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Design and Performance Analysis of a Triple Band Micro-Strip Patch Antenna with CPW-Fed

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Abstract

A compact microstrip patch antenna (RMPA) using systematic coplanar waveguide (CPW-Fed) triple printed antenna has designed for WiMAX/WLAN applications in this paper. A prototype CPW-Fed antenna was fabricated with FR4 Substrate with the dielectric constant of 4.4 and thickness h =1.6 mm. The antenna primarily consists of the symmetrical coplanar waveguide with rectangular slotted patch and excite by a 50 Ω CPW feed line for impedance matching to generate wide triple operating bands. This antenna is suitable for the range from 2.39 -2.75 GHz, 3.4-3.7GHz and 4.6 -6.9 GHz. It is designed miniaturized CPW-Fed microstrip patch antenna has a compact size 20 mm x 35 mm. In this paper researcher has focused on to improve the gain, impedance bandwidth and also have lower return losses, better impedance matching. The simulated results show that the proposed antenna has achieved wider bandwidth with satisfactory gain by introducing a stub with CPW-Fed in the assistant of a rectangular slot in the upper layer.

Index Terms: Triple band, CPW-Fed Microstrip antenna, FR-4 substrate, CST Software, VSWR, WiMAX, WLAN applications.

1. Introduction

Microstrip patch antenna (MPA) technology came into existence in the 1970s [1]. The IEEE 802.16d technology is a wideband wireless data communications technology, provided that extraordinary speed data

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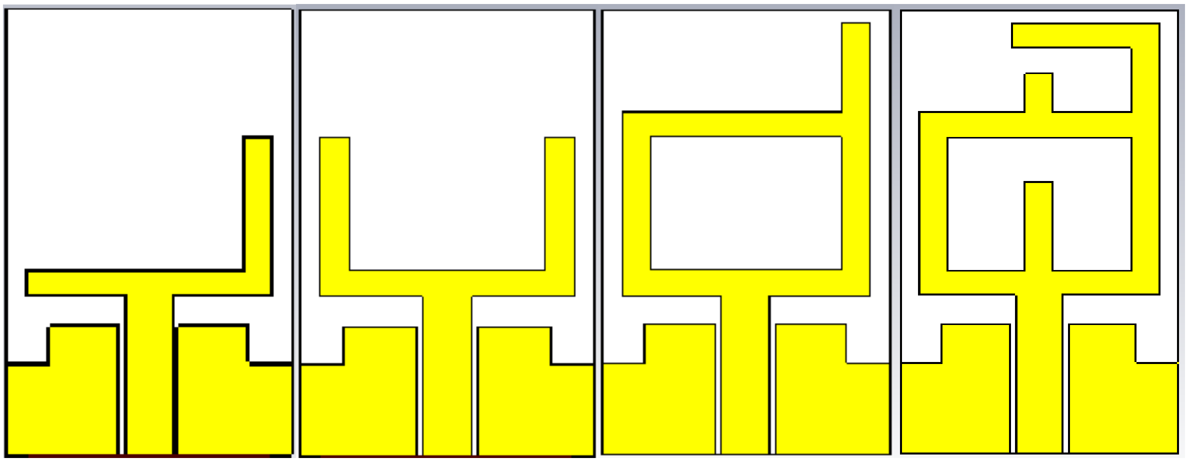
over a wide-ranging area. It is a technology for point to multipoint, free space networking [2]. Recently, there is growing research activity on multi-frequency and wideband antennas for various wireless applications such as WLAN (Wireless Local Area Network) or WiMAX (Worldwide Interoperability for Microwave Access) [3,4]. Current wireless communication systems wideband and small shape patches are in great demand for both commercial and military applications [5]. In this techniques antenna designed for L-band applications using asymmetric CPW with an inverted L-shaped strip. It has gain 8 dBi at 1.5 GHz [6]. The researcher has designed a CPW-fed antenna for WLAN. It has achieved 400 MHz bandwidth (5.02 GHz to 5.42 GHz) at 10 dB return loss. It is getting a peak gain of 8.5 dBi. It attains antenna size of 37 x 37 x 1.6 mm^3 [7]. The authors have designed a slot antenna using CPW-fed. It is performed for miniaturization and circular polarization. It shows the bandwidth of 5.2 % and peak gain is 1.8 dBi. Its antenna size is 60 x 30 x 1.6 mm^3 [8]. The authors have designed an open slot antenna using CPW-fed for wireless communication. It has Bandwidth of 5.330 GHz (2.13–7.46GHz) and covered 2-6 GHz frequency range for WiMAX and getting peak gain of 5.3 dBi and antenna dimensions are 50 x 50 mm^2 [9]. The researcher has designed octagonal slotted shaped using coplanar waveguide fed. The experimental results show impedance bandwidth is from 2.40 GHz to 2.46 GHz and 3.2 GHz to 6.2 GHz, which is covered with the WiMAX, WLAN applications. The dimensions of the antenna are 20 x 20 mm^2 [10]. The researcher has designed a microstrip patch antenna with the defected substrate using CPW-fed for C and X band applications. This covered frequency band from 4.5 to 13.5 GHz (9.0 GHz) and overall size of the antenna is 36 × 42 × 1.6 mm^3 [11]. In this paper discus about the defected substrate and its size 36 mm × 42 mm × 1.6 mm. The antenna is designed for c-band and x-band [12]. In the paper researcher has designed a 20 mm × 37 mm × 1.56 mm dual band antenna form 2.62 to 2.73 GHz (110 MHz) and from 3.02 to 7.30 GHz (4.2 GHz) [13].

2. Parametric Analysis and Simulation Results of a Symmetric Cpw-Fed Microstrip Patch Antenna

The frequency range of operation (f_o) is the selection of the resonant frequency of the antenna must be selected properly. The resonant frequency range selected for our design is 2GHz – 8GHz.The dielectric constant of the substrate of an antenna (εr) is the selection of dielectric material is very important because it does reduce the size of the antenna. It is essential that the antenna is not bulky. The overall size of the proposed antenna is 20 mm x 35 mm. The optimized parameters of the proposed CPW-fed tilted symmetrical rectangular printed antenna after numerically studied on CST Microwave Studio are listed in Table 1.

Table 1 shows the parametric parameters values

Parameters	Antenna1 (mm)	Antenna 2 (mm)	Antenna 3 (mm)	Proposed antenna (mm)
W	20	20	20	20
L1	9	9	9	9
L3	--------	-------	-------	4
W1	7.0225	7.225	7.225	7.225
Lg	11.2	11.2	11.2	11.2
d	2	2	2	2
L	35	35	35	35
L2	-------	10.5	10.5	10.5
L4	3.3	3.3	3.3	3.3
Wg	8.79	8.79	8.79	8.79
Wf	3.39	3.39	3.39	3.39
W2	-----		5.625	5.625
g	0.4	0.4	0.4	0.4
P1	3	3	3	3
S	-------------	-----------	--------	1
P2	3	3	3	3
h	1.6	1.6	1.6	1.6



(a) Antenna1 (b) A ntenna2 (c) Antenna3 (d) Proposed antenna

Fig.1. Evolution of the proposed symmetrical rectangular-shaped antenna.

The proposed antenna is shown in Fig 2. The proposed antenna is designed using CST Microwave Studio simulation software and its physical dimensions are W= 20 mm, L=35 mm, Where L2 = 10.5 mm, L1 = 9 mm, Width of the feed= 3.39 mm and d = 2 mm, Gap distance is g = .4 and Lg = 11.2 mm. in the proposed antenna researcher used the FR-4 substrate with ε_r = 4.3 with height 1.6 mm. The Proposed antenna has better impedance matching which corresponds to 50 Ω characteristic impedance.

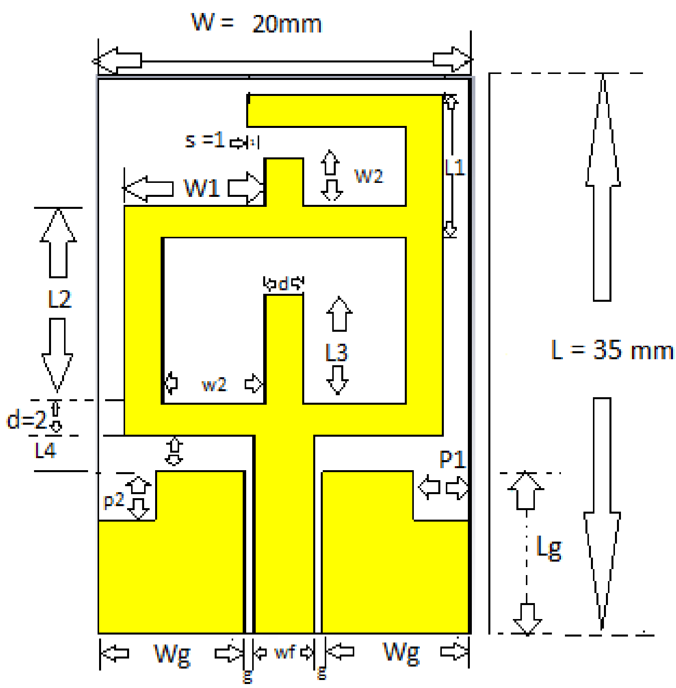


Fig.2. Schematic diagram of the proposed antenna structure

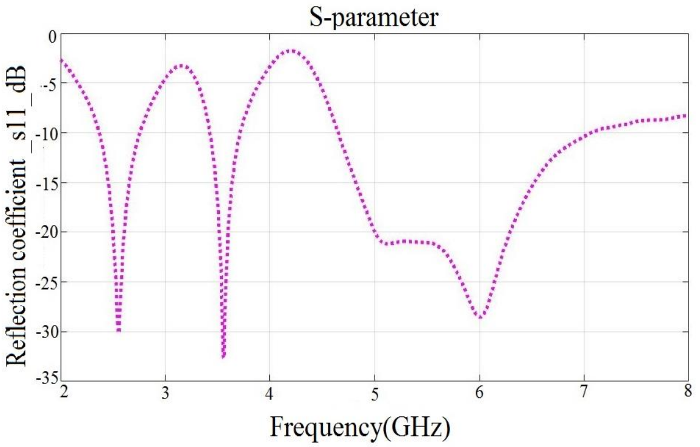


Fig.3. EM Simulation |S11| of the proposed antenna

In Fig. 3 the Return loss of proposed antenna shown, the first frequency band from 2.37 GHz to 2.75 GHz has return loss is -23.71 dB and in the second frequency band from 3.4 GHz to 3.7 GHz has return loss -36.1 dB and in last frequency band from 4.6 GHz to 7.0 GHz has return loss -36.1 dB.

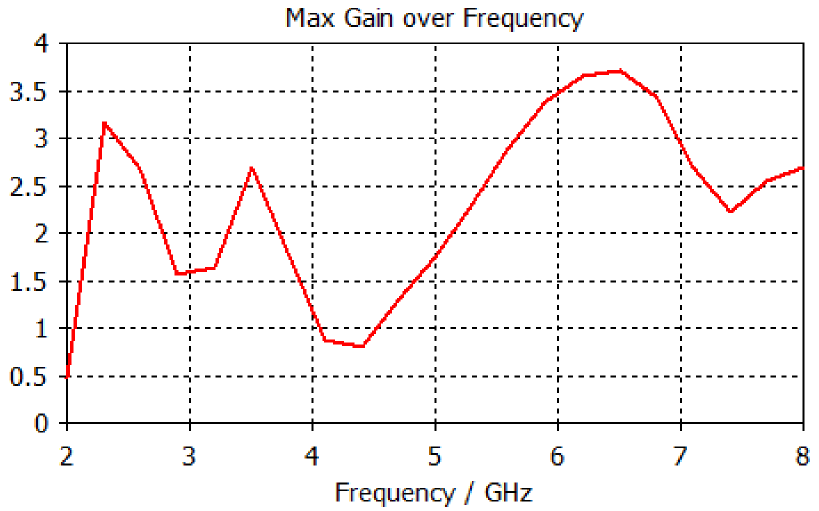


Fig.4. Gain of the proposed antenna

In Fig 4 shows the gain plot of the proposed antenna, the first frequency band from 2.37 GHz to 2.75 GHz has Gain is 3.16 dBi (Max) and in the second frequency band from 3.4 GHz to 3.7 GHz has Gain is 2.70 dBi (Max) and in last frequency band from 4.6 GHz to 7.0 GHz has Gain is 3.74 dBi (Max).

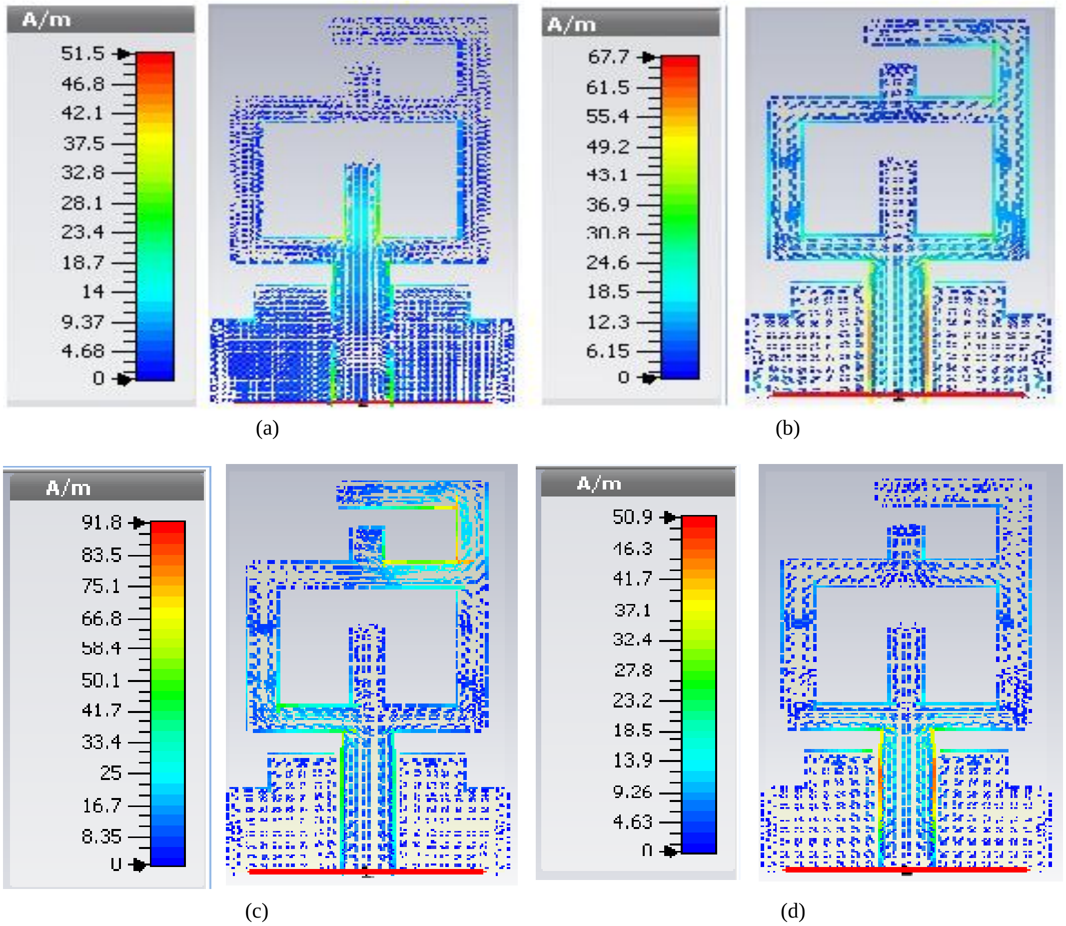


Fig.5 (a), (b), (c) and (d) are Shows the current distribution

In Fig 5(a), (b), (c) and (d), Furthermore exploration of the triple band operation mechanism, the surface current distribution of proposed antenna at frequency range 2 GHz to 8 GHz. In order to better understand the proposed antenna behaviour the current distribution of the proposed antenna at the frequency of 5 GHz, 2.4 GHz, 3.5 GHz, 5.8 GHz are simulated.

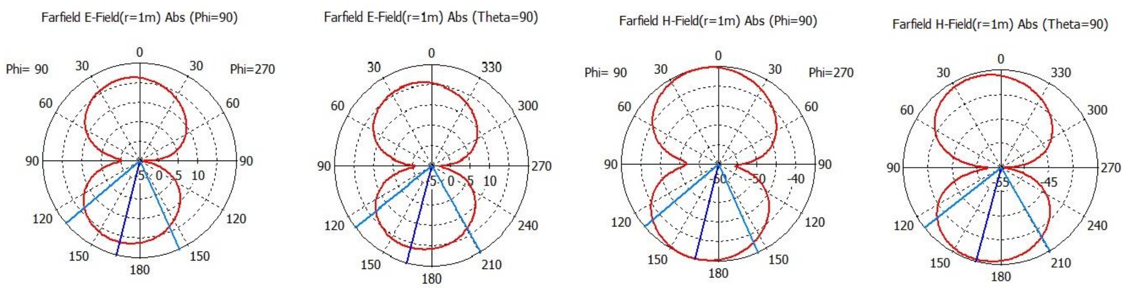


Fig.6 (a), (b), (c) and (d) are Shows the E-field and H-field

In the above fig 6, E-field and H-field plot at (Phi = 90^0) or (Theta = 90^0) Show that the antenna has a directional radiation pattern By using E- field or H-field plot we can determine the radiation pattern of the antenna.

3. Outcomes

Table 2. Ccomparative results of Antenna1, Antenna2 Antenna3 and the proposed antenna

	Frequency Range	Operating Frequency	|S11|(dB)	VSWR	BW (%)	Gain (dBi)
Antenna 1	3.03-3.7	3.5	-17.74	1.2	19.91	1.58
	4.9-7.5	5.8	-23.288	1.18	41.93	2.5 (3.27 Max)
Antenna 2	3.3-4.7	3.5	-16.37	1.35	35	2.04
	6.6-7.7	7.28	-14.63	1.41	15.38	5.4
Antenna 3	2.6-3.4	2.95	-31.381	1.05	26.67	2.10
	5.6-7.0	6.2	-17.289	1.20	22.22	3.47
Proposed Antenna	2.37-2.75	2.5	-23.719	1.0778	14.84	2.74 & 3.16 (Max)
	3.4-3.7	3.5	-36.1	1.027	8.45	2.58 & 2.70 (Max)
	4.6-7.0	5.8	-36.1	1.05	41.37	3.22 & 3.74 (max)

4. Conclusions

In the previous few decades, the quickly rising requirement of high data rate communication has ready the communication systems the fastest increasing area of communication engineering. Designing, optimization can be done by using CPW-fed for the wireless communication like- Wi-MAX WLAN etc. The concept of CPW-fed has been developing to improve the characteristics of Antenna. A triple band symmetrical CPW-fed antenna is designed to enhance the bandwidth, enhance the gain and return losses etc. This proposed antenna is useful for 2.4 GHz (2.37-2.75 GHz) applications, 3.5 GHz WLAN (3.4-3.7 GHz), 5.15 to 5.35 GHz, 5.47 to 5.725 GHz, or 5.725 to 5.875 GHz, 5.9 GHz (4.6-7.0 GHz). In future, the antenna needs to be fabricated, tested and comparison between existing research paper.

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