As per UGC guidelines an electronic bar code is provided to seure your paper

International Journal for Modern Trends in Science and Technology, 8(04):110-115, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0804020
Available online at: http://www.ijmtst.com/vol8issue04.html

Design of Rectangular Microstrip Patch Antenna for UWB Applications

K. Sailakshmi | N. Niharika | N. Spandana | K. Naveen Naik

Department of Electronics and Communication Engineering, R.V.R & J.C College of Engineering, Guntur, A.P, India
*Corresponding Author Email ID: ksailakshmi83@gmail.com

To Cite this Article
K. Sailakshmi, N. Niharika, N. Spandana and K. Naveen Naik. Design of Rectangular Microstrip Patch Antenna for UWB Applications. International Journal for Modern Trends in Science and Technology 2022, 8(04), pp. 110-115. https://doi.org/10.46501/IJMTST0804020

Article Info
Received: 03 March 2022; Accepted: 4 April 2022; Published: 07 April 2022.

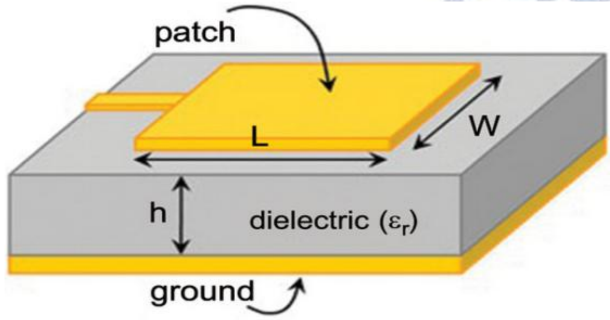
ABSTRACT

In this paper, the performance of a rectangular micro strip patch antenna fed by edge and inset micro strip feed line is designed at resonant frequency of 5.2 GHZ to operate for ultra-wide band applications. Good return loss and radiation pattern characteristics are obtained in the frequency band of interest. The proposed antenna is designed on FR-4 substrate and Rogers RT 5870 fed by a 50-Ω micro strip line. The simulation was performed in High Frequency Structure Simulator Software (HFSS). The antenna parameters such as resonant frequency, return loss, radiation pattern, gain and VSWR are simulated and discussed in this paper.

KEYWORDS: HFSS, UWB, Finite ground plane, Return loss, VSWR

1. INTRODUCTION

Antennas have fundamental importance in the field of wireless communication. With the rapid development and advancement of wireless broadband technologies we require light weight, low cost, and small size antennas. It is well known fact that micro strip patch antennas offers many advantages such as low profile, light weight, ease of fabrication and compatibility with printed circuits.



The Federal Communication Commission (FCC) allocation the unlicensed use of band from 3.1 to 10.6 GHz widely known as UWB technology and opens it for commercial applications for short range indoor and outdoor wireless communication .The UWB antenna is an significant component of UWB communication system and has drawn growing attention[1] .

The micro strip patch antenna consists of a dielectric substrate which is sandwiched between the ground plane and patch as shown in the above figure. The patch, feed and ground plane are made of highly conducting materials. The patches may be in variety of shapes but one of the most popular and commonly used patch is rectangular shaped because of its ease of analysis and fabrication, attractive radiation characteristics, especially low cross polarization. The patch is designed in such a way that its pattern is normal to it [2].

The micro strip patch antenna can be used for many kinds of applications by using a contacting feed [3]. The advantage of inset feeding technique is that it is easy to implement, easy to know the behavior of the antenna by adjusting the inset gap and inset length. This feed also provides good impedance matching. The edge feeding technique main advantage is of providing a planar structure since the feed is etched on the same substrate.

In this paper, rectangular micro strip patch antenna is designed using edge and inset feeding techniques are presented. Ring slot is inserted on rectangular radiating patch for edge feed and a triangular slot is inserted on the rectangular radiating patch for inset feed to improve the performance of the proposed antennas. At last the simulated results of the antennas are compared.

2.ANTENNA DESIGN

An important parameter for designing the micro strip patch antenna is the operating frequency (f_r).The resonant frequency of the antenna should be chosen appropriately. The chosen resonant frequency for our design is 5.2 GHz.

The dielectric substrate used here is Fr4 with dielectric constant (ϵ_r) of 4.4 and Roger RT5870 with dielectric constant (ϵ_r) of 2.33 with height (h) as 1.6mm for edge and inset feeding techniques respectively.

The design parameters that are assumed and evaluated with the help below equations:

Step 1: Calculation of the Width (w): The width of the micro strip patch antenna is given by following equation:

$$width(w) = \frac{c}{2\, f_r\sqrt{\frac{\epsilon_r+1}{2}}}$$

Step 2: Calculation of Effective Dielectric Constant (ϵ_{reff}): The following equation gives the effective dielectric constant as:

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{w}\right)}}\right]$$

Step 3: Calculation of Actual Length of Patch (L): The actual length of the antenna can be calculated as:

$$Length(L) = \frac{c}{2f_r\sqrt{\epsilon_{reff}}} - 0.824h\left(\frac{(\epsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\epsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)}\right)$$

Where,

h = height of the dielectric substrate.

ϵ_r= relative permittivity of the substrate.

f_r= resonant frequency of the antenna.

A. Edge Feed

For the design of edge feed rectangular micro strip patch antenna by using the above formulae the dimensions of the patch obtained as 17.56mm x 12.56mm and the ground area is 58.94mm x 35.9mm. The dimensions of .edge feed are 8.294mm x 0.723mm. The height and width of feed is 14.895mm x 3.059mm and the impedance is taken as 50Ω.

The design of the antenna is as shown in the figure given below:

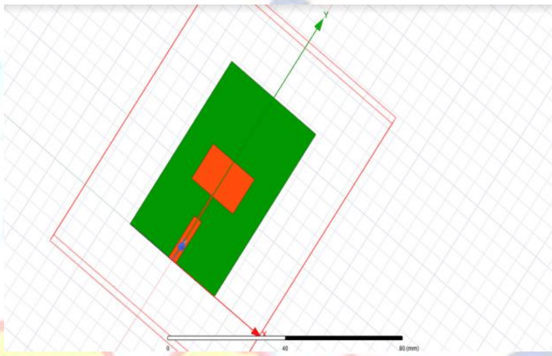


Figure 1 : Edge feed antenna without any slots.

Performance of the antenna depends upon number of factors such as feeding point, dimensions of rectangular slot and rectangular patch, shape and size of ground plane. In order to improve the performance of the antenna, a ring slot of inner and outer diameters 3mm and 2mm are incorporated into the rectangular patch respectively. The antenna is designed as:

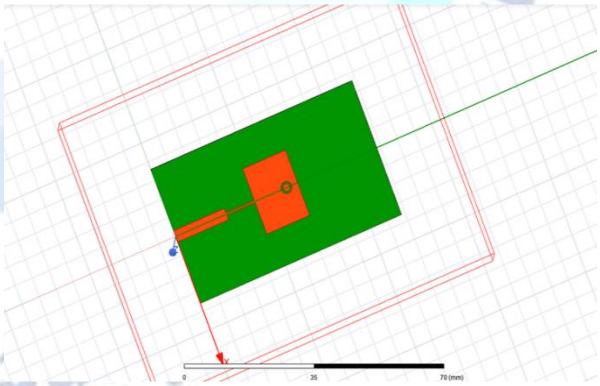


Figure 2 : Edge feed antenna with ring slot.

Ring slot position = (0, 32.5, 0)

For designing the above antenna, by increasing and decreasing the radii of ring slots resonant frequencies are not adequate. Therefore it is required to maintain the minimum size as 3 mm and 2 mm for the ring slot.

Only by choosing the optimized feed location and adequate diameters of the slots, the performance of the antenna will be improved.

B. Inset feed

For the design of inset feed rectangular micro strip patch antenna by using the above formulae and substituting the dielectric constant of substrate material Roger RT5870, the dimensions of the patch obtained as 22.35mm x 18.01mm and the ground area is 44.71mm x 36.03mm. In order to design the feed, the inset cut length (F*i*) should be calculated and the width of inset feed is 2mm. It is calculated as,

$$F_i = 0.20682(L)$$

Where,

L = length of the ground plane (or) antenna length.

Here the length of inset cut obtained is 9.2460 mm and the antenna is designed as shown in the figure below:

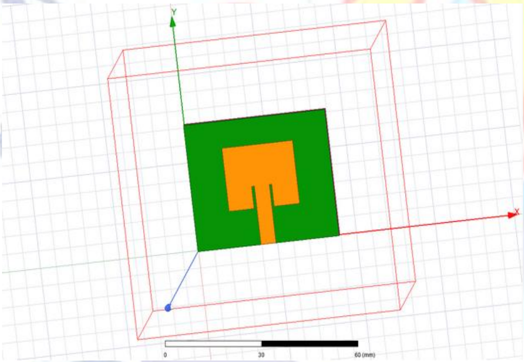


Figure 3 : Inset feed antenna without any slots.

In order to improve the performance of the antenna, a triangular slot is incorporated into the rectangular patch. It is designed as:

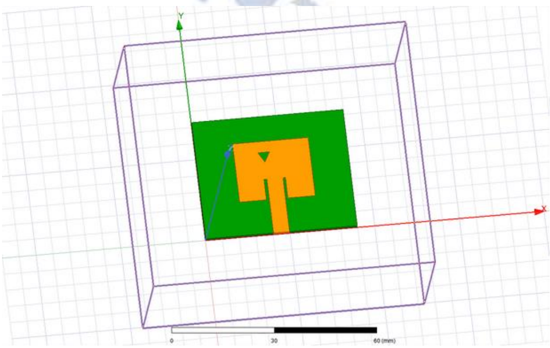


Figure 4 : Inset feed antenna with a triangular slot.

Position of the triangular patch is given as, Start = (20, 22, 1.6) and Center = (20, 24, 1.6).

3. SIMULATION RESULTS

After designing the above proposed antennas, they are simulated by using the HFSS (High Frequency Simulator Tool) software. For every design of the antenna its return loss, VSWR, gain and radiation patterns are plotted using HFSS. The simulation results are:

A. Edge feed antenna without slot

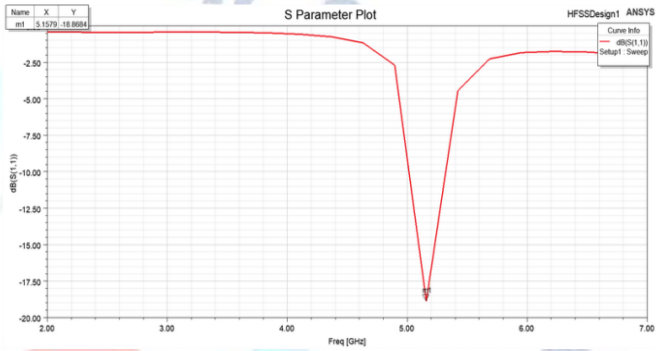


Figure 5 : S Parameter (S_{11})

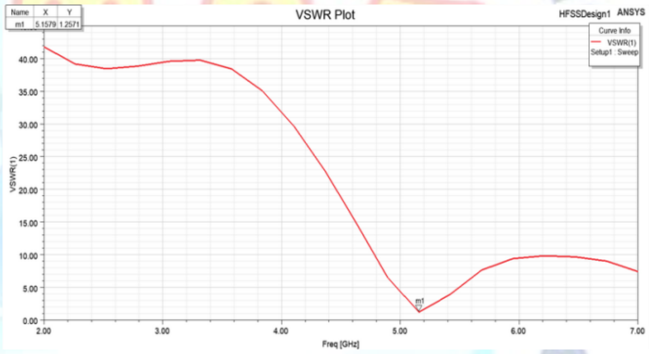


Figure 6 : VSWR

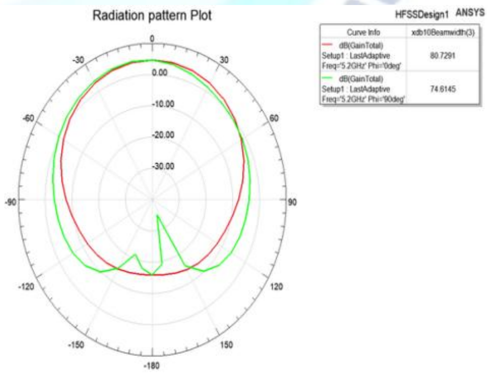


Figure 7 : Radiation Pattern

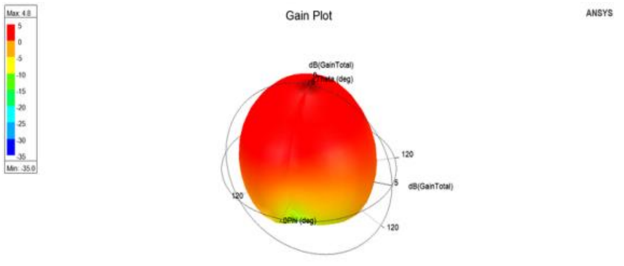


Figure 8 : 3D Polar Plot

B. Edge feed antenna with ring slot

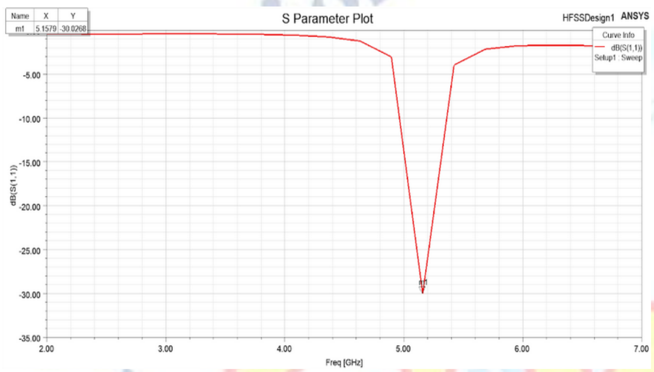


Figure 9: S Parameter (S_{11})

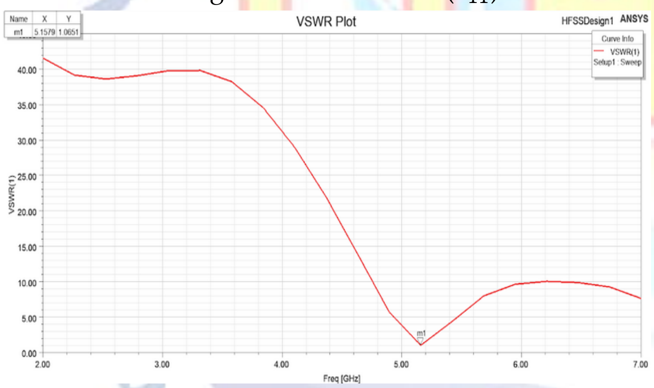


Figure 10: VSWR

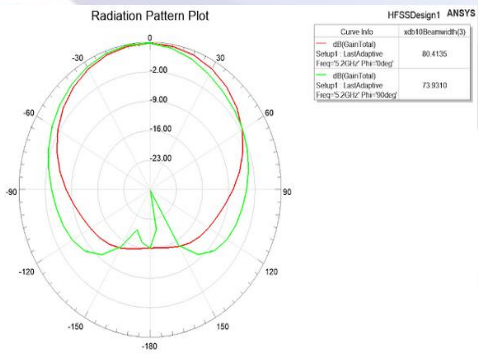


Figure 11: Radiation Pattern

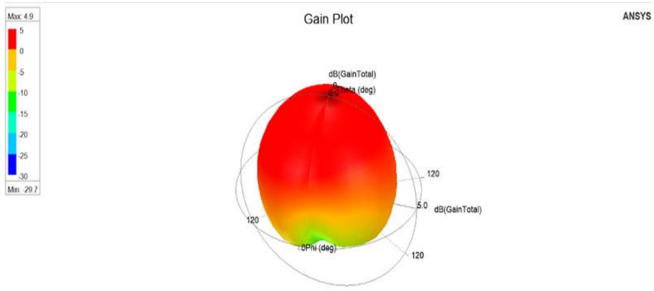


Figure 12: 3D Polar Plot

C. Inset feed antenna without slot

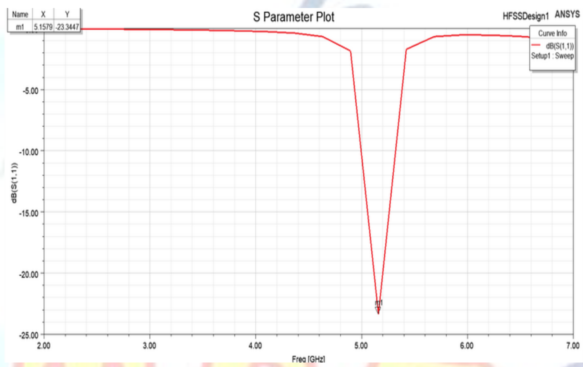


Figure 13: S Parameter (S_{11})

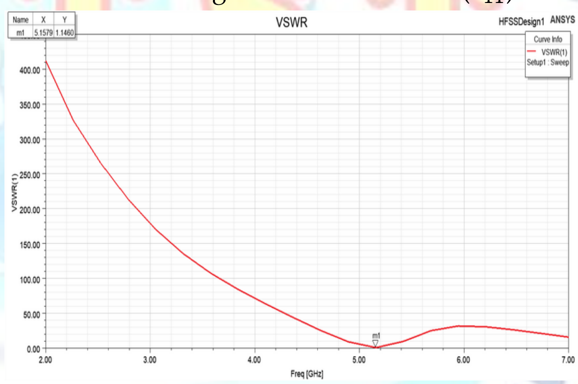


Figure 14: VSWR

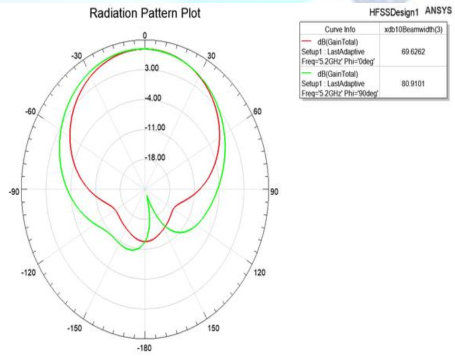


Figure 15: Radiation Pattern

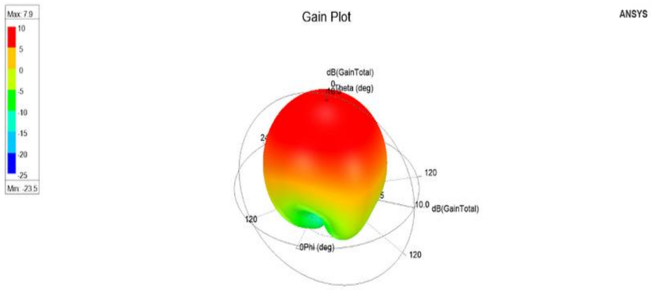


Figure 16: 3D Polar Plot

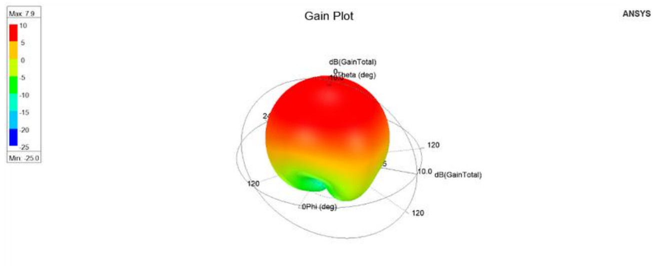


Figure 20: 3D Polar Plot

D. Inset feed antenna with triangular slot

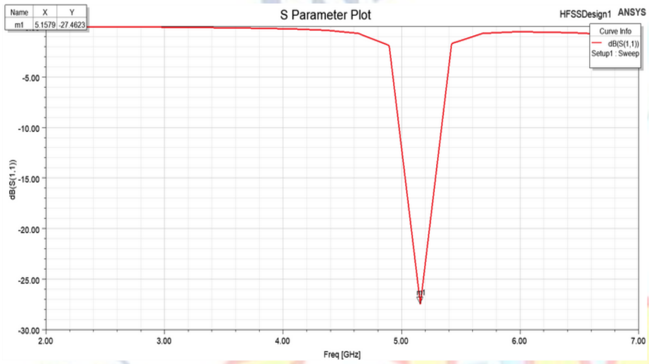


Figure 17: S Parameter (S_{11})

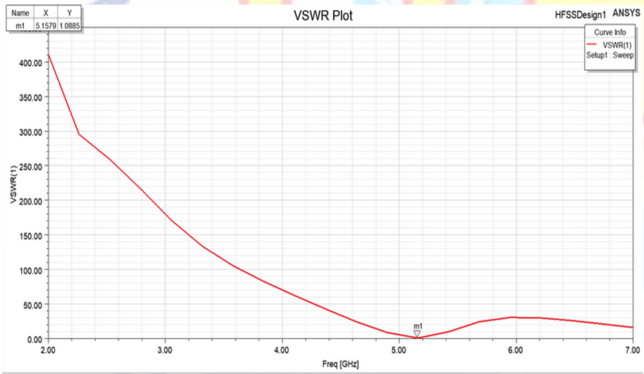


Figure 18: VSWR

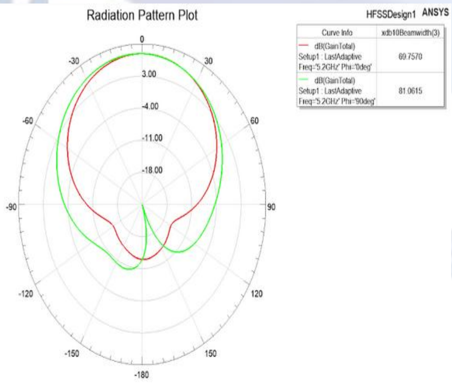


Figure 19: Radiation Pattern

4.RESULTS COMPARISON

S.No	TYPE OF FEED	TYPE OF SLOT	fr (GHz)	S11 (dB)	VSWR	GAIN (dB)	BEAM WIDTH (degree)
1	Edge	No Slot	5.15	-18.8	1.25	7.82	80.729
2	Edge	Ring	5.15	-30.0	1.06	4.24	80.413
3	Inset	No Slot	5.15	-23.3	1.14	4.45	69.626
4	Inset	Triangle	5.15	-27.4	1.08	3.86	69.757

5. CONCLUSION

From the above table of comparison, it is concluded that:

- Different feeding techniques like inset and edge were used.
- Inset feed rectangular patch micro strip antenna with triangle slot and Edge feed rectangular patch micro strip antenna with ring slot are simulated.
- By comparing the results of these designs, it is concluded that edge feed rectangular patch micro strip ring slot antenna is having greater return loss of -30.0 dB and VSWR of 1.06.

Hence the edge feed rectangular patch micro strip ring slot antenna found to be reliable with greater performance operated at resonant frequency of 5.2 GHZ for Ultra Wide Band applications.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] C. A. Balanis, Antenna Theory, Analysis and Design, John Wiley & Sons, New York, 1997.

[2] Maryam Majidzadeh, C. Ghobadi, "A novel UWB CPW-fed ring shaped antenna wit band-notched characteristics," Turkish Journal of Electrical Engineering & Computer Sciences, vol. 21, pp. 1595-1602, Oct 2013.

[3] Pozar, D. M., A review of bandwidth enhancement techniques for microstrip antennas, Microstrip Antennas: Analysis and Design of

Microstrip Antennas and Arrays, D. H. Schaubert (ed.), 157– 166, IEEE Press, New York, 1995.
[4] Vibha Gupta and Nisha Gupta, Gain and Bandwidth Enhancement in Compact Microstrip Antenna, International Union of Radio Science, Proceedings, 2005.
[5] C.Marchais, G.Leray "Strip line slot Antenna for UWB communication" IEEE Trans. Antennas Propagation vol. 5,2006, pp. 319-322.
[6] FCC report and order for part 15 acceptance of ultra wideband (UWB) systems from 3.1– 10.6 GHz, Washington, DC, 2002.
[7] Hosseini, S. A., Z. Atlasbaf, and K. Forooraghi, "A new compact ultra wide band (UWB) planar antenna using glass as substrate," Journal of Electromagnetic Waves and Applications, Vol. 22, No. 1, 47–59, 2008.
[8] Pozar, D. M., A review of bandwidth enhancement techniques for microstrip antennas, Microstrip Antennas: Analysis and Design of Microstrip Antennas and Arrays, D. H. Schaubert (ed.), 157– 166, IEEE Press, New York, 1995.