Design and Analysis of Multiband Microstrip Antenna Array

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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. Simple fabrication techniques can be used, since the radiating elements and the feeding network are placed on the same layer. It is demonstrated that the proposed antenna designed at 2.4 GHz frequency is suitable for WLAN application. The antenna is coaxial line feed and is simulated on IE3D Zeland software. Performance parameters evaluated are also satisfactory, such as it has directivity up to 13.6 dBi and gain of about 5 dBi.**

Keywords: Microstrip anteena array, Multiband , U -Slot, IE3D

I. INTRODUCTION

WIRELESS communications have been developed widely and evolving rapidly in the modern world especially during the last two decades. The future development of the personal communication devices will aim at providing 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 etc because of their advantageous features in terms of simple 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 .

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.

II. ANTENNA DESIGN

The geometry and detailed dimensions of a single U-slot antenna element and 2*2 array are shown in figure 1. The detailed dimensions of the radiating element and the feeding network are given as following: L = 32 mm, w = 38 mm, w_1 = 4mm, w_2 = 4 mm, w_3 = 2 mm, w_4 = 2 mm, w_5 = 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 the antenna 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:

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

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

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

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

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

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 antenna.
(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.

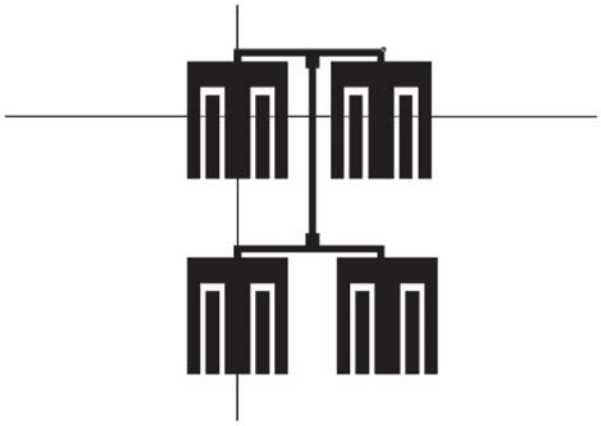

Figure1. Proposed antenna array geometry with double U_slot.

III. SIMULATION RESULTS

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 figures 2 and 3.

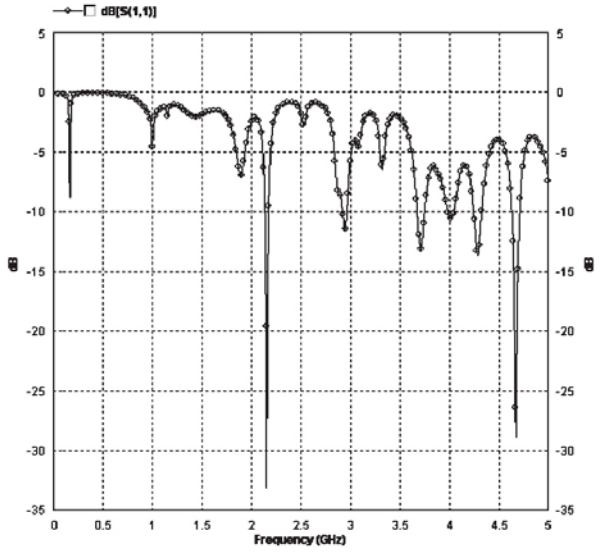

Figure 2. The simulated return loss curve for array antenna.

TABLE 1-- RETURN LOSS AND VSWR.

Number of iterations	Resonant frequency GHz	Return loss 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

After completion of simulation setup IE3D provides various antenna parameters through its easily accessible in user graphics format for analysis point of view. Figure 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 $S_{11} < -10$ dB. On this rule our proposed double U-slot geometry antenna provides multiple frequency sample point where $S_{11} < -10$. The same is also verified by VSWR curve in VSWR < 2).

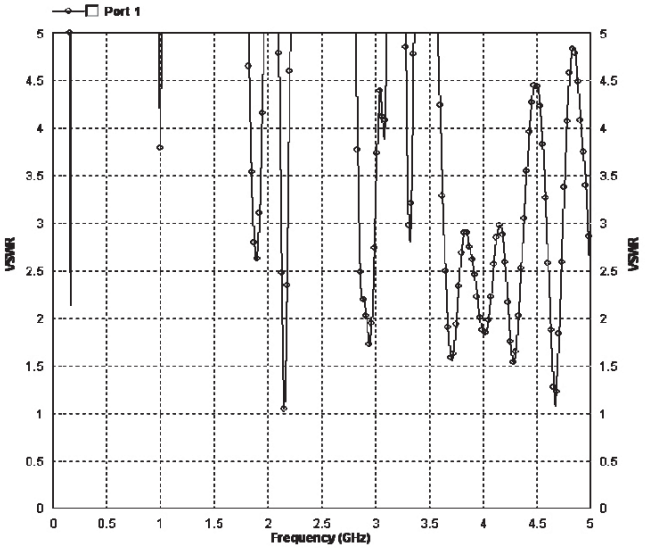

Figure 3. Simulated VSWR curve for array antenna.

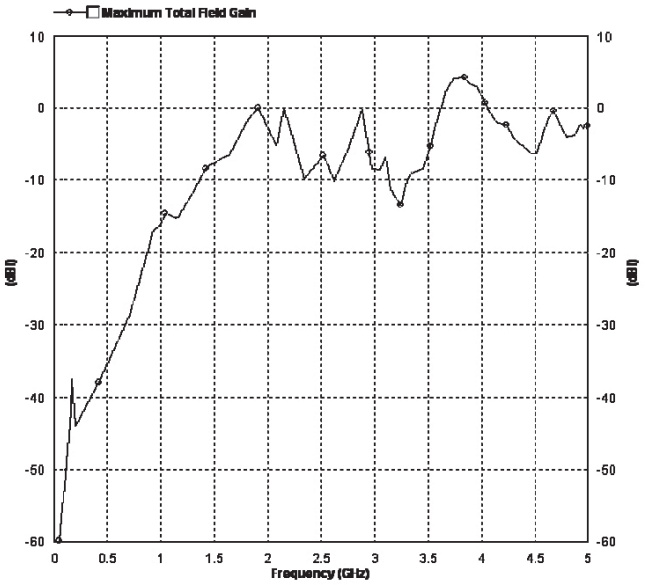

Figure 4. Simulated gain curve for array antenna.

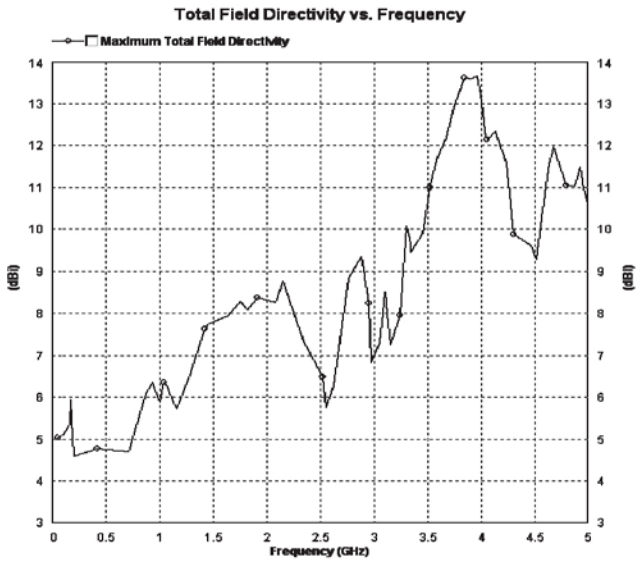

Figure 5. Simulated curve for directivity for array antenna

V. CONCLUSION

A microstrip antenna array with double U-slot is 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 compactness in size. Therefore, such type of antennas can be useful for wireless/WLAN/PCS type of applications in personal communication It can also fulfill the requirements of indoor wireless system applications.

VI. ACKNOWLEDGEMENT

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VII. REFERENCES

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