iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XI **Month of publication:** November 2017

DOI: http://doi.org/10.22214/ijraset.2017.11089

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

Modified U-Slot Loaded Circular Inset-Fed Microstrip Antenna for Penta-Band Operations

Ashwini C. Tengli[1], P. M. Hadalgi[2]
[1]Research Scholar, Department of P. G. Studies and Research in Applied Electronics, Gulbarga University, Kalaburagi-585106, Karnataka, India
[2]Professor, Department of P. G. Studies and Research in Applied Electronics, Gulbarga University, Kalaburagi-585106,

Abstract: **in *this paper, a novel design of the inset-fed circular microstrip antenna by inserting a modified U-slot on the patch and arrow mark slot in the ground is proposed. The antenna prototypes were simulated by Ansys HFSS software and measured practically. Low cost FR-4 dielectric substrate material with relative permittivity of 4.4 having physical dimension of 55.4 × 44 × 1.6 mm3 has been fabricated for validation with simulations. The proposed antenna resonates at five frequency points 2.4, 5.8, 6.7, 7.6 and 9.8 GHz with >-10 dB return loss having impedance bandwidths of BW1= 9.54% (2.32-2.55 GHz), BW2= 5.68% (5.73-6.07 GHz), BW3= 8.94% (6.39-6.99 GHz), BW4=10.71% (7.25-8.07 GHz), and BW5=13.36% (9.16-10.47 GHz). Virtual size reduction of 36.90% is achieved when compared to conventional antenna. The proposed antenna shows broadside radiation characteristics and finds application in WLAN (2.4/5.2/5.8GHz) and wireless communication.***
Keywords: Inset-fed, U-slot, arrow mark slot, impedance bandwidth, penta-band, WLAN, wireless communication.

I. INTRODUCTION

Microstrip antennas (MSAs) offer many attractive features such as low-profile, light weight, planar configuration, ease of fabrication, conformable to planar and non-planar surfaces [1] etc. In the last four decades, the extensive technological work on MSAs have been developed for many wireless communication systems such as WLAN, Wi-Fi, sensors, satellite, broadcasting services, ultra-wideband (UWB), radio frequency identifications (RFIDs), reader devices, radars [2,3] etc. Still extendable work has been going on MSAs for modern wireless communication systems capable to work for applications such as portable, handheld devices, RFID reader devices which provide wireless networks. In the recent technological development, MSAs of smaller physical size are very much preferable to integrate in the systems especially operating at the lower microwave frequency ranges.

Moreover, the applications like land mobile telephony as well as in the field of WLANs [4, 5] further requirement would be a multi-frequency operations. So the designs of a printed antenna with intend to conform to multiple communications protocols, for example the IEEE 802.11b/g at 2.4 GHz and the IEEE 802.11a at 5.3 GHz and 5.8 GHz [6, 7] would be a challenging and difficult task for the designers.

In this paper, a novel design of inset-fed circular microstrip antenna by inserting a modified U-slot on the patch and arrow mark slot in the ground is proposed. The antenna is designed to work for penta-band operation covering different wireless communications. The details of the antenna design, simulation and experimental results are presented and discussed in next sections.

II. ANTENNA DESIGN

The conventional circular inset-fed microstrip antenna in Fig. 1 and modified U-slot loaded on patch and arrow mark slot in the ground are designed by commercially available low cost FR-4 dielectric material with relative permittivity (ε_r) of 4.4 with thickness (h) of 1.6 mm having loss tangent is 0.02. The top and bottom view of the proposed penta-band inset-fed circular microstrip antenna is shown in Fig 2. The designed physical dimensions of the conventional and proposed antennas are tabulated in Table 1. These physical dimensions of antennas were used for simulation by Ansys HFSS software [8] and measured practically. The results are discussed in next section.

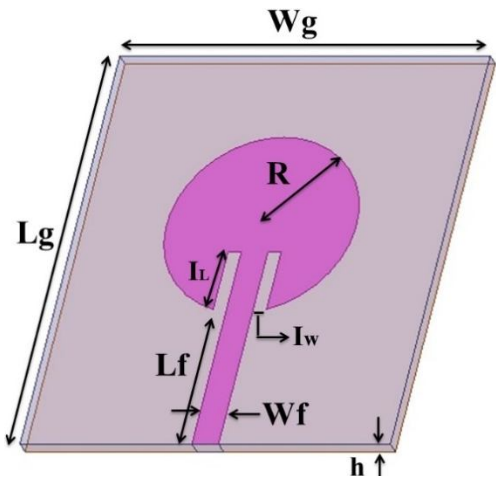


Fig. 1 Geometry of the conventional circular inset-fed microstrip antenna

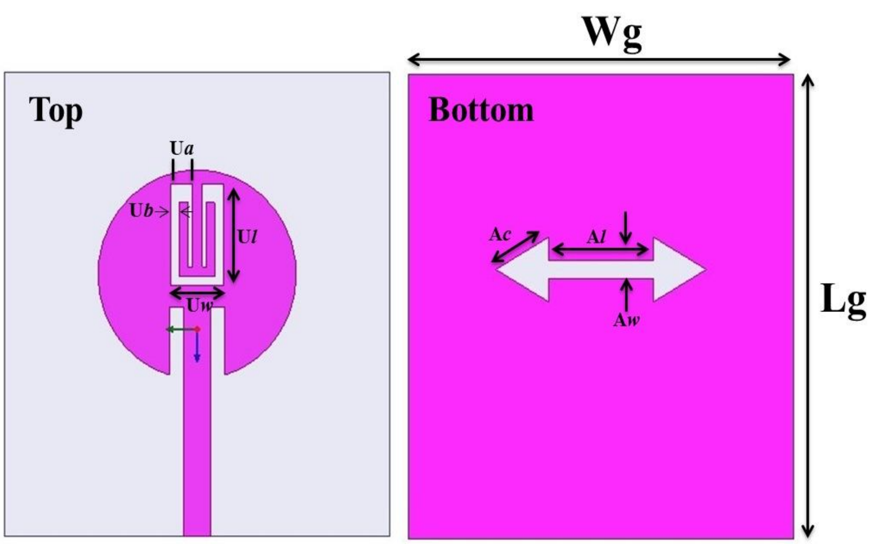


Fig. 2 Geometry of the proposed penta-band inset-fed circular microstrip antenna

TABLE I
DIMENSIONS OF CONVENTIONAL AND PROPOSED ANTENNA

Antenna parameters	W	L	R	W_f	L_f	I_W	I_L	h	Ua	Ul	Uw	Ub	Ac	AL	Aw
Dimensions (mm)	55.4	44	11.5	3.17	17.18	1.58	6.98	1.6	2.5	11	6	1	6.98	12	2

III. RESULTS AND DISCUSSION

The scattering parameters of the proposed antennas are measured by Vector Network Analyzer (VNA) (Rhode and Schwarz, Germany make ZVK model 1127.8651). The comparison of simulated and measured return loss characteristics of the conventional and proposed penta-band circular microstrip patch antennas are shown in Fig. 3 and 4. From Fig. 3 it is observed that the conventional antenna is resonating at fr= 3.75 GHz with -10dB return loss with impedance bandwidth of BW= 4.26% (3.69-3.85 GHz). But, from Fig.4 it is observed that by loading U type slot on the patch and arrow mark slot in the ground plane of antenna it is resonating at five different frequencies 2.4, 5.8, 6.7, 7.6 and 9.8 GHz with -10 dB impedance bandwidths of BW1= 9.54% (2.32-2.55 GHz), BW2= 5.68% (5.73-6.07 GHz), BW3= 8.94% (6.39-6.99 GHz), BW4=10.71% (7.25-8.07 GHz), and BW5=13.36% (9.16-10.47 GHz) respectively.

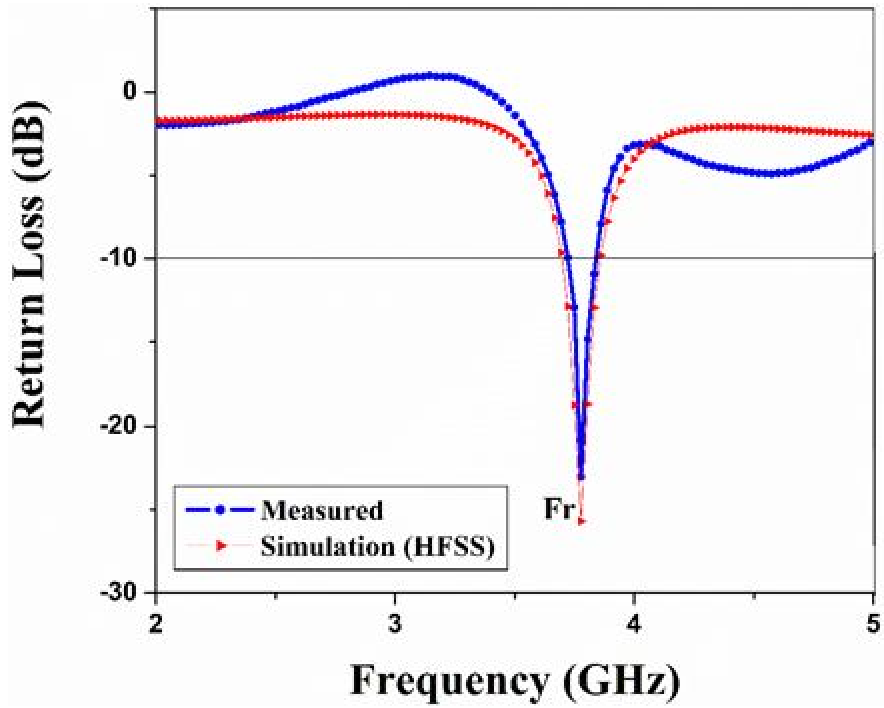


Fig. 3 Comparison of simulated and measured return lss characteristics of conventional circular inset-fed microstrip antenna

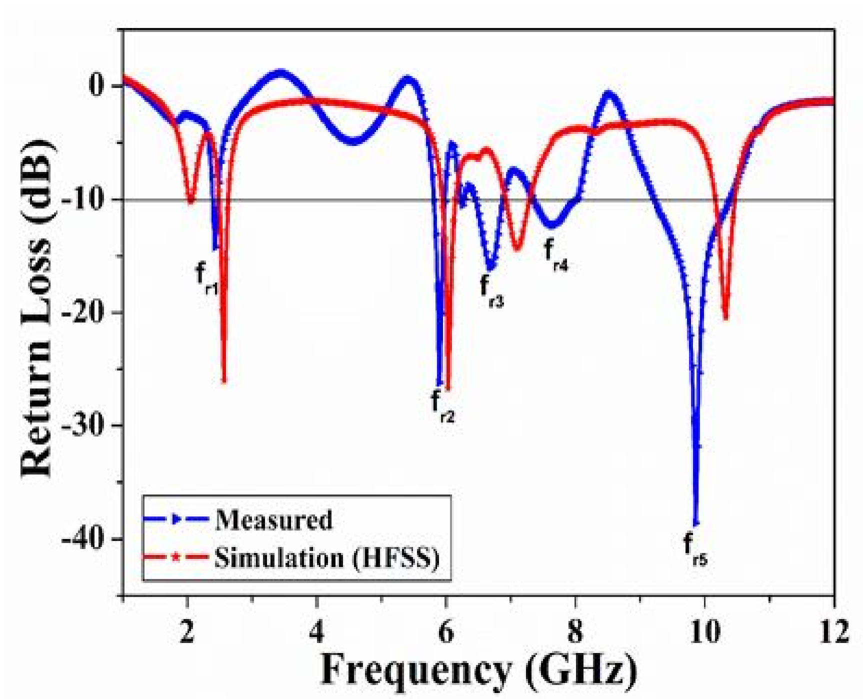


Fig. 4 Comparison of simulated and measured return loss characteristics of proposed penta-band circular patch antenna

To illustrate the resonance mechanisms for the proposed antennas, the simulated surface current distribution of the conventional antenna and the proposed antenna are shown in Fig. 5 and Fig. 6 (a) – (b). From Fig. 5 it is observed that the current on radiating patch of conventional antenna is uniform and it's smoothly moving from one end to the other end. But, in case of Fig. 6 (a) it is clear that the more current is accumulated at the U type slot. This phenomenon leads to good virtual size reduction and good radiation performance of the proposed antennas.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

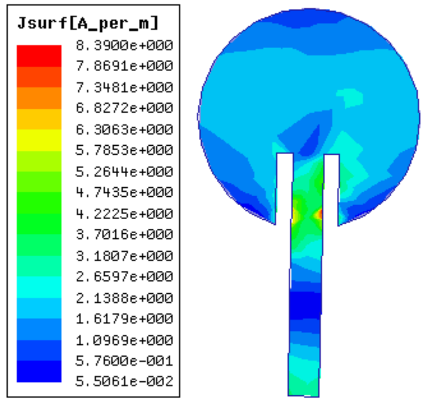
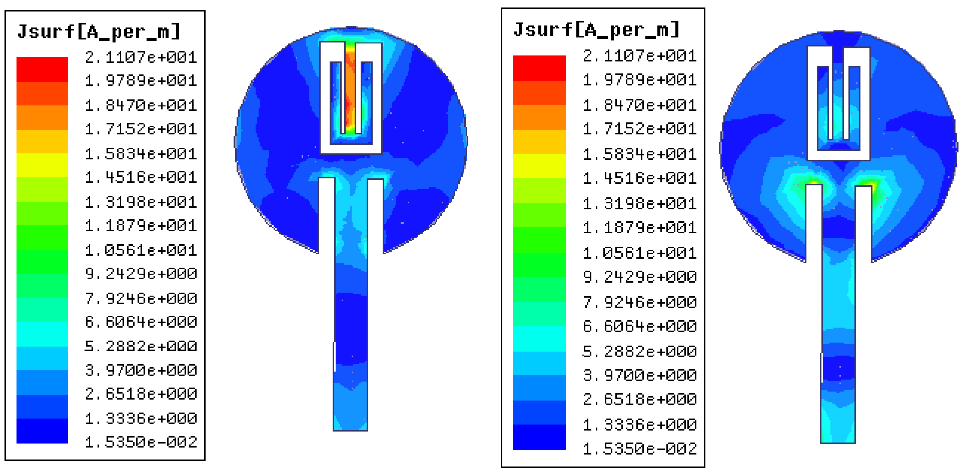


Fig. 5 Simulated surface current distribution of the conventional antenna at 3.75 GHz



(a) (b)

Fig. 6 Simulated surface current distributions of the proposed penta -band antenna observed at (a) 2.4 GHz, (b) 5.8 GHz

The desired normalized co-polarization and cross-polarization radiation pattern plots in E-plane at the resonating frequencies of the conventional antenna and proposed antennas are shown in Fig. 7 and Fig. 8(a)-(e). The radiation patterns are observed to be broadside in nature and linearly polarized at respective resonating frequencies. Also the proposed antenna exhibits similar radiation characteristics in its remaining operating frequencies.

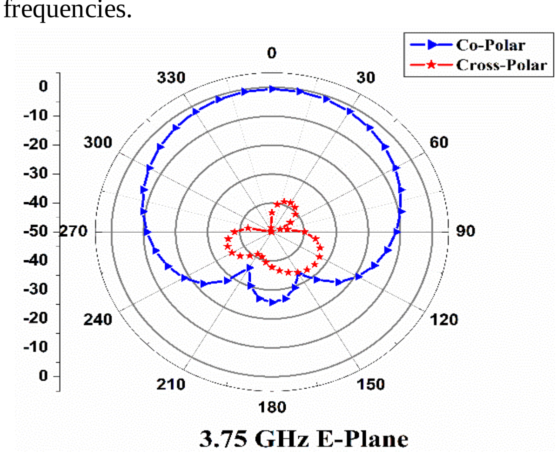
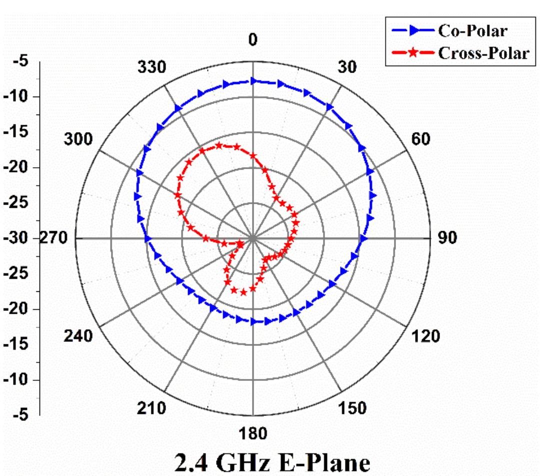
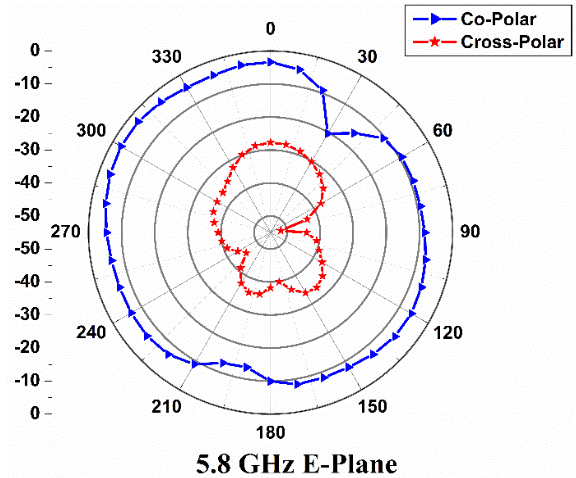


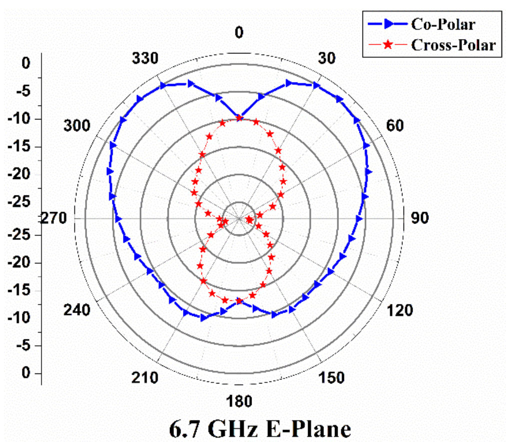
Fig. 7 Typical E-plane co-polarization and cross- polarization radiation patterns of the conventional circular microstrip patch antenna measured at 3.75GHz



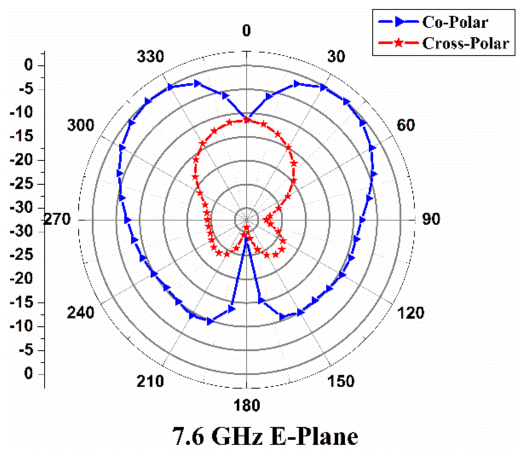
(a)



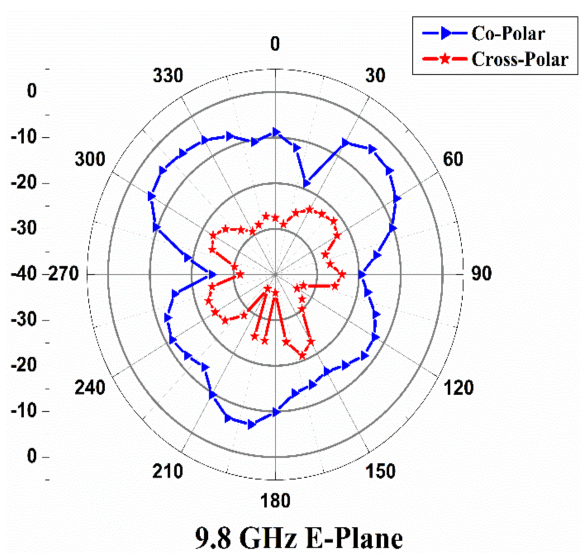
(b)



(c)



(d)



(e)

Fig. 8 Typical E-plane co-polarization and cross- polarization radiation patterns of the proposed antennas measured at (a) 2.4 GHz, (b) 5.8 GHz, (c) 6.7 GHz, (d) 7.6 GHz and (e) 9.8 GHz

IV. CONCLUSIONS

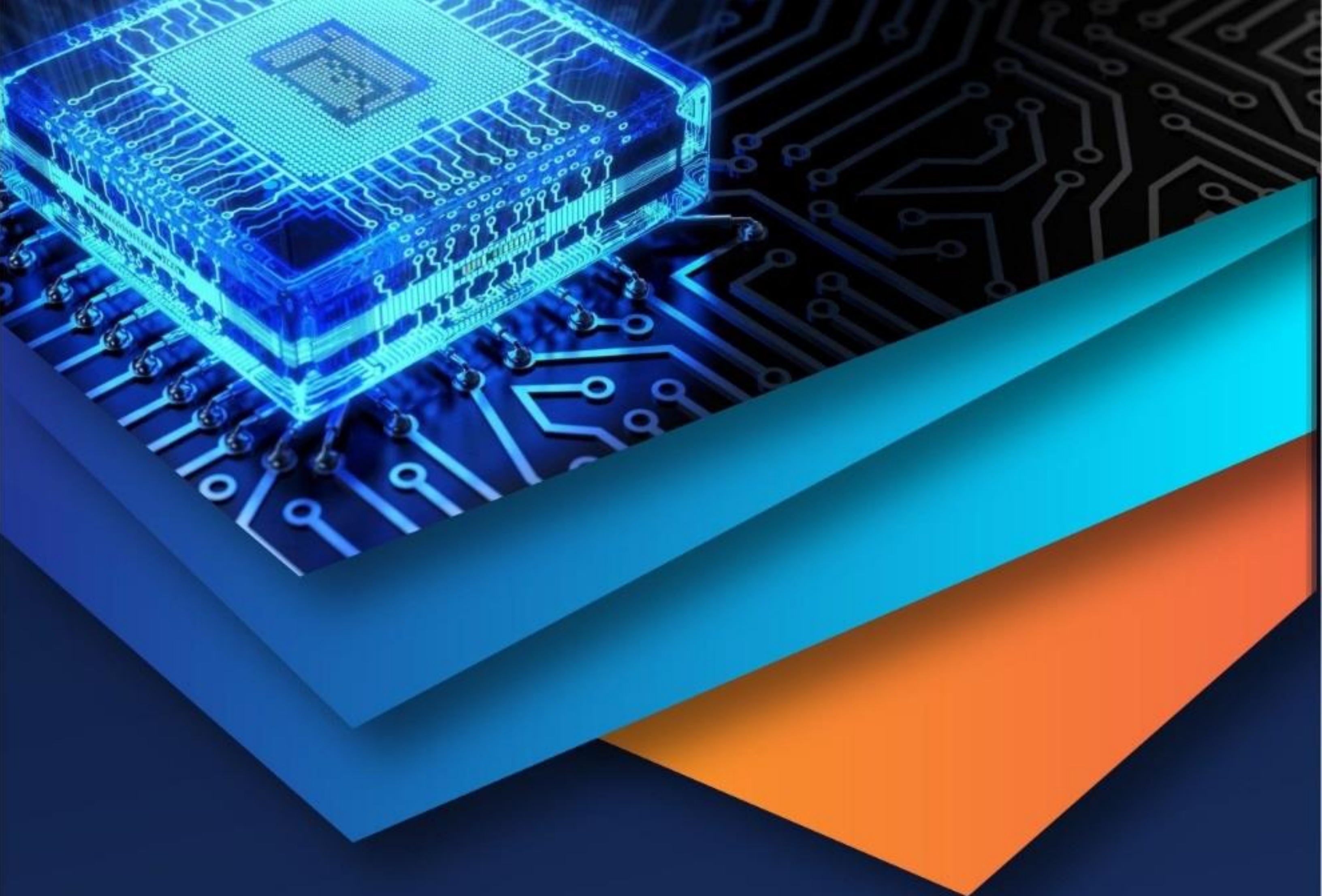
In this paper, a novel design of penta-band circular microstrip antenna is designed and developed. From the detailed experimental study, it is observed that by inserting U-slot on patch and arrow mark slot in the ground the antennas resonating at five different frequencies and achieved virtual size reduction of 36.90% when compared to conventional antenna without slots. The proposed antenna is compact in its structure and shows broadside radiation patterns. The measured and simulated results are in good agreement with each other. This antenna may find application in WLAN and wireless communication system.

V. ACKNOWLEDGMENT

The authors would like to express their sincere gratitude the authorities of Dept. of Science & Technology (DST), Govt. of India, New Delhi, for sanctioning the Vector Network Analyzer (VNA) to the Department of Applied Electronics, Gulbarga University, Gulbarga under the FIST project.

REFERENCES

[1] C. A. Balanis, Antenna Theory Analysis and Design, John Willey & Sons, New York, 2005.
[2] Nasimuddin, Microstrip Antennas, In Tech Org., 2011.
[3] K. Siakavara, Methods to design microstrip antennas for modern applications in Microstrip Antennas, N. Nasimuddin (ed.), ch. 9 , pp. 173-236, In Tech Org., 2011.
[4] I. J. Bahl and P. Bhartia, Microstrip Antennas, MA: Artech House, 1982.
[5] Sheta, A. F., A. Mohra and S. F. Mahmoud, “Multi-band operation of compact H-shaped microstrip patch antenna”, Microwave Opt. Technol. Letter, Vol. 35, No. 5, 363-367, December 2002.
[6] Sheta, A. F., A. Mohra and S. F. Mahmoud, “Modified compact H-shaped microstrip antenna for tuning multi-band operation”, 25th National Radio Science Conference (NRSC2008), Tanta university, Tanta, Egypt, March 18-20
[7] Siddiqui Naushad Ather et al, “Truncated Rectangular Microstrip Antenna with H and U Slot for Broadband”, International Journal of Eng. Sc. and Techno., Vol. 5, No.01, pp 114-118, January 2013.
[8] Ansoft Corporation, Ansoft High Frequency Structure Simulation(HFSS), Ver. 13, Ansoft Corporation, Pittsburgh, PA, 2010.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY