MICROSTRIP PATCH ANTENNA DESIGN FOR GPS APPLICATION USING ADS SOFTWARE

BHAMBHANI PRIYANK NARENDRA

Department of Electronics & Communication Engineering,
Lok Jagruti Institute of Technology, Gujarat technological University,
Ahmedabad –380015, Gujarat, India.

priyankbhambhani2000@gmail.com

ABSTRACT : *In recent years low profile, light weight antennas are preferred for the applications which need mobility. In this research the E-shape Microstrip Patch Antenna has been designed for GPS application (GPS L5 1.176 GHz band). Simulated results for main parameters such as return loss, bandwidth, radiation patterns and gains are also discussed herein. The Designing & simulation of this antenna is done in ADS Software.*

KEY WORDS : E-shape, Global Positioning System(GPS) Application, Microstrip Patch, ADS Software.

1. INTRODUCTION

A microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantages such as low weight , low profile planar configuration, low fabrication costs and capability to integrate with microwave integrated circuits technology, the microstrip patch antenna is very well suited for applications such as wireless communications system, GPS, cellular phones, pagers, radar systems, and satellite communications systems[1].

The development of small-integrated antennas plays a significant role in the progress of the rapidly expanding military and commercial communications applications. The technology to support these applications has been made possible by recent advances in high-density RF and microwave circuit packaging. As system requirements for faster data transmission in lighter compact designs drive the technology area, higher frequency design solutions with large density layouts require integration of microwave devices, circuitry, and radiating elements that offer light weight, small size, and optimum performance. Over the past two decades, microstrip patch antenna has received considerable attention for use in personal communication systems applications due to its compactness among other advantages. Intensive research has been carried out to develop new techniques to overcome the microstrip patch antennas drawbacks, the most restrictive being narrow band. The bandwidth enhancement and its return loss improvement without increasing antenna size and production process is important to apply this antenna to the modern mobile communication systems and need to be carried out.

Many applications in communications and radars require circular or dual linear polarization, and the flexibility afforded by microstrip antenna technology has led to a wide variety of designs and techniques to fill this need . In recent years, the demand for compact mobile telephone handsets has grown. Handsets with size of a pocket have begun appearing in the market and, as the demand for increased electronic mobility grows, the need for small handsets will most likely increase. A small antenna size is required as one of the important factors in portable mobile communication systems.

The Microstrip Patch Antennas (MPA) is widely being used because of its low volume and thin profile characteristics. The size of MPA is basically determined by its resonance length and width. The reduction of the patch size can be achieved by using patch substrate material with very high permittivity and small substrate height [2]. But, in this case, the low radiation efficiency will reduce the antenna gain.

In this study, a novel E-shape patch antenna optimized for simplicity in design and feeding is proposed. It has characteristic which will meet GPS system application. Parameters of the antenna such as return loss, impedance bandwidth, radiation patterns and gains are discussed in this paper. This paper shows extensive benefits of 3D view of radiation pattern facility provided by the ADS software.

2. E-SHAPED PATCH ANTENNA DESIGN

The results of the desired antenna of a compact band radiator for use in wireless communications applications are presented in this section. Bandwidth is specified as the frequency bandwidth in which the return loss is less than -10 dB.

A general model can be useful in an initial design and usually plays an appreciable role in antenna scaling. Typically, these models include the cavity model and the transmission line model for modeling of microstrip patch antenna. The transmission line analysis for a microstrip patch antenna is a well-established approach among the antenna engineers. It is general that increasing the thickness of the patch antenna will increase the impedance. However, the thicker the substrate of the antenna, the longer the coaxial probe will be used and, thus, more probe inductance will be introduced [3], which limits the impedance bandwidth. Consequently, a patch antenna design that can counteract or reduce the probe inductance will enlarge the impedance bandwidth.

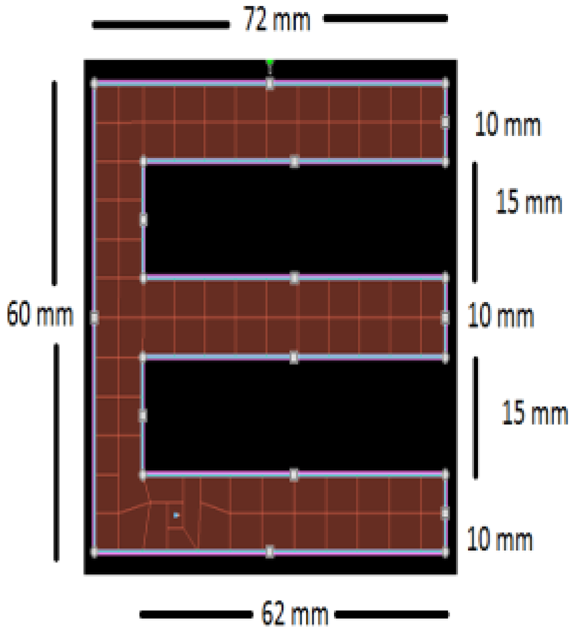


Figure.1 Actual ADS Model (top view)

Here in Fig.1 depicts the geometry of the proposed patch antenna. The rectangular patch, with dimensions of 60 mm ×72mm is supported by a low dielectric substrate with dielectric permittivity ε with material ABS as shown in Table 1. And it is in between patch and ground plane. The substrate is very thin.

Here the patch contains two slots; the dimension is shown in figure 1.the height of the antenna substrate that is made up of ABS material is taken as 1.5 mm. The material ABS is a dielectric component that is already defined in the ADS library. It is acrylonitrile butadiene styrene resin material. It is having the dielectric constant as 2.8. the substrate height is of much of importance for the perfect matching of antenna impedance with the line feed impedance. If a mismatch occurs then the return loss occurs and return loss is to be expected as much as less possible for better performance of antenna. More the return loss poor the bandwidth and performance of antenna.

The antenna patch can be made either of copper or gold. Here in this ADS software copper has been taken by default as the patch material. Patch material is shown in brown color in the figure 1 as in the form of E shape. The pattern seems to be of particular english alphabet but its actually a rectangular patch which is having two slots of 15 mm forming the shape which is visualized as English alphabet E.

Table 1. Material Used for Patch Antenna

Structure	Material
Patch	Copper
Substrate	ABS (ε=2.8)

Table 1. Showing details about the material. Patch is of copper material. Substrate is of ABS material with ε=2.8 the base material is also of copper.

The near to straight lines which are forming the rectangular boxes in the patch are the lines which are formed by the transmission line analysis model executed by the ADS software.

3. SIMULATION RESULTS

For simulation we used ADS, which is very good simulator for RF antennas. After simulating the design the result we got is as follows. The gain of the antenna for GPS if obtained low then also the antenna can be used for the aid application with a purposeful result as if the gain is less means antennas directivity is less as gain and directly proportional to eachother.

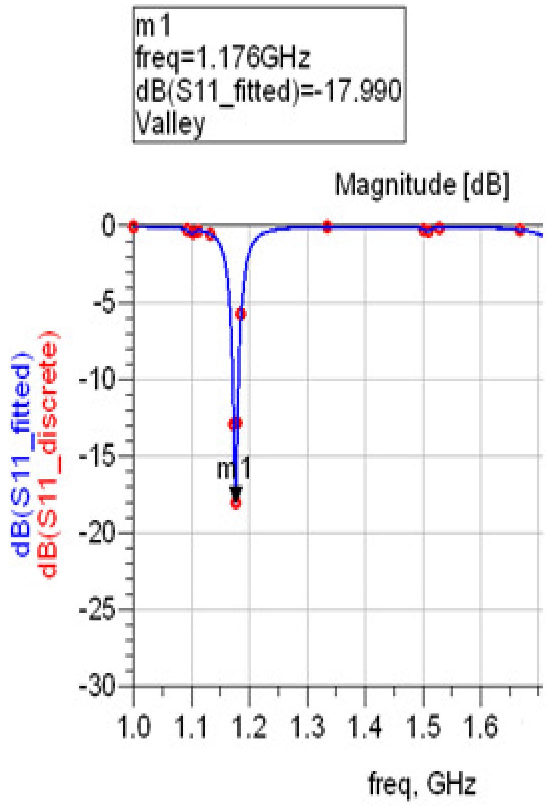


Figure.2 Return Loss (S11) parameter of the antenna

Figure. 2 shows the Return Loss (S_{11}) plot of the design and For the whole range from 1.171GHz to 1.181GHz the Return loss is less than -10 dB and at frequency 1.176 GHz it's minimum and the value is -17.990dB.

As seen from the above figure the return loss is less than -10db at frequency 1.176 GHz. This is a standard level of return loss which can be allowed for any frequency of operation to be worked upon if it has return loss less than -10db. The parameters that affect the return loss are the imperfect impedance matching of the micro strip line feed and the microstrip patch antenna impedance. This is the root cause of return loss. It should be as much as less possible means more negative the value of return loss as better as the performance. The bandwidth that is measured at the -10db level of return loss in the abov
Figure of return loss versus frequency yields a band width of 10 MHz . From 1.171 GHz to 1.181 GHz the bandwidth comes to be as 10 MHz of frequency band for which the concerned designed antenna is

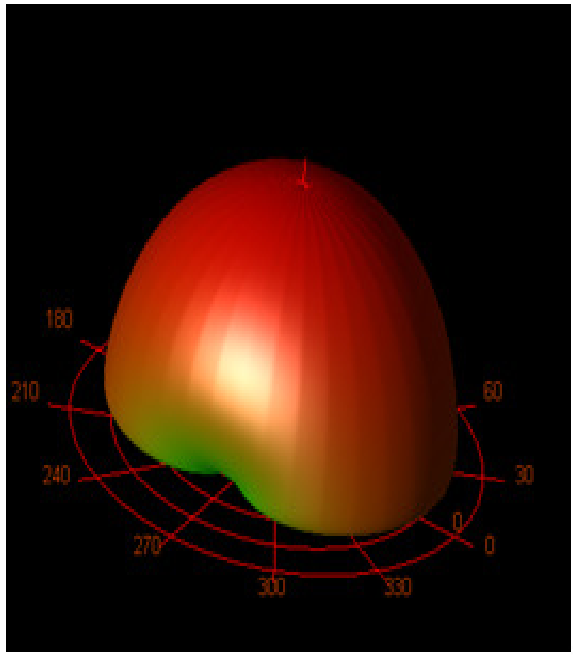
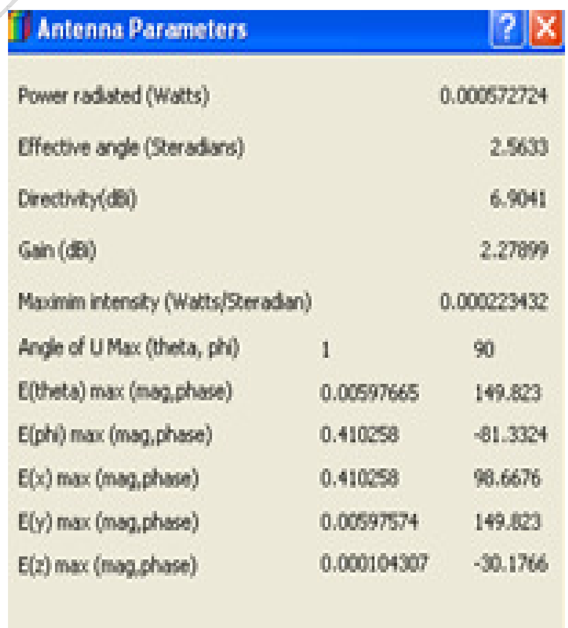


Fig.3 Radiation Pattern of the antenna

Fig. 3 shows the Radiation Pattern of the design. The various parameters can be calculated from this 3Dimensional radiation pattern that are shown in following below figure.


Antenna Parameters

Power radiated (Watts)		0.000572724
Effective angle (Steradians)		2.5633
Directivity(dBi)		6.9041
Gain (dBi)		2.27899
Maximim intensity (Watts/Steradian)		0.000223432
Angle of U Max (theta, phi)	1	90
E(theta) max (mag,phase)	0.00597665	149.823
E(phi) max (mag,phase)	0.410258	-81.3324
E(x) max (mag,phase)	0.410258	98.6676
E(y) max (mag,phase)	0.00597574	149.823
E(z) max (mag,phase)	0.000104307	-30.1766

Figure .4 A Window showing parameters of the designed antenna in ADS

Fig.4 shows the window for frequency 1.176 GHz for
all the Radiation pattern values for gain, directivity power radiated. Same way patterns for other frequencies can be generated.

4. CONCLUSION AND FUTURE SCOPES

Microstrip antennas have become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. The low profile E-shape patch is presented in this paper. Simulations and results of the E-shape microstrip patch antenna have provided a useful design for an antenna operating at the frequency of 1.176 GHz for the GPS applications. The reflection coefficient is below −10dB from 1.171 GHz to 1.181 GHz. At the same time, the antenna is thin and compact with the use of low dielectric constant substrate material.

REFERENCES

[1] C.A. Balanis, Antenna Theory, 2nd ed. New York: John Wiley & Sons, Inc., 1997.
[2] R. Bancroft, Microstrip and Printed Antenna Design, Prentice Hall of India, 2006
[3] Wi S.H., Kim J.M., Yoo T.H., Lee H.J., Park J.Y., Yook J.G., Park H.K. Bow-tieshaped meander slot antenna for 5 GHz application . in *Proc. IEEE Int. Symp. Antenna and Propagation*. 2, 456–459,2002
[4] J. R. James, P. S. Hall, and C. Wood, Microstrip Antenna Theory and Design, Peter Perigrinus, London, 1981.
[5] B. L. Ooi, M.S. Leong, and Q. Shen, "A novel equivalent circuit for E-shaped slot patch antenna," in Proc. IEEE Antennas and Propagation Society Int. Symp., 2001, vol. 4, pp. 482-485, 8-13 Jul. 2001.
[6] K. C. Gupta and A. B. Norwood, Microstrip Antenna Design,Norwood, MA: Artech House, 1988.
[7] X. -X. Zhang and F. Yang, "The study of slit cut on the microstrip antenna and its applications", Microwave Opt. Technol. Lett., vol. 18, no. 4, pp. 297-300, Jul. 1998.
[8] Shobhit K. Patel, Y.P.Kosta "E-shape Microstrip Patch Antenna Design for GPS Application" Institute of Nirma University, 08-10 Dec, 2011, IEEE.