Microstrip Patch Antenna with inset feed and Ground CSRR for Multiband Applications

Jasleen kaur[1], Amandeep Singh[2], Ekambir Sidhu[3]

Abstract--- **In this paper, multiband rectangular Microstrip patch antenna (MPA) with CSRR etched on the ground plane has been designed with sufficient bandwidth and minimal return loss, suitable to be effectively utilized for Wi-MAX and IMT applications. The antenna has been designed and simulated using CST Microwave Studio 2013. The simulated antenna is a multiple resonant antenna having three resonant frequencies of 3.9 GHz, 3.68 GHz, and 4.68GHz with adequate bandwidth of 261MHz and minimal return loss of -19dB, -18dB and -24MHz respectively. The gain and directivity of proposed antenna is high. The VSWR is less than 2.**

Keywords- **Inset cut feed, IMT, Microstrip patch antenna (MPA), CSRR loaded ground plane, Multiband antenna, WiMax**

1. INTRODUCTION

With the fast growth of wireless communication, it has become important that the antenna which is used should be of compact in size so that it can be easily installed in portable devices. Microstrip patch antenna is one of the popular antennas that have various advantages such as small size, low profile, less weight, simple and inexpensive, easy fabrication and installation etc. which makes it suitable to be used for wireless applications [1]. It consists of a substrate which is having a ground plane on its bottom side and a conducting patch on its top. The substrate is made up of dielectric material with particular permittivity and the patch and ground should be of perfect electric conductor (PEC) material e.g. copper. The patch can be of any shape such as rectangular, circular, elliptical, ring etc [2].

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However, the main drawback of microstrip patch antenna is that it has narrow bandwidth and low radiation efficiency [3].

A microstrip patch has been used with inset feed mechanism. The basic advantage of using inset cut feed is that the antenna bandwidth and return loss has been also sufficiently improved. The antenna has been simulated using rectangular CSRR etched on ground plane. It has been observed that the antenna performance gets improved from conventional design using CSRR in terms of bandwidth.

2. GEOMETRY OF PROPOSED ANTENNA

Fig.1 represents the geometry of proposed microstrip patch antenna. As shown in the Fig.1, inset feed is used to feed the microstrip patch antenna of certain feed line width so that the antenna impedance matches with port impedance of 50 ohms. The antenna is designed on FR4 substrate having relative permittivity of 4.4 and thickness of substrate is 1.6 mm. The width of the feed line and spacing is adjusted to make sure that the impedance of antenna is 50 ohms. The dimensions of proposed antenna are listed in Table1.

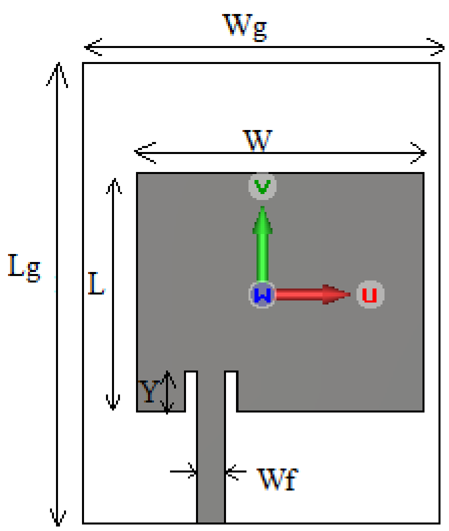

Fig.1Top view of CSRR loaded MPA.

Table1. Parameters of proposed antenna

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Antenna Parameter	Specification
Ground size, Lg × Wg	37.15×28.65mm
Substrate size, Lg × Wg	37.15×28.65mm
Patch size, L × G	19.02 ×22 mm
Feed line width,Wf	2.35 mm
Gap ,Gpf	0.9mm
Y	5mm

3. DESIGN OF COMPLEMENTARY SPLIT RING RESONATOR

Recently, a matametrial element has been used as substrate in antenna to improve antenna bandwidth. However, Complementary split ring resonator (CSRR) can be used with patch antenna for improvement in its impedance bandwidth. A sufficient increase in antenna bandwidth has been demonstrated by loaded CSRR on ground plane. CSRR interacts with electric field and provide negative permittivity around its resonance frequency. There are some parameters that affect the performance of microstrip patch antenna. The main parameters is the gap between split ring, width of ring, number of split rings, size of split rings used, and also the location of ring. In this paper, the rectangular split ring resonator has been constructed on ground plane with dimensions of width 0.5 mm, split gap 3 mm, height 5 mm and length 12 mm as shown in Fig.2.

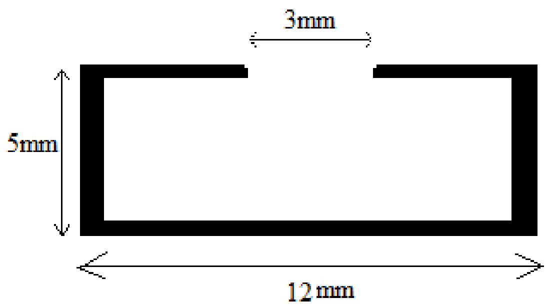

Fig. 2 CSRR design

4. INCOPERATION OF CSRR ON GROUND PLANE OF ANTENNA

In this section, the effect of CSRR on design of microstrip patch antenna has been shown. As shown in Fig 3, the CSRR has been etched on ground plane and also the position and dimensions of CSRR has been shown. This gives the multiband microstrip patch antenna and improves the antenna bandwidth, return loss and gain as compared to conventional microstrip patch antenna.

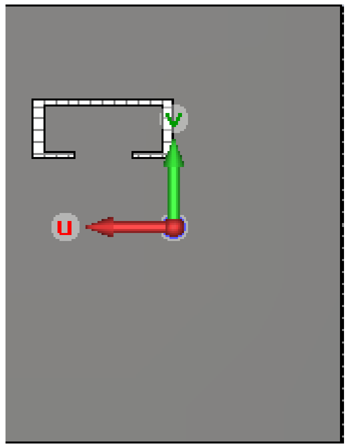

Fig.3 Bottom view of CSRR loaded MPA

5. RESULTS AND DISCUSSIONS

The proposed antenna has been simulated using CST Microwave Studio 2013 and the performance of the antenna has been analyzed in terms of bandwidth, return loss, VSWR, radiation pattern and gain.

A) RETURN LOSS AND BANDWIDTH

Fig.4 below represents the simulated return loss plot and bandwidth results of CSRR loaded patch antenna. It has been analyzed that the antenna is triple resonant antenna having three resonant frequencies of 2.9 GHz, 3.68 GHz and 4.68 GHz. The return loss of proposed antenna is -19dBi, -18dBi and -24dBi respectively. The calculated bandwidth of antenna is 261MHz.

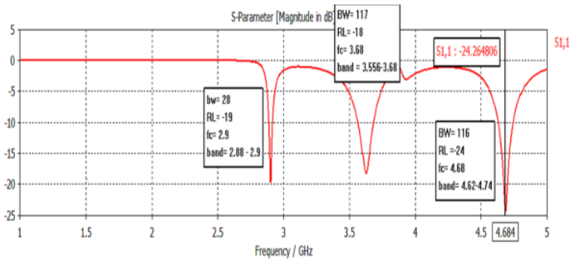

Fig. 4 Return loss and bandwidth plot of CSRR loaded on ground plane

B) DIRECTIVITY OF PROPOSED MPA

Fig 5 (a), (b) and (c) represents the 3D radiation pattern that showing directivity of CSRR loaded MPA at all three resonant frequencies. The directivity is 4.822 dBi at 2.9GHz, 5.883 dBi at 3.68GHz and 4.068dBi at 4.68 GHz.

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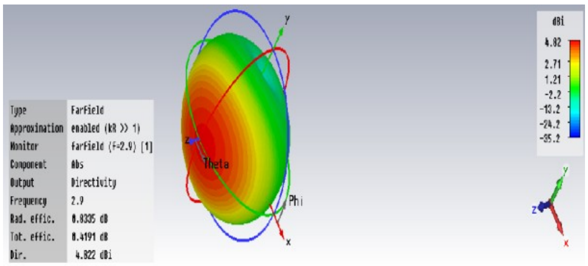

Fig. 5(a) Directivity of CSRR loaded MPA at 2.9 GHz

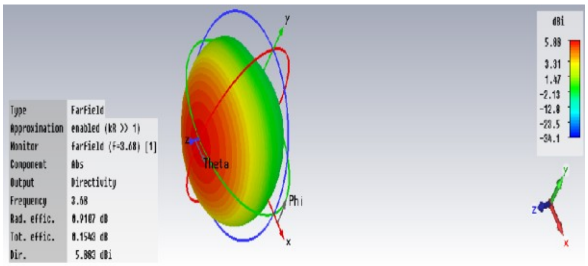

Fig. 5(b) Directivity of CSRR loaded MPA at 3.68 GHz

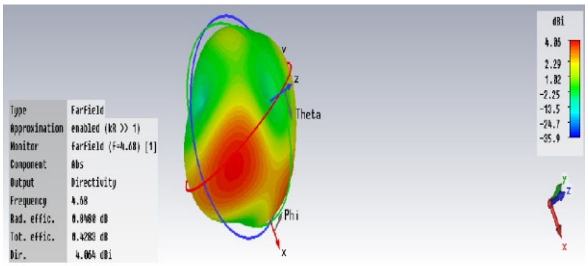

Fig. 5(c) Directivity of CSRR loaded MPA at 4.68 GHz

C) GAIN OF PROPOSED MPA

Fig 6 (a), (b) and (c) illustrates the simulated results of gain for the designed MPA loaded with CSRR. The 3D radiation pattern shows that the gain is 5.655 dB at 2.9 GHz, 6.794 dB at 3.68 GHz and 4.912 dB at 4.68 GHz, respectively.

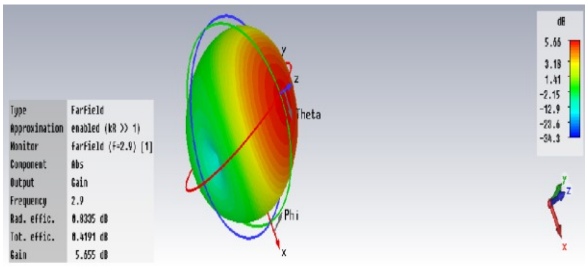

Fig. 6(a) Gain of CSRR loaded MPA at 2.9 GHz

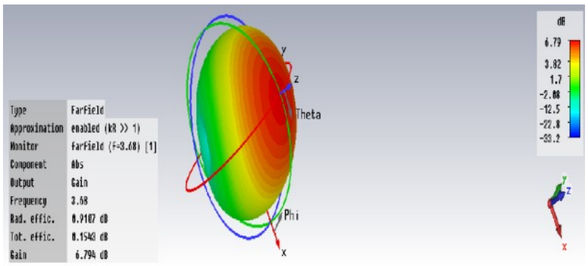

Fig. 6 (b) Gain of step slotted MPA at 3.68 GHz

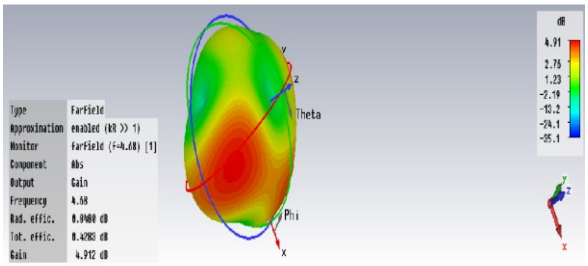

Fig. 6(c) Gain of CSRR loaded MPA at 4.68 GHz

D) VSWR OF PROPOSED MPA

Fig. 7 (a). (b) and (c) shows the simulated VSWR plot for the designed MPA. For efficient working of the antenna, the VSWR should be ≤ 2. The observed value of VSWR is less than the maximum acceptable value of 2 at all the resonant frequencies.

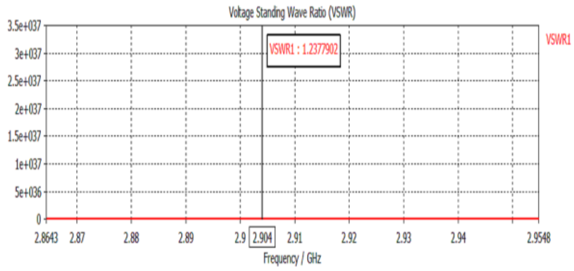

Fig. 7 (a) VSWR plot of CSRR etched MPA

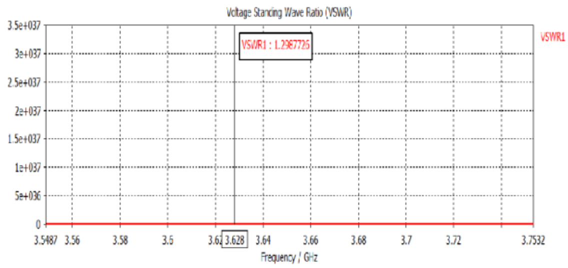

Fig. 7 (b) VSWR plot of CSRR etched MPA

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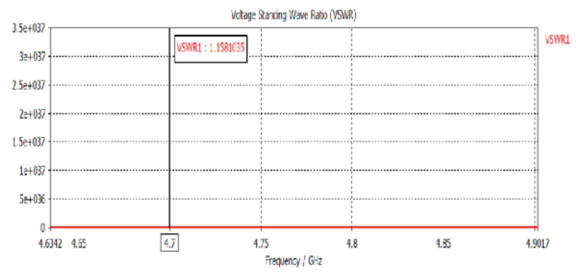

Fig. 7 (c) VSWR plot of CSRR etched MPA

5. CONCLUSION

The triple band microstrip antenna has been proposed and simulated results such as bandwidth return loss (S_{11}), VSWR, gain (dB), directivity (dBi) has been observed. By employing CSRR on conventional radiating patch, multiband response has been achieved. It has been observed that sufficient bandwidth can be achieved by etched rectangular CSRR of specific dimensions on the ground plane.

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