

A Novel Design and Characterization of 3-Shape Microstrip Patch Antenna for C-Band and X-Band Applications

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Abstract – This paper describes a novel 3 Shape slot on square patch micro strip antenna and it has been presented for Bandwidth enhancement of the Micro strip Patch Antenna (MPA). The antenna parameters such as Bandwidth, Return loss and VSWR are more improvised in the proposed antenna than simple MPA. Finite Element Method (FEM) based on High Frequency Structure Simulator (HFSS) software Version- 13.0 is used to obtain the performance parameters of the proposed antenna. The main aim of this paper is to focus on how to increase the multi bands and impedance bandwidth of the microstrip patch antenna. This proposed antenna is made by using the CPW feeding method and designed for multiband frequency. Three different dielectric substrates namely: Duroid FR-epoxy and Rogers for TM10 are considered.

Keywords – Rectangular patch Antenna, FEM, Multiband frequency, C and X Bands.

1. INTRODUCTION

A microstrip patch antenna comprises types of antennas that offer a low profile, i.e. thin and easily manufactured ability, which provides great advantages over traditional antennas [1-3]. An 3-shaped patch antenna is easily formed by cutting two slots from a rectangular shape [4-6]. By cutting the slots from a patch, gain, return loss and bandwidth of microstrip antenna can be improved. The increased development of wireless communications, the urgency to design low volume, compact, low profile planar configuration and wideband multi-frequency [7-9] planar antennas become highly desirable. Narrow bandwidth is a serious limitation of these microstrip patch antennas. Different techniques are used to overcome this narrow

bandwidth limitation. These techniques include increasing the thickness of the dielectric substrate, decreasing dielectric constant and using parasitic patches. 4-8 GHz (C Band) used for satellite communications, for full-time satellite TV networks or raw satellite feeds. Commonly used in areas that are subject to tropical rainfall, since it is less susceptible to rain than Ku band (the original Telstar satellite had a transponder operating in this band, used to relay the first live transatlantic TV signal in 1962. 8-12 GHz (GHz Band) Primarily used by the military [10-11]. Utilized in radar applications including continuous-wave, pulsed, single-polarization, dual-polarization, synthetic aperture radar and phased arrays. X-band radar frequency sub-bands are used in civil, military and government institutions for weather monitoring, air traffic control, maritime vessel traffic control, defense tracking and vehicle speed detection for law enforcement. Proposed antenna shows good and optimum behavior at the C and X band frequency of 4.31 GHz, 6.45GHz and 8.88 GHz.

2. ANTENNA DESIGN

The geometry of the proposed 3-shape patch antenna is shown in Fig.1. It consists of an equal 3-shape patch antenna, a rectangular patch, partial grounding and substrates dimensions 18 X 12 X 1.6mm. There are three important parameters which are to be considered carefully for the designing a rectangular microstrip patch antenna for C and S Band frequencies.

1) Frequency of operation (f_0): The C -Band and S-Band uses the frequency range from 4 GHz-12 GHz. Hence the antennae designed must be able to operate for this frequency range. The default resonant frequency chosen for this research design simulation is 4.2 GHz.

2) Dielectric constant of the substrate (ϵ_r): The dielectric material chosen for this design is FR4Glass epoxy which has dielectric constant of 4.4.

3) Height of dielectric substrate (h): For the Microstrip patch antennae to be used in cellular phones, it is essential that the antennae are kept light and compact Hence, the height of the dielectric substrate is chosen as 1.6 mm. Hence, the essential parameters for the above explained design are chosen as $f_0 = 4.2$ GHz, FR4Glass epoxy = 4.4 and $h = 1.6$ mm.

The optimal dimensions of the designed antenna are as follows: $W_s=12$ mm, $L_s=18$ mm, $W=10$ mm, $W_f=2$ mm, $L_f=7$ mm, $W_g=4.5$ mm, $L_g=6$ mm.

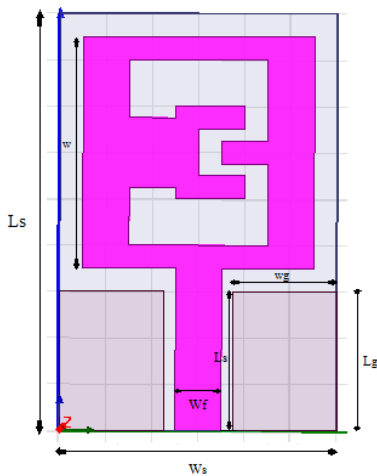


Fig1. Microstrip patch antenna

3.RESULTS

This section describes the simulation results obtained for the proposed design, “3 shape slot Antenna”. Antennas have been modeled and analyzed antenna simulation software. Different antenna parameters have been analyzed to obtain the antenna behavior. Ratio of input to output power is defined as the S-parameters or the reflection coefficient. It is also called as return loss parameters. Proposed antenna is a single port excited device. So, S_{11} Vs. frequency curve of antenna is shown in Figure 2, Antenna resonating at 4.31 GHz, 6.45GHz and 8.88 GHz and return loss at -15.39dB,-11.31dB and -12.41dB respectively.

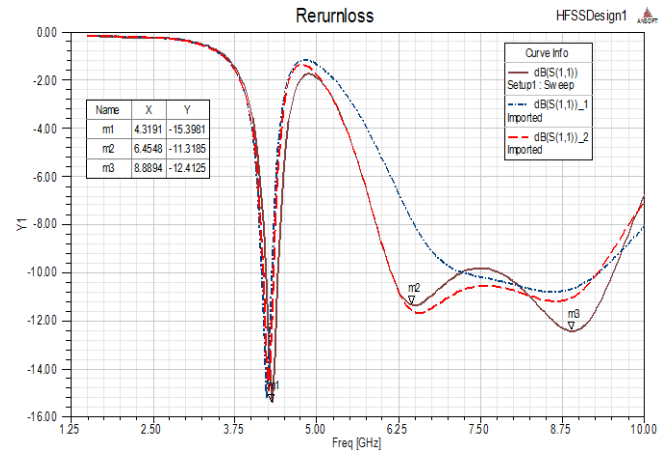


Fig.2 Return loss curve

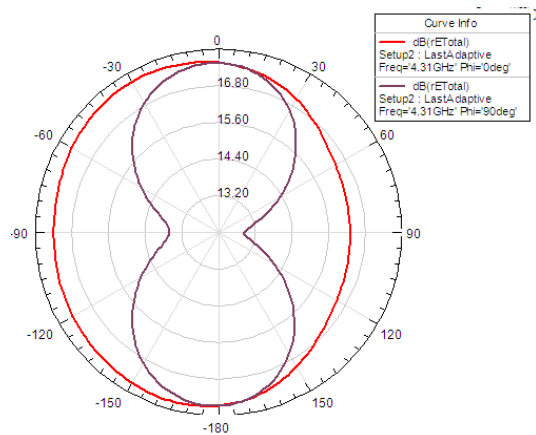


Fig.3 Radiation pattern at 4.31GHz

A radiation pattern defines the variation of the power radiated by an antenna in a desired direction to that of undesired direction. Figure.3, Figure.4 and Figure.5 present the radiation pattern of the antenna at 4.31 GHz, 6.45GHz and 8.88 GHz, Figure.6 represents the E field current distribution of the antenna and Figure.7 shows VSWR of the proposed antenna.

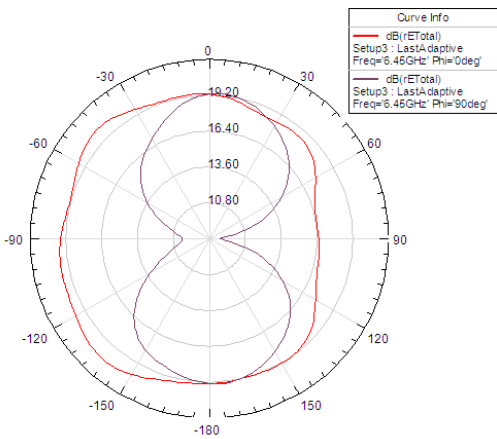


Fig.4 Radiation pattern at 4.31GHz

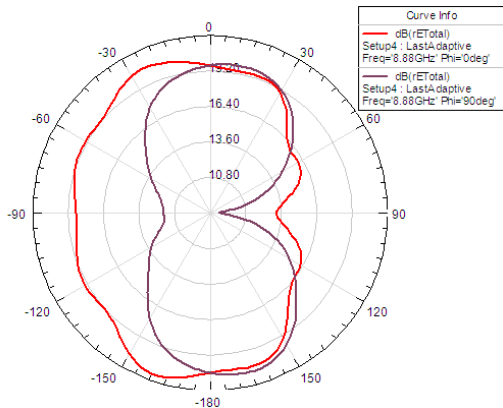


Fig.5 Radiation pattern at 4.31GHz

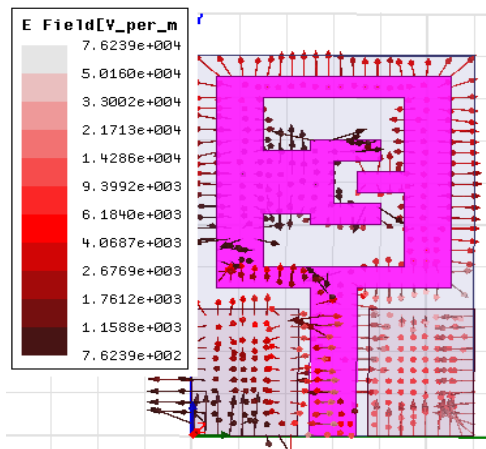


Fig.6 E field current distribution

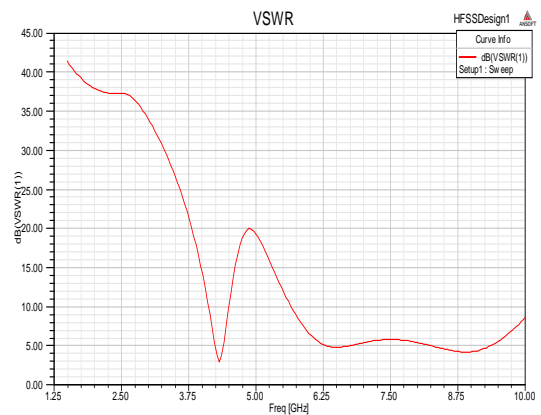


Fig.7 VSWR Curve

4. CONCLUSION

The work focused on the analysis and design parameters of microstrip patch antenna. A compact multiband band microstrip antenna with improved bandwidth and gain using a 3-Shape slot resonator design has been presented. The proposed design helps to achieve improvement in the gain, bandwidth and VSWR. The results presented in this paper are promising design of compact antennas without having to sacrifice the antenna bandwidth. The antenna has applications in the C (4-8 GHz) and X (8-12 GHz). The C-band contains frequency ranges that are used for many satellite communications transmissions, some Wi-Fi devices, some cordless telephones, and some weather radar systems. The X band is used for short range tracking, missile guidance, marine, radar and airborne intercept.

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REFERENCES

- [1] C. A. Balanis, "Antenna Theory-Analysis and design", Second Edition, John Wiley & Sons., New York, 1997.
- [2] K. R. Carver and J. W. Mink, "Patch Antenna Technology", IEEE Trans. Antennas Propagation, vol. AP-29, no. 1, pp. 2-24, Jan. 1981

[3] Deschamps, G. A., "Patch Microwave Antennas", Proc. 3rd USAF Symposium on Antennas, 1953

[4] Munson, R. E., "Single Slot Cavity Antennas Assembly", U.S. Patent No. 3713162, January 23, 1973

[5] Munson, R. E., "Conformal Patch Antennas and Patch Phased Arrays," IEEE Trans. Antennas Propagation, Vol. AP-22, 1974, pp. 74-78.

[6] Qian, Yongxi, Dan Sievenpiper, Vesna Radisic, Eli Yablonovitch, and Tatsuo Itoh. "A novel approach for gain and bandwidth enhancement of patch antennas." In *Radio and Wireless Conference, 1998. RAWCON 98. 1998 IEEE*, pp. 221-224. IEEE, 1998.

[7] Guo, Y. X., K. M. Luk, and K. F. Lee, "Dual-band slot loaded short circuited patch antenna," *Electronics Letters*, Vol. 36, No. 4, 289-290, 2002.

[8] Lu, J.-H., "Broadband dual-frequency operation of circular patch antennas and arrays with a pair of L-shaped slots," *IEEE Transactions on Antennas and Propagation*, Vol. 51, No. 5, 1018-1024, 2003.

[9] Liu, W. C. and W. R. Chen, "CPW-fed compact meandered patch antenna for dual-band operation," *Electronics Letters*, Vol. 40, No. 18, 1094-1095, 2004.

[10] Lau, K.-L., H. Wong, C.-L. Mak, K.-M. Luk, and K.-F. Lee, "A vertical patch antenna for dual-band operation," *IEEE Antennas and Wireless Propagation Letters*, Vol. 5, 95-98, 2006.

[11] Guterman, J., Y. Rahmat-Samii, A. A. Moreira, and C. Peixeiro, "Quasiomnidirectional dual-band back-to-back E-shaped patch antenna for laptop applications," *Electronics Letters*, Vol. 42, No. 15, 367-370, 2006.

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