STAIR SHAPED SEMICIRCULAR MICROSTRIP PATCH ANTENNA LOADED WITH CSRR FOR UWB APPLICATIONS

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Abstract - In this paper, a CSRR (Complementary Split Ring Resonator) based antenna is proposed for Ultra-Wide Band Applications. The modelled structure consists of a monopole antenna loaded with CSRR and partial rectangular ground plane on the opposite side, which is fed by 50Ω microstrip transmission line. CSRR modifies the direction of current and achieve Ultra-wide band characteristics. The proposed antenna with a compact size of 28 × 23 × 1.6 mm 3 is fabricated on a FR-4 substrate of thickness of 1.6 mm, with relative dielectric constant ε_r = 4.4 and loss tangent tan δ =0. 002. The antenna had given an extra band with the introduction of CSRR.UWB behavior with better return loss characteristics are achieved by the use of CSRR. With CSRR the proposed antenna has increased its gain from 2.23 dBi to 3.58 dBi. The proposed antenna works on UWB range and can be used for Wi-Max (3.4-3.69 GHz) and WLAN (5.15-5.825 GHz) applications.

Key Words: **Microstrip Patch Antenna, Ultra-wide band antennas, Return loss, SRR, CSRR.**

1. INTRODUCTION

The demand for compact hand held communique devices has grown considerably. Devices having inner antennas have regarded to fill this need. Wireless communication structures require small length and compact antennas that have wider bandwidth than traditional antenna design [1]. Antenna length is a first-rate issue that limits device miniaturization. For the beyond few years, new designs based on the Microstrip patch antennas (MSPA) are getting used for hand-held wifi gadgets because those antennas have low-profile geometry and can be embedded into the gadgets. New wifi applications requiring operation in a couple of frequency band are rising. Twin-band and tri-band phones have received recognition due to a couple of frequency bands used for wifi applications.

Meta material-inspired antennas have concentrated on the special impact of electromagnetic wave belongings. Split Ring Resonator (SRR), Complementary split Ring Resonator (CSRR) and electric powered-LC (ELC) are the primary unit factors of meta material for boosting the antenna performances. Planar monopole antenna loaded with SRR shape may be used to obtain bandwidth improvement [13] and miniaturization [14]. CSRR-loaded substrate has spurred for appropriate impedance matching [15], multiband [16], and benefit improvement [17].

Here in this paper, a monopole antenna loaded with CSRR meta material element is supplied. UWB behavior with higher go back loss characteristics are executed by using the usage of CSRR. The antenna is proposed to operate over a bandwidth of 10.01 GHz for UWB programs. The proposed antenna works within the UWB range (4.24–14.25 GHz). This structure also can be used for C-band (4-8 GHz) applications in satellite communication, WiMAX, WiFi, C band, X band and additionally for scientific uses to discover cancers and tumors in which the safe frequency variety for human tissues is 4 GHz - 9.5 GHz.

2. ANTENNA DESIGN

The model of Microstrip Antenna can be represented by two slots of width (W) and height (h) separated by transmission line of length (L). The width of the patch can be calculated from the following equation [7].

W=C2fo√2εr+ 1

The effective dielectric constant of the substrate can be calculated as ,

εreff= εr+ 12+εr−12[1 + 12hW]−1/2

The actual length of the antenna is different from the calculated L since the fringing field also needs to be considered here. The actual length is calculated by subtracting the excess lengths from both the sides of the patch. The length of the Patch Antenna L is given by,

ΔLh= 0.412 (εreff+ 0.3) (Wh+ 0.264)(εreff−0.258)(Wh+ 0.8

Higher values of permittivity allow a shrinking of the Patch Antenna. Particularly in cell phones, the designers are given very little space and want the antenna to be a half-wavelength long. One technique is to use a substrate with a very high permittivity. The actual length of the Patch Antenna is given by, Leff=C2fo√εreff−2ΔL

The length (Ls) and the width (Ws) of a ground plane are calculated using the following equations,

Lg= 6h+L(3.15)

Wg= 6h+W

Hence, if the permittivity is increased by a factor of 4, the length required decreases by a factor of 2. Using higher values for permittivity is frequently exploited in antenna miniaturization. All of the parameters in a Rectangular Patch Antenna design (L, W, h, permittivity) control the properties of the antenna. Table 1 gives the design specifications of a standard rectangular patch with FR4 substrate.

Table -1: Sample Table format

Substrate materials used	FR4(εr=4.4)
Thickness between ground and fed patch (h)	1.6 mm
Radius of the first semicircular patch (R 1)	9.5 mm
Radius of the second semicircular patch (R 2)	4.5 mm
Width of the ground plane (Wg)	28 mm
The length of the ground plane (Lg)	23 mm.

3. PARAMETRIC STUDY OF PROPOSED PATCH ANTENNA

The basic structure is that of a Proposed Patch Antenna shown in Figure.1.

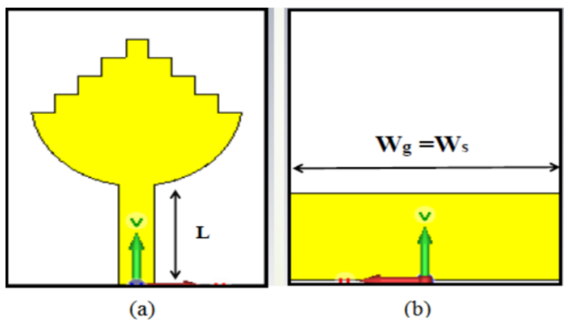

Fig -1: Proposed Patch Antenna (a) Front Side (b) Back Side

3.1 Return Loss

The response S11 shows in Figure. 2 and the antenna resonate at single frequency band, with a Return Loss maximum of -15.54 dB at resonant frequency 3.54 GHz.

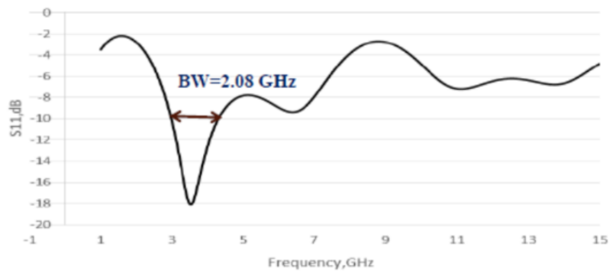

Fig -2: Plot of S11 Parameters versus Frequency of Proposed Patch

3.2 Radiation Pattern

The Radiation property of an antenna can be analyzed to understand the distribution of power around the orientation. The simulated gain pattern of the antenna can be observed at different resonant frequencies. The simulated gain pattern of the antenna shows (Figure.3) that the antenna has a gain of 2.78 dBi at first resonant frequency 3.54 GHz.

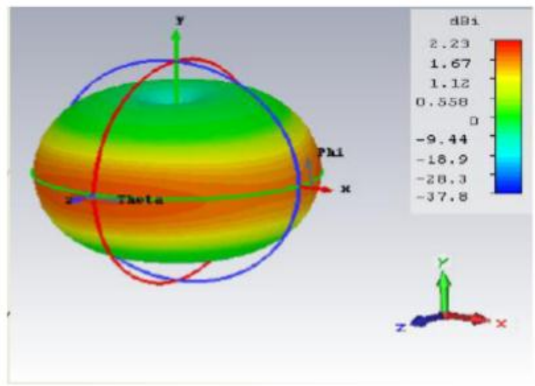

Fig -3: Radiation Pattern at 3.54 GHz

4. PARAMETRIC STUDY OF PROPOSED ANTENNA LOADED WITH CSRR

A Complementary Split Ring Resonator (CSRR) is loaded to the proposed microstrip patch antenna as shown in Figure. 4. Here two-ring split ring resonator is loaded in microstrip patch antenna substrate. Same way three-ring split ring resonator and four-ring split ring resonator are also added in the microstrip patch antenna.

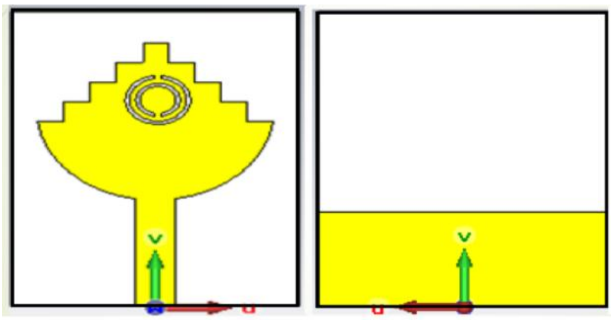

Fig -4: Proposed Patch Antenna loaded with CSRR (a) Front Side (b) Back Side

Unit Cell analysis of CSRR is shown in Fig.5. From the frequency verses permeability graph, an extra band is provided by the CSRR structure, as it shows negative resistance behavior at frequency 5.76 GHz

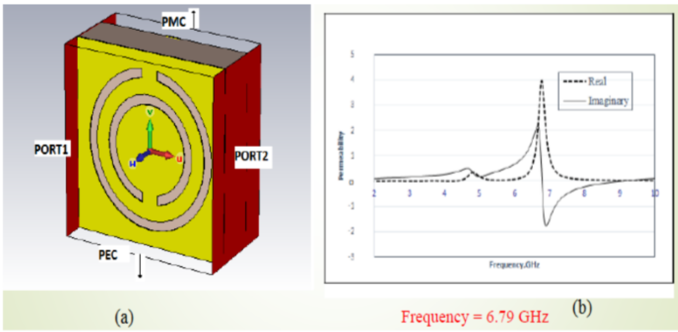

Fig -5: Unit Cell Analysis of CSRR a) Unit Cell b) Frequency Permeability Characteristics

4.1 Return Loss

The response S11 shows in Figure.6 and the antenna resonate at UWB bands, (4.24 – 14.25 GHz).

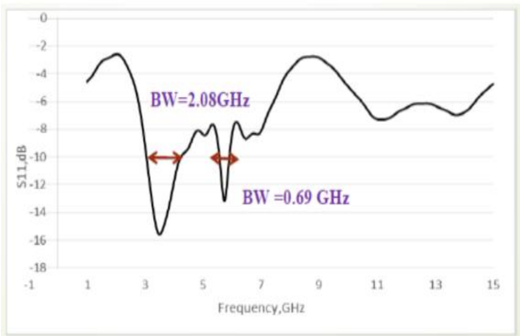

Fig -6: Plot of S11 Parameters versus Frequency of Proposed Patch loaded with CSRR

4.2 Radiation Pattern

The Radiation property of any antenna can be analyzed to understand the distribution of power around the orientation. The simulated gain pattern of the antenna shows (figure.7) that the same antenna has a gain of 3.58 dBi at second resonant frequency 5.76 GHz.

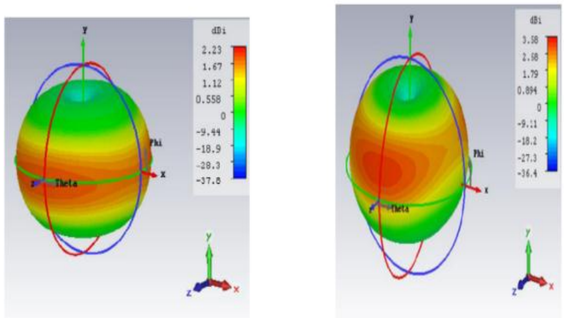

Fig -7: Radiation Patterns at 3.54 GHz (left) and Radiation Patterns at 5.76 GHz(right)

5. COMPARATIVE STUDY

Table 2 shows the comparison of proposed patch antenna loaded with and without CSRR on FR4-epoxy substrate material with dielectric constant in terms of operating frequency Band width and gain.

Table -2: Comparison with Proposed antenna loaded with and without CSRR.

Structure	Resonating Frequency (GHz)	Bandwidth (GHz)	Gain (dBi)
Proposed Patch Antenna	3.54	2.08	2.78
Proposed Antenna Loaded with CSRR	3.54	2.08	2.78
	5.76	0.69	3.58

Figure.8 shows that the simulation results of proposed antenna with and without CSRR. The simulation results give dual frequency bands bandwidth at 3.54 GHz and 5.76 GHz, which is suitable for UWB applications.

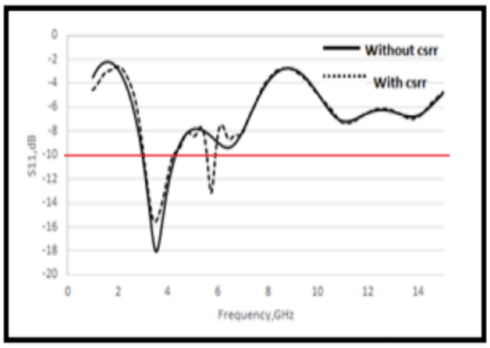

Fig -8: Comparative study of S11 Parameters versus Frequency of Proposed Patch loaded with and without CSRR.

6. CONCLUSION

The proposed antenna is evolved on 28 × 23× 1.6 mm 3 FR-4 Substrate. The CSRR within the monopole antenna creates wide-band characteristics for UWB, WiMAX and WLAN packages. The designed antenna includes a monopole antenna loaded with CSRR and partial rectangular ground plane on the alternative side. CSRR metamaterial modifies the current direction and yields ultra-wide band traits.

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