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Design of SRR inspired Dual Band Notch Antenna for C –Band and WLAN Applications

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Abstract

This paper presents the design of rejection band centered at 4 GHz and 5.5 GHz is obtained by etching out split ring resonator slots Coplanar Waveguide (CPW) with band notch. The proposed double band notch antenna is designed on a FR4 substrate of thickness 1.524 mm and relative permittivity of 4.4 and mounted above the ground plane at a height of 6 mm.

The simulated and measured results have been discussed for the proposed antenna. The parameters of the antenna are simulated using the (HFSS) software

Keywords

Ultra Wide Band, CPW Feed, MSA.

I. Introduction

Microstrip Antennas (MSA) has the high resonating frequency and narrow bandwidth, but the exploding growth of wireless communication system leads to an increasing demand for wideband, compact, low-cost Microstrip antennas. After wideband antenna the technology of Ultra-Wide Band (UWB) antenna has been introduced. The UWB technology allows high-speed data transmission with low power consumption. Now a days these low-cost UWB antennas have their use almost everywhere. Apart from widely used in wireless communication, these are also desirable for radar, medical imaging, and indoor positioning.

In this paper the proposed band-notched antenna has rejection characteristics at 4 GHz (for C-band 3.7 GHz to 4.2 GHz) and at 5.5 GHz (for WLAN-band 5.15GHz to 5.825 GHz.)

II. Antenna Design

The proposed antenna is designed using dielectric material of FR4 having height of 1.6 mm and of 4.4. The size of UWB antenna is reduced to 20x20 mm^2. Whereas the length and width of substrate is 34mm and 36mm respectively. The truncated ground structure is made beneath the radiating patch to improve the return loss characteristics and to cover the frequency band of range 3.1 to 10.6GHz

A square shape radiating patch (20mm x 20mm) with CPW feeding is selected. The partial ground has been chosen to achieve UWB spectrum (broad bandwidth) with VSWR less than 2. With the help of commercialyl available HFSS software the geometry of proposed antenna is decided by parametric study. The band notches are introduced in order to overcome the electromagnetic interferences. This interference is due to the narrow band applications which exist in UWB spectrum. The electromagnetic interference between UWB spectrum and narrowband application is reduced up to a great extent with the help of band notch feature of the antenna. Designing of this type of UWB antennas advantages to obsolete the use of band stop filters and hence reducing the cost, weight, size, and complexity of the antenna, upto a great level.

A. Primary antenna

Primitive antenna consists of a square patch and a ground plane to enhance the antenna's broadband performance. This arrangement increases the Flow of surface current through the CPW feed-line and concentrates the surface current around the bottom of the radiating patch.

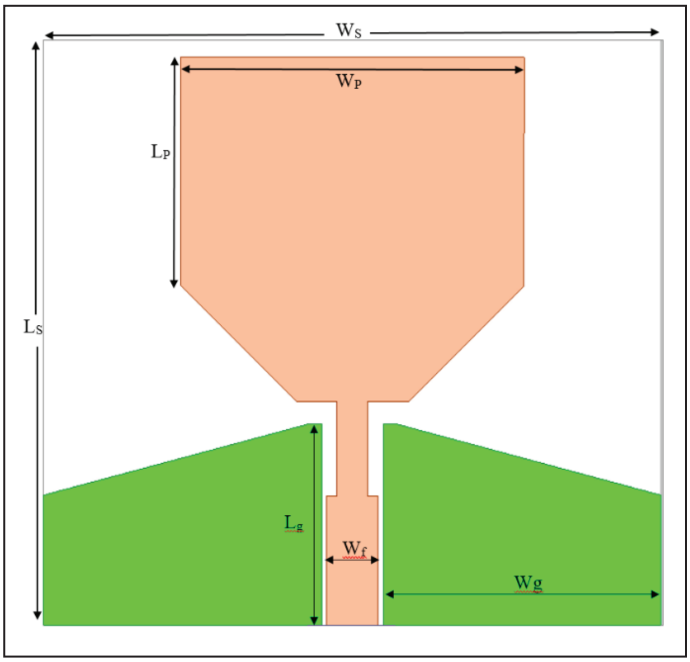

Fig. 1: Primitive UWB Antenna

From the fig. 1 we can clearly see that primitive antenna consists of a square radiating patch and partial ground plane to enhance broadband performance of antenna.

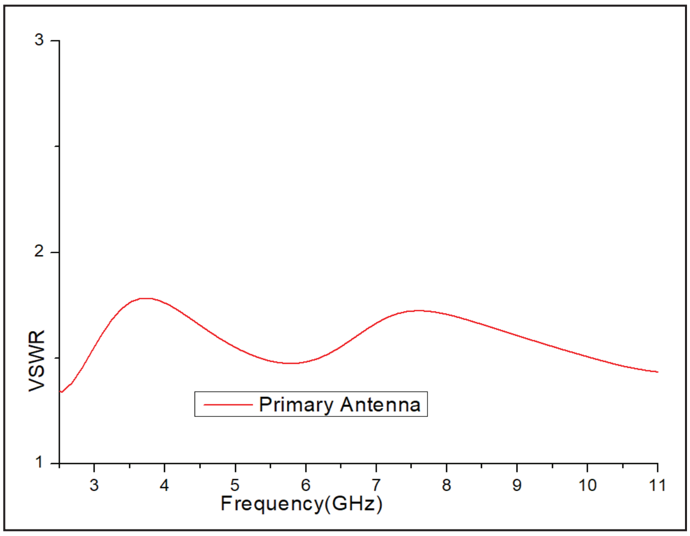

Fig. 2: VSWR of Primary UWB Antenna

From the fig. 2 it can be realized that primary antenna achieves broad bandwidth and radiates for complete UWB range from 3.1 to 10.6 GHz with VSWR less than 2. VSWR less than 2 implies that the antenna has good impedance matching for entire UWB spectrum and it can effectively radiate or receive electromagnetic signals for the entire UWB spectrum. The dimensional details of the primitive antenna has been shown in the Table 1.

Table 1: Dimensions of Primitive Antenna

Parameter	Unit (mm)
W_s	36
L_s	34
W_g	16.20
L_g	7.55
W_f	3
L_f	13
W_p	20
L_p	20

The results for return loss and smith chart for primitive antenna is shown in the fig. 3 and in fig. 4.

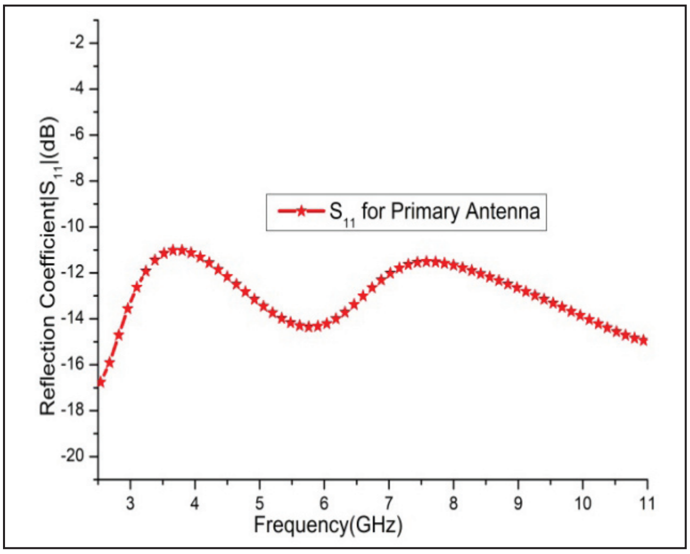

Fig. 3: Return Loss of Primitive Antenna

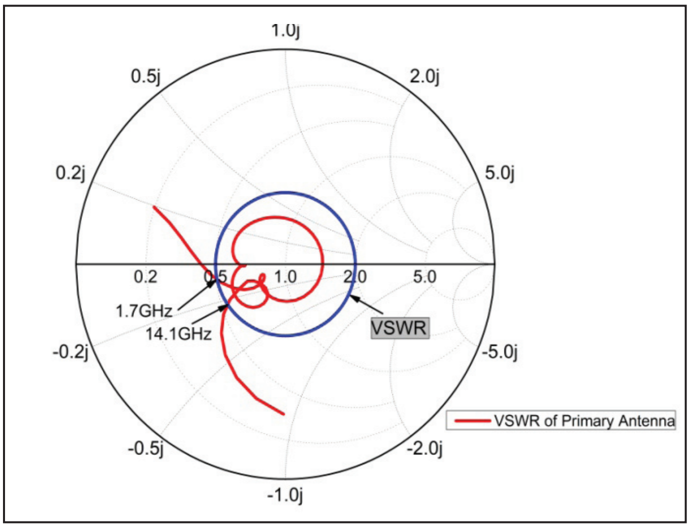

Fig. 4: Smith Chart of Primitive Antenna

B. UWB Antenna with ECSRR in Patch

The frequency range from 3.1 GHz to 10.6 GHz band as the UWB (Ultra-Wide Band) has permitted and certified by FCC (Federal Communication Commission) for the unlicensed commercial applications. For the short-range communications up to 10 meter UWB spectrum is also appreciated due to its very high data rate. But C-band (Satellite Communication downlink) application operates in the range of 3.8 –4.2 GHz and it highly interferes the UWB devices. UWB devices are used to operate at a very low power from few microwatts to some mili watt. So instead of integrating the antenna with band-stop filter, we are introducing a Elliptical Complementary Split Ring Resonator(ECSRR) as parasitic element near the microstrip feed line to enable band-rejection capability around 4.0GHz so that the interference is minimized between the C-band applications and UWB devices.

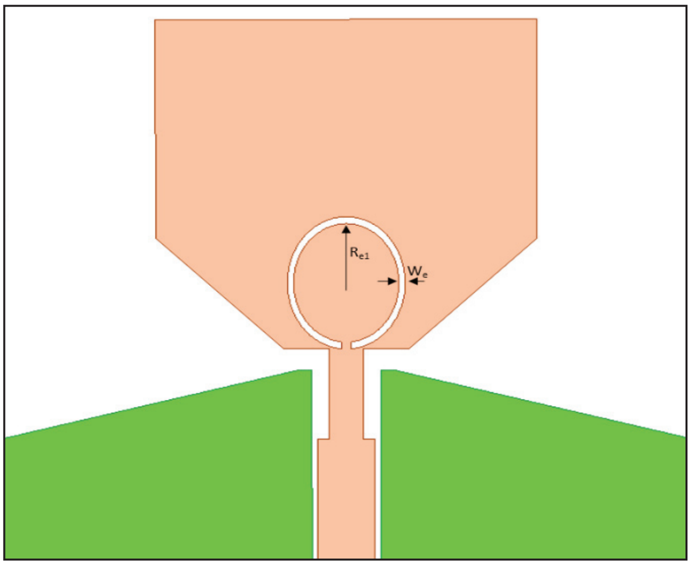

Fig. 5: Geometry of Antenna with ECSRR

The VSWR(voltage standing wave ratio) verses frequency graph for C-band notched UWB antenna has been shown in Fig. 6 which tells that the VSWR is approximately 3.6 at 4.0 GHz while for rest of UWB spectrum VSWR is less than 2.
From the fig. 6 it can be observed that proposed antenna effectively notches the C-band and so it can be used to eliminate the interference in UWB spectrum due to C-band.

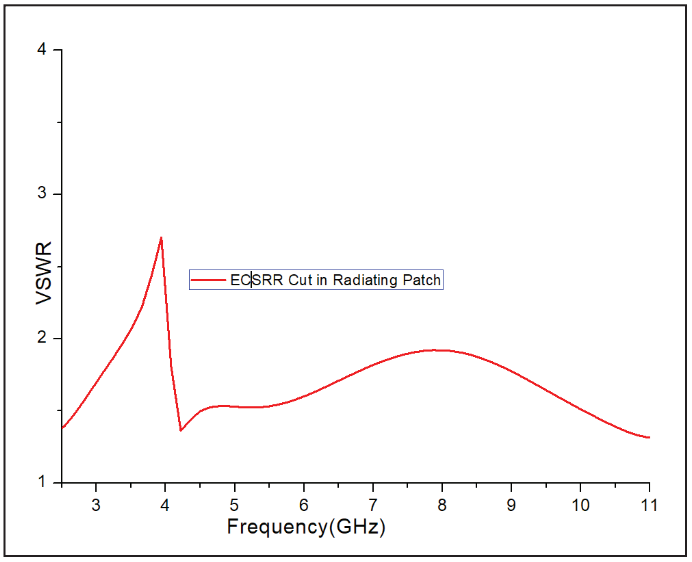

Fig. 6: VSWR of the Antenna With ECSRR

Table 2: Dimensions of Antenna with ECSRR in Patch

Parameter	Unit (mm)
W_e	0.33
R_{e1}	2.77
R_{e2}	3.1
G_1	0.5

The results for return loss and smith chart for antenna with ECSRR in patch is shown in the fig. 7 and in fig. 8.

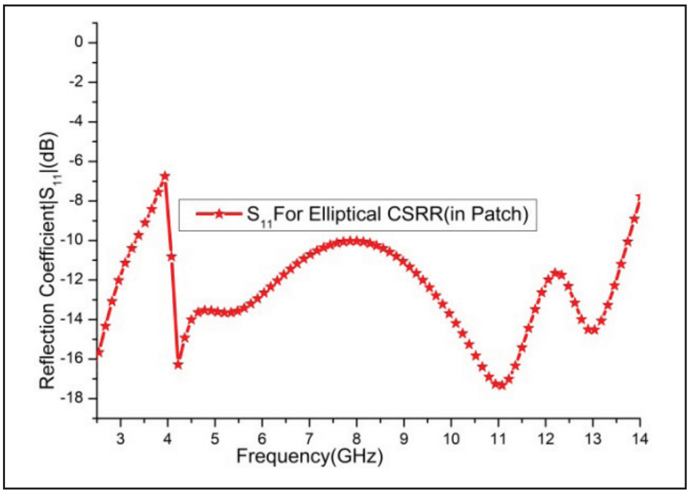

Fig. 7: Return Loss of Antenna with ECSRR in Patch

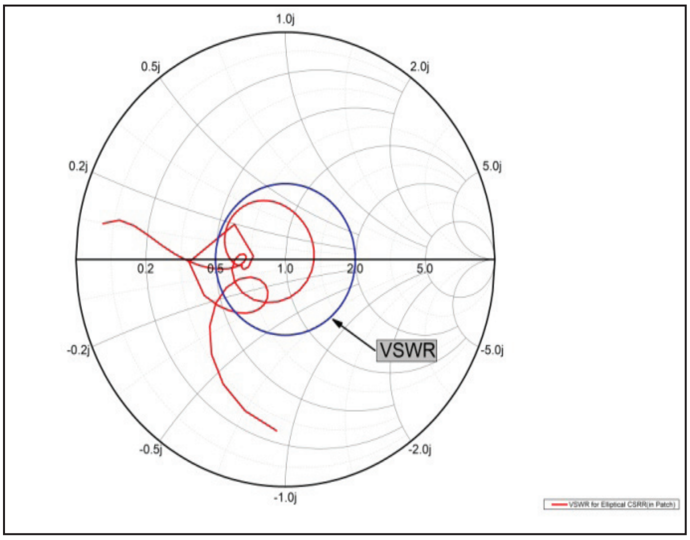

Fig. 8: Smith Chart of Antenna With ECSRR in Patch

A. UWB Antenna with Circular Split Ring Resonator (SRR) on back side of patch

WLAN which is a wireless narrowband application also generate electromagnetic interference with in UWB spectrum. And in comparison to UWB devices the wireless narrow band applications are used to be operated at high power level. WLAN (Wireless Local Area Network) applications which operates within 5.1 GHz to 5.8 GHz frequency band highly interrupts the UWB devices. So instead of implementing a band-stop filter at the receiver antenna we are loading back side of patch with SRR (Split Ring Resonator) in order to facilitate band-rejection facility around 5.5 GHz, so that we can reduce the electromagnetic interference to a great extent.

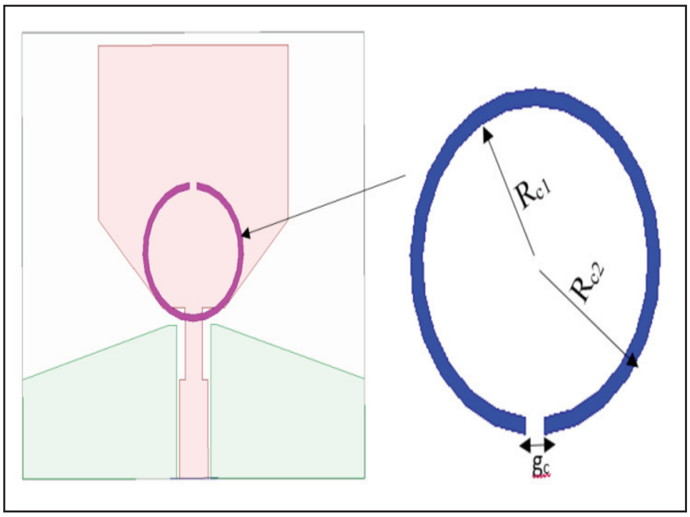

Fig. 9: UWB Antenna With Band Notch for WLAN Band

Fig. 10 shows the simulated results in terms of VSWR verses frequency graph of proposed antenna with circular SRR which is loaded on back side of patch. From the graph we can observe that band notches at 5.5 GHz successfully.

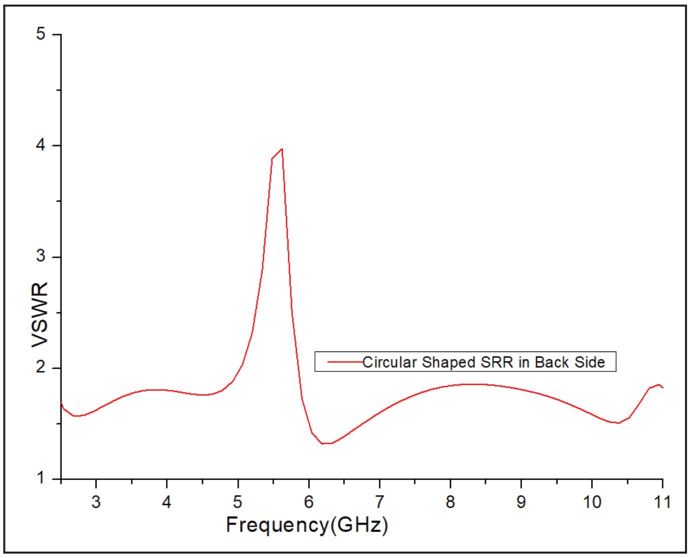

Fig. 10: VSWR of Antenna with SRR on Back Side of Patch

As shown in fig. 10 proposed antenna possesses band notch or band rejection for 5.1-5.8 GHz with VSWR approximately 4. It shows that the proposed SRR loaded band notched antenna effectively radiate/receive EM signals except WLAN band (VSWR is greater than 2).

Table 3: Dimensions of Antenna with SRR Patch

Parameter	Unit (mm)
R_c	0.5
R_{c1}	5.8
R_{c2}	5.3
G_c	0.8

The results for return loss and smith chart for antenna with SRR on back side of patch is shown in the fig. 11 and in fig. 12.

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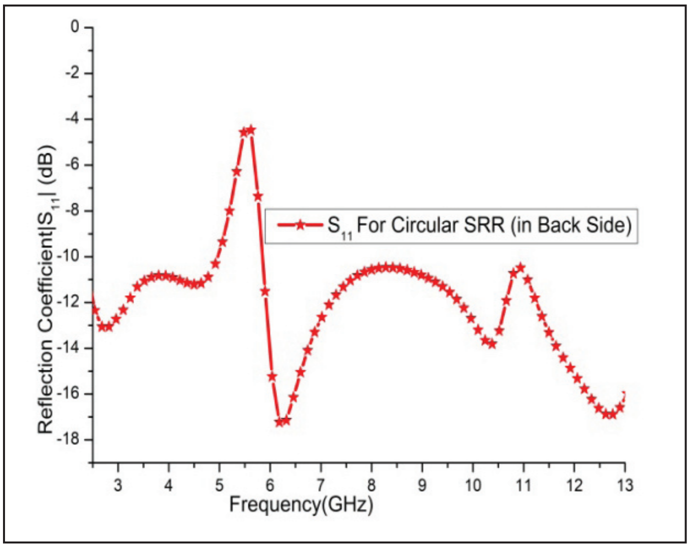

Fig. 11: Return loss of Antenna With SRR on Back Side of Patch

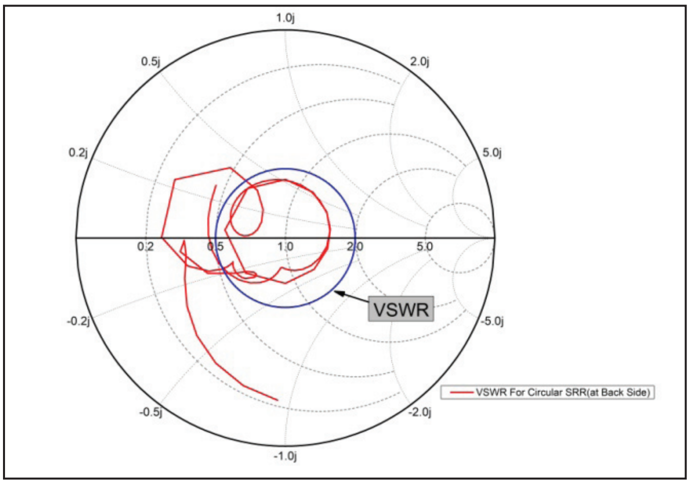

Fig. 12: Smith Chart of Antenna with SRR on Back Side of Patch

B. Effects of Current Distribution of ECSRR and SRR in Patch

The current distribution of an antenna shows how the current density is flowing on the radiating patch. Whenever the current distribution disturbed, the radiation of EM wave from an antenna will also change. Fig 13(a) shows the effect of CSRR in patch on current distribution, from the figure it can be seen that due to the elliptical shaped CSRR on patch current density is highly disturbed so there is a notch at 4.0 GHz frequency.

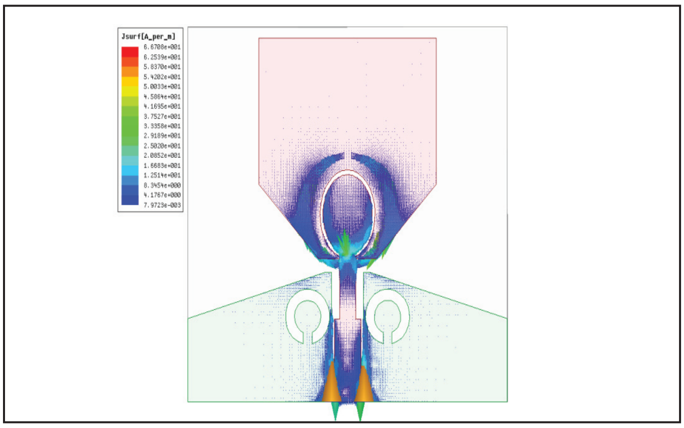

Fig. 13(a): Effect of Current Distribution of ECSRR on Patch

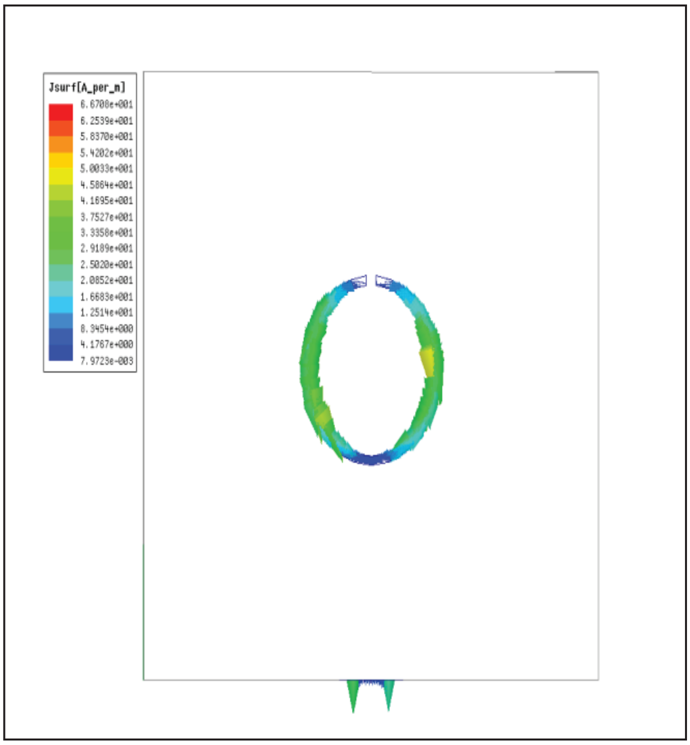

Fig. 13(b): Effect of Current Distribution of SRR on Bakc Side of Patch

Fig. 13(b) shows the effect of SRR which is designed on the back side of patch on current distribution. And due to this SRR current density is highly disturbed so there is a notch at 5.5 GHz frequency.

III. Conclusion

In this paper we have successfully designed, and simulated the dual band notched UWB antenna. The motivation behind this work is to develop a planar band notched UWB antenna which works with band stop filtering characteristics over UWB spectrum.

To minimize the electromagnetic interference problem that is associated with UWB spectrum and device, here band notching techniques have been used. To verify simulated results we have measured the proposed antennas VSWR and found that the results have good agreement.

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