International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 3, Issue 1, January 2014

DESIGN AND ANALYSIS OF MULTIBAND MICROSTRIP ANTENNA ARRAY

SONIKA SINDHIYA, NEHYA CHAUDHARY, K.K TRIPATHI (A.K.G.E.C)

Department of Electronics and Communication

U.P. Technical University,Lucknow,India

Abstract -A novel 2* 2 microstrip patch antenna array is presented in this paper. With two U-Slot etched in the radiating element, the proposed structure achieves multi band and high gain. It is demonstrated that the proposed antenna designed at 2.4 Ghz frequency suitable for WLAN application. The antenna is coaxiale line feeded and is simulated on IE3D Zeland software. Performance parameter evaluated are also good, such as it has directivity upto 13.6 dBi Gain of about 5 dBi. Good agreement between the simulated and measured responses has been obtained.

Keywords – Microstrip anteena array, multiband , U - Slot,IE3D

I. INTRODUCTION

Wireless communications have been developed widely and rapidly in the modern world especially during the last two decades. The future development of the personal communication devices will aim to provide image, speech and data communications at any time, and anywhere around the world. This indicates that the future communication terminal antennas must meet the requirements of multi-band or wideband to sufficiently cover the possible operating bands. In addition, for miniaturizing the wireless communication system, the antenna must also be small enough to be placed inside the system.Microstrip antenna arrays are widely used in many applications, such as satellite communications,radar, missiles because of their advantageous features in terms of low profile, low cost, light weight and easy fabrication. However, the general Microstrip patch antennas have some disadvantages such as narrow bandwidth of about (2% - 5%) and less gain etc [3-4].

In this paper, a novel microstrip radiating patch with double U-slots is proposed. A 2* 2 antenna array with double U-slot is designed and optimized.

. According to the results, this Microstrip anteena array is applicable in 2 GHz–5 GHz frequency range and the gain of this microstrip antenna is reasonable in entire bandwidth.

This communication is arranged in four sections. Design of pro-posed antenna is discussed in Section II. Simulated and measured re-sults are presented in Section III,IV .

II.ANTENNA DESIGN

The geometry and detailed dimensions of a single U-slot antenna element and 2*2 array are shown in Figs. 1–2. The detailed dimensions of the radiating element and the feeding network are given as following: L=32mm,w=38mm,$w1$ = 4mm, $w2$ = 4 mm, $w3$ = 2 mm, $w4$ = 2 mm, $w5$ = 48 mm, The dielectric substrate is with a relative permittivity of 4.4 and a thickness of 1.6 mm.The central frequency is 2.4 GHz. The design procedure of theantenna array can be summarized as follows:

1) Decide the initial width and length of the patch according to the specified central frequency for a practical application. We suggest using the following approximate equation:

$$W = \frac{c}{2 f_0 \sqrt{\frac{(\varepsilon_r + 1)}{2}}} \quad \text{.........................(1)}$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}} \quad \text{......(2)}$$

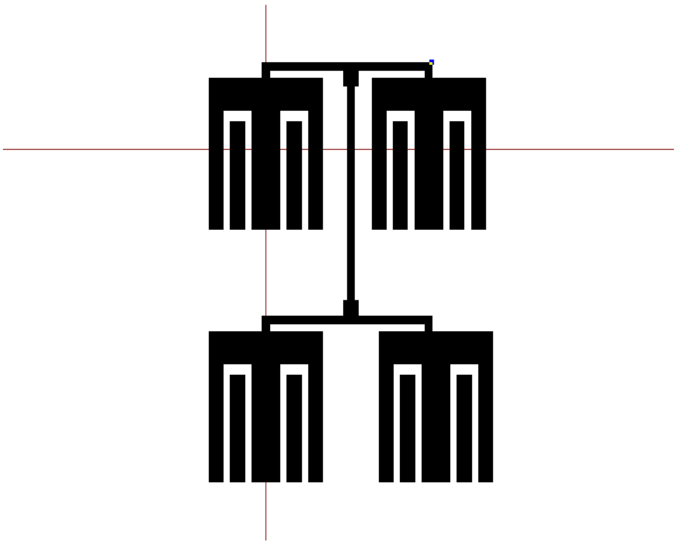
$$L_{eff} = \frac{c}{2 f_0 \sqrt{\xi_{eff}}} \quad \text{..................(3)}$$

ISSN: 2278 – 909X

$$\Delta L = 0.412h \frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \ldots.(4)$$

$$L = L_{eff} - 2\Delta L \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

2) Design the slot. The U-slot is composed of two paralleled vertical rectangular slots and a horizontal rectangular slot. There are three parametersto characterize the slots, namely slot length, slot position, and slot width. During the process of the optimization,we can exhibit a multiband anteena.
(3) Implement the optimization of the radiating element using simulation software.
(4) Initial design of the feeding network.
(5) Implement of the optimization to the whole antenna array using simulation software.



.fig.1 proposed antenna array geometry with double U_slot

III. SIMULATED RESULT

The performance of this antenna was simulated and optimized by "IE3D" 14 version of Zeland. This was used to calculate the return loss, alongwith directivity, gain and antenna efficiency etc for performance analysis of the antenna. In this regard the primary step is to measure the Return Loss parameter i.e (S11) and VSWR for proposed antenna as given below in fig. nos. 2 & 3.

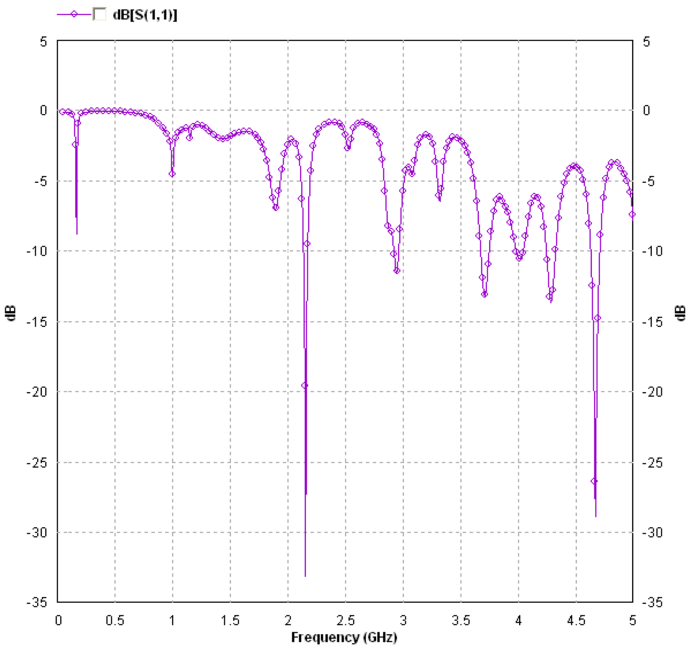


Fig.2 The simulated return loss curve for array antenna

After completion of simulation setup IE3D provides various antenna parameters through its easily accessible in user graphics format for analysis point of view. The fig 1.represents the simulated curve of Return Loss parameter (in dB). As far a freq. to be resonant freq, it must follow the rule of $S_{11} \leq$ -10 dB. On this rule our proposed double U-slot geometry antenna provides multiple frequency sample point where $S_{11} \leq$ -10 .The same is also verified by VSWR curve in VSWR $\leq$ 2).

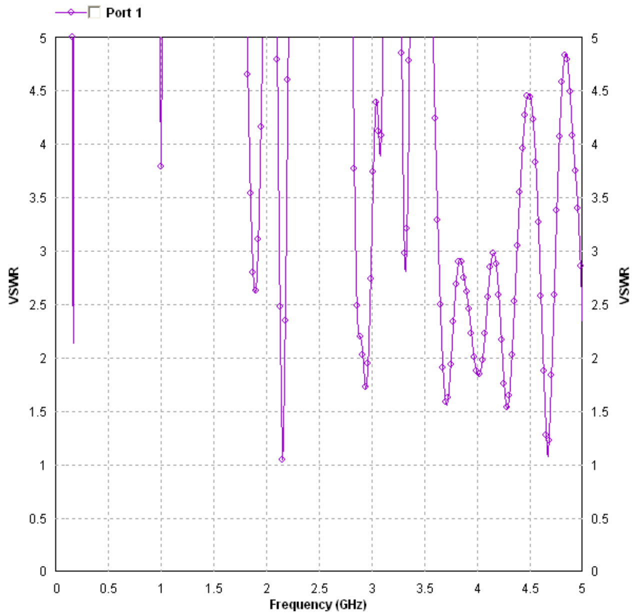


Fig.3 simulated VSWR curve for array antenna

ISSN: 2278 – 909X

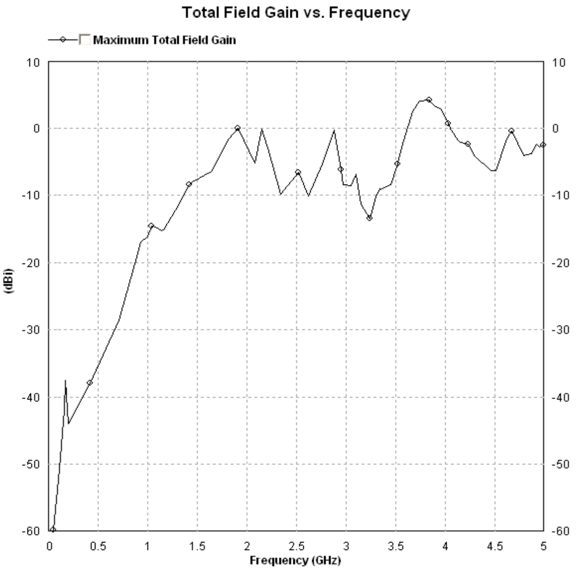


Fig4. Simulated gain curve for array antenna

Other important parameters such as Directivity, Gain and Antenna efficiency are also evaluated /simulated for antenna. From fig 5.0, the curve is drawn in between Directivity and frequency and it is meaningful that value of directivity increases from 5 dBi to 13 dBi

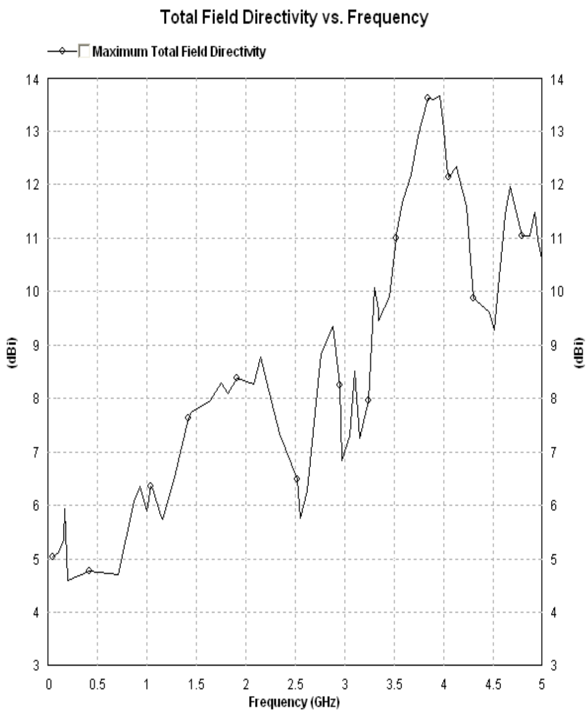


Fig.5.simulated curve for directivity for array antenna

Table 1 return loss and VSWR

No.	Resonant frequency ghz	Returnloss db	vswr
1.	2.1	-34	1
2.	2.9	-12	1.7
3.	3.7	-13	1.6
4.	4.3	-13	1.5
5	4.7	-29	1.1

IV. MEASURED RESULT

In order to validate the simulated results, a prototype of the proposed antenna was implemented and fabricated on FR4 substrate (εr= 4.4,tanσ = 0.02). The picture of a physically realized module is shown in Fig. 6. The return loss was measured using an vector network analyzer at theMicrowave.Lab,atVidutYantraLtd.,Modinagarghaziabad). Fabricated antenna on Glass Epoxy material analyzed with Network analyzer (VNA) for finding out Return Loss (S 11) parameter in dB as shown in the Fig. 6.

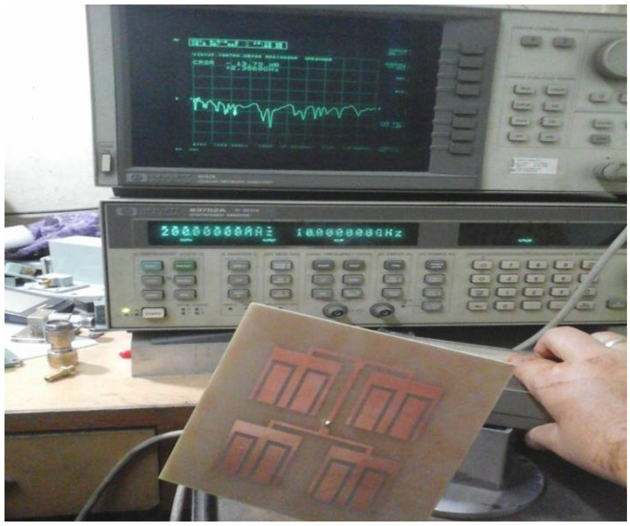


Fig.6 fabricated antenna array under testing showing the Return Loss plot

On comparing in between simulated results and measured results for return loss as depicted in fig. 11 it is quite promising that the simulated and measured results follows each other with high degree of accuracy and are nearly the same, the variation in between these two curves can also be anticipated on the basis of design accuracy. In general, good agreement is observed between the measured and simulated results.

ISSN: 2278 – 909X

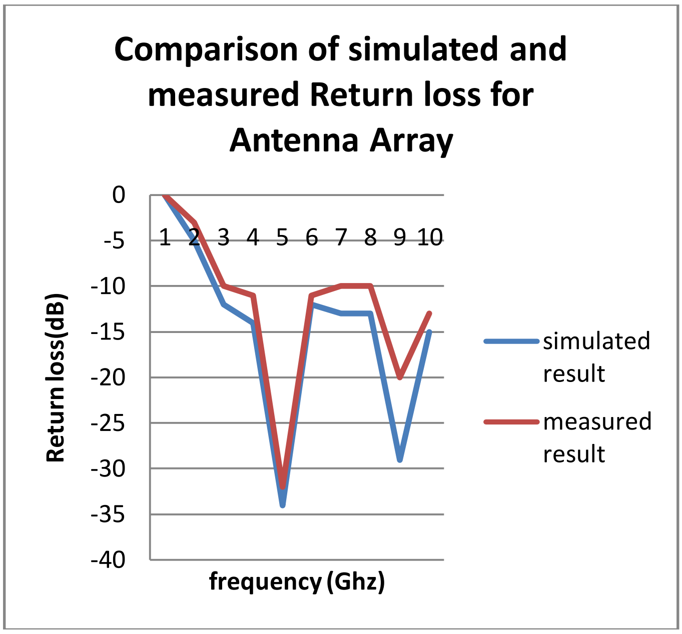


fig.7 Comparison between in b/w measured and simulated return loss curves for fabricated antenna

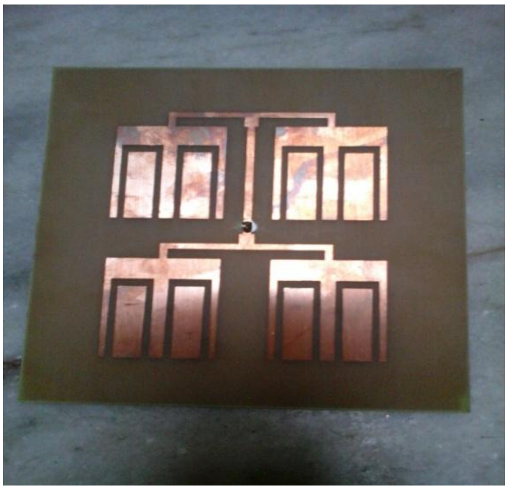


Fig. 8 shows the structure of antenna on the substrate.

V. CONCLUSION

A Microstrip antenna array with double U-slot designed and proposed. The proposed antennas have all the advantages of array implementation.The antenna and its implemented arrays have higher values of gain and directivity upto 5dB and 13.6 dBi respectively in comparison to its basic patch. Furthermore, this antenna has many advantages such as easy fabrication, low cost and compact in size.Therefore, such type of antennas can be useful for wireless/WLAN/PCS type of applications in personal communication It can also fulfills the requirements of indoor wireless system applications.

REFERENCES

[1]. Wang, H., X. B. Huang, and D. G. Fang, 2008"A single layer wideband u-slot microstrip patch antenna array," *IEEE Antennas and Wireless Propag. Letters, Vol. 7,*

[2]. Wang, H., X. B. Huang, and D. G. Fang, 2007"A microstrip antenna array formed by microstrip line fed tooth-like-slot patches," *IEEE Trans. Antennas Propag., Vol. 55, No. 4, 1210{1214,*Apr. .

[3]. Huynh, T. and K. F. Lee, "Single-layer single-patch wideband microstrip antenna," *Electron Lett., Vol. 31, No. 16, 1310{1312, 1995.*

[4]. Lau, K. L., K. M. Luk, and K. F. Lee, 2001"Wideband U-slot microstrip patch antenna array,"*Inst. Elect. Eng. Proc. Microw. Antennas Propag., Vol. 148, No. 1, .*

[5]. R.BGonad,g.mpushpajali, 2008 "Microstrip Array Antenna for Multiband operation'' *IEEE Trans. Antennas Propag.*

[6]. Md. TanvirIshtaique-ul Huque1, Md. Shihabul Islam, Mst. FatehaSamad ,2008 ''Design and Performance Analysis of the Rectangular Spiral Microstrip Antenna and Its Array Configuration''. *IEEE Trans. Antennas Propag.*

[7]. SohiniSengupta, David R. Jackson,2011"Analysis of a Linear Series-Fed Rectangular Microstrip Antenna Array''. *IEEE Trans. Antennas Propag*

[8]. Horng-Dean Chen, Chow-Yen-Desmond Sim, Jun-Yi Wu, and Tsung-Wen Chiu,

2012"Broadband High-Gain Microstrip Array Antennas forWiMAX Base Station", *IEEE Trans. Antennas Propag.*

[9]. Constantine A. Balanis, 2005 *Antenna theory: analysis and design* / third edition, New York, NJ: Wiley & Sons.

[10]. Girish Kumar,KP Ray,2003 *Broadband microstrip Antenna*,London,Artech House Publication