iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5041

Employing Iron Nanoparticles on Equilateral Triangular Microstrip Antenna for Multiband Operation

Mahesh C P[1], Shweta Kalase[2], Maheshwar Sharon[3], Madhuri Sharon[4]
[1, 2, 3, 4]*Department of Nanotechnology, Walchand Centre for Research in Nanotechnology and Bionanotechnology, Solapur, Maharashtra, India,*

Abstract: This paper reports equilateral triangular microstrip antenna for multi band operation. The proposed antenna is resonates at 6.3 GHz with bandwidth of 4.76%, after loading the iron nanoparticles on the radiating patch of the antenna resonates for 2.3 GHz, 3.1 GHz, 5.8GHz, 7.1 GHz, 8.85 GHz, 9.8 GHz and 11.1 GHz respectively. The antenna consist of glass epoxy substrate material with relative permittivity 4.2 and thickness (h) is 0.08cm.The experimentally measured and calculated antenna parameters such as return loss, VSWR, radiation pattern and gain are presented. The design considerations are also presented.
Keywords: Iron nanoparticles, Equilateral microstrip antenna, Bandwidth, Gain, Return loss and VSWR

I. INTRODUCTION

The microstrip antenna was first introduced in the 1950s. However, the technology of Printed Circuit Board (PCB) was later introduced in 1970s.Therefore, from that time MSA had become a very common antenna having wide range of applications due to their advantages light weight, low profile, low cost, planar configuration and many more[1]. The microstrip antenna are widely used in Radio-Frequency Identification (RFID), Broadcast radio, mobile systems, satellite communication, television systems, multiple-input multiple output (MIMO) systems, vehicle collision avoidance system, radar systems, remote sensing, missile guidance, and so on [2].

The other part of researches on electrically small patch antenna is optimizing conductive parts of the antenna. Different techniques like meandering line technique; capacitive loading, inductive loading and employing parasitic stubs etc have been used in conjunction with the main antenna pattern to widen the bandwidth in addition to miniaturization [3-5]. However this arrangement reduces radiation efficiency. Also, MPAs at higher microwave band offer higher metallic losses there by reducing the bandwidth, radiation efficiency and gain. Recently new technologies and nano materials have been developed to allow the fabrication of patch antennas. One of the technologies is to deposit required amount of conductive patch material on the dielectric substrate using nanotechnology tools like Physical (PVD) or chemical vapor deposition (CVD) method [6]. In this paper we proposed equilateral triangular microstrip antenna using iron nanoparticles on the radiating patch to study the enhancement of bandwidth and multiband operation performance.

II. ANTENNA DESIGN CONSIDERATION

To achieve multi band frequencies and increase the bandwidth of microstrip antenna there were so many different methods are adopted like increasing in the substrate thickness, making use of a low dielectric constant substrate, using different feeding techniques and impedance matching and usage of slot antenna geometry. This work, propose a antenna is designed for the frequency of 5.5GHz utilizing the relations currently present in the literature of the design of equilateral triangular microstrip antenna using economy cost glass epoxy substrate having dielectric constant $\varepsilon r = 4.2$.

The shape of the equilateral triangular microstrip antenna(ETMSA) is shown in Figure 1.The making of equilateral triangular microstrip patch antenna is side of length ‘a’ cm over a substrate with substrate thickness ‘h’ cm. The value of ‘a’ is calculated by the equation (1),

$$a = \frac{2C}{3 f_r \sqrt{\varepsilon_r}} \qquad (1)$$

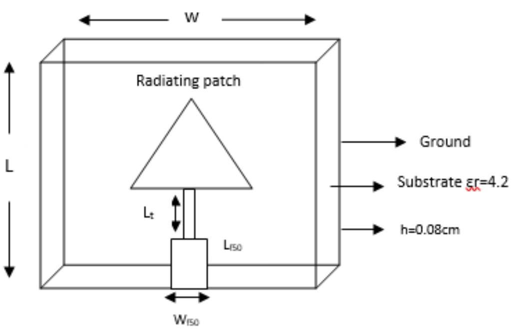


Figure 1: Geometry of ETMSA

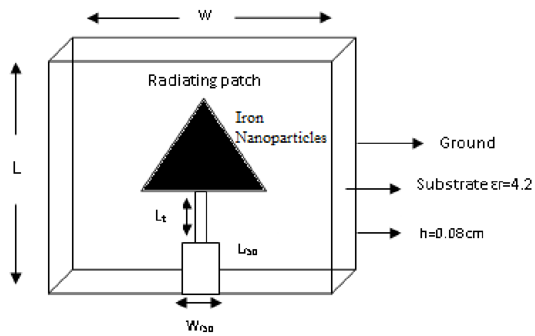


Figure 2: Top View of INETMSA

The proposed antenna work is constructed using the computer software AUTOCAD to gain the best accuracy. The antenna is fabricated using the photolithography process.

Further, the study is made by loading iron nanoparticles on the radiating patch which provides extent to achieve multiband frequencies and high enhancement in bandwidth. The top view of iron nanoparticles loaded equilateral triangular microstrip antenna (INETMSA) is shown in Figure 2. All the parameters of proposed antenna are given in Table 1.

TABLE 1
Designed Specifications of the Proposed Antennas

Antenna Specifications	Dimensions in Cm
Side length of equilateral triangle (a)	2.24
Substrate thickness, h	0.08
L_{f50}	0.629
W_{f50}	0.306
L_t	0.63
W_t	0.046
L_g	3.35
W_g	2.48

III.EXPERIMENTAL RESULTS

The impedance bandwidths over return loss less than -10 dB for the proposed antennas are measured. The measurements are taken on Vector Network Analyzer (Rohde & Schwarz, German make ZVK Model No. 1127.8651). The variations of return loss versus frequency of ETMSA and INETMSA antennas are shown in Figure 3 and Figure 4. The experimental impedance bandwidth is calculated using the equation (2),

$$\text{Bandwidth (\%)} = \left[\frac{f_2 - f_1}{f_c}\right] \text{x}100\% \qquad (2)$$

where, f_1 and f_2 are the upper and lower cut off points of resonating frequency when its return loss reaches -10 dB and f_c is a center frequency between f_1 and f_2. The ETMSA resonates at 6.3GHz with impedance bandwidth of 4.76% (6.1GHz –6.4GHz). From the Figure 4, it is found that the INETMSA resonates at seven bands of frequencies i.e, f_1, f_2, f_3, f_4, f_5, f_6 and f_7 with their corresponding bandwidths BW_1= 8.69% (2.2GHz - 2.4GHz), BW_2= 6.45% (3.05GHz –3.25GHz), BW_3= 6.89% (5.5GHz -5.9GHz) ,BW_4= 4.22% (7.00GHz-7.3GHz), BW_5= 5.64% (7.4GHz – 7.9GHz), BW_6= 6.12% (9.3GHz -9.9GHz) and BW_7= 12.6% (10.6GHz-12GHz) respectively.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

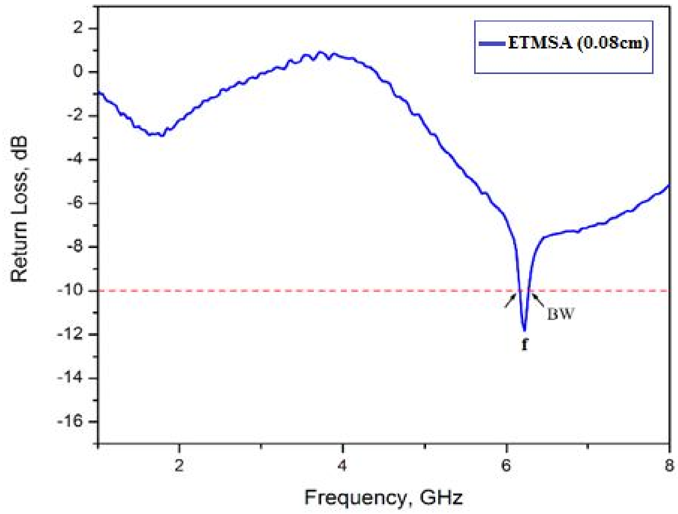


Figure 3: Variation of Return Loss v/s Frequency of ETMSA

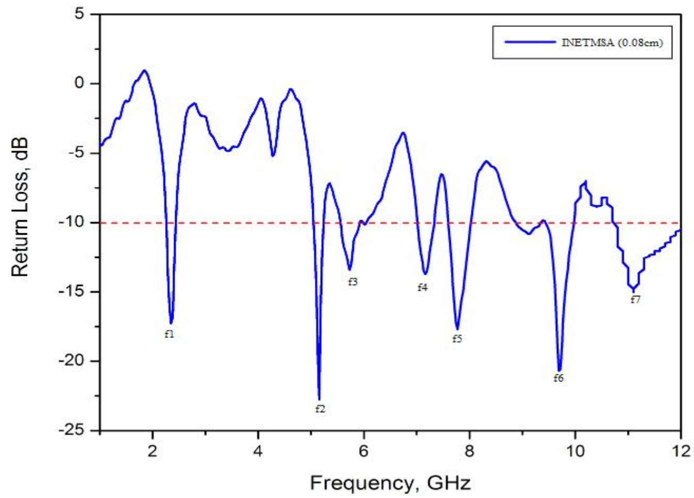
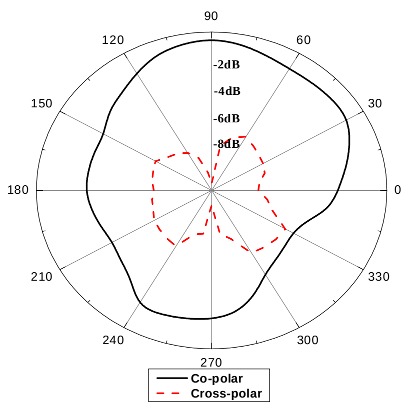
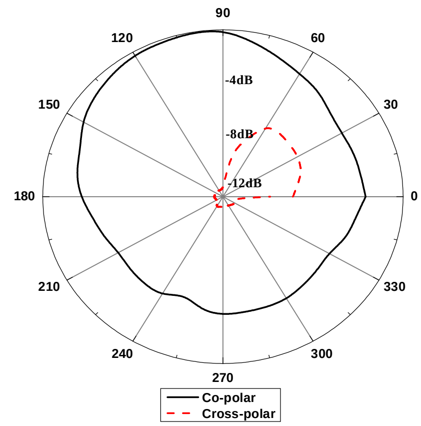


Figure 4: Variation of Return Loss v/s Frequency of INETMSA

The X-Y plane co-polar and cross-polar radiation patterns of ETMSA and INETMSA are measured at their resonating frequencies and are shown in Figure 5 to Figure 6. These figures indicate that the antennas show broad side radiation characteristics.



Radiation Pattern at 6.3 GHz



Radiation Pattern at 2.3 GHz

The gain of proposed antenna is calculated using absolute gain method given by the equation (3),

$$(G)_{dB} = 10\log\left(\frac{P_r}{P_t}\right) - (G_t)_{dB} - 20\log\left(\frac{\lambda_0}{4\pi R}\right)_{dB} \; dB \qquad (3)$$

where, Pt and Pr are transmitted and received powers respectively, G_t is the gain of the pyramidal horn antenna and R is the distance between transmitting antenna and antenna under test. The return loss, gain and VSWRof the antennas are also tabulated in Table 2.

TABLE. 2
Calculated Return loss, Gain and VSWR

Antennas	Frequency in GHz	Return loss in dB	Gain in dB	VSWR
ETMSA	6.3	-12	3.75	1.21
INETMSA	2.3	-16.95	6.28	1.05

IV. CONCLUSIONS

From the detailed study it is concluded that, the novel geometries of iron nanoparticles loaded equilateral triangular microstrip antenna (INETMSA) derived from ETMSA are effective for producing seven band frequency and enhancement in bandwidth. The radiation patterns of all the antennas are found to be broadsided and linearly polarized. The designed antennas are simple in their design, compact and they use low cost substrate material. These antennas may find applications in Bluetooth, Wimax, radar and in satellite systems.

REFERENCES

[1] TanishNarang; Shubhangijain; “Microstrip Patch Antenna- A Historical Perpective of the Development”,Conference on Advances in Communication and Control Systems 2013 (CAC2S 2013).
[2] Ogunlade Michael Adegoke; Ismael SaadEltoum; “Analysis and Design of Rectangular Microstrip Patch Antenna AT 2.4GhzWLAN Applications”, International Journal of Engineering Research &Technology (IJERT) ISSN: 2278-0181Vol. 3 Issue 8, August – 2014.
[3] C. R. Rowell and R.D. Murch, “A Capacitively loaded PIFA for compact mobile telephone handsets,” IEEE Trans. Antennas Propag. vol. 45, pp. 837-842, May 1997.
[4] C. R. Rowell and R. D. Murch, “A Compact PIFA Suitable for Dual-Frequency 900/1800-MHz Operation,” IEEE Trans. Antennas Propag, vol. 46, no. 4, pp. 596-598, Apr. 1998.
[5] R, Li, G. DeJean, M. M. Tentzeris and J. Laskar, “Development and Analysis of a Folded Shorted Patch Antenna with Reduced Size,” IEEE Trans. Antennas Propag, vol. 52, no. 2, pp. 555-562, Feb. 2004.
[6] A, Sharma, J. Bellare, and A. Sharma, Advances in Nanoscience and Nanotechnology. National Institute of Science Communication and Information Resources, 2006.