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# Design and Performance Analysis of a Dual Band Micro-Strip Patch Antenna with CPW-FED Wireless Communication

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**Abstract**

A dual-band microstrip patch antenna using Asystematic coplanar waveguide (CPW-Fed) dual band rectangular-slotted shaped printed antenna has designed for WiMAX/WLAN applications in this paper. A prototype CPW-Fed antenna was fabricated with FR4 Substrate with dielectric constant of 4.3 and thickness h =1.6 mm. The antenna primarily consists of a Asymmetrical coplanar waveguide with two stub in the patch and excite by a 50 Ω CPW feed line for impedance matching to generate wide dual operating bands. This antenna is suitable for the range from 1.81-5.57 GHz and 6.5-8.02GHz. It is designed miniaturized CPW-Fed microstrip patch antenna has a compact size 50 mm x 50 mm. This antenna to improve the Bandwidth, have lower return losses, better impedance matching and non-uniformly gain. The main purpose of this work is to propose a dual band antenna to enhanced Bandwidth mobile, 3G/4G/ WiMAX, Wi-Fi/WLAN and military applications. The simulated and measured results show that, the proposed antenna has achieved wider bandwidth with satisfactory gain by introducing CPW-fed.

**Keywords*:*** Dual band, CPW-Fed Micro strip antenna, FR-4 substrate, CST Software, VSWR, WiMAX, WLAN applications

## INTRODUCTION:

Microstrip patch antenna (MPA) technology came into existence in 1970s. The MPA consists of two conducting layers separated by a dielectric substrate [1]-[3]. In recent years, MPA has aroused general applications, especially in low power wireless communication [4]. Moreover, the narrow band antenna can sustain reasonable gain and stable radiation pattern throughout the application band. Narrowband is the main drawbacks of a patch antenna [5].The IEEE 802.16d technology is a wideband wireless data communications technology, provided that extraordinary speed data over a wide-ranging area. It is a technology for point to multipoint, free space networking [6]. This mechanism is able to meet the requirements of a great variety of users from those in developing nations wanting to connect a novel extraordinary speed data network with very cheaply and time required to connect a wired network, to those in rural regions wanting fast access where wired explanations may not be practical, for the reason that the spaces and charges involved [7]. Recently, there is growing research activity on multi-frequency and wideband antennas for various wireless applications such as WLAN (Wireless Local Area Network) or WiMAX (Worldwide Interoperability for Microwave Access) [8]-[9]. Current wireless communication systems wideband and small shape patches are in great demand for both commercial and military applications [10].

## DESIGN OF A PROPOSED ANTENNA USING CPW-FED:

A dual-band antenna is achieved by keeping the primary resonant frequency very close to the basic designed frequency and without affecting the nature of broadside radiation characteristics. The design concepts of antennas are presented and simulation results are discussed. The proposed antenna with CPW-fed is shown in figure 1. The Essential parameters of the design are shown in table 1. First a simple rectangular microstrip antenna (RMSA) is designed using FR-4 as substrate. It has dielectric constant of 4.3 and a loss tangent of 0.02. Table 1 Below gives all the dimensions of the antennas. The width (W) and length (L) of the substrate are approximated to 50 mm and 50 mm respectively.

**Table 1**. Rectangular Microstrip Patch Antenna Specifications

| Parameters (mm) | Antenna1 | Antenna2 | Antenna3 | Antenna4 (Proposed Antenna) |
|---|---|---|---|---|
| L | 50 | 50 | 50 | 50 |
| W | 50 | 50 | 50 | 50 |
| $W_1$ | …… | 4 | 4 | 4 |
| $W_2$ | ……. | 6 | 6 | 6 |
| $W_3$ | 22.905 | 22.905 | 22.905 | 22.905 |
| $W_4$ | 26 | 26 | 26 | 26 |
| $W_5$ | 18.5 | 18.5 | 18.5 | 18.5 |
| $W_6$ | 18 | 18 | 18 | 18 |
| $L_1$ | 20 | 20 | 20 | 20 |
| $L_2$ | 13 | 13 | 13 | 13 |
| $L_3$ | 24 | 24 | 24 | 24 |
| $L_4$ | 24 | 24 | 24 | 24 |
| g | 0.4 | 0.4 | 0.4 | 0.4 |
| h | 1.6 | 1.6 | 1.6 | 1.6 |
| $W_f$ | 3.39 | 3.39 | 3.39 | 3.39 |
| S | 1 | 1 | 1 | 1 |

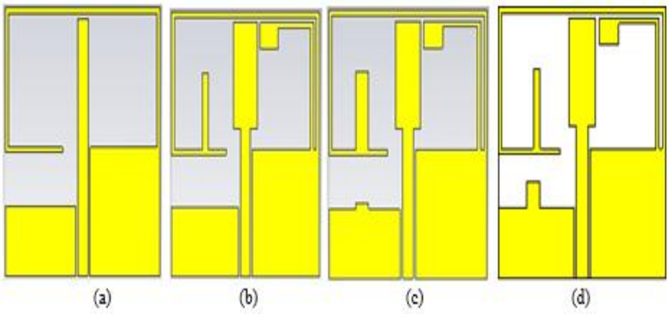



**Figure. 1.** Schematic diagram of (a) the antenna1 structure (b) the antenna2 structure, (c) the antenna3 structure and (d) the proposed antenna structure.

So now describes the proposed antenna structure dimensions

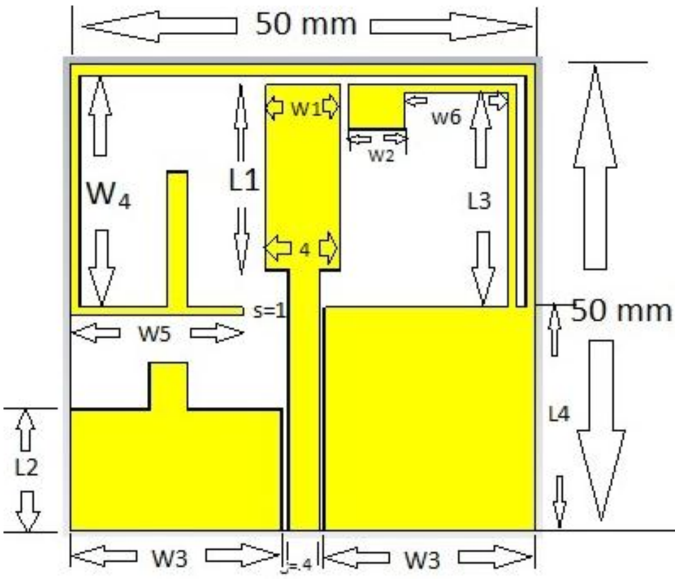



**Figure. 2.** Schematic diagram of the proposed antenna structure

## SIMULATION RESULTS AND DISCUSSION OF PROPOSED ANTENNAS USING ELECTROMAGNETIC SIMULATION SOFTWARE CST

The reflection coefficient (|S11|) curves against frequency proposed antenna is shown in Fig. 3. The gain curves and radiation efficiency curves are against frequency of proposed antenna is shown in Fig. 4 and 5, respectively and the current distribution of antenna1, 2, 3 and proposed antennas are shown in Fig. 6. The Fig. 7 (a), (b), (c) and (d) are Shows the E-field and H-field A parametric study was passed out by varying the dimensions and location of the slot in the patch and analysis listed in Table 1 & Table 2. This proposed dual-band CPW-Fed wideband antenna is designed for wireless communication and simulated on microwave studio CST simulation software.

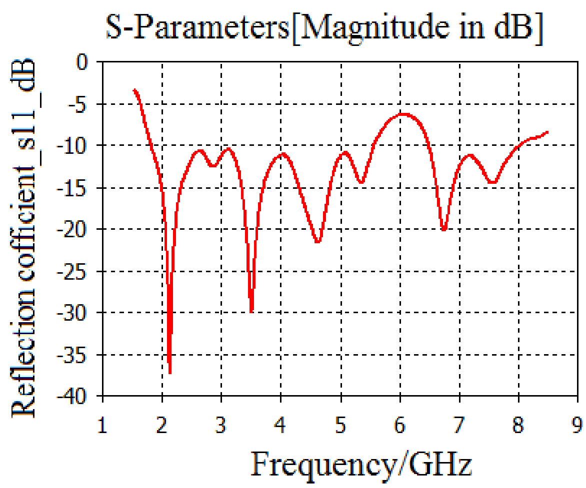



**Figure 3.** EM Simulation |S11| of proposed antenna

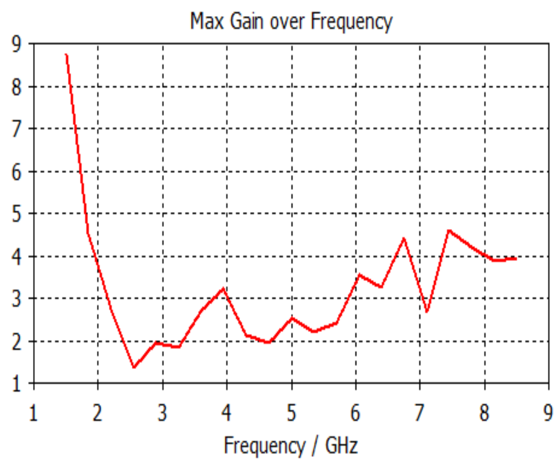



**Figure 4.** Gain of the proposed antenna

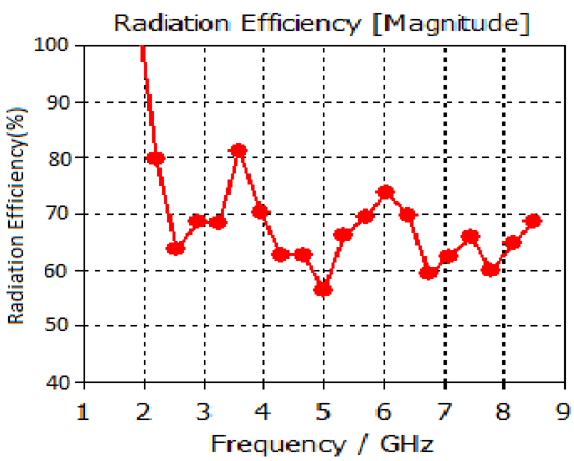



**Figure 5.** Radiation efficiency of proposed antenna

**Current distribution of the Antenna1,2,3 and proposed Antenna :-**

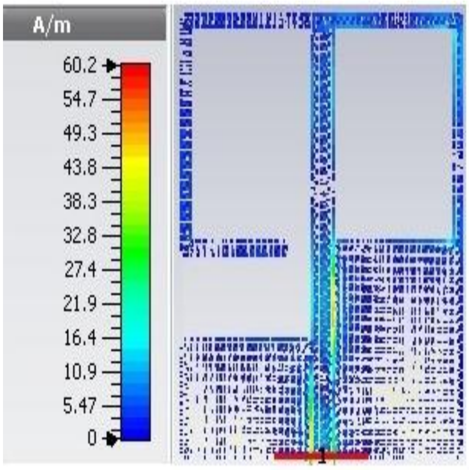
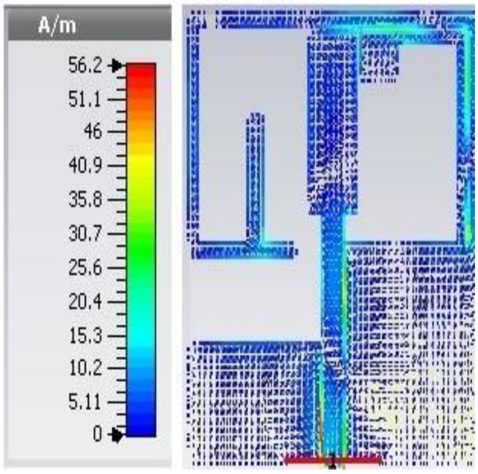



**Fig (a)**




**Fig(b )**

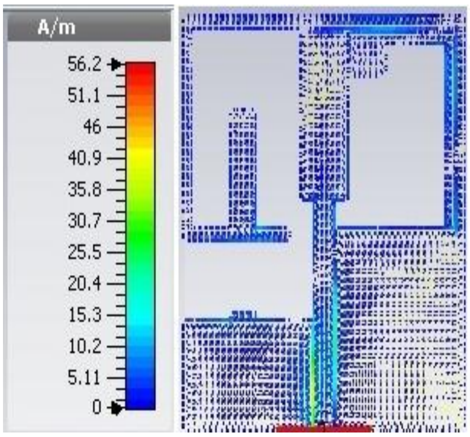



**Fig (c)**

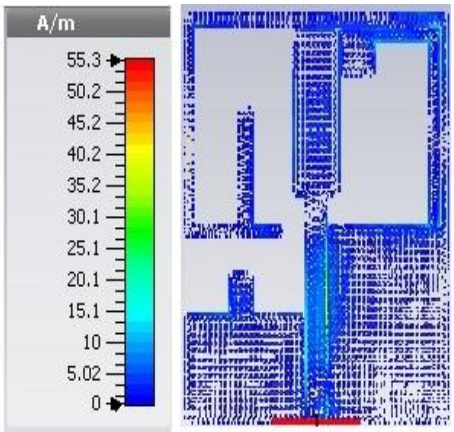



**Fig (d)**

**Figure 6.** (a), (b), (c) and (d) are Shows the current distribution

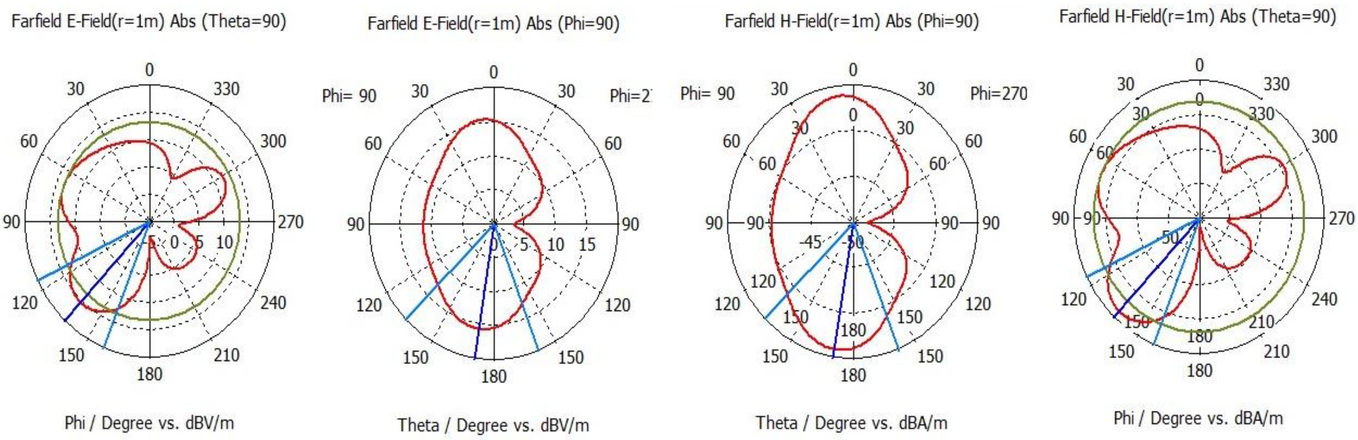



**Figure 7.** (a), (b), (c) and (d) are Shows the E-field and H-field

**Schematic Diagram and Measured Results of the Proposed Antenna:-**

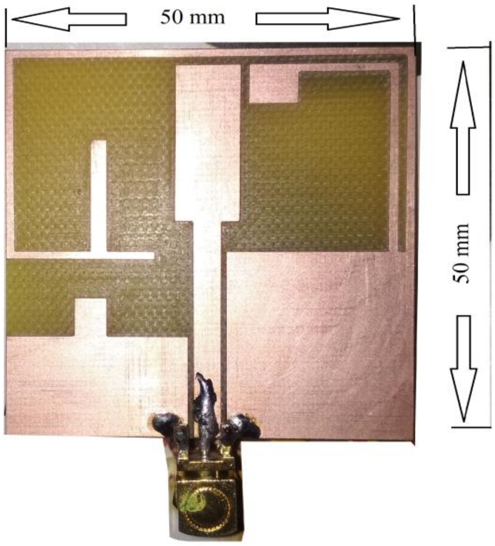



**Figure 8.** Schematic Diagram of proposed antenna

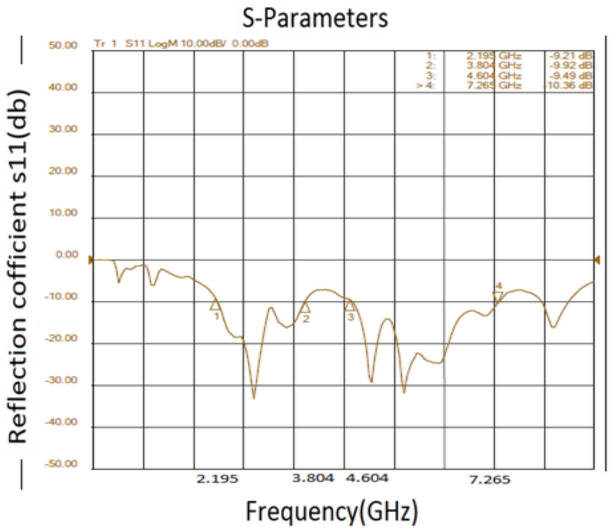



**Figure 9.** Measured results of |S11| of proposed antenna

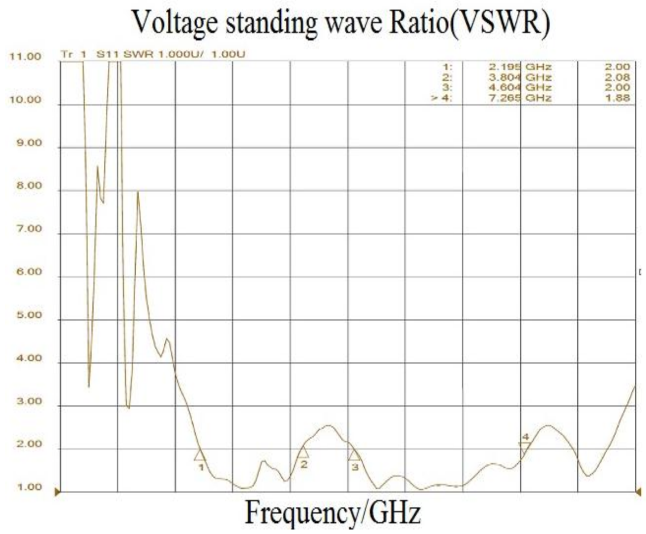



**Figure 10.** VSWR of proposed antenna

## OUTCOMES

The CST simulation software was chosen to simulate the structures shown in the Figures. The S-parameter was obtained from simulation. The simulated results of Proposed Antennas with CPW-fed are shown in the Table 2. Reduction of Return Loss, BW and improves the Gain.

**Table 2**. Comparative Simulation Results Of Antenna1, Antenna2 Antenna3 And The Proposed Antenna

| | Size (mm) | Lower Frequency range (GHz) | BW (%) & Gain (dB) | Return loss & VSWR | Upper Frequency range (GHz) | BW & Gain (dB) | Return loss & VSWR |
|---|---|---|---|---|---|---|---|
| Antenna1 | 50x50 | 1.81-5.64 (3.83) | 104 % & 3.14 | -37.14 & 1.01 at 2.14 GHz,-54.35 & 1.002 at 3.5 GHz | 6.49-8.13 (1.64) | 22 % & 3.89 | -24.53 & 1.11 at 6.77GHz, -21.43 & 1.18 at 7.54 GHz |
| Antenna2 | 50x50 | 1.80-5.65 (3.85) | 103 % & 3.13 | -37.05 & 1.01 at 2.14 GHz,-51.94 & 1.003 at 3.51 GHz | 6.47-8.11 (1.64) | 22.5 % & 3.90 | -24.19& 1.13 at 6.53GHz, 21.39& 1.19 at 7.53 GHz |
| Antenna3 | 50x50 | 1.80-5.64 (3.84) | 10 3% & 2.96 | -38.12 & 1.01 at 2.12 GHz,-34.47 & 1.03 at 3.5 GHz | 6.47-8.17 (1.67) | 22.8 % 4.07 | -24.19 & 1.13 at 6.77 GHz -20.55 & 1.20 at 7.54 GHz |
| Antenaa4 **(Proposed)** | 50 x 50 | 1.81-5.575 (3.76) | 101 % & 3.27 | -37.38 & 1.01 at 2.15 GHz, -30.211 & at 3.5 GHz | 6.49-8.02 (1.53) | 20.56% & 4.67 | -20.22 & 1.19 at 6.75 GHz |

**Table 3**. Comparison b/w different type of published antenna or proposed antenna:

| S. No. | Published literature references | Size (mm) | Operating frequency band (GHz) | S11\|<−10 dB bands | Feeding method |
|---|---|---|---|---|---|
| 1 | [4] 2004 | 75x75 | 2.410-2.785 GHz & 4.575-6.355GHz | Dual | Coaxial feed |
| 2 | [5] 2007 | 48x58 | 2.01-4.27 GHz & 5.06-6.79 GHz | Dual | Micro strip feed |
| 3 | [10] 2013 | 50x50 | 3.3-3.8 GHz in,3.2-4.2 GHz | Dual | CPW-fed |
| 4 | [11] 2013 | 60×60 | 3.22–4.5 GHz &4.76–5.98 GHz | Dual | CPW-fed |
| 5 | [12] 2013 | 50x50 | 1.90-2.75 GHz & 3.65-6.75GHz | Dual | CPW-Fed |
| 6 | [13] 2014 | 55×52 | 2.35–2.8 GHz & 3.3–7.4 GHz | Dual | CPW-fed |
| 7 | [14] 2017 | 55×66 | 1.527–1.917 GHz & 2.598–3.248 GHz | Dual | CPW-fed |
| 8 | [15] 2017 | 70×70 | 1.4–4.0 GHz | Single | CPW-fed |
| 9 | [17] 2018 | 50×58 | 2.04–2.26 GHz, 3.22–3.80 GHz 5.08–6.65 GHz & 7.10–9.94 GHZ | Quad | CPW-fed |
| 10 | **Proposed antenna** | 50x50 | 1.81-5.575 GHz & 6.49-8.02 GHz | Dual | CPW-Fed |

## CONCLUSION

This research work designing, optimization of the proposed antennas with CPW-fed done by using Simulation software CST Microwave Studio for Dual-band application like- Wi MAX/WLAN etc. The concept of CPW-fed has been developing to improve the characteristics of Antennas. Researchers are using CPW-fed for enhancement of bandwidth, enhancement of gain and calculate the return losses etc. different type of shapes are use in MPA but most commonly are rectangular and circular. The CST simulation tool is used for simulation and design, where take the substrate FR-4 ($\varepsilon r$=4.3) and taking height 1.6 mm. the overall size of antenna is 50mmx50mm. It is useful for 2.4 GHz, the WiMAX 2.5 GHz (2.5-2.69 GHZ), 3.5 GHz (3.4-3.69 GHZ) (1.81-5.57 GHz) applications, and (6.5-8.0 GHz).

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