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Split Ring Resonator Based Antenna Development For Wireless Communications

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Abstract:
In recent years, wireless technology is in demand. The Split Ring Resonator(SRR) based antenna has been designed, analysed, developed and fabricated. The researchers are doing research in designing technology-based, multiple application-oriented, efficient, and cost-effective RF structures. Incorporating all requirements of existing industries, various wireless applications-oriented, negative refractive index-based antenna structure is designed and analysed in this paper. The claimed antenna resonates at 1.70 GHz and 2.27 GHz frequencies. The output parameters show very good potential for the L and C band frequency applications.
Keywords: Negative refractive index, wireless communications, Split ring resonator

I. INTRODUCTION:

The growth of wireless communication demands a structural change in multiband antenna design to meet the present industry requirement. The requirement needs a smart, compact antenna that covers the application-oriented frequencies for navigation, WiFi, and satellite communication. In order to get the desired response, various feeding techniques could be utilized, viz., microstrip line feed, insert feed, and quarter-wave feed. The presented design utilizes a quarter-wave feeding technique to meet the maximum impedance matching requirement. The left-handed material helps to reduce the size of an antenna significantly and get the desired frequency bands for specific applications. Metamaterials are artificial materials that show negative permittivity and permeability for certain frequency spectrum [1– 4]. Split Ring Resonator (SRR) is considered a fundamental block for metamaterials. The artificial metamaterials make themselves suitable for enhancing the electromagnetic properties of any microwave devices such as antennas. It also enhances filter performance with overall structure compactness and application-oriented frequency resonance [5, 6]. Dual-band microstrip antennas could be used for higher frequency performances [7]. Complementary Split Ring Resonator (CSRR) could also be an effective technique to enhance antenna performance [8]. The literature also exhibits a combination of microstrip slot and SRR which plays a significant role in designing a miniaturized antenna for dual-band performance [9]. The radiation characteristics and miniaturization techniques have been systematically covered in [10]. The researchers have also tested the SRR technique to get an adequate response from reconfigurable antennas [11]. The literature also covers a wide spectrum of miniaturization without the presence of SRR/CSRR; however, optimum size reduction may not be achievable [12, 13]. There are many effective and interesting techniques are available for antennas miniaturization and bandwidth enhancement like negative refractive index materials [14- 18], planar inverted antennas[19-21] and frequency selective surfaces. Dielectric Resonator antennas, however, without major fabrication stress can provide high gain and wide bandwidth. DRAs offer the benefits of high radiation proficiency, simplicity of excitation, little size, and wide data transmission [22-25]. Optimum designing of an antenna plays a major role in its application for wireless communication. Electrically small antenna could be utilised for RFID, GPS and IEEE 802.11 a/b/g/s Applications. In this manner, DRAs could be the appropriate candidate for wireless communication applications. The antenna bandwidth could be enhanced using negative refractive indexed material [26-36].
The figure 1 depicts the flow of antenna design. It gives idea about how the authors have finalized athe specific application oriented antenna.

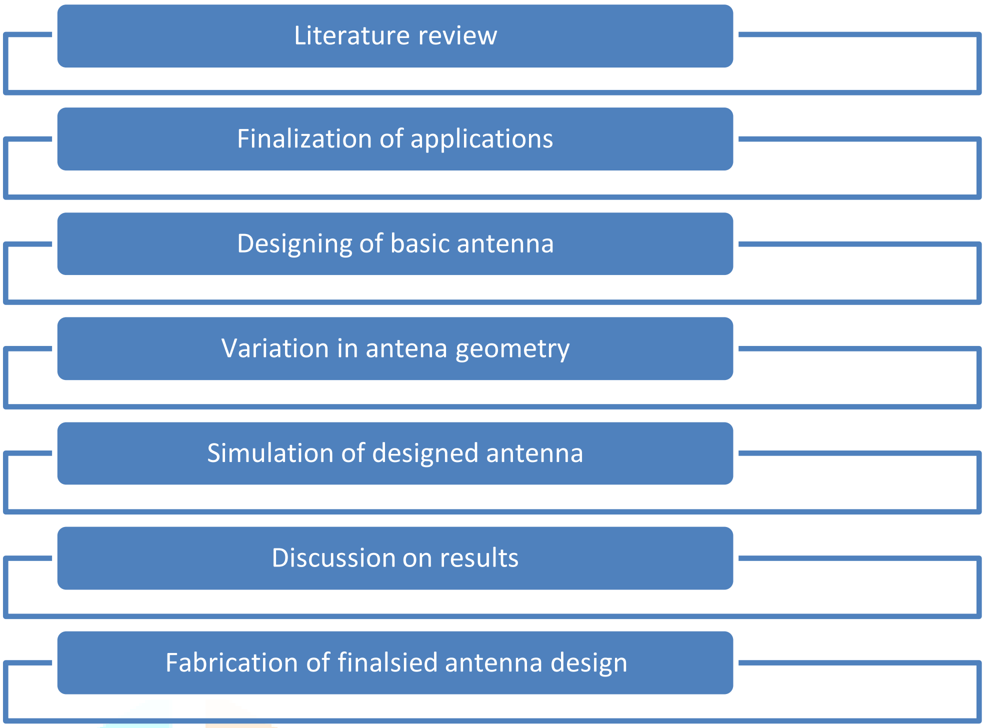
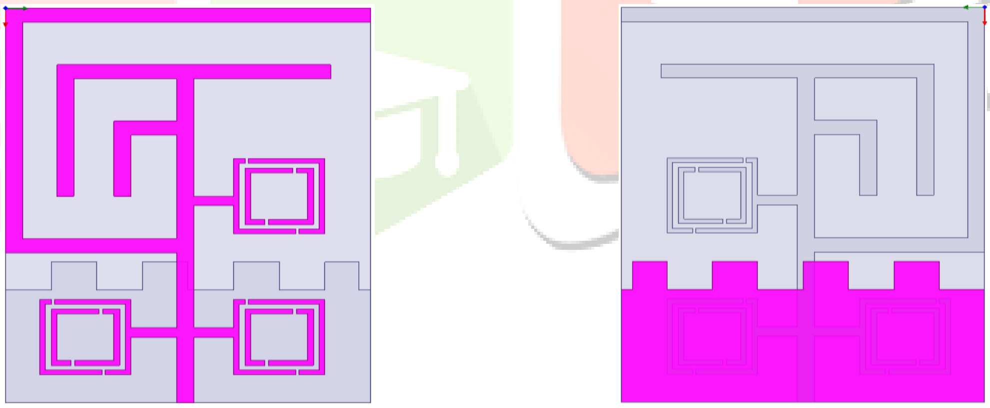


Figure 1: Flow of antenna designing

II. ANTENNA GEOMETRY:

The figure 2 depicts the antenna geometry. Here, Split Ring Resonator (SRR) block is considered as a unit cell. Over the top layer, the geometry having the combination of meandered branches and SRR unit cell has been developed. The comb shape ground plane is provided for optimum impedance matching. The middle layer is made from FR4 substrate. All layers are visible in figure 2 (c). The excitation has been provided to the primary patch which is eventually excite the conducting SRR-based array structure.



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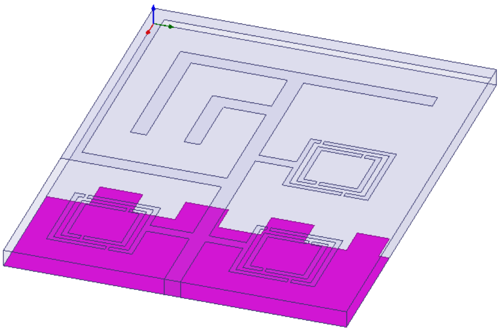


(iii)

Figure 2: (i) Top View (ii) Back View (iii) Bird-eye View

III. RESULT AND DISCUSSION:

Figure 3 illustrates the return loss for a frequency range from 1 GHz to 10 GHz. It could be observed from the figure that four resonating bands could be achieved by the proposed geometry. The appropriate impedance matching is required to improve the return loss graph.

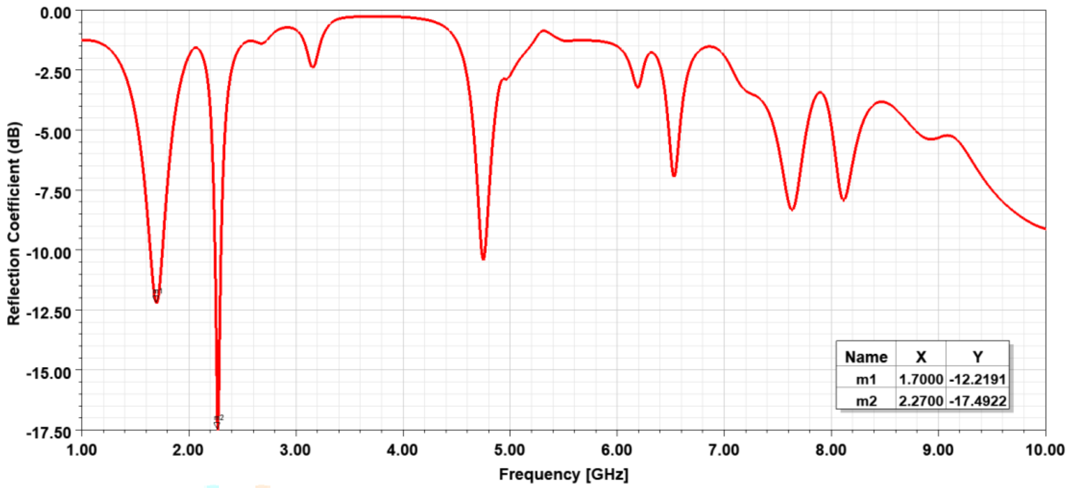
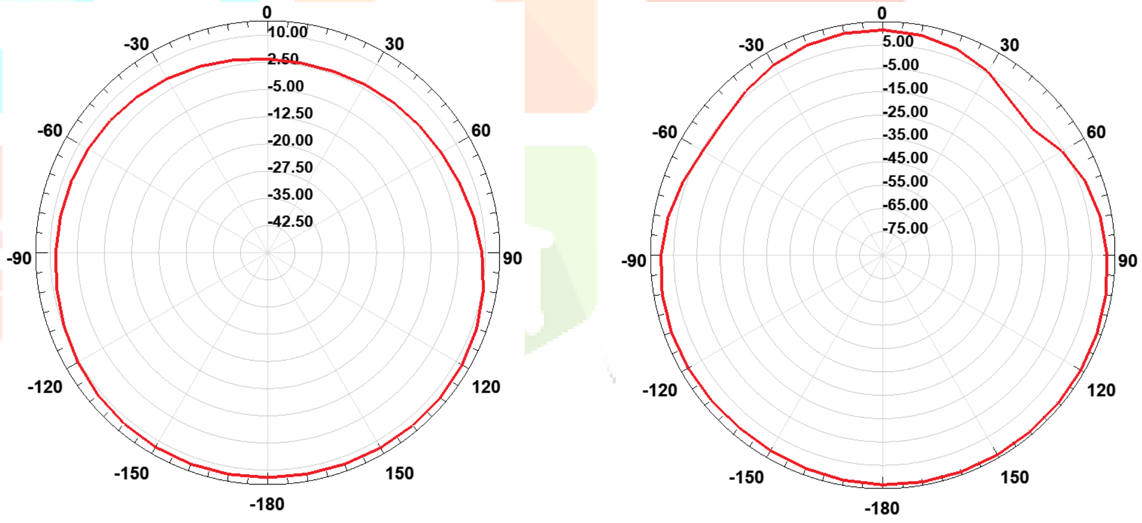


Figure 3: Graph of reflection coefficient vs. frequency

The 2 Dimension radiation pattern is shown by figure 4. The radiation pattern is having omnidirectional and moderate positive gain. Figure 4 (a), and (b) shows radiation pattern for 1.70 GHz, and 2.27 GHz frequencies.



(i) (ii)

Figure 4: 2D radiation pattern at 1.70 GHz and 2.27 GHz frequencies

IV. CONCLUSION:

The Split Ring Resonator inspired metamaterial antenna is developed 3.34 GHz and 5.35 GHz frequencies. The presented antenna could be projected for bulk production as it uses FR4 material as a substrate. The developed structure also gives other antenna parameters such as radiation pattern and gain. The bandwidth and gain could be further increased by using the laminates which are having minimum losses.

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