DESIGN OF MICROSTRIP PATCH ANTENNA FOR ULTRA WIDE BAND APPLICATIONS

Dhupam Arun Kumar[1] Palla Yamini Ratna Shilpa[2], Bantupalli Nagasai[3] ,
Lenka Srinu[4], B.Pravallika[5] ,

Department of Electronics and Communication Engineering

Raghu Institute of Technology(A), Visakhapatnam, India.

Abstract: The project focuses on the design and simulation of the Micro-strip patch antenna, the most groundbreaking concept in antenna theory and design, for ultra-wide band applications. Applications have been gradually found in a large variety of modern Microwave systems in recent years. There are various types of Micro-Strip antenna which can be used in communication networks for many applications. The UWB antenna is printed on a FR4 dielectric plate with a dielectric constant of 4.4 mm and a dielectric plate thickness of 1.4 mm. The design parameters of the square patch antenna are calculated from the transmission line model equation. The process is performed to cut the steps in the corners of the square patch and insert the slots in the ground plane.The antenna model was designed and stimulated using the Ansoft HFSS (High Frequency Structure Simulator) software. Antenna parameters such as return loss , radiation pattern, and gain were calculated. This antenna has the advantages of lower weight and simple feed structure.

KEYWORDS

UWB Antenna, Microstrip, FR4, HFSS, Return Loss, Gain, Feeding

1. INTRODUCTION:

Because of their light weight, compact in size, low cost, low profile and planar configuration microstrip patch antennas are now used for various types of communication system [3].Microstrip antennas are mounted on the circuit board which is scanned. Such antennas are currently suitable to satisfy other requirements such as multi frequency/multiband and broadband service. There are different types of applications in different types of communication systems [2].For this purpose an antenna should be build which is capable of multiband operation so that it can be used simultaneously for various types of applications. In this paper the multiband antenna is designed .

2. DESIGN PROCEDURE FOR PROPOSED ANTENNA:

This paper describes a patch created by the insertion of slots on a square patch as seen in Fig.4.7. These slots are inserted to make the antenna more light weight as well as use for multiband operation. We use Coaxial Probe Feed.

The required parameters for the design are

f_0 =2.1 GHz (design frequency)

Dielectric constant=4.4

Height of the substrate =1.4 mm

The transmission model is used for antenna architecture

Step 1: Calculation of width (W): The width of the Micro strip antenna is given by the equation

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r+1)}{2}}} \quad (2.1)$$

Substituting $c=3\times10^8$m/s, ε_r =4.4 f_0=2.1GHz we get W=43.44mm

Step 2: Calculation of Effective Dielectric Constant (ε_{reff}):

The Effective Dielectric constant is given by

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2}$$
(2.2)

Substituting ε_r= 4.4 and W=38 mm and h=1.6 mm we get ε_{reff}=3.737

Step3: Calculation of Effective Length (L_{eff}):

The Effective Length is given by

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$
(2.3)

Substituting the ε_{reff} =3.797, c=3×10^8m/s and f0=2.4GHz, L_{eff}=36.94mm

Step4. Calculation of the Length extension (ΔL):

The actual length is obtained by equation

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)}{(\varepsilon_{reff}-0.258)}\frac{(\frac{w}{h}+0.264)}{(\frac{w}{h}+0.8)}$$
(2.4)

$$\Delta L = 0.6558mm$$

Step5: Calculation of actual length of the Patch (L):

The actual length of the patch is given by

$$L = L_{eff} - 2\Delta L$$
(2.5)

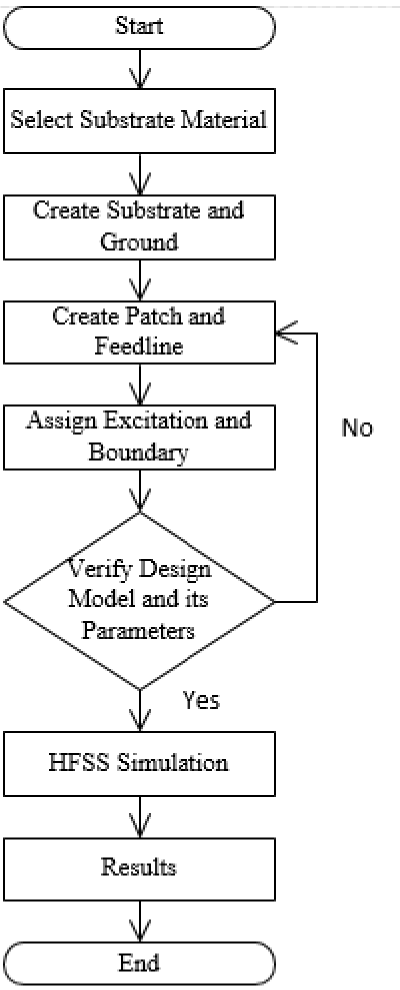
Substituting the L_{eff} and ΔL we get L=35.62mm

Step6: Determination of Feed point location (X_f, Yf):

In this design a coaxial probe type feed shall be used. In the center of the patch the origin is taken and the position of the feed point is given by the co-ordinates (X_f, Yf) from the origin. The feed point must be on the patch at that point, where the input impedance is 50 ohms for the resonant frequency. Therefore a method of trial and error is used to locate the feed point. The return Loss (RL) is measured with various positions of the feed point, and that feed point is chosen where the return loss is most negative . According to it a point exists along the length of the patch where the return loss is minimum. Thus Y_f will be zero in this phase and only X_f will be varied to locate the feed point

DESIGN PROCEDURE OF SQUARE PATCH ANTENNA USING HFSS

Follow this general procedure for creating an HFSS configuration. Remember that you don't need to perform the steps sequentially after you insert a design, but they have to be completed before a solution can be created.



In this paper, the square patch is intended to operate at frequency 2.1 GHz in this paper. We then add some slots by eliminating copper from the patch. Modeling and analysis of HFSS is performed for structures that show the slots converting the single square patch frequency antenna into multiband frequency antenna..The parameter used for the design of simple square patch are: W=L=33.7mm, h=1.4mm, and substrate ε_r =4.4 for the design frequency 2.1 GHz. The co-axial probe is used as a patch feeding tool. The position of the probe is designed at (8.5mm,26.2mm,0 mm) for best impedance matching the 50 ohm feedline. The inner conductor radius is 0.5 mm and the outer conductor radius is 1.75 mm for the coaxial probe[1].

RESULTS:

Table1: Dimensions of Rectangular Microstrip Antenna (MSA) For Different Input Frequencies

Input Frequency ()	Width (mm)	Effective Dielectric Constant	Effective Length (mm)	Length Extension (mm)	Actual Length (mm)	Length of Ground (mm)	Width of Ground (mm)
2.7	33.79	3.594	29.31	0.6583	27.99	36.39	42.19
3.4	26.83	3.450	23.75	0.6593	22.43	30.83	35.23
3.9	23.39	3.356	20.99	0.6598	19.67	28.07	31.79
4.9	18.62	3.190	17.13	0.6602	15.80	24.20	27.02

MICROSTRIP PATCH ANTENNA ONLY WITH PATCH

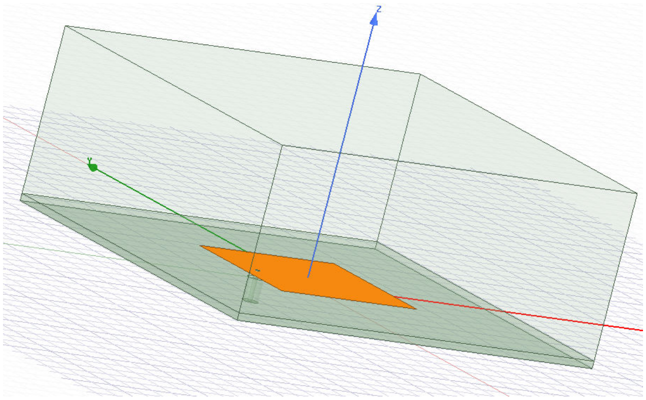


Figure 2.1 Antenna only with Patch

Table2: Antenna only with Patch

Parameter								
Value	43.3	43.3	33.7	33.7	43.3	43.3	0.5	1.6

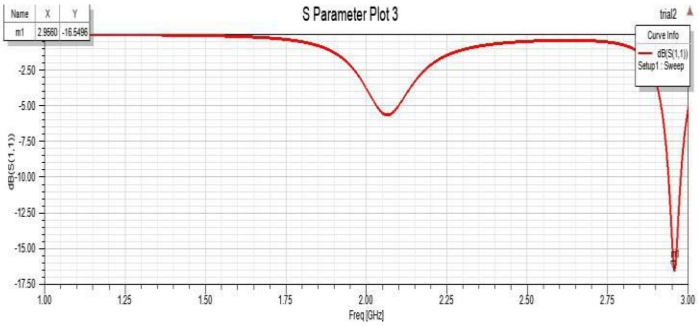


Figure 2.2 S parameter plot of Antenna only with Patch

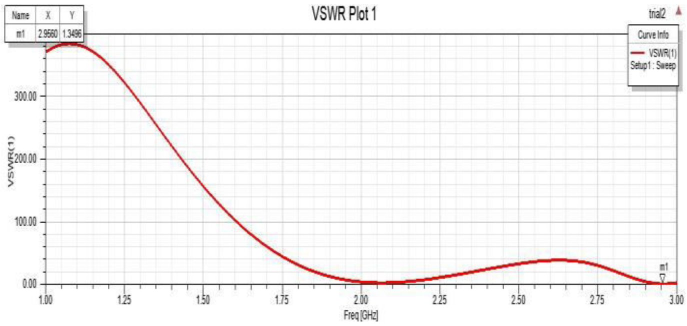


Figure 2.3 VSWR Plot of Antenna only with Patch

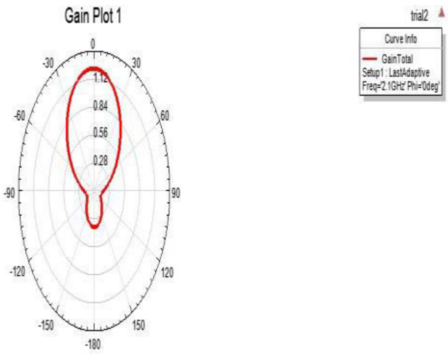


Figure 2.4 Gain Plot of Antenna only with Patch

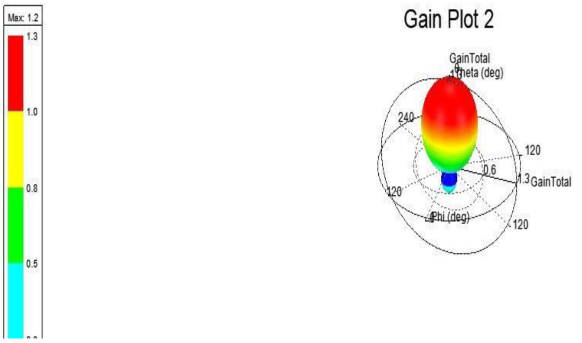


Figure 2.5 3D Gain Plot of Antenna only with Patch

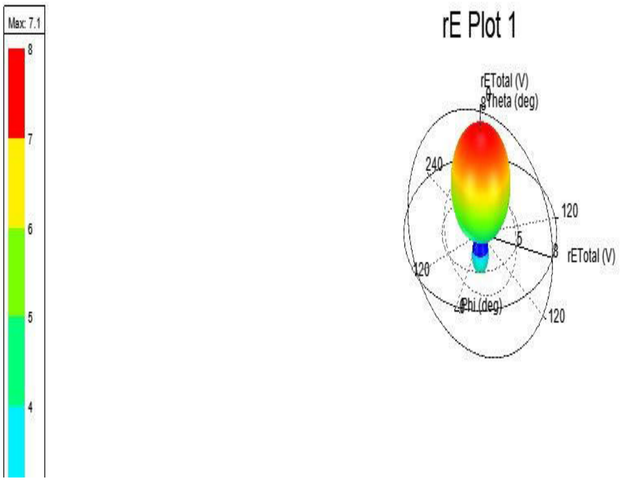


Figure 2.6 Radiation Plot of Antenna only with Patch

MICROSTRIP PATCH ANTENNA WITH MULTIPLE SLOTS

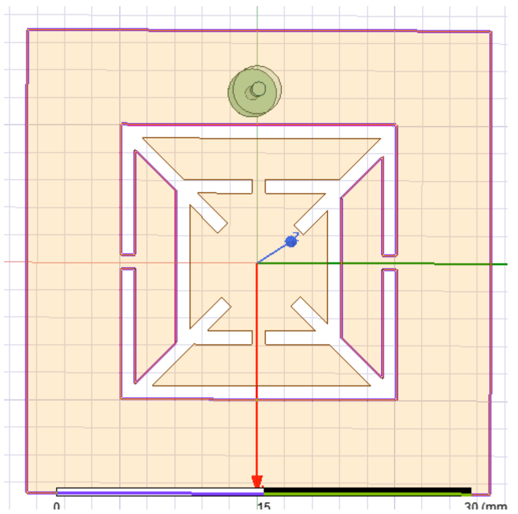


Figure 2.7 Antenna with multiple slots in Patch

Table3: Antenna with multiple slots in Patch

Parameter	L_{gnd}	W_{gnd}	L_{Pat}	W_{Pat}	L_{Sub}	W_{Sub}	R_f	H_f
Value	43.3	43.3	33.7	337	43.3	43.3	0.5	1.6

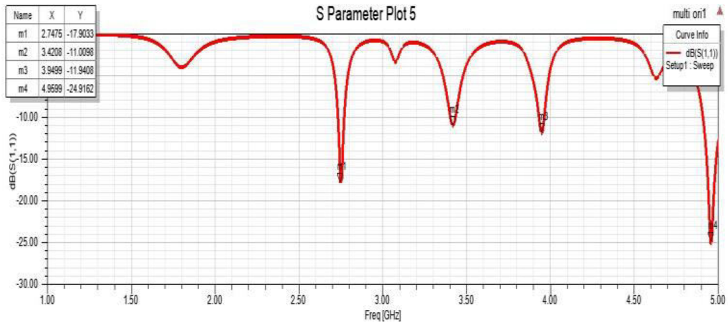


Figure 2.8 S parameter plot of Antenna with multiple slots in Patch

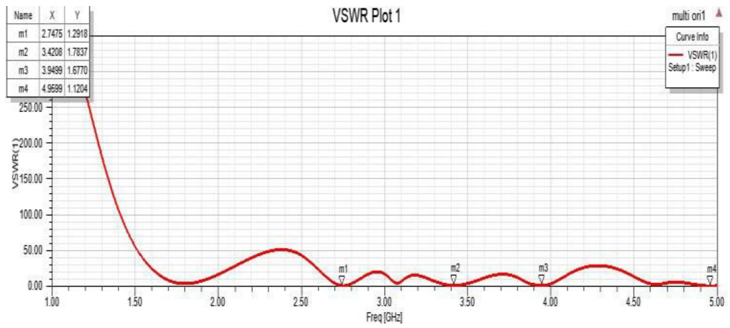


Figure 2.9 VSWR Plot of Antenna with multiple slots in Patch

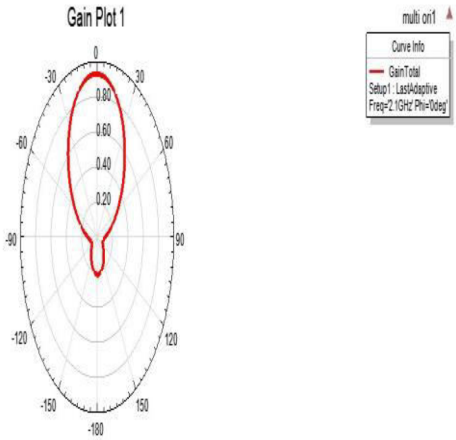


Figure 2.10 Gain Plot of Antenna with multiple slots in Patch

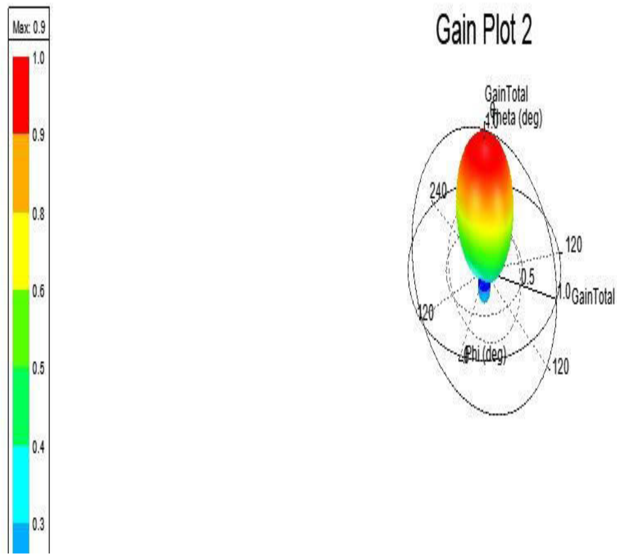


Figure 2.11 3D Gain Plot of Antenna with multiple slots in Patch

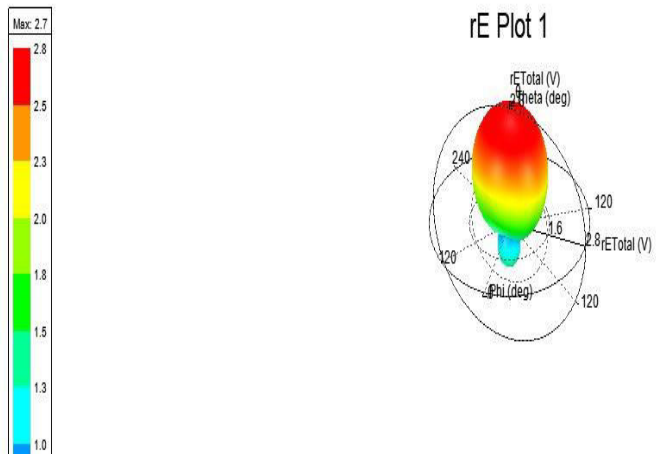


Figure 2.12 Radiation Plot of Antenna with multiple slots in Patch

3. CONCLUSION

The major and unique characteristic of this Micro Strip Antenna is its simplicity to maintain high performance. In many applications, generally in the field of satellite -based and radar communication, it is necessary to design antennas with very high Directive features in order to meet the requirements for long-distance communication. A square patch antenna by is designed and simulated using HFSS software. The designed antenna is incredibly effortless in appearance and diminutive in volume covering the C band (2Ghz-4Ghz) on a glass epoxy FR-4 substrate with thickness 1.4 mm and dielectric constant of 4.4. This antenna is used for satellite applications in C band .The antenna performance considerations such as return loss, VSWR, impedance bandwidth, gain have been calculated. From the design and simulation performance of proposed antenna, a good impedance match is observed at 2.7 GHz, 3.4 GHz, 3.9 GHz and 4.9 GHz frequencies. The resulting return loss and radiation patterns indicate here that single configuration can be used for a multi band operation. It is believed that these properties make the antenna suitable for many applications, namely medical imaging and monitoring, satellite and RADAR applications.

REFERENCES

[1] Antara Ghosal, Anurima Majumdar , Annapurna Das, Sisir Kumar Das,"Analysis of a class of multi-frequency microstrip antenna for mobile handset" IJECSE,2018, Volume3, Number 2, pp 108-115.

[2] Pathak, P., & Singhal, P. K. (2018). "Compact Broadband Monopole Antenna for C Band Applications". Advanced Electromagnetics, 7(5), 118-123. https://doi.org/10.7716/aem.v7i5.815

[3] S. C. Deshmukh, R. P. Labade and S. Sureshkumar, "Design of Modified Hexagonal UWB Slot Antenna with Dual Band Notched Characteristics," *2018 International Conference On Advances in Communication and Computing Technology (ICACCT)*, Sangamner, 2018, pp. 420-425.

[4] M. S. Iqbal and S. A. W. Shah, "Design of a compact UWB patch antenna having rectangular parasitic elements for UWB and bluetooth applications," *2017 First International Conference on Latest trends in Electrical Engineering and Computing Technologies (INTELLECT)*, Karachi, 2017, pp. 1-6.

[5] Antenna and Wave Propagation, First Edition, Sisir K Das and Annapurna Das, Tata-McGraw-Hill Education Pvt. Ltd., 2013

[6] K. L. Wong "Compact and Broadband Microstrip Antennas" New York: J. WileyAnd Sons.2002, ISBNs: 0-471-41717-3 (Hardback); 0-47122111-2 (Electronic)

[7] T. Holzheimer and T. 0. Miles, "Thick multilayer elements widen antenna bandwidths," Microwaves & RF, vol. 24, n.2, 1985, pp. 93-95.

[8] Bernhard, J.T, "Compact single-arm square spiral microstrip antenna with tuning arms," Antennas and Propagation Society International Symposium, 2001. IEEE, vol.2, no., pp.696-699 vol.2, 2001 .

[9] International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 7, January 2013 "Design and Performance Optimization of a Microstrip Antenna" G.C Nwalozie, C.C Okezie, S.U Ufoaroh, S.U Nnebe.

[10] "The Fundamentals of Patch Antenna Design and Performance" By Gary Breed Editorial Director

[11] "A study of UWB microstrip antenna parameters for wireless applications" by N.Sheshaprasad Electronics and Communication Department B. N. M. Institute of Technology and S. B. Bhanu Prashanth Medical Electronics Department B. M. S. College of Engineering , Bangalore, India

[12] " Cylindrical-Rectangular Microstrip Antenna" Clifford M Krowne IEEE Transactions on Antennas and Propagation , Vol. AP-31, No. 1,January 1983.