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Microstrip Patch 2x1 Array Antenna with T Slot in Radiating Patch and DGS

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***Abstract*-This paper illustrates the comparison between fabricated and simulated results of the designed T-Slot 2×1Microstrip Patch Antenna Array which operates for the Wi-max and WLAN applications. Designed array antenna is compact in size with complete dimensions of 82 X 48 X 1.5 mm^3 including the ground plane. Fr-4 substrate of 4.6 dielectric constant is used for this antenna. This antenna array have two distinct frequency bands with resonant frequencies 3.5GHz and 5.5GHz.The antenna array structure is simulated using the CST electromagnetic (EM) simulation software, the results like return loss and VSWR are compared with the results obtained after the fabrication of this antenna.**

Index Terms— *Array, microstrip feed line, resonance frequency, rod-shaped parasitic element, slit and slot.*

I. INTRODUCTION

There is a developmental slope towards wireless communication system that needs the use of antennas capable of accessing services in various frequency bands [1], sometimes with the use of a single antenna [2]. Enhancement in technology is increasing, the wireless communication systems such as WiFi (Wireless Fidelity) and WiMAX (Worldwide Interoperability Mobile Access). As WLAN and Wimax have applications in day to day life with a multiplicity of advantages, such as to grant communication services at anytime and anywhere to the users. At the present time, there is huge demand by the end user for integrated wireless digital applications. These demands are completed by microstrip antenna.

In this paper a multiband microstrip patch antenna is designed which can be obtained by various techniques like etching slots on the patch or on the ground plane, for examples H-shaped slot [4], U-shaped slot [5], C-shaped slot [6]. Some other techniques of this are parasitic strips [7] near the radiation elements or the ground plane for achieving the notched band and multi-functionality.

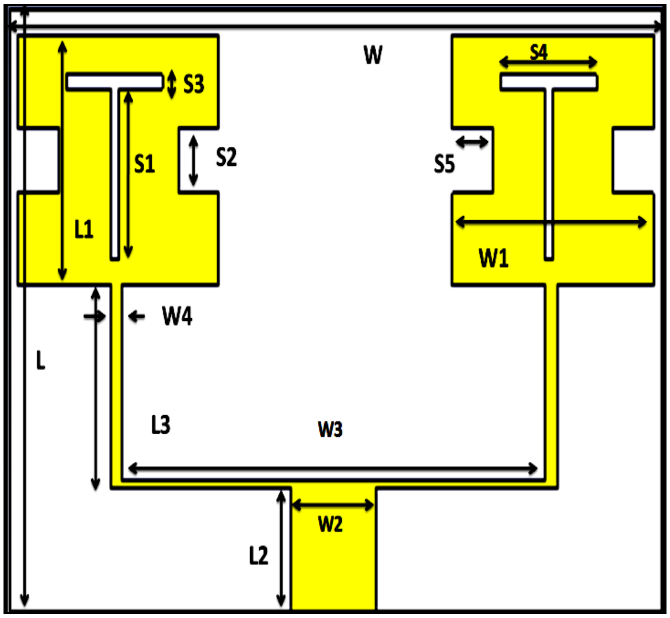
Also to enhance the performance DGS (defected ground plane) is used, that adds an extra degree of freedom in microwave circuit design and also opens the door to a wide range of applications. In DGS resonant gap or slot in the ground metal is placed directly under a transmission line and aligned for efficient coupling to the line [8]. The name for this technique itself defines the meaning that the “defect” has been placed in the ground plane, which is typically considered to be an approximation of an infinite, perfectly-conducting current sink. Single microstrip antenna has various advantages but at the same time it has disadvantages like as low gain, narrow bandwidth with low efficiency, so in order to achieve higher gain (directivity) antenna array is preferred over single microstrip antenna. In general, the more the number of individual antenna elements used, the higher the gain and the narrower the beam is achieved [10].Also antenna array can detect and process signals arriving from different directions in Comparison with single antenna.

This antenna array is designed for Wi-Max and WLAN applications. Firstly a microstrip patch antenna with dual band is designed then array of that antenna is designed for improving directivity gain beam-width and other antenna parameters. A T-slot is cut into patch for improving the return loss at particular frequencies.

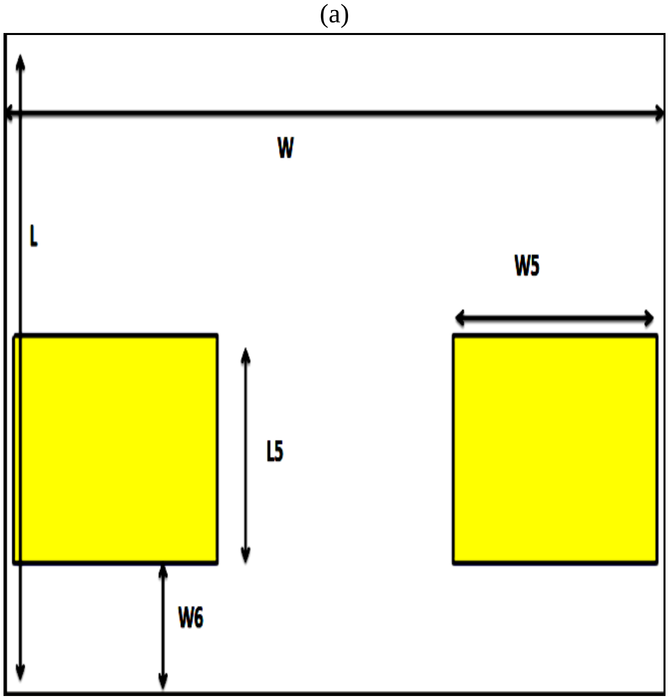
In this paper there are three sections. First section includes introduction about the need of antenna array. In second section the designed and fabricated structure of antenna array is explained. In third section the simulated and measured results of the designed and fabricated array antenna are explained, in results we are calculating return loss and VSWR of the antenna. And in final section there is conclusion of the paper.

II. ANTENNA ARRAY STRUCTURE

An antenna array of 2X1 elements is shown in Fig.1. The array is designed using two single microstrip patch antenna and then these two same antennas are connected using quarter wave transformer technique [10]. Microstrip feed line technique is used here to feed both the antennas. The impedance at main input port should be half of input at input lines connected to both antennas only then proper feeding will be provided to both antennas. Size of the designed antenna is kept small with complete dimensions of 82 X 48 X 1.5 mm^3 including the ground plane. Fr-4 substrate of 4.6 dielectric constant is used for this antenna [10].



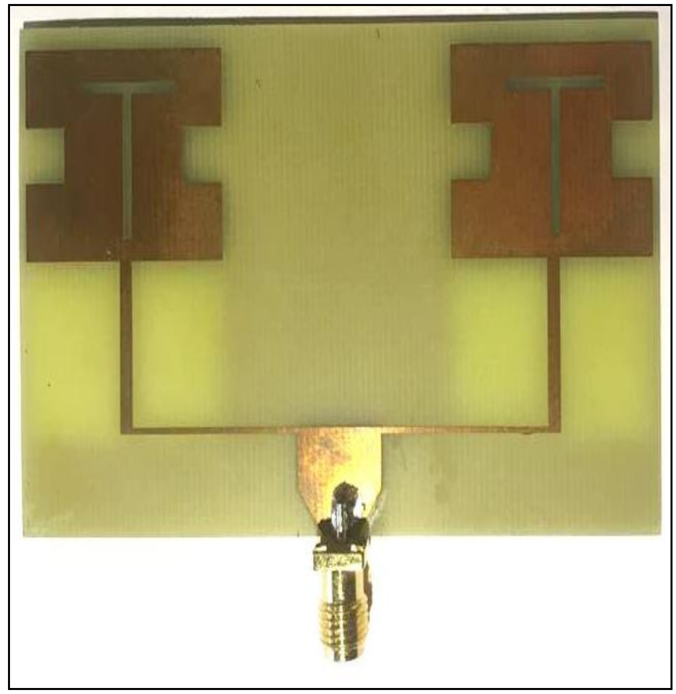
(a)



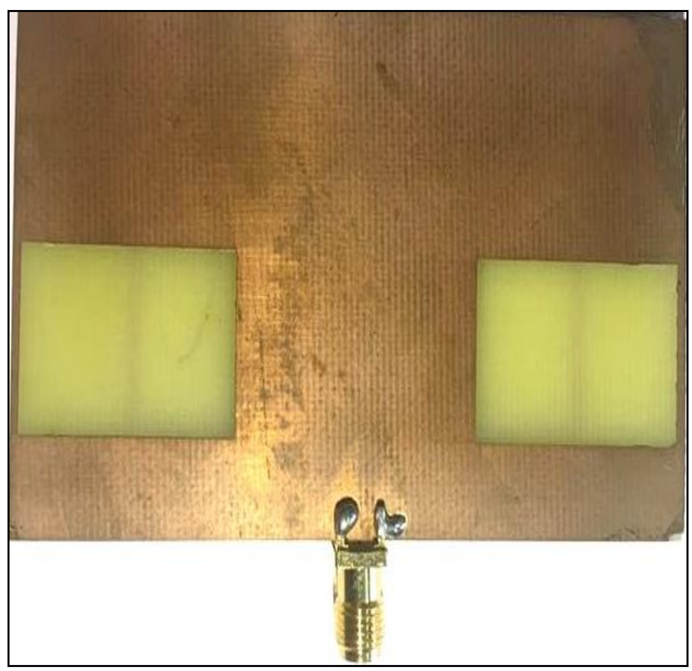
(b)

Fig. 1. Antenna Array design (a) Front view (b) Back View

Geometry shown in Fig.1 (a) is the front view of array and back view of array is shown in Fig.1 (b).



(a)



(b)

Fig.2 Fabricated antenna structure (a) Front view (b) Back View

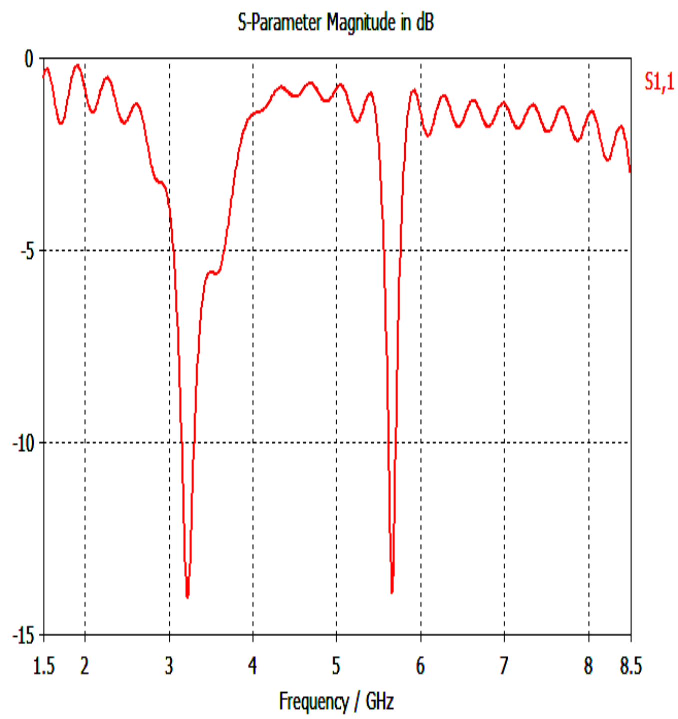
The above figure shows the front and back view of designed T-slot Microstrip antenna array. All the parameters of the antenna are described in TABLE I.

Table I . Dimensions Of Array Antenna Design

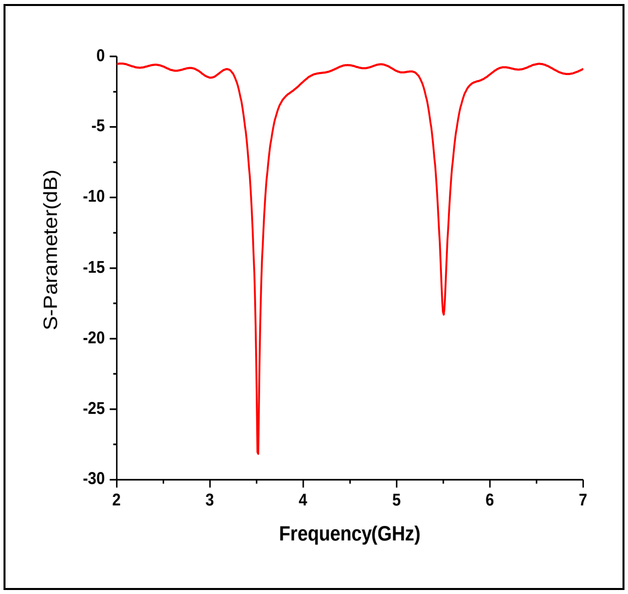
Antenna parameter	Value	Antenna parameter	Value
W	48mm	W3	52.5mm
L	82mm	L3	15
L1	19 mm	W4	1.5mm
W1	25mm	W5	25mm
L2	9.5mm	L5	15.77mm
W2	10.5mm	W6	9mm
S1	13mm	S2	5mm
S4	12mm	S3	1mm
S5	5mm		

III. SIMULATED AND FABRICATED RESULTS

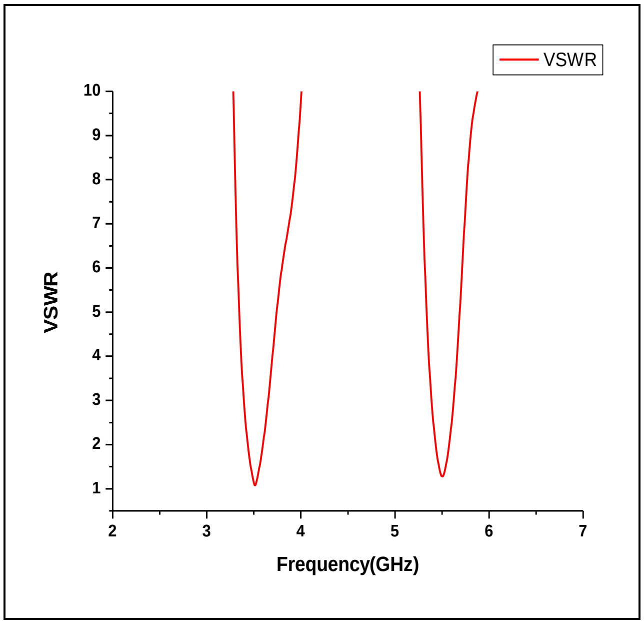
Firstly the simulated results are explained in this section and then the comparison between simulated and the measured results are made. In the results return loss, radiation pattern and VSWR are discussed. The above parameters are observed for the 3.5GHZ and 5.5GHz frequency. The proposed antenna is simulated with the help of Electromagnetic (EM) simulation software which is also used to calculated and plot the s11 parameter, mono static RCS, insertion loss, current distribution as well as the radiation pattern.



(a)



(b)



(c)

Fig. 3 Simulated results of proposed antenna structure (a) Return loss for single element (b) Return loss for array antenna (c) VSWR for array

Figure 3(a) shows the S11 parameter for the single antenna in which the return loss is less the -15db at 3.5 and 5.5GHz frequency but when the array is made using two single antennas

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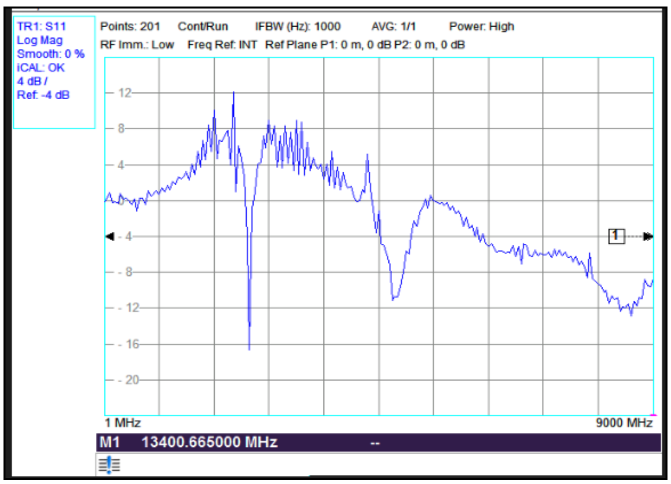
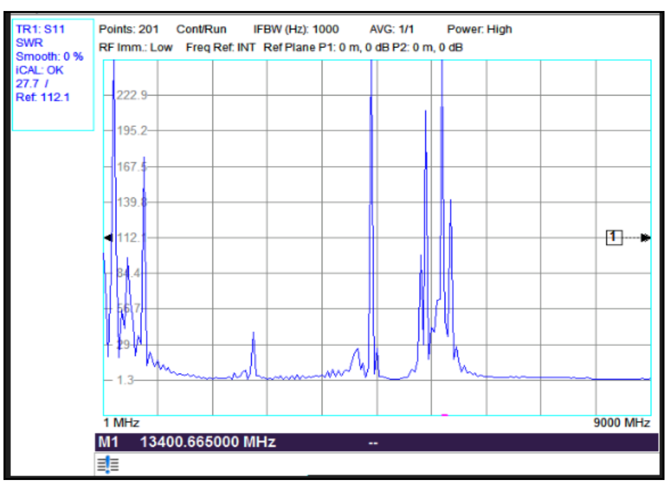
and T slot is cut in the patch then for the same frequency return loss improves that is $S_{11} \leq$ -20 dB which is shown in fig3(b). And if fabricated result is seen it is observed that for these two above mentioned frequency the result is between -10dB and-20dB which is shown in figure 4(a).Thus it is concluded that simulated and fabricated result graph for the return loss have equivalent value.

From figure 3(c) which is a simulated graph of VSWR it can be seen that for the two resonant frequencies (3.5GHz and 5.5GHz) the VSWR result is less than 2and also in fig 4(b) the VSWR value for the two frequencies is less than 2 which is the required condition. So the simulated and fabricated results are closer to each other.



(a)



(b)

Fig. 4 Fabricated results of designed antenna structure (a) Return loss for array antenna (c) VSWR for array

IV. CONCLUSION

In this paper, 2×1 array antenna is fabricated for dual-band applications. The size of the antenna is compact with dimensions of 82 X 48 X 1.5 mm^3 including the ground plane**.** The simulated and measured results are compared in this paper for two resonant frequency and both results are very good and showing close proximity as the return loss is less than -10dB, also VSWR is less than 2dB.Hence array antenna is showing the improvement in directivity, gain, return loss and other parameters for Wi-Max and WLAN. For now this antenna is designed for 2×1 elements in which return loss is improved using the T-Slot cut in patch and two operating bands are obtained using the step structure of microstrip patch antenna, but in future improvements can be made in this antenna characteristics like multi-element antenna array can be extended and even for reconfigurability condition PIN diodes can be attached and so that a single antenna can be used for multiple frequency operations. All together characteristics of antenna are good and can be used for WLAN , Wi-max application.

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