Ambresh et al., 2015

Volume 1 Issue 1, pp. 01-07

Date of Publication: 14 November 2015

DOI-https://dx.doi.org/10.20319/mijst.2016.s11.0107

This paper can be cited as: Ambresh P. A., Sujata A. A., Hadalgi P. M., & Hunagund P. V., (2015). Experimental Study on Multiband Arrow Shape Patch Antennawith Inverted V-Slot. MATTER: International Journal of Science and Technology, 1(1), 01-07.

EXPERIMENTAL STUDY ON MULTIBAND ARROW SHAPE PATCH ANTENNAWITH INVERTED V-SLOT

Ambresh P. A
*Department of Electronics, Mangalore University, Mangalore-574199, Karnataka, India
ambreshpa@rediffmail.com

Sujata A.A
Godutai Engineering College for Women, Gulbarga, Karnataka, India
sujata.kamalapurkar@gmail.com

P M Hadalgi
Department of Applied Electronics, Gulbarga University, Gulbarga-585106, Karnataka, India
pm_hadalgi@rediffmail.com

P.V. Hunagund
Department of Applied Electronics, Gulbarga University, Gulbarga-585106, Karnataka, India
Prabhakar_hunagund@yahoo.com

Abstract

A multiband arrow shape patch antenna with inverted V slot (MASPAIVS) is designed and proposed for 3.5 GHz frequency. The antenna is designed with novel inverted wide V-slot and arrow shape patch is fed with a microstripline feed method. The wide inverted V-slot make the antenna to have multiple resonances to operate in the frequency bands of 1 GHz to 13 GHz achieving a maximum impedance bandwidth of 37.38 % in the satellite applications operating *band. The antenna shows good return loss characteristics and operates in the L, S, C-Band and military X-band making it suitable for Wi-Max, WLAN and Satellite applications.*

Keywords

Wireless, Satellite, Frequency, Bandwidth, Military.

1. Introduction

Communication is one of the fastest growing sector in any wireless communication applications with the usage of antennas. Thus, the demand for multi-function device is rapidly increased with the miniaturization of portable devices. In line with this trend, communication devices, antennas are required to operate in at least two frequency bands, aside from being compact, efficient and low-profile studied by Garima, D. Bhatnagar, V. K. Saxena, and J. S. Saini, 2009. Microstrip antenna (MSA) is among the best choice to be implemented for operation in electronic devices, as it offers many attractive features such as simple structure, low production cost, light weight, robustness and ease of fabrication as studied by T. Jing-Yao, O. Ban Leong and L. Mook Seng, 2005 and S. Satthamsakul et.al., 2008. However, the drawback of the patch antenna is the limitation by its narrow impedance bandwidth. To overcome this, many techniques have been suggested – probe fed stacked antenna as studied by M. T. Islam et.al., 2008, and A. S. Elkorany, A. A. Sharshar, and S. M. Elhalafawy, 2009, microstrip patch antennas on electrically thick substrate as studied byM. Rahman and M. A. Stuchly, 2001, slotted patch antenna as studied by Y. K. Cho et.al., 2010, H. S. Shin and N. Kim, 2010 and V. Natarajan, E. Chettiar, and D. Chatterjee, 2004, and addition of parasitic elements as studied by P. Jearapraditkul et.al., 2008.

In the present work, design, fabrication and practical testing of a line-fed, slotted microstrip antenna is carried out. In order to prove its improvements, it is also benchmarked with conventional rectangular microstrip antennas (RMA), which are both designed for operation in the 3.5 GHz Industrial, Scientific and Medical (ISM) band. The proposed design is able to operate in at least two other frequency ranges (5.2 GHz and 5.8 GHz) satisfactorily, with broad impedance bandwidth and better return loss. Details of the investigation based on experiments of the proposed antenna are described.

2. Antenna Design

In this study, antenna prototypes are designed; first, a conventional rectangular microstrip antenna (CRMA) and a multiband arrow shape patch antenna with inverted V slot (MASPAIVS). All prototypes are fed by a 50 Ω connector using a microstrip transmission line and implemented on a glass epoxy dielectric material. The dimension of the proposed antenna's patch width (*W*) and length (*L*) are calculated from below equation,

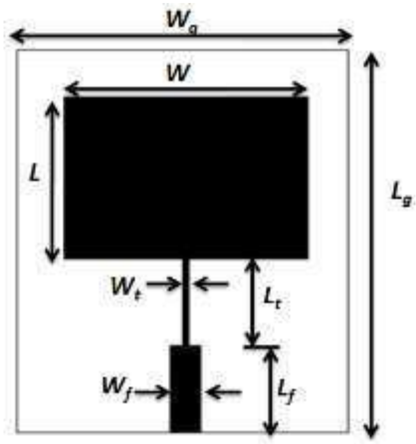
The patch width W shown in Figure 1 is given by,

$$W = \frac{c}{2f_r}\sqrt{\left(\frac{\varepsilon_r + 1}{2}\right)} \tag{1}$$

The length of patch is given by,

$$L = \frac{c}{2 f_r \sqrt{\varepsilon_r}} - 2\Delta l \tag{2}$$

At 3.5 GHz, the calculation yields, for compact patch length and patch width (L x W) of the patch is (18.99 *x* 26.92 mm). The length and width of quaterwave transformer $(L_t x W_t)$ is (10.18 x 0.66 mm). The length and width of microstripfeedline$(L_f \; x \; W_f)$ is (10.19 x 3.35 mm) which is as shown in Figure 1. The patch is fabricated on a low cost glass epoxy substrate material of thickness h = 1.66 mm and permittivity $\varepsilon_r = 4.4$. In order to get better accuracy, the antennas are presketched using computer software AutoCAD-2013 and are fabricated using photolithography process. Later, the inverted wide V-slot and arrow shape patch is etched on the patch plane of conventional RMA which is fed with a microstripline feed method as shown in Fig. 2. This antenna is named as multiband arrow shape patch antenna with inverted V slot (MASPAIVS).The dimensions of the slots are taken in terms of λ_0, where λ_0 is the free space wavelength corresponding to the designed frequency of conventional RMA i.e. 3.5 GHz. The side lengths of arrow shape patch (*A*) is are 7.19 mm and (*B*) = 9.44 mm keeping the length, width of patch, feed line length and width, quaterwave transformer length and width unchanged as compared to the RMA.



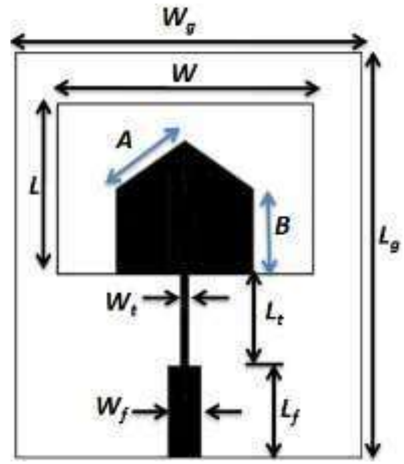


Figure 1: *Top view geometry of conventional RMA* **Figure 2:** *Geometry of MASPAIVS*

3. Results & Discussion

For the proposed antennas, the impedance bandwidth over return loss less than −10 dB is measured on Agilent Technologies E8363B Network Analyzer operating for the frequency range of 10 MHz to 40 GHz. Before and after insertion of the slot on patch, the fundamental resonant frequency splits into multiple frequency bands starting from 1 GHz to 13 GHz in the fabricated antenna. The variation of return loss verses frequency of RMA is as shown in Figure 3. From the figure it is clear that, the antenna resonates at fr_1 = 3.7 GHz of frequency which is very much close to the designed frequency of 3.5 GHz and hence validates the design. From this graph, the experimental impedance bandwidth is calculated using the above equations. The bandwidth of conventional RMA is found to be BW_1 = 2.06 %. Fig. 4 shows the variation of return loss verses frequency of MASPAIVS. The antenna resonates at five distinct bands with resonant frequencies of fr_1 = 3.1 GHz, fr_2 = 5.8 GHz, fr_3 = 7.4 GHz, fr_4 = 10.58 GHz and fr_5 = 13.58 GHz with corresponding impedance bandwidths of BW_1 = 0.9 % for RL= -16.44 dB, BW_2 = 2.1 % for RL= -23.47 dB, BW3 = 1.8 % for RL= -14.03 dB, BW4 = 37.38 % for RL= -40.65 dB and BW5 = 19 % for RL= -31.95 dB respectively. Fig.5 shows the smith chart plot of MASPAIVS and is quite clear that the resonant frequency point are near to the centre impedance point 1 which validates better matching characteristics between input and load. Fig.6 shows the measured VSWR of 1.36, 1.17, 1.52, 1.03 and 1.07 less than VSWR of 2 at respective resonant frequencies of PSMSA signifying less reflected power. Figure 7 shows the measured phase plot values 148.740, 52.360, -85.680, -58.410 and 91.430 for respective resonant frequencies of MASPAIVS.

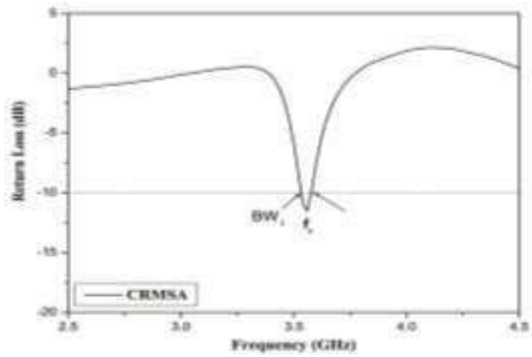


Figure 3: *Variation of RL Vs frequency of frequency of MASPAIVS*

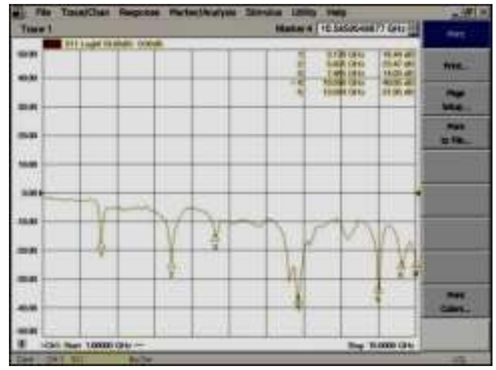


Figure 4: *Variation of RL Vs Conventional RMA*

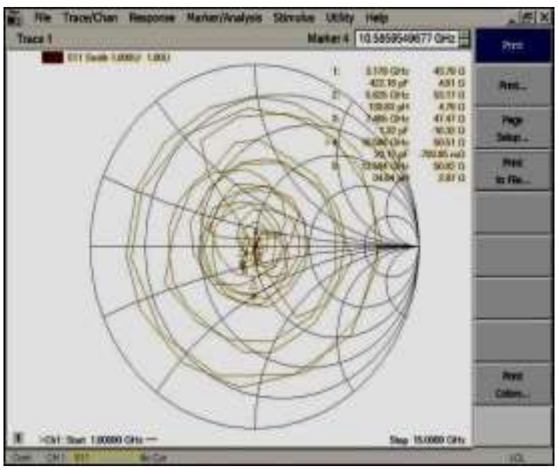


Figure 5: *Smith chart plot of MASPAIVS*

Figure 6: *VSWR plot of MASPAIVS*

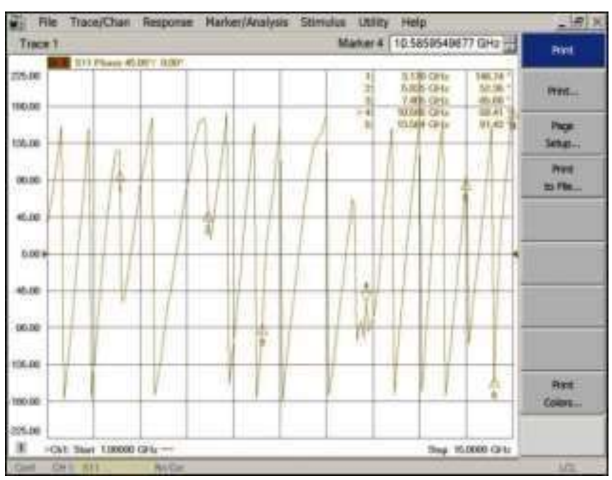


Figure 7: *Phase plot of MASPAIVS*

4. Conclusion

A multiband arrow shape patch antenna with length and width (L x W) of the patch is (18.99 *x* 26.92 mm) for wireless applications is presented. The proposed design, which incorporates modified patch with wide inverted V-slot and an arrow shape patch, has been successfully designed for multiband operations at GSM 1800, 3G-UMTS, Bluetooth and WLAN applications. Practically, a bandwidth of 37.38 % for RL= -40.65 dB with VSWR less than 1.5 is readily achieved using the proposed structure.

Acknowledgement

Authors thank University Grants Commission (UGC) for sanctioning the funds under BSR Start-up research grant scheme/project to carry out this research work and also thanks to Prof. Muralidhar Kulkarni, Head, Dept of E & CE, National Institute of Technology, Surathkal, Dakshin Kannada, Karnataka, India for providing an opportunity to use Agilent Technologies E8363B Network Analyzer.

REFERENCES

Garima, D. Bhatnagar, V. K. Saxena, and J. S. Saini (2009), Broadband circular patch microstrip antenna with diamond shape slot for space communication, in *International Conference on Emerging Trends in Electronicand Photonic Devices & Systems, ELECTRO '09.*332-335.

T. Jing-Yao, O. Ban Leong, and L. Mook Seng (2005), Diamond-shaped broadband slot antenna, *IWAT 2005. IEEE International Workshop on Antenna Technology: Small Antennas and Novel Metamaterials,* 431-434.

S. Satthamsakul, N. Anantrasirichai, C. Benjangkaprasert, and T. Wakabayashi (2008), Rectangular patch antenna with inset feed and modified ground-plane for wideband antenna, in *SICE Annual Conference,* 3400-3403.

M. T. Islam, N. Misran, M. N. Shakib, and B. Yatim (2008), Wideband Stacked Microstrip Patch Antenna for Wireless Communication, *International Symposium on Parallel and Distributed Processing with Applications,* 547-550.

A. S. Elkorany, A. A. Sharshar, and S. M. Elhalafawy (2009), Ultra wideband stacked microstrip patch antenna, *EuCAP 2009. 3rd European Conference on Antennas and Propagation*, 1464-1466.

M. Rahman and M. A. Stuchly (2001), Wideband microstrip patch antenna with planar PBG structure, *International Symposium*in *Antennas and Propagation Society*, 2, 486-489.

Y. K. Cho, J. H. Yoo, E. J. Kim, Y. Kim, and Y. S. Lee (2010),Wideband microstrip-fed slot loop antenna with the conducting via," in *Electromagnetic Compatibility (APEMC)*, pp. 834-838.

S. Shin and N. Kim (2010), Wideband annular ring slot microstrip antenna with low impedance feed line,*2010 Asia- Pacific Symposium on*in *Antennas and Propagation Society International Symposium*, 2, 288-291.

Natarajan, E. Chettiar, and D. Chatterjee (2004), An ultra-wideband dual, stacked, U- slot microstrip antenna, *IEEEAntennas and Propagation Society International Symposium*, 3, 2939-2942.

P. Jearapraditkul, W. Kueathaweekun, N. Anantrasirichai, O. Sangaroon, and T. Wakabayashi (2008), Bandwidth Enhancement of CPW-Fed Slot Antenna with Inset Tuning Stub, *International Symposium on*in *Communications and Information Technologies*, 14-17.

C. A. Balanis (1997), *Antenna Theory: Analysis and Design*, John Wiley& Sons.