CSRR loaded Microstrip Antenna using Defected Ground Structure (DGS) for Wireless Applications

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

[#]*Lecturer in Department of Electronics & Communication Engineering (ECE), Thapar Polytechnic College, Patiala.*

**Assistant professor in Department of Electronics & Communication Engineering, Punjabi University, Patiala.*

[#]*Assistant professor in Department of Electronics & Communication Engineering, Punjabi University, Patiala.*

***Abstract* — In this paper, a rectangular microstrip path antenna with DGS technique has been proposed. The proposed antenna has been designed using dielectric substrate FR4 and CSRR etched on ground plane with improved 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 designed antenna resonates at 3.7 GHz. The proposed antenna has adequate bandwidth of 578 MHz and return loss of -55 dB. The gain and directivity of designed antenna is high. The VSWR is less than 2.**

***Keywords*— Microstrip patch antenna, DGS, CSRR, Inset feed cut, reduced ground.**

I. 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 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]. However, the major drawback of microstrip patch antenna is narrow bandwidth.

The Defected Ground Structure is one of the methods which is used for improving the bandwidth of antenna. The defect created in a ground plane is one of the unique techniques to reduce the antenna size. Designing an antenna with the defected ground structure tends to reduce the antenna size also in comparison to the antenna size without the defect in the ground [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. In this paper, the single ring CSRR is introduced in the ground plane and its effect on the radiation properties has been analyzed.

II. GEOMETRY OF DESIGNED 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.

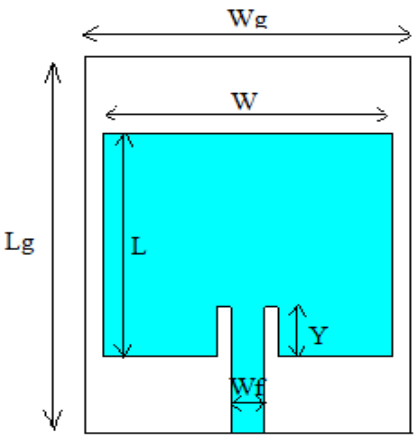

Fig.1 Top view of designed antenna

Table1. Parameters of designed antenna

ANTENNA PARAMETER	SPECIFICATION
GROUND SIZE, LG × WG	30.6 × 14 MM
SUBSTRATE SIZE, LG × WG	30.6 × 23.4MM
PATCH SIZE, L × G	18 × 25 MM
FEED LINE WIDTH,WF	2.4 MM
GAP ,G	1 MM
LENGTH OF INSET, Y	4 MM

A) Design of complementary split ring resonator

Recently, a metameral element has been used as a 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 1 mm, split gap 1 mm, height 8 mm and length 12 mm as shown in Fig.2.

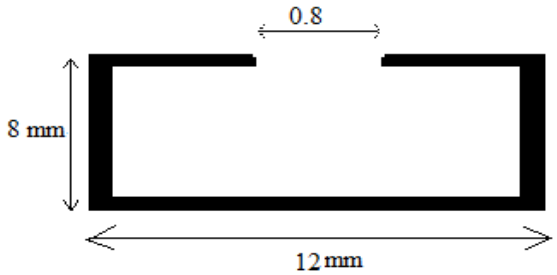

Fig2. Structure of CSRR

B) Design of microstrip patch antenna with CSRR

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 improves the antenna bandwidth, return loss, gain, and directivity as compared to conventional antenna. Also, ground has been reduced to specific value so that the bandwidth and return loss has sufficiently improved. As shown in Fig.3, the bottom view of proposed antenna has been visualized.

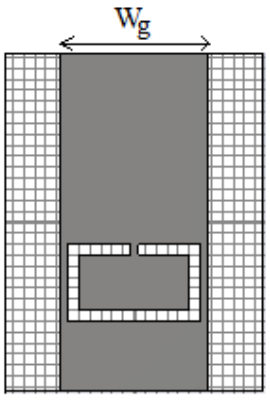

Fig. 3 Bottom view of MPA with CSRR loaded on reduced ground

. The CSRR structure of desired dimensions has been etched on the ground plane. The bandwidth has been improved by using reduced ground. The DGS is basically used in microstrip antenna design for different applications such as antenna size reduction, cross polarization reduction, in antenna arrays, harmonic suppression etc. DGS are widely used in microwave devices to make the system compact and effective.

III RESULTS AND DISCUSSIONS

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

A) Return loss and bandwidth of proposed antenna

Fig.4 below represents the simulated return loss plot and bandwidth results of CSRR loaded patch antenna. The proposed antenna resonates at frequency 3.7 GHz. It has been analysed the return loss of proposed design is -55dB and the improved bandwidth of microstrip patch antenna with reduced ground and CSRR loaded ground is 578 MHz.

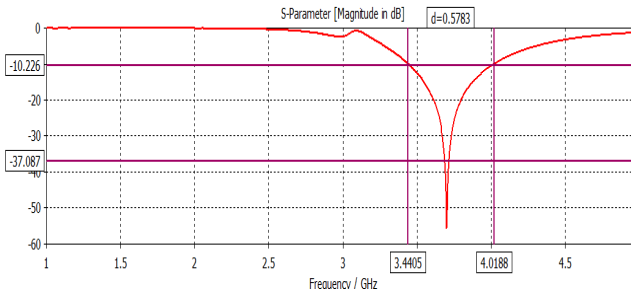

Fig.4 Bandwidth and return loss of proposed CSRR loaded MPA

B) Gain of proposed antenna

Fig.5 shows the 3D radiation pattern that showing the gain of proposed microstrip patch antenna. The analysed gain at resonant frequency of proposed antenna is 4.568 dB.

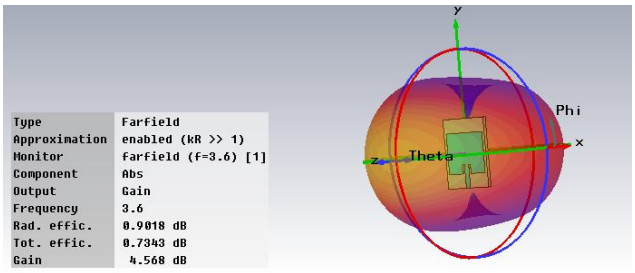

Fig.5 Gain for proposed CSRR loaded MPA antenna

C) Directivity of proposed antenna

Fig.6 shows the 3D radiation pattern that showing the directivity of proposed antenna. The observed directivity of proposed microstrip patch antenna with CSRR etched on ground plane is 3.66 dBi .

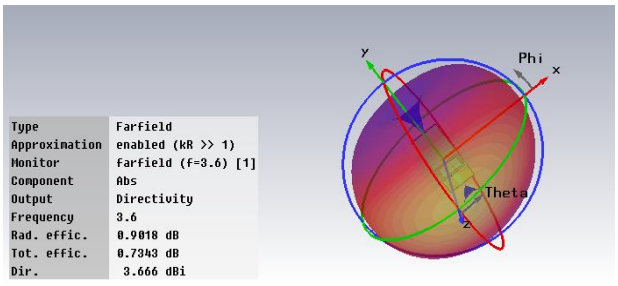

Fig.6 Directivity of proposed CSRR loaded MPA antenna

D) VSWR plot for proposed antenna

Fig.7 shows the VSWR plot for proposed CSRR loaded microstrip patch antenna with ground reduced.

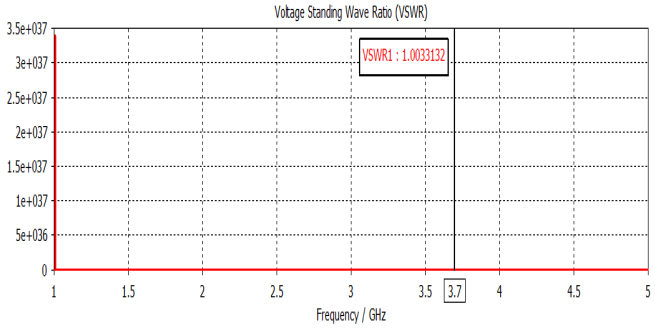

Fig.7 VSWR plot for proposed CSRR loaded MPA antenna

For efficient working of antenna, VSWR should be less than equal to 2. The observed value of VSWR is below acceptable value.

E) Surface current of proposed antenna

The Fig. 8 shows the current distribution on the patch. The arrows in the upward direction indicate the power fed to the antenna and the reverse arrows shows the reflections.

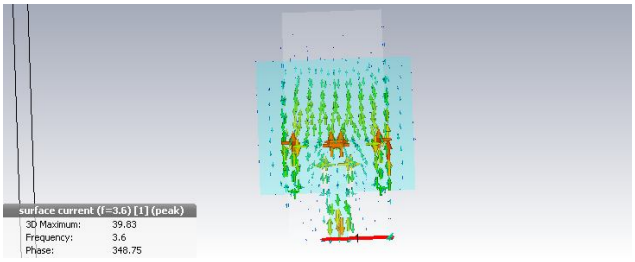

Fig 8 Surface current of proposed antenna

IIII CONCLUTION AND FUTURE WORK

The designed microstrip patch antenna loaded with CSRR on reduced ground has been simulated in CST Microwave Studio 2013. The simulated results such as bandwidth, gain, directivity, return loss, VSWR, surface current has been observed. It is observed that bandwidth and return loss has been improved by using DGS technique and by loading CSRR on ground of specific dimensions. The location and dimensions of complementary split ring resonator can be varied to enhance the bandwidth of MPA.

ACKNOWLEDGEMENT

The proposed work has been done effectively under the guidance of Er. Ekambir Sidhu, Assistant Professor in Department of Electronics and Communication Engineering, Punjabi University, Patiala.. I am thankful to Mr. Amandeep Singh for his valuable support and guidance. I am also thankful to my friend Arashdeep Kaur.

REFERENCES

[1] Sunil Kumar Rajgopal and Satish Kumar Sharma, Investigations on Ultrawideband Pentagon Shape Microstrip Slot Antenna for Wireless Communications, IEEE Transaction on Antennas and Propagation, Vol. 57,No. 5, May 2009

[2] Neha Parmar, Manish Saxena, Krishnkant Nayak, Review of Microstrip Patch Antenna for WLAN and WiMAX Application, *International Journal of Engineering Research And Applications, Vol. 4, Issue I,* January 2014, pp.168-171

[3] .Rajeshwar Lal Dua, Himanshu Singh, Neha Gambhir,2.45 GHz Microstrip Patch Antenna with Defected Ground Structure for Bluetooth,International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-1, Issue-6, January 2012.

[4] CST Microwave studio 2013, available at www.cst.com