# DOUBLE L-SLOT MICROSTRIP PATCH ANTENNA ARRAY FOR WIMAX AND WLAN APPLICATIONS

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ABSTRACT

*Microstrip patch antenna has tremendous scope in WLAN and WiMAX applications due to their low profile platform design. In this paper, a double L-slot microstrip patch antenna array with the Coplanar Waveguide (CPW) fed has been presented for WLAN and WiMAX multiband operating frequencies. The results of simulation shows that employing two different slots, a good bandwidth and a perfect impedance match can be obtained. The results obtained with IE3D simulations and real time measurements are in good agreement with each other. This design results in a reduction in size and weight and allows easy integration in hand-held devices.*

***Keywords*: *Microstrip Patch Antenna, Double L-Slot, Multiband, Coplanar Waveguide Fed.***

## I. INTRODUCTION

The microstrip antenna was first proposed by G.A. Deschamps [1] in 1953, but didn't become practical until the 1970s when it was developed further by researchers such as Robert E. Munson [2] and others using low-loss soft substrate materials. Microstrip antenna's becoming more popular due to their extraordinary properties like low profile, light weight, low cost, conformance to planar and non-planar surfaces, simplicity and inexpensive manufacturability using modern printed circuit technology, mechanical robustness when mounted on rigid surfaces, compatibility with Microwave Monolithic Integrated Circuit designs, etc [3]. Also, on selecting a particular patch shape and mode microstrip patch antennas are very versatile in terms of resonant frequency, polarization, pattern and impedance [4].

A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. This concept was undeveloped until the revolution in electronic circuit miniaturization and large scale integration in 1970. After that many authors have described the radiation from the ground plane by a dielectric substrate for different configurations [5]. The microstrip antennas are the present day antenna designer's choice. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configuration. A microstrip antenna is characterized by its length, width, input impedance, and gain and radiation patterns [6].

Deshmukh and Kumar [7] proposed compact L Shape patch broadband microstrip antenna and reported experimentally increase in bandwidth up to 13.7%. Reja [8] experimentally analyzed microstrip feed line patch antenna and reported increase in the return loss of 3.6dB at 2.5GHz frequency and VSWR of 1.5 by using CAD for RT DUROID 5880. Behara and Choukiker [9] proposed design and optimization of dual band micro strip antenna and reported the return loss for dual band frequency at 2.4GHz is -43.95dB and at3.08GHz is -27.4dB.

Sun et al. [10] reported fabrication three L-slots and one rectangular slot on a compact CPW-fed slot antenna for quad band operation which covered all the operating bands of WLAN and WiMAX, but the gain is reduced due to more number of slots on the patch. Enhanced the gain has been addressed using a double U-slot microstrip patch array by [11]. Jyoti Chitra et al. [12] designed a microstrip patch antenna with double L-slot in order to increase the gain and transmit radiations over all frequency bands. Further, in other study they reported the double L-slot microstrip patch antenna array design and demonstrated that the gain has increased considerably when compared to single patch antenna [13].

The purpose of this paper is to present microstrip patch antenna array for WiMAX and WLAN applications. The antenna model consists of double L-slot microstrip patch antenna array with coplanar waveguide feed. The designed antenna is simulated using IE3D simulation package. The fabricated antenna is tested with help of Rohde and Schwarz network analyzer.

## II. ANTENNA DESIGN

The schematic configuration of the microstrip patch antenna embedded with double L-slot is shown in Fig. 1. The dimensions of the radiating structures, patch width, slot length and the feed point position are chosen according to [13]. The radiating patch is fed by a 50 π coplanar waveguide transmission line. The dimensions of two slots were selected such that it should produce wider bandwidth and perfect impedance matching.

Initially, double L-slot microstrip single patch antenna is designed and simulated. Then, in order to improve the gain, microstrip patch antenna array model is considered and thus a 2 x1 model of antenna is chosen. The antenna array is modeled as two single patches on the same substrate. Fig. 1 shows the geometry and dimensions of the double L-slot microstrip patch antenna array. In an antenna array, the gap between the antennas is selected in such a way that the mutual coupling is minimum between them. Usually the spatial relationship of the individual antennas also contributes to the directivity of the antenna array. The IE3D software is used to numerically investigate the antenna configuration. To meet the actual design requirements, i.e. operating frequency, bandwidth, radiation pattern, and some approximations are considered. The calculations are based on the transmission line model [4].

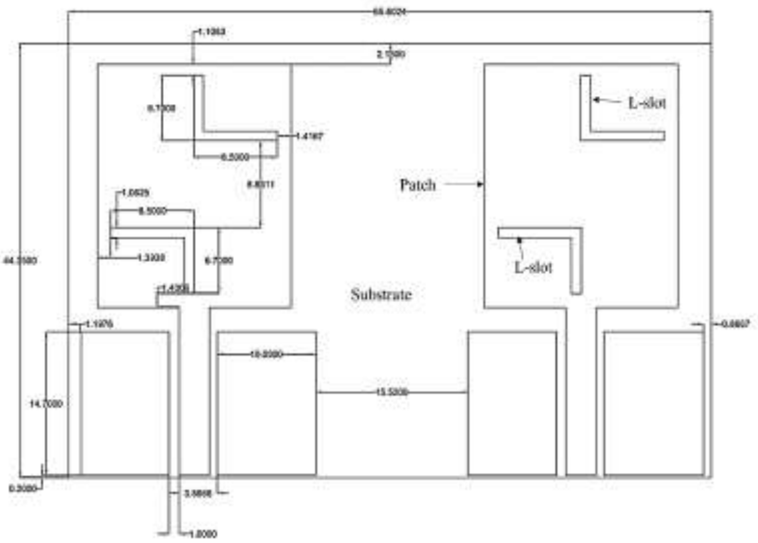


**Figure 1: Geometry and Dimensions of the Proposed Double L-Slot Microstrip Patch Antenna Array**

The objective of present work is to present double L-slot microstrip patch antenna array with coplanar waveguide feed for WiMAX and WLAN applications. The performance metrics such as radiation pattern, VSWR, return loss and gain of designed single microstrip patch antenna are simulated. A design of microstrip patch antenna array is also considered to increase the gain. The simulation performance of double patch antenna array is compared with measured one. The IE3D software package is used to simulate designed antenna.

## III. RESULTS AND DISCUSSIONS

In this section simulations results for the return loss, VSWR, radiation patternof the designed antennas are presented. The frequency range of 2–6 GHz is used for simulation as the WiMAX and WLAN frequency bands lies in this range. Fig. 2 shows the simulated return loss of double patch antenna array. It is observed that return loss for WLAN operating frequencies 2.4 GHz/5.2 GHz/5.8 GHz are -13.98 dB, -13.02 dB, -13.89 dB respectively and for WiMAX operating bands2.5 GHz/3.5 GHz/5.5 GHz are -15.05 dB, -12.00 dB, -11.25 dB respectively. The return loss below -10 dB is sufficient for radiation. Therefore, from the simulation results we may conclude that the proposed antenna exhibits wideband impedance bandwidth. Fig. 3 shows the simulated and measured return loss of the double patch antenna array. The design is simulated using IE3D package and the hardware model outputs are measured using Network Analyzer. It is observed that the measured and simulated results show good agreement with each other.

Fig.4 shows the VSWR of single patch antenna. It is observed that VSWR of double patch antenna for WLAN operating frequencies 2.4 GHz/5.2 GHz/5.8 GHz are 1.5,1.52 and 1.51 respectively and for WiMAX operating bands 2.5 GHz/3.5 GHz/5.5 GHz are 1.56, 1.76, 1.51 respectively. Fig.5 shows the comparison of simulated and measured VSWR which is in good agreement.

The radiation characteristics are studied in Figure 6. The two dimensional (2-D) patterns at various resonance frequencies with respect to total power in azimuthal plane (x–y planes) and elevation plane (y–z planes) are shown. It is observed that these radiation patterns are nearly omnidirectional for designed antenna.

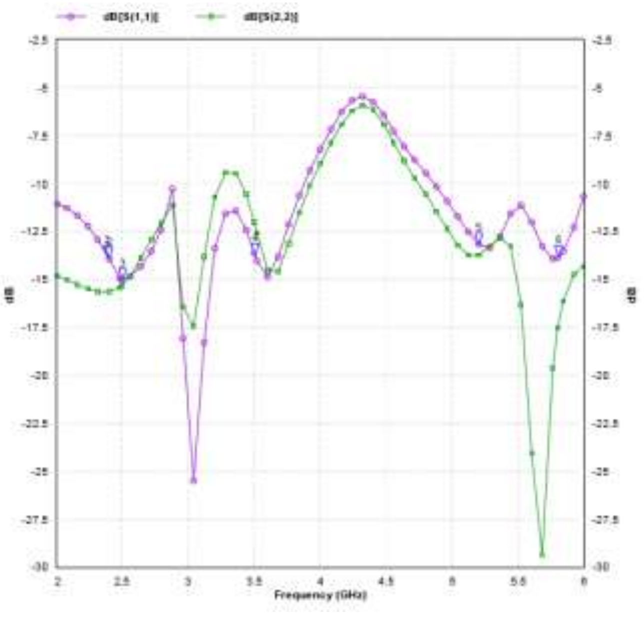


**Figure 2. Simulated Return Loss of Double Patch Antenna Array**

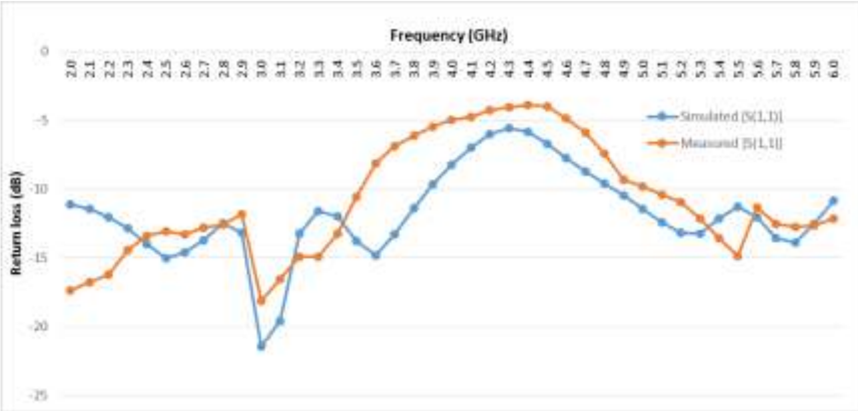


**Figure 3. Simulated And Measured Return Loss of Double Patch Antenna Array**

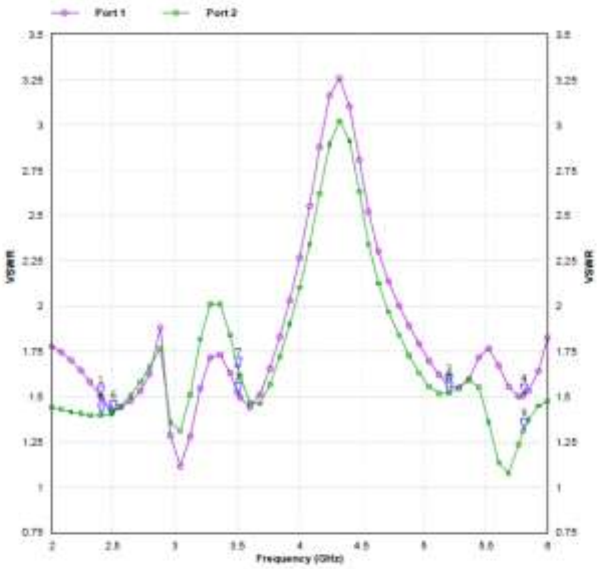


**Figure 4. Simulated VSWR of Double Patch Antenna**

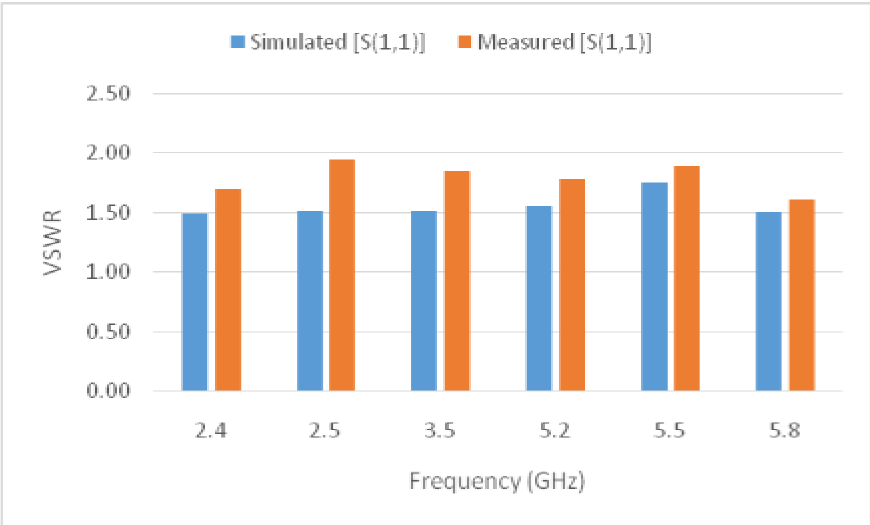


**Figure 5. Simulated And Measured VSWR Of Double Patch Antenna Array At Selected Frequencies**

Fig. 7 shows the current distribution of double L-slot patch antenna. The current distribution spreads along the lower edges of the microstrip feed line and along the edges of the patch. The current distribution is dense and well spread. Radiation efficiency depends on the current distribution.

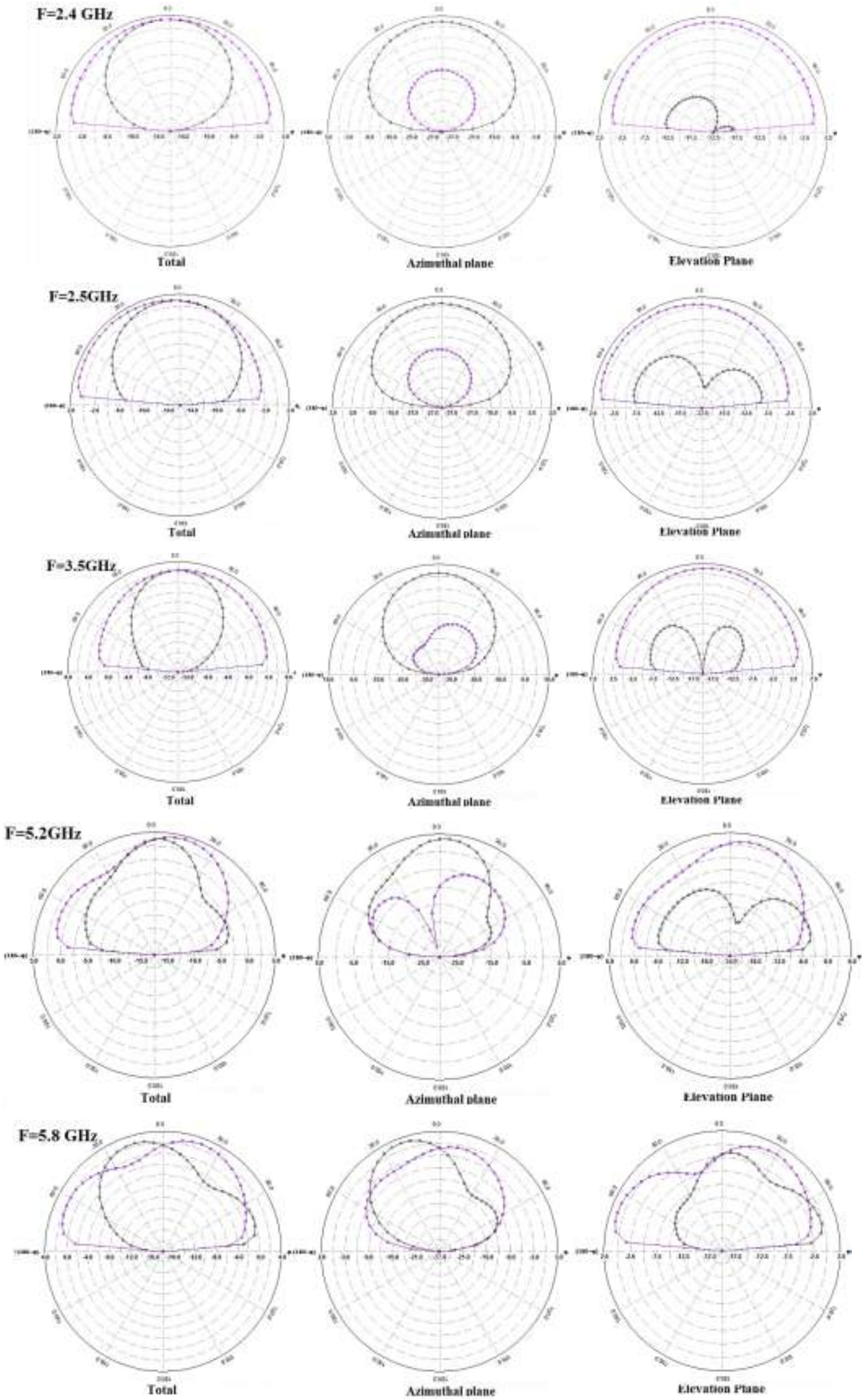


**Fig 6. 2D Radiation Pattern of Double Patch Antenna Array**

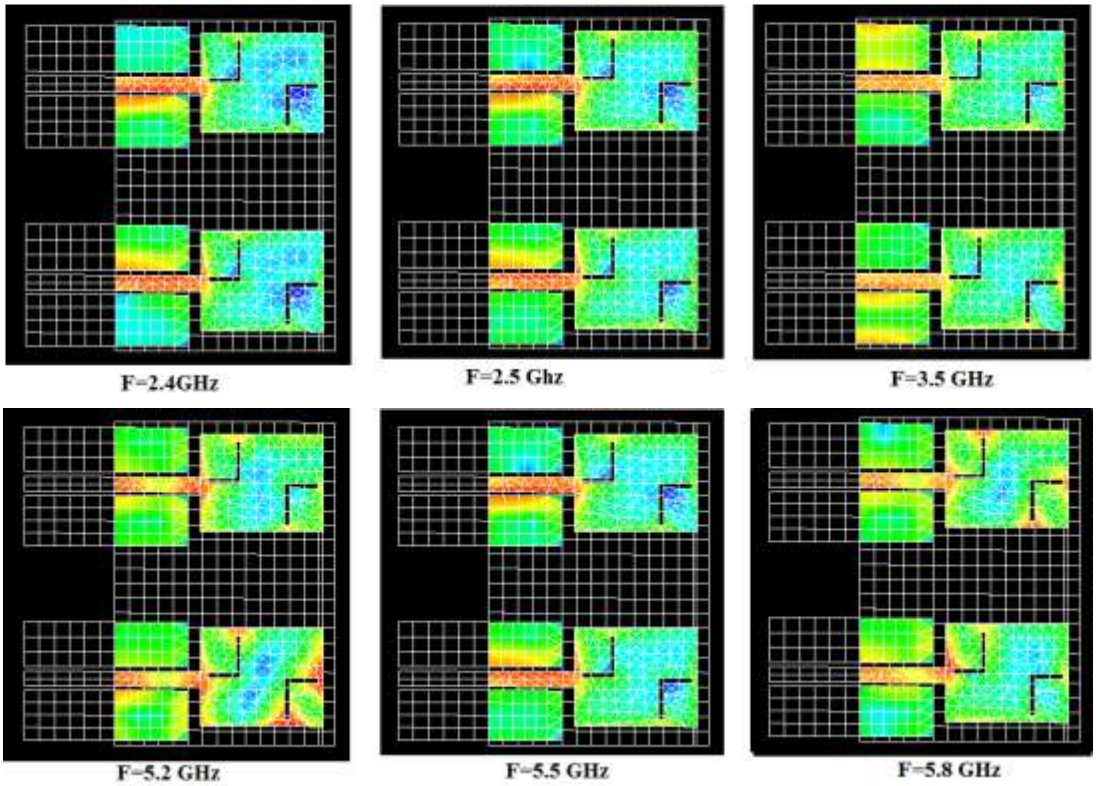


**Figure 7: Current Distribution of Double Patch Antenna**

Table 1 shows the comparison between simulated and measured return loss, and VSWR values of antenna array for all WiMAX and WLAN frequency bands. VSWR gives indication about mismatch between the antenna and feeding line impedances. VSWR = 1 indicates perfect matching. The return loss and VSWR depend on the operating frequency. The constraint of VSWR <= 2 is usually sufficient, which corresponds to about 10% of the reflected power from the antenna. For multiband applications VSWR <=3 is sufficient.

Table 1: Comparison of simulated and measured Return loss, VSWR of double patch antenna array

| **Antenna performance** | | **Double patch antenna array** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **WLAN** | | | **WiMAX** | | |
| | | **2.4 GHz** | **5.2 GHz** | **5.8GHz** | **2.5 GHz** | **3.5 GHz** | **5.5 GHz** |
| **Simulated** | **Return loss(dB)** | -13.98 | -13.02 | -13.89 | -15.05 | -12.0 | -11.25 |
| | **VSWR** | 1.50 | 1.52 | 1.51 | 1.56 | 1.76 | 1.51 |
| **Measured** | **Return loss (dB)** | -13.38 | -10.92 | -12.73 | -13.07 | -10.56 | -14.85 |
| | **VSWR** | 1.70 | 1.95 | 1.85 | 1.79 | 1.90 | 1.62 |

## IV. CONCLUSION

The design of a double L-slot microstrip patch antenna for WLAN and WiMAX operating frequencies has been presented and discussed. The design resulted in smaller size antenna with good omnidirectional radiation characteristics for all operating frequencies. The performance metrics results such as return loss, VSWR after simulations have been presented and discussed. The measured and simulated results of return loss, VSWR have been presented and discussed. Obtained results show that the antenna operates effectively in all the required WLAN and WiMAX communication bands.

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