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CPW Microstrip Patch Antenna with Circular Slot for Wireless Applications

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ABSTRACT: This paper describes the design and resonant analysis of circular slotted micro strip rectangular patch antenna. The proposed antenna consisting of circular slotted patch mounts on the rectangular patch. The antenna performance is analysed using HFSS13 tool with respect to the reflection coefficient, bandwidth, radiation pattern, VSWR and gain. The proposed antenna exhibit good radiation and reflection coefficient and has advantage of low cost and small size for S-band, C-band and X band wireless applications.

KEYWORDS: Slotted antenna, High Frequency Structure Simulator (HFSS), Gain, bandwidth, return loss.

I. INTRODUCTION

A microstrip patch antenna[1] used in several applications, like satellite and airborne communication, wireless communication system and electronic counter measure (ECM) systems, because of its smaller size, low manufacturing cost ,ease of integration with feed networks, and lighter weight antenna systems that have properties to achieve selectivity in frequency, bandwidth, polarization and gain. Mobile phones are operating in 0.8 GHz range. Wi-Max works in 5.8 GHz. Wireless applications from 5-15 GHz. The microstrip patch antenna has different feeding techniques [2-3] like probe fed, aperture coupled, proximity and insert feed. Whatever, microstrip patch antenna suffers from very narrow bandwidth and they suffer from reduced gain and efficiency due to surface wave excitation. This poses design challenge for the microstrip antenna designer to meet the broadband requirements. Different methods [4] have been applied to overcome this problem such as using thick substrate with low dielectric constant, parasitic patch loading on the same layer with the main patch, stacked multilayer patches, U-slot and E- slot etched on the same patch and L-probe feeding.

The antenna is designed with substrate dimensions of 21 X 29 X 1.6mm, circular patch radius with 6.4mm and circular slot created in the circular patch with 4mm.CPW feed is used due to less radiation loss ,uniplaner configuration and its give wideband characteristics. The proposed antenna finds operating frequencies 3.1 GHz and 5.1 GHz for wireless applications.

II. ANTENNA DESIGN & STRUCTURE

The proposed CPW microstrip Circular Slot patch antenna structure[5], as shown in figure1.By using parametric analysis proposed antenna parameters are obtained for antenna design. The FR4 epoxy substrate with dielectric constant 'ε_r' of 4.4, dielectric tangent of 0.02 and substrate thickness 'h' of 1.6mm has been used in this design. To excite the antenna feed line width 'w_f' of 3.5 mm for 50Ω characteristic impedance of transmission line. The metal patch has been printed on one side of the dielectric substrate and there is no metallic printing on other side.

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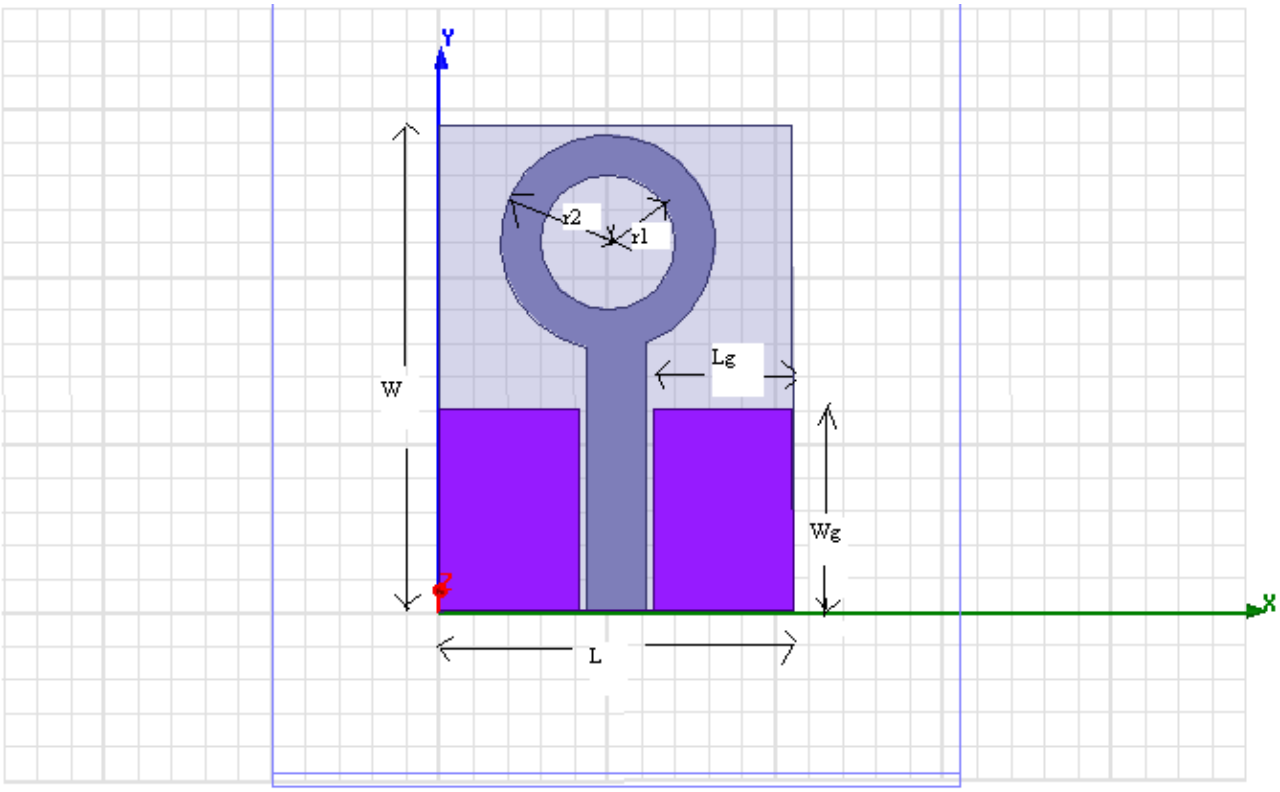

Figure1. Geometrical Construction of the proposed micro strip patch antenna with circular slot.

The parameters dimensions of the antenna referred in the following equations [3-6].

$$L = \frac{0.412h(\varepsilon_{reff}+0.3)(Wh^{-1}+0.264)}{[(\varepsilon_{reff}\ 0.258)(Wh^{-1}+0.8)]}$$

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+12hW^{-1}}}$$

$$L_{eff} = L + 2\Delta L$$

$$f_r = 1/\left[2L_{eff}\sqrt{\varepsilon_{reff}\sqrt{\varepsilon_0\mu_0}}\right]$$

$$W = 1/(2f_r\sqrt{\varepsilon_0\mu_0}) \times \sqrt{2/\varepsilon_r+1}$$

$$L = \left[1/\left(2f_r\sqrt{\varepsilon_{reff}}\sqrt{\varepsilon_0\mu_0}\right)\right] - 2\Delta L$$

L=21mm, W=29mm, wg=8.25mm, lg=12mm,g=0.5mm,R1=6.4mm,R2=4mm

III. SIMULATION RESULTS

The proposed antenna simulation result has been calculated using HFSS13 simulator. Figure.2 to shows the return loss of the proposed antenna operated at 3.18GHz with -17.7dB return loss and 5.10GHz with -33.0dBreturn loss. It is observed from figure.2 that antenna can operate 0.69GHz, 1.0GHz bandwidths at 3.18 GHz and bandwidth at 5.10GHz operating frequencies.

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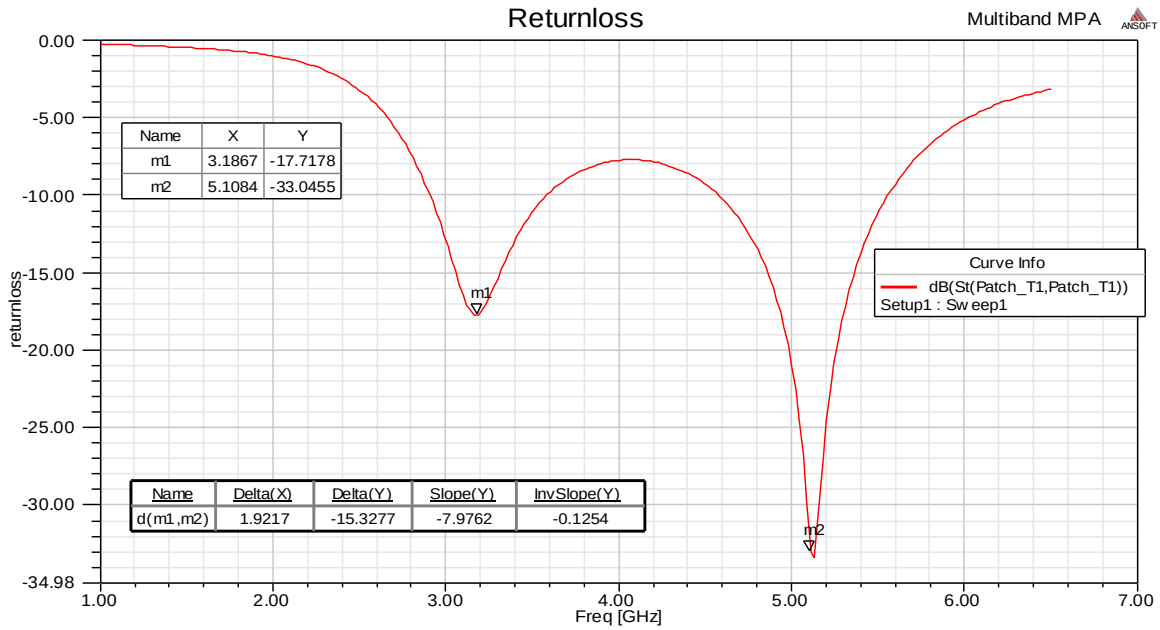

Figure 2. Return losses of the proposed antenna structure

Figure.3 shows the frequency verses VSWR. It defined in terms of the input reflection Coefficient 'Γ'as:

$$VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

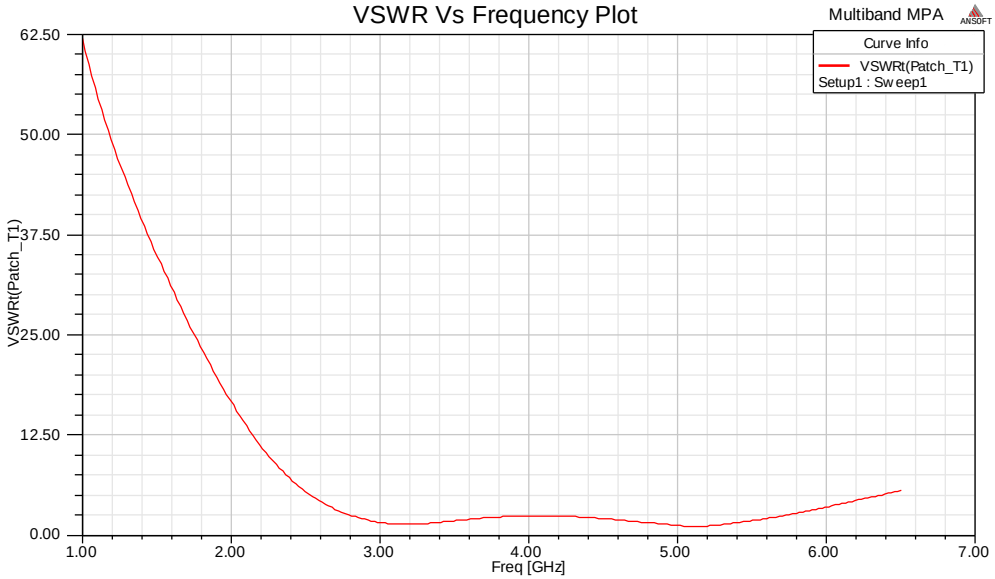

Figure3. The frequency (GHz) versus VSWR plot.

Figure.3 to shows the VSWR of the proposed antenna operated at 3.18GHz with 1.33 VSWR and 5.10GHz with VSWR is 1.1 observed.

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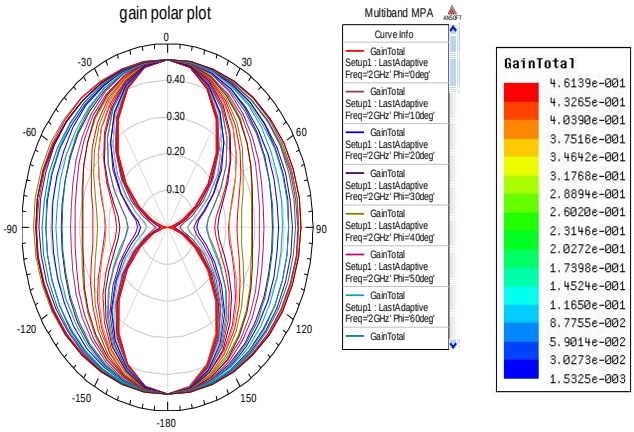

Figure4. Gain Polar Plot.

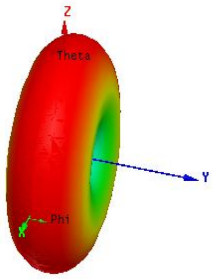

Figure5. Gain 3D Polar Plot.

Figure4.shows the gain polar plot it is observed good gain at desired frequencies and figure.5 represent 3D polar plot representation at desired frequencies.

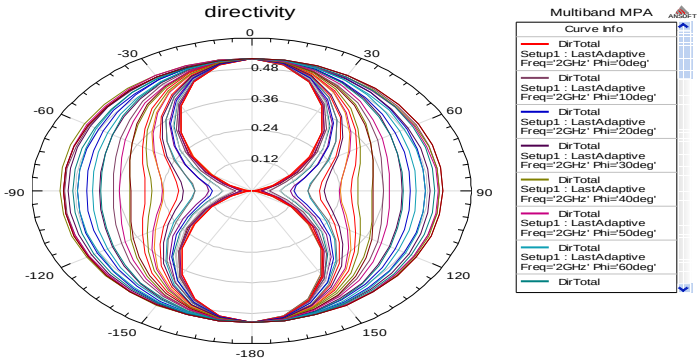

Figure.6 Directivity polar plot

Figure6.shows the Directivity polar and figure.5 represent 3D radiation Pattern polar plot representation at desired frequencies.

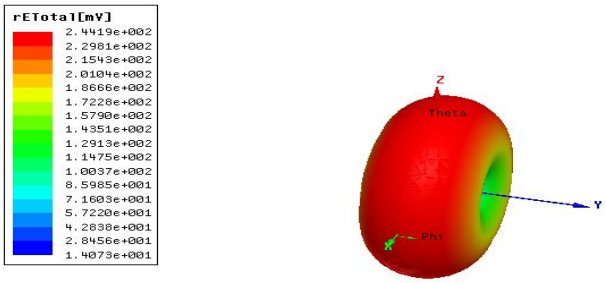

Figure.7 Radiation Pattern in 3D Polar plot

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IV. CONCLUSIONS

Proposed circular ring slot antenna is designed and simulated through HFSS13.0.The designed antenna is simple size and antenna has good performance in terms of return loss, radiation pattern, VSWR is 1.1 at 5.1 GHz and it has 87.9% radiation efficiency. Proposed Microstrip Patch Antenna will work in the frequency range of 3-5GHz. which covers the frequency of operation of WLAN, WiMAX, and wireless communication through satellite as well as the frequency of operation of RADAR that's why it is multipurpose microstrip patch antenna.

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