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DESIGN AND FABRICATION OF DUAL BAND RFID ANTENNA USING HYBRID COUPLER WITH CSRR

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ABSTRACT

Nowadays wireless communication devices are flourishing. The performance of the wireless devices must be improved and should have small size and less weight. There are many miniaturization techniques to enhance the characteristics and it gathered a widespread concentration. Microstrip patch antenna is widely used as it has better performance such as higher bandwidth, virtuous efficiency. This paper proposes design of dual band circularly polarized (CP) patch antenna with incorporation of branch line coupler with complementary split ring resonator (CSRR). The design has aperture coupled feeding technique designed for UHF and ISM band. FR-4 substrate is used for the proposed antenna. The relative permittivity of the FR-4 substrate is 4.6 and thickness of 1.6 mm which has greater design flexibility, reduced weight, low cost. The branch line coupler is evaluated in terms of S-parameters. Moreover, the antenna with the dual band coupler with separate transmit and receive ports is evaluated in terms of its impedance bandwidth, isolation, antenna gains, and axial ratios. The results showed that the coupler has good return loss and isolation loss characteristics. The proposed structure covered the band of 900 MHz and 2.4 GHz which can be used for UHF and RFID applications.

INTRODUCTION

In recent years, huge development is happening in wireless communication system. Tracking and identification of an object using Radio Frequency Identification (RFID) plays an important role in wireless communication system. RFID based tracking and identification of the object is being used in shopping malls, export, logistics, defense, medicine and security. In RFID technology, each object is attached with an electronic tag. RFID reader antenna is used to read the electronic tag through radio waves. RFID uses the frequency bands 125-135 KHz, 433.92 MHz, UHF 860-960 MHz, ISM 2.45 GHz. As RFID technology is being used in all the fields, the design of the antenna should be of simple and low cost. To satisfy these requirements, the RFID reader antenna should be designed such that it reads multi bands instead of single bands. Realization of multi band antenna is tedious work. In the existing antenna design several antennas have been designed using conventional hybrid coupler. To increase the performance of the antenna in terms of size, good stop band characteristics and cost, in this paper, dual band circularly polarized RFID reader antenna with hybrid coupler loaded with complementary split ring resonator (CSRR) is proposed. The CSRR present in the proposed antenna design ensures excellent performance compared to the conventional hybrid coupler antenna.

2. LITERATURE SURVEY

Cheng and Wong (2004) has proposed an antenna for Global Position System (GPS) applications with Circularly Polarized(CP) and aperture coupled for the frequency of 1575 and 1227 MHz. Eleftheriades et al., (2002) have proposed an antenna for an RFID system at ISM band with CP modulation. The author also compared ACP antennas for the parameters impedance, axial ratio, cross polarization, Gain and bandwidth. Liao and Chu (2010) have interchanged the positions of L and C and are assumed to possess the negative values. These are analyzed in the planar form. Maddio et al., (2011) have used a novel branch-line coupler that can operate at two arbitrary frequencies is proposed. Marcel et al., (1999) proposed RFID reader antenna using dual-band CP. The authors have used Wilkinson power divider.

Nasimudin, et al., (2010) have used UHF based RFID metallic patch antenna is proposed using CP metallic patch. The authors proposed two layered dual-band RFID reader antenna with an aperture coupling technique. Using a compact single-feed dual-band CP microstrip antenna design is proposed. The CP characteristics are attained by an uneven cross-slot that is placed in the circular patch. Circular shaped slotted microstrip patch antennas with asymmetric- slits are proposed. In this paper a new analytical has been proposed that is suitable for single-feed CP microstrip patch antenna. The two conditions are imposed by a technique derived from an equivalent circuit model of a quasi-symmetrical patch antenna. In all the above papers, patch antenna with hybrid coupler have been proposed. In the proposed paper, the performance of the antenna can be further improved by placing Complement Split Ring Resonator (CSRR)

PROPOSED WORK

(i) **Design of Hybrid coupler:** Hybrid couplers also called as branch line coupler are fundamentally 3dB directional couplers. In 3dB directional there is a phase difference of 90° between the coupled output signal and the output signal. Power is equally divided between the output port and coupled output ports in a 3dB coupler the. The design of microwave components such as electronically variable attenuators, modulators, and microwave mixers use the 90° phase difference property of directional (David, 2010).

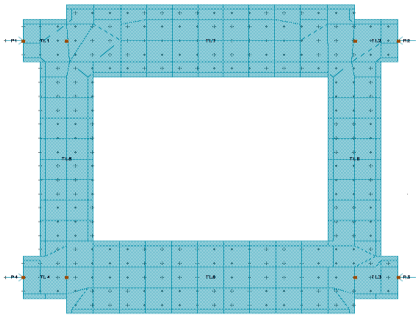

Figure-1: single band coupler

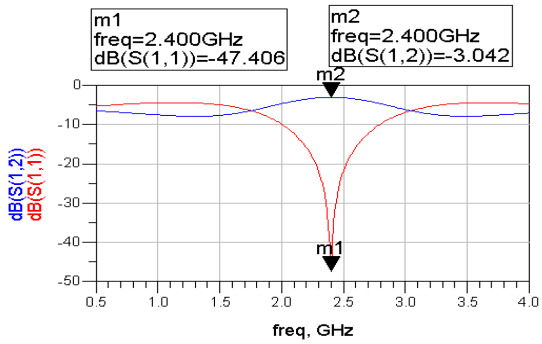

Figure-2: Return loss measurement

Fig 1 shows single band branch line coupler with Zo and Zo/√2 impedance of λ/4 transmission line. Branch Line Coupler is designed using microstrip technology on FR4 substrate, operating at a frequency of 2.4GHz. Return loss is an appropriate way to depict the input and output of signal sources. The Fig. 2 shows the measurement of return loss -47.406 dB where ideal value of return loss is less than -15 dB. Since branch line coupler also called as 3dB coupler and fig 2 observes insertion loss of single band branch line coupler as -3 dB**.**

(ii) Design of CSRR

In addition, by using SRRs in coupler design, their performance is improved compared to conventional structure as shown in fig 3. It Provides an effective negative permittivity, rather than permeability. By applying an axial time varying electric field parallel to the axis of the rings the dominant mode of excitation of SRRs is achieved. From Fig 4 at 920 MHz and 2.4 GHz return loss observed to be -27 dB and -16 dB. S_{21} is observed as -3 dB (Balanis, 2005).

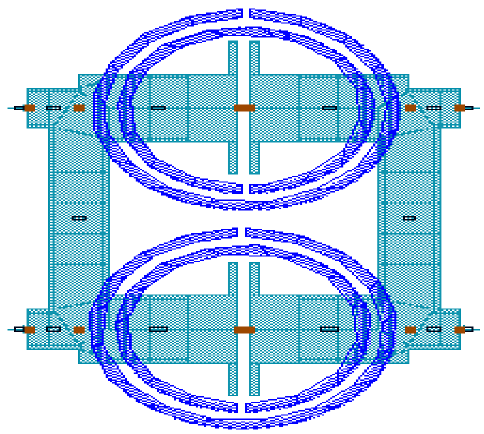

Figure-3: 90º coupler with CSRR

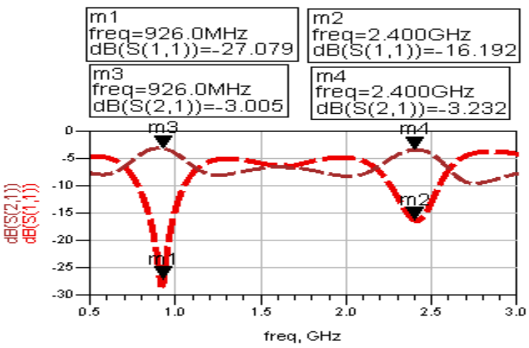

Figure-4: Return loss and insertion loss measurement

(iii) **Complete design of antenna using hybrid coupler and CSRR:** Nowadays planner microwave components are designed using split-ring resonator (SRR) and CS-RR. This is mainly used in band-pass and band-reject couplers. Micro strip lines behave as high-Q, band-reject filters when loaded with SRRs. High-Q, band-reject filters have deep stop-bands in the locality of their resonant frequencies. This is because of the generation of an effective medium with negative permeability. Similarly, a CSRR loaded micro strip line, considered as the dual of the SRR-loaded line, hinders signal propagation over a narrow band around the resonant frequency of the CSRRs. However, because of the dual relationship between the SRR and CSRR, signal reticence is due to the existence of an effective medium with negative permittivity over the stop-band.

Figure 5 represents the simulated layout of branch line coupler. To attain specific band of operation, the distance between two stubs are optimized. By minimizing the distance between the two stubs, right handed band (2.4 GHz) will move towards right and vice-versa.

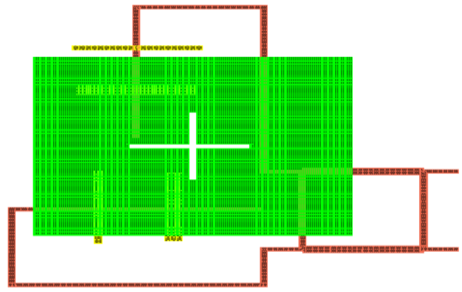

Figure-5: Structure of Complete design of antenna using hybrid coupler with CSRR

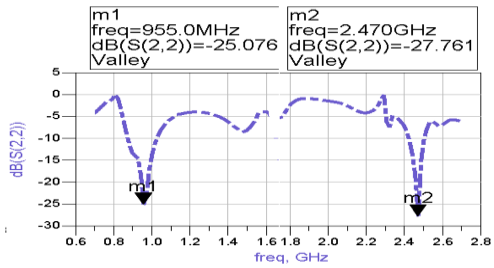

Figure-6: Return loss measurement

The return loss is alternative way of stating incongruity. Return loss is a logarithmic ratio obtained between the power reflected by the antenna to the power given into the antenna. Fig 6 shows return loss of approximately -25 dB for dual band operation.

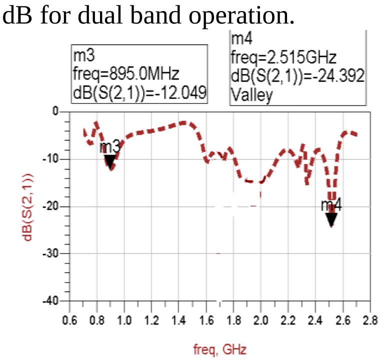

Figure-7: Isolation loss measurement

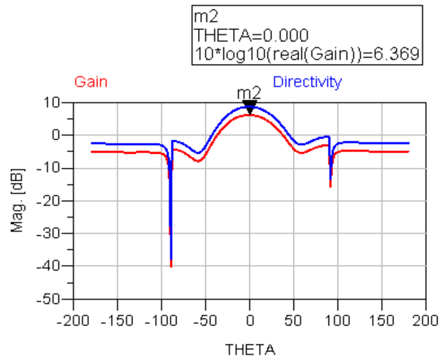

Figure-8: Gain of antenna

The coupler outputs are isolated that means, signal incoming output port two does not flow into the output port three. Isolation is defined as the ratio of a signal entering output one that is measured at output two, when all the ports are impedance matched with 50Ω. Here in Fig 7, ISM band has better isolation compared to UHF band. Gain of an antenna in a given direction is defined as "the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated iso-tropically. The axial ratio is the ratio of orthogonal components of an E-field. Axial ratios are often quoted for antennas in which the desired polarization is circular. The ideal value of the axial ratio for circularly polarized fields is 0 dB. In addition, the axial ratio tends to degrade away from the main beam of an antenna, so it indicates that the deviation from circular polarization is less than 3 dB over the specified angular range. In figure 9 shows the axial ratio as 4.550 at UHF band and 0.843 at ISM band, it is found to be good.

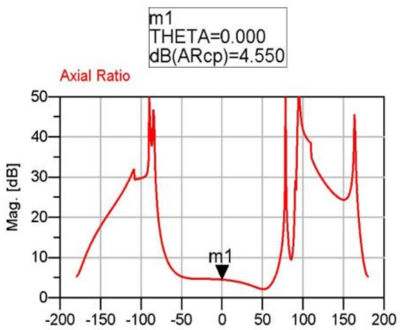

Figure-9: Axial ratio

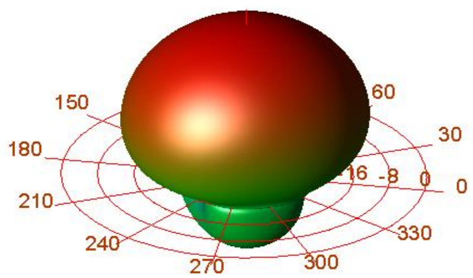

Figure-10: Radiation Pattern

Radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. It defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. The patterns are usually presented in polar or rectilinear form with dB strength. Fig.10 shows radiation pattern at UHF and ISM band

CONCLUSION

A dual-band circularly polarized aperture-coupled microstrip RFID reader antennas with separate transmit and receive ports has been proposed with a dual-band branch-line coupler. Proposed layout is designed and simulated using ADS simulation tool. The proposed antenna presents return loss of -25.076dB at UHF frequency and return loss of -27.761dB at ISM frequency. The proposed antenna presents isolation of -12.049 dB at UHF band and isolation of -24.392dB at ISM band. The maximum measured gain is 6.369dBi and 8.389dBi for dual band operation. The cross-polar gains near the broadside of the proposed RFID reader antenna are approximately less than -16dB compared with the co-polar gains. Besides, the measured axial ratios are 4.550 in the UHF band (917–923 MHz) and 0.843 in the ISM band (2.4–2.48 GHz). Thus, this antenna possesses favorable characteristics such as compact size and efficiency. The proposed antenna is easier to analyze for a dual-band RFID reader for both UHF and ISM band applications.

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