennas Arrays" , Applied Physics Research, Vol. 4, No. 2; 2012.

[5]. Rampal K., Prof. K. C., " Design and analysis of gain for rectangular microstrip patch antenna using symmetrical cuts" , International Journal of Advance Technology & Engineering Research (IJATER), Vol. 1, Issue 1, November 2011.

[6]. Dalia N., Hala A. E., Esmat A. A., Magdy F. I., and Hadia M. E. H., "Ultrawide Bandwidth 2x2 Microstrip Patch Array Antenna Using Electromagnetic Band-Gap Structure (EBG)", IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 59, NO. 5, MAY 2011.

[7]. Xin M. Y., Quan H. S., Ya J., Qiang Cheng, X. Y. Z., Hong W. K., and Tie J. C., "Increasing the Bandwidth of Microstrip Patch Antenna by Loading Compact Artificial Magneto-Dielectrics", IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 59, NO. 2, FEBRUARY 2011.

[8]. H. W., X. B. H., and D. G. F., "A Single Layer Wideband U-Slot Microstrip Patch Antenna Array", IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 7, 2008.

[9]. Indrasen S., Dr. V.S. Tripathi, " Micro strip Patch Antenna and its Applications: a Survey", Indrasen Singh et al, Int. J. Comp. Tech. Appl., Vol. 2 (5), 1595-1599.