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Quad Band Microstrip patch Antenna with loaded CSRR

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ABSTRACT

In this paper a Quad band microstrip patch antenna with loaded CSRR has been developed. Since a microstrip patch antenna works only on one resonant frequency so converting that into a multiband patch antenna would enhance the bandwidth and also utilizes the multiple frequencies of operation. Proposed Quad band microstrip patch antenna is simulated for FR4 lossy dielectric substrate whose dielectric constant is 4.3 and height is 1.6mm. Proposed design is working for quad band of 6.5GHz, 10.2GHz, 8GHz and 5.2GHz frequencies. A Complimentary Split Ring Resonator (CSRR) has been incorporated in the ground plane of a microstrip patch antenna to enhance gain and bandwidth of antenna. CSRR is a type of metamaterial. CST software has been used for Simulation of proposed design. Sim8lation results show that the presented antenna design characteristics meet with the standard characteristics of antenna.

Keywords: *CSTMW studio software, CSRR, FR4 lossy material*

INTRODUCTION

Novel design of antennas plays a pivotal role in the field of wireless. Different wireless communication applications require different frequency [1]. So constructing an antenna which is much conformal to different surfaces and can work in different bands simultaneously is the need for the advancement of this field [2]. Simulation and fabrication of different structures of microstrip patch antenna and has made progress in recent years. Characteristics of microstrip patch antenna can be improvise by applying CSRR[3]. Microstrip patch antennas are one of the most widely used antenna due to certain advantages. It consist light weight, less volume, economic and compatible with integrated circuits so that it can easily install on the rigid surface. Furthermore, they can be easily designed to operate in dual-band, multi-band application, dual or circular polarization. In this paper, we propose a new design approach to the realization of compact antennas with improved impedance bandwidth using a ground plane loaded with complementary split-ring resonators (CSRRs). The characteristics of the split-ring resonator (SRR) have already been studied by several groups . In its complementary structure, the CSRRs behave as an electric dipole excited by an axial electric field, and exhibit strong dispersion near the resonance frequency reducing the guided wavelength significantly [4, 5]. In this work, we investigate a microstrip patch antenna on a dielectric substrate with CSRRs employed in the ground plane, and examine the resonant frequency, impedance bandwidth, and radiation characteristics. The comparison of the impedance bandwidth between the microstrip patch antenna on a conventional high permittivity substrate and with the CSRR substrate is presented.

Patch antenna has narrow bandwidth. For extending the bandwidth many approaches have been utilized such as super substrate, dimensions of antenna, metamaterial, feed network etc [6]. This paper presents a Quad Band Microstrip patch Antenna loaded with CSRR working for four frequencies 6.5GHz, 10.2GHz, 8GHz and 5.2GHz frequencies. Aim of this design is to obtain a small size, light weight and cheap miniaturized antenna with good antenna characteristics. CST MW studio software is used for simulation of proposed antenna. CST MICROWAVE STUDIO® (CST MWS) is a specialist tool for the 3D EM simulation of high frequency devices such as antennas, filters, couplers, planar and multi-layer structures and SI and EMC effects [6].

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DESCRIPTION OF ANTENNA

Quad Band Microstrip patch Antenna loaded with CSRR is simulated by using CST MW studio software. This antenna is simulated for FR-4 lossy material with dielectric constant 4.4, loss tangent 0.02 and height 1.6mm.Ground plane has one CSRR. Required Parametric Analysis has given below:

Calculation of Width (W) Calculation of Width (W)

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (1)$$

Error! Digit expected.

Error! Digit expected. (1

Effective dielectric constant is calculated from:

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right) \quad (2)$$

The actual length of the Patch (L)

$$L = L_{eff} - 2\Delta L \quad (3)$$

where

$$Leff = \frac{C}{2f_r\sqrt{\varepsilon_{eff}}} \quad (4)$$

Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{w}{h}+0.8\right)} \quad (5)$$

where,

ε_{reff} = Effective dielectric constant,
ε_r= Dielectric constant of substrate,
h = Height of dielectric substrate,
W= Width of the Patch,
L = Length of the Patch,
ΔL = Effective Length,
f_r = Resonating Frequency[7,8]

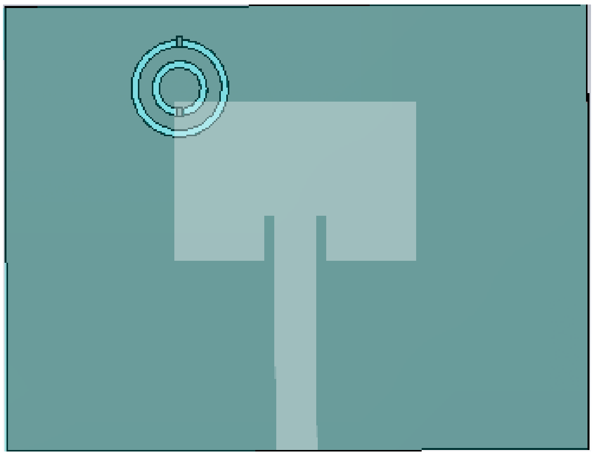

Figure 1: Layout of presented design

RESULTS AND DISCUSSION

CST-MWS software in Transient Mode is used for simulations.

Figure 2 shows the return loss of antenna.[9]

N	Frequency	Return Loss
	5.8GHz	3dB
	8GHz	3dB
	9.5GHz	2dB
	10.2GHz	7dB

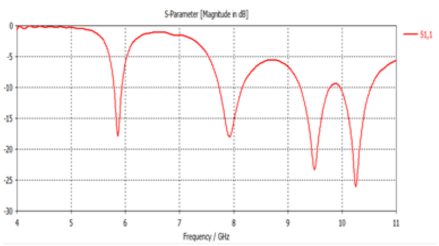

Figure 2: Return loss of Quad band antenna

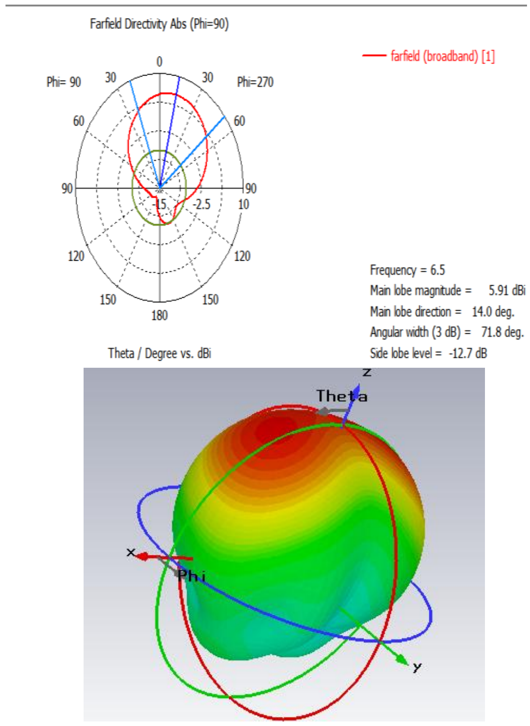

Figure 3: Gain in 2D and 3D view at 9.5GHz

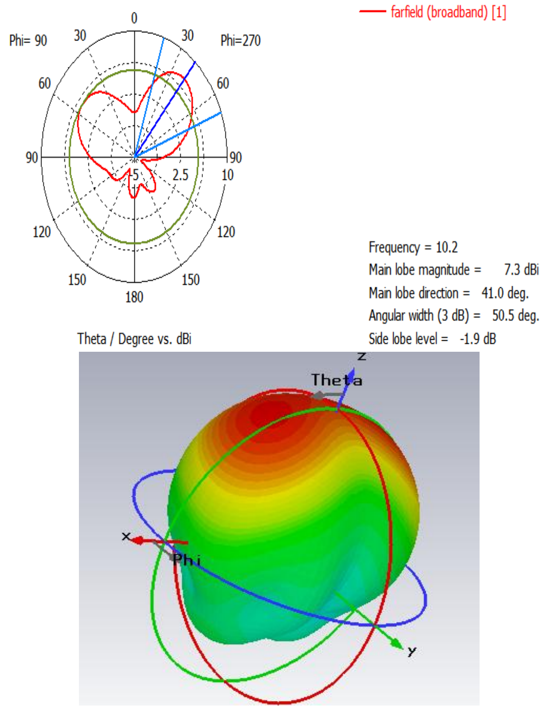

Figure 4: Gain at 10.2GHz

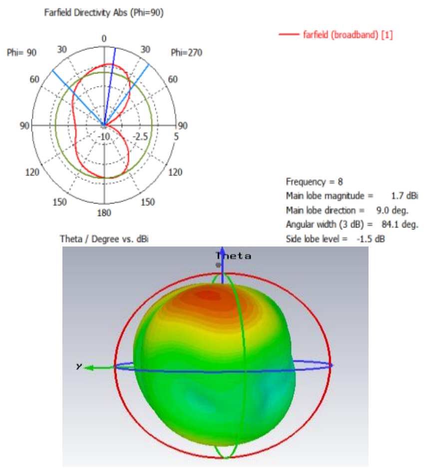

Figure 5: Gain at 8GHz

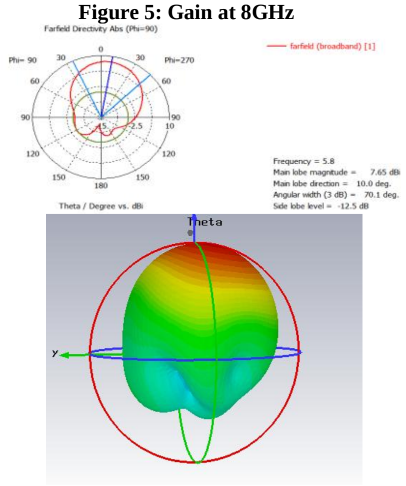

Figure 6: Gain at 5.8GHz

Figure 3, 4, 5 and 6 shows the gain of rectangular micro strip patch antenna.

CONCLUSION

Proposed prototype of Quad Band Microstrip patch Antenna with loaded CSRR has been simulated by using CSTMW software. The return loss at frequency 5.8GHz is -17dB, at frequency 8GHz is -18 dB,at frequency 9.5GHz is -22dB, at frequency 10.2GHz is -27dB which is below -10 dB hence impedance of antenna is matched and return loss is very low. Gain of proposed design shows the good agreement.

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