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Analysis of Circular Patch Antenna with Complementary Split Ring Resonator on Ground Plane

S. Sandhya Rani, K. Kumar Naik

Abstract*: *A complimentary split ring resonator (CSRR) defected ground structured Circular Patch Antenna is proposed for WiMAX applications. Rectangular slits are loaded on circular patch with CSRR on ground plane for better impedance matching and enhanced gain. The proposed antenna is designed using High Frequency Structural Simulator (HFSS) and Computer Simulation Technology (CST) simulation tools. The proposed rectangular slit loaded circular patch antenna resonates at 8.5GHz and 8.54 GHz frequencies for HFSS and CST simulator with return loss of -26.39dB and -33.8 dB respectively. The maximum gain is observed as 8.29dBi and 8.17dBi for both HFSS and CST simulators.

Index Terms*: C*ircular patch antenna, CSRR, WiMAX application.

I. INTRODUCTION

The demand of microstrip patch antennas (MPA) in wireless communication systems is increasing day-by-day due to its attractive features like low cost, ease of fabrication, light in weight, etc. Extensive efforts are being carried out in microstrip patch antenna in-order to work for wireless communications.

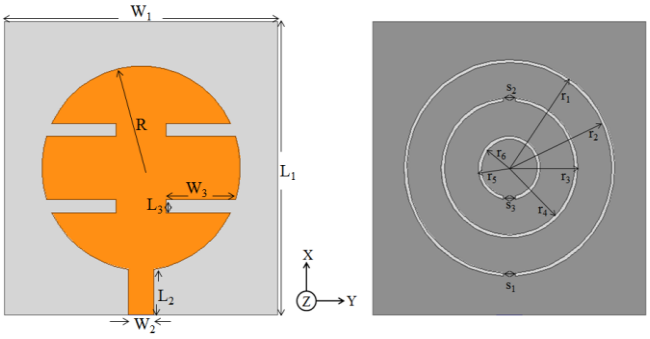
In the literature survey, A U-shaped slotted microstrip patch antenna works at four bands with appreciable gain is presented in [1]. Microstrip patch antenna with L-slots for multi band wireless communications with good return loss and impedance matching is presented in [2],[7]. Ultra wideband antennas with notched band characteristics [3], broken heart shaped antenna with good impedance matching [4] is described.

A circular reactive impedance substrate was proposed to miniaturize the patch antenna [6], a low profile compact planar microstrip line-fed triple-band MIMO antenna for WiMax / WLAN applications [7] is presented. A CPW – fed circular polarization (CP) reconfigurable slot antenna with inverted L-shaped slots that covers ISM band at 5.8 GHz wireless applications [8], a high gain circularly polarized U-slot antenna array to enhance bandwidth [9], a compact microstrip antenna with five circular slots for wide band applications [10] is presented. [11] Presents the design, simulation and fabrication of MPA with multiple broadband techniques and improvement in impedance bandwidth. The effect of reactive loading on a U-slot loaded MPA is studied using theory of characteristic modes for wide band applications [12].

In this paper, a simple structure of circular patch antenna (CPA) with four slits and CSRR on the ground plane has proposed. The antenna operates at 8.5GHz frequency with HFSS and 8.54GHz with CST. The maximum gain of 8.29dBi is observed for the proposed antenna. The antenna operates for WiMAX application.

II. DESIGN AND ANALYSIS OF CPA

The geometry of the proposed slits on CPA with defected ground structure is presents in Fig. 1



(a) (b)

Fig. 1 Geometry (a) slits on CPA, (b) CSRR on ground plane

The slits on circular patch is loaded on rogers RT/duroid 5880 substrate material with dielectric constant 2.2. The length and width of the substrate material are L_1 and W_1 with a height of 1.12mm. The circular patch is metalized with a radius of R. A feed line with length L_2 and width W_2 is added to the circular patch with an input impedance of 50Ω. Four slits are loaded on the circular patch each are having a dimensions of L_3 and W_3.The ground plane is constructed with three circular shaped CSRR are loaded with a slot width of 0.5mm. The inner and outer dimensions of the first ring (outer ring on ground plane) are r_1 and r_2. Similarly, the outer and inner radius of the second and third ring is r_3, r_4, r_5, and r_6 respectively. The optimized parameters of proposed CPA antenna are tabulated in table 1.

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Table-I
Proposed CPA antenna optimized parameters

Parameter	Value (mm)
L_1	46
W_1	44
L_2	7
W_2	4
R	16
r_1	17
r_2	16.5
r_3	11
r_4	10.5
r_5	5
r_6	4.5
s_1	2
s_2	2
s_3	2

III. RESULTS AND DISCUSSIONS

The analysis of the proposed CPA with four slits and DGS on ground plane is carried out with HFSS and CST simulator. The return loss of the slotted CPA is presents in Fig. 2.

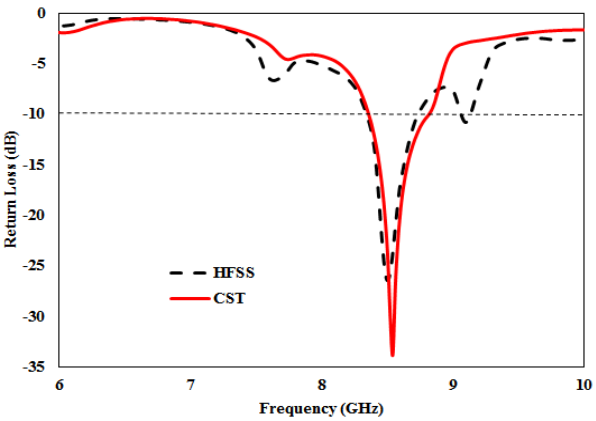
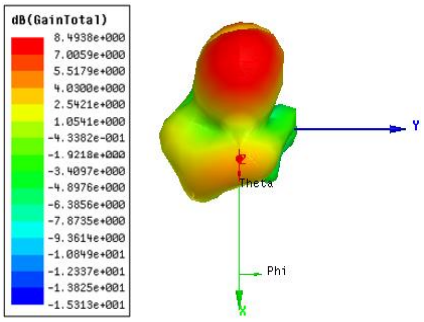
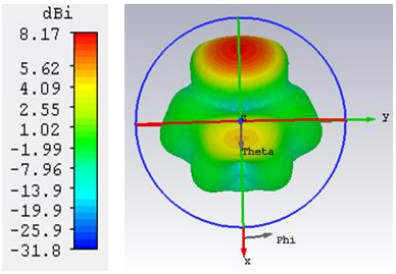


Fig. 2 Return loss of the slits on CPA

The proposed antenna operates at 8.5GHz frequency with HFSS and a return loss of -26.39dB is observed from the plot. Similarly, antenna operates at 8.54GHz frequency with a return loss of -33.8dB using CST.



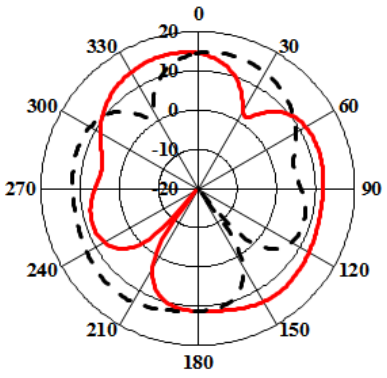
(a)



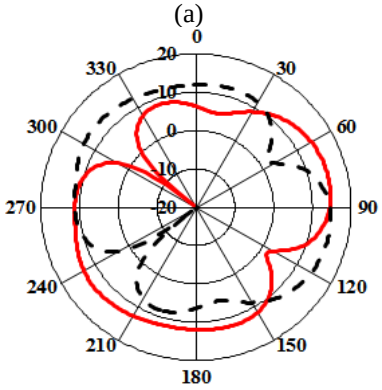
(b)

Fig. 3 Gain of the slits on CPA at θ= 90⁰

The gain of the slotted CPA with respect to HFSS and CST is shown in Fig. 3. The maximum gain of 8.49dB in HFSS and 8.17dB are observed at θ= 90⁰ from the plots. The radiation patterns of the antenna with respect to left hand circular polarization (LHCP) and right hand circular polarization (RHCP) is shown in Fig. 4 and Fig. 5 respectively. From the Fig. 4, the radiation patterns are observed at ϕ = 0⁰ with XZ-plane, XY-plane, and YZ-plane. Similarly, Fig. 5 represents the radiation pattern by considering ϕ = 90⁰. The radiation pattern is observed a phase shift of 180⁰ between the LHCP and RHCP. Fig. 6 shows the current distribution plot of the proposed antenna at 8.54GHz frequency with circular distribution both on radiating patch and ground plane.



(a)



(b)

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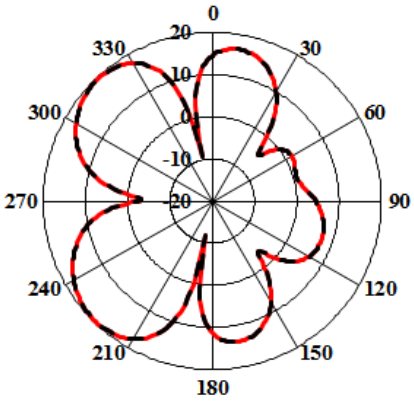
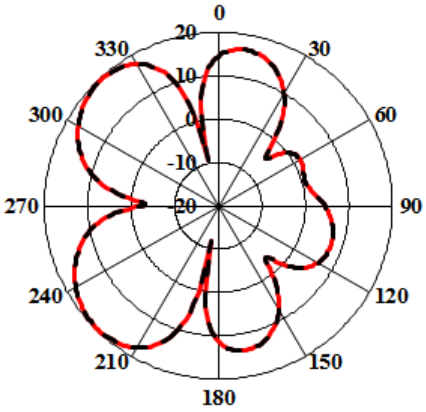
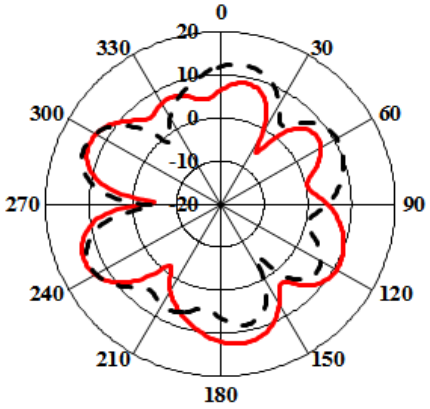


(c)

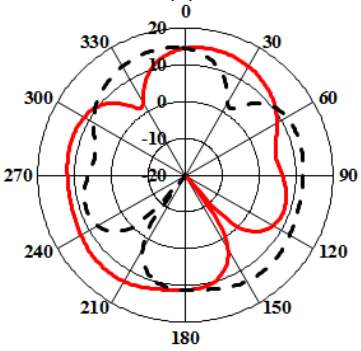
Fig. 4 Directional pattern of slits on CPA at 8.54GHz, with
ϕ = 0^0 (a)XZ-plane (b) XY-plane, (c)YZ-plane



(a)

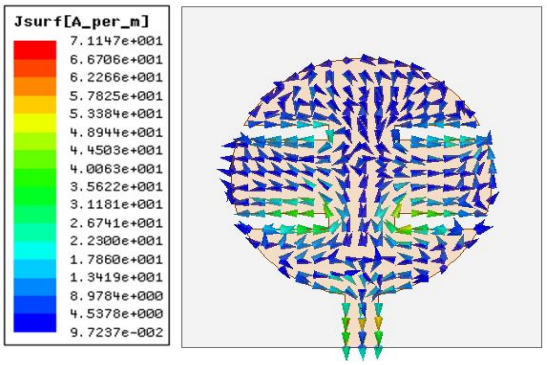


(b)

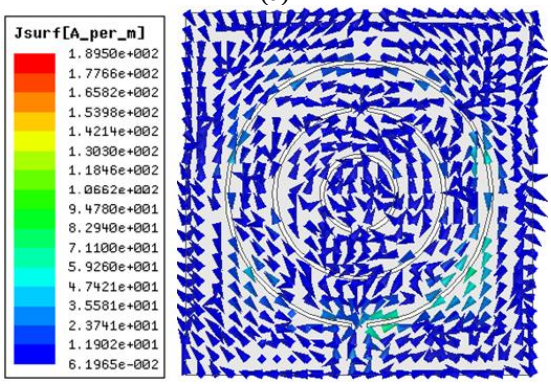


(c)

Fig. 5 Directional pattern of slits on CPA at 8.54GHz, with
ϕ = 900 (a)XZ-plane (b) XY-plane, (c)YZ-plane



(a)



(b)

Fig. 6 Surface current distribution of the CPA antenna at 8.54GHz frequency (a) radiating patch, and (b) ground plane

IV. CONCLUSION

A slotted CPA with DGS on the ground plane is work at WiMAX application. The simulations is carried out in both HFSS and CST simulators. The slits on the radiating patch improves the impedance matching and operates the antenna with minimum losses. The CSRR on the ground plane enhances the gain of the proposed antenna. Hence, the proposed CPA antenna operates at 8.54GHz frequency for WiMAX application with return loss -33.8dB and a maximum gain of 8.49dB.The HFSS and CST simulations tool results are shown small deviation in return loss and gain plots of the proposed antenna.

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