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Design of Isotropic Planar Antenna for Radio Frequency Identification

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Abstract : This paper proposes an antenna which consists of four sequential rotated L-shaped monopoles that are fed by a compact uniform sequential-phase (SP) feeding network with equal amplitude and incremental 90deg phase delay. Since SP feeding is used, separate feeding is not given to all four monopole antennas. Symmetrical meander lines are used in this antenna. Rotated field method is used for a full spatial coverage with good gain deviation. RFID is used for the purpose of automatically identifying and tracking the tags attached to the object. Planar Antenna, works in 2.45 GHz and this can be used for RFID application.Since RFID tag antennas are costly, it can be replaced by planar antennas. This Planar antenna works at the bandwidth of 39 MHz and covers a distance of one-two meters with good impedance matching.

Index Terms—Isotropic radiation pattern, rotated field, Planar antenna, RFID.

I. INTRODUCTION

Antennas are essential components of all equipment that uses radio. They can be located within the systems or outside the system. They are used in systems such as radio broadcasting, broadcast television, two-way radio communication receivers, radar communication, cell phones and Satellite and Space communication, as well as other devices such as garage door openers, wireless microphones, Bluetooth-enabled devices, wireless computer networks baby monitors and RFID tags on merchandise.

This paper aims at design an antenna which primarily covers 2.45GHz. RFID antennas are designed for operation with speedway revolution readers. They have been designed to address tough use cases where a standard patch antenna won't suffice. Antenna delivers superior system performance for applications ranging from pharmacy, retail point of sale, and race timing. The isotropic radiator antenna radiates equally in all directions and polarization does not exist. Quasi-isotropic radiation pattern has uniform power over a sphere. It is considered to be a point in space with no dimensions and no mass. This antenna cannot physically exist, but is useful as a theoretical model for comparison with all other antennas. Most antennas' gains are measured with reference to anisotropic radiator, and are rated in dBi (decibels with respect to isotropic radiator). Radio-Frequency Identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purpose of automatically identifying and tracking tags attached to objects. RFID is one method for ADIC. RFID tags are used in many industries. An RFID tag attached to an automobile during production can be used to track its progress through the assembly line. Many antennas are proposed for RFID technology. Three dimensional antennas are a combination of three antennas. One monopole antenna and two slot antenna. Small spherical antenna also supports quasi-isotropic radiation and is used in wireless sensor networks. Array of antennas are used to improve the gain and the directivity of antenna. It gives full spatial coverage. But the antenna structure is very complex. Planar antennas are having low profile, light weight, high performance and reduced cost. The low profile antennas systems are used for the next generation communications and internet applications.

II. DESIGN OF AN ANTENNA

To design the antenna, choose proper substrate, thickness and tanδ. Other dimensions like width, length are also to be defined. The structure of proposed antenna is shown in the Figure 1. The effect of the various physical parameters like patch length, patch width, aperture dimensions, antenna and feed structure, feed line dimensions are studied, by varying one parameter at a time and keeping all other parameters constant so that one can get an optimized antenna for the desired applications. In this design the length of meanderline is changed. The simulated output differs for the change in length. By decreasing the width of feeding line, the return loss increases and the resonating frequency also increases, but it affects the impedance of the antenna.

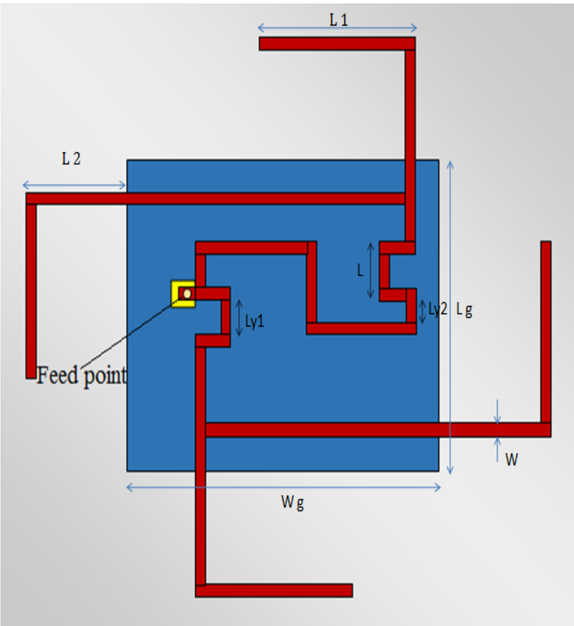


Figure 1 Structure of proposed antenna

The proposed antenna consists of array four monopole antennas. The proposed antenna dimensions and feeding point is clearly shown in the figure 1. For array of antennas, feeding should be givenseparately to allantennas. The system looks complex and energy gets wasted. To reduce the complexity of the antenna, individual feeding is eliminated. Here, coaxial feeding is given at centre part of the conductor, where the energy is transmitted equally to all parts.That is sequential type feeding system is employed in the proposed antenna structure. The width of the microstrip line is W = 1.4m, which match 50-Ohm impedance. Four L-shaped monopoles are arranged in rotational sequence and connected to the feeding ports.

Antenna is designed and simulated using Advanced Design System software. Advanced Design System provides full, standards-based design and verification with Wireless Libraries and circuit-system, EM co-simulation in an integrated platform. Table I gives the dimensions of different parameters used in the planar antenna.

Table I. Dimensions to design the proposed antenna.

Parameter	Value
L	4.5 mm
L1	14.5 mm
L2	8.5 mm
Lg	24.5 mm
Ly1	1 mm
Ly2	1 mm
Wg	24.5 mm
W	1.4 mm

The designed planar antenna is shown in Figure 2. L1 and L2 are the lengths of the monopole. L is the length of the meander line. By varying this length, the output is taken for analysis. W is the width of the top conductor. Wg is the width of Ground conductor and antenna is designed using the details given. It is simulated by setting the substrate as FR_4 with thickness of 1.2 and the tanδ value 0.02. Two conductors are used in the antenna. Both ground conductor and top conductor are chosen to be copper.

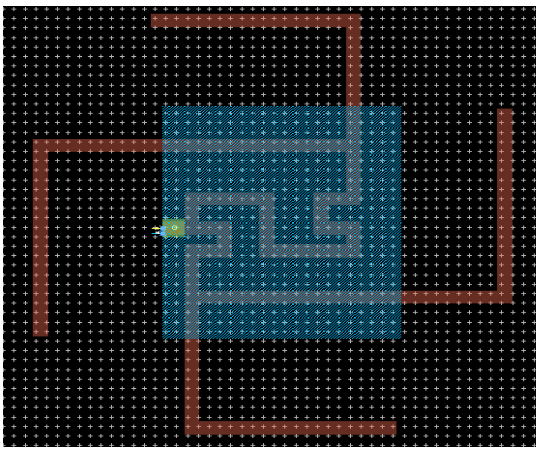


Figure 2 Design of the proposed antenna

The simulated output is shown in the figure 3(a) and figure 3(b).

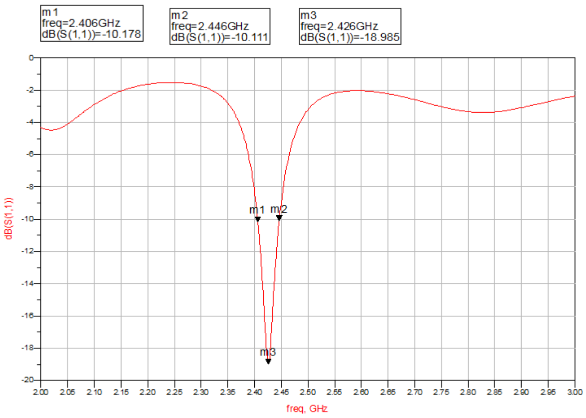


Figure 3(a)

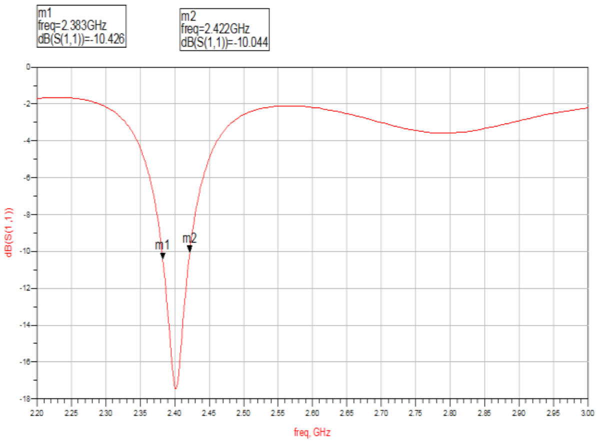
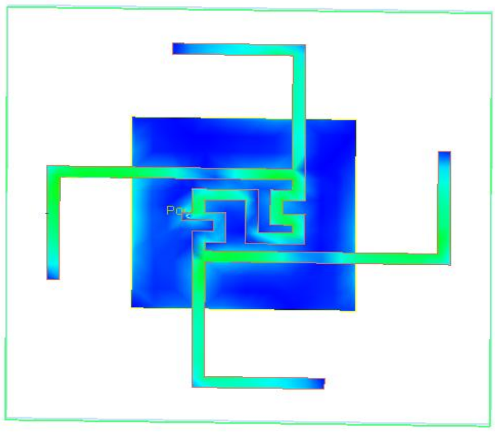


Figure 3(b)

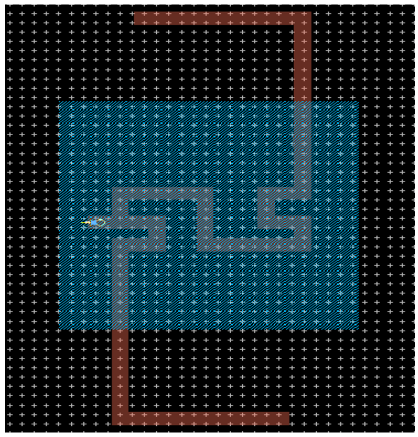
Figure 3(a) Return loss for the antenna with meanderline length L=4.5mm, (b)Return lossfor the antenna with length L = 4.4mm.

III. RESULT AND DISCUSSION

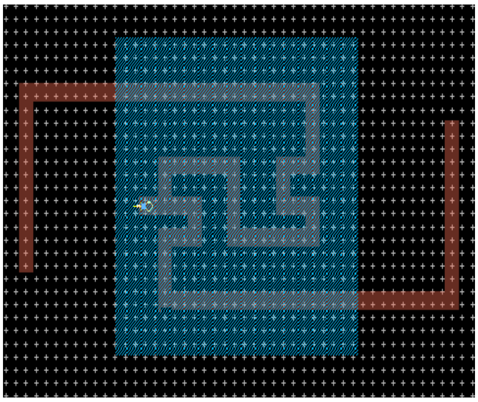
In Figure 3, m1 and m2 are the markers used in the response curve for indicating the frequencies that would be covered by the antenna, m3 is the marker to indicate the center frequency in that range. On the two sides of the substrate sequential phase feeding network and a ground plane are printed. The length of meander lines is L1 and total length of the two meander lines provide an extra 180 phase difference. Thus, the SP feeding network provides four feed ports to the four monopole antenna with equal amplitude and phases of 0, 90, 180 and 270. Four L-shaped monopoles are arranged in rotational sequence, and connected to their feeding ports. The operating principle of the proposed antenna for isotropic planar antenna is illustrated in Figure 4. Figure 4(a) illustrates the four L-shaped monopoles that are fed with different feeding combinations. In Figure 4(b) only two monopoles are excited with equal amplitude and 180 phase difference, while other two are not excited. The radiation pattern is similar to that of a dipole. Similar radiation pattern can be seen in Figure 4(c), where other two pair antenna is excited. When the four monopoles are excited with equal amplitude and phases of 0, 0, 180, and 180, the radiation pattern is shown in Figure 4(d). The four monopoles are existed with the same amplitude and phase.



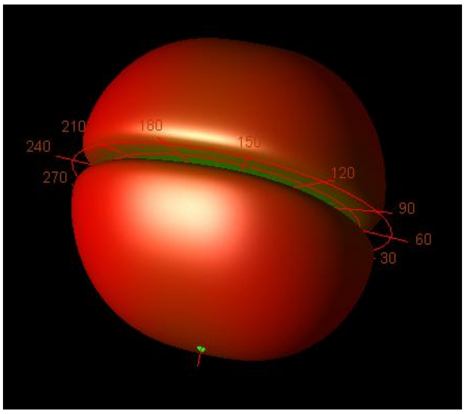
(a)



(b)

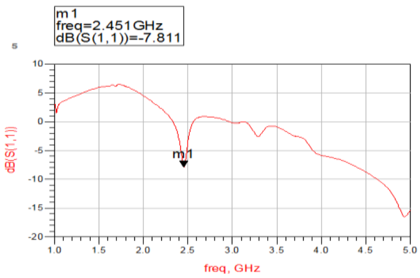


(c)

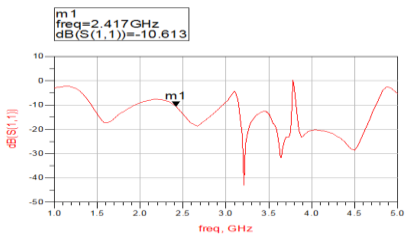


(d)

Figure 4: (a) Current distribution of planar antenna. (b) & (c) Excitation of two opposite monopole antennas. (d) Radiation pattern of the antenna.



(a)



(b)

5 (a) & (b) Return loss for the two opposite monopole antenna.

IV. CONCLUSION AND FUTURE WORK

The Planar antenna is applicable for wireless applications as it has features such as low profile, low cost, light weight, easily mounted and it is easy fabricate, it has a limitation of very narrow bandwidth. Therefore, there is a need to enhance the bandwidth of the microstrip planar antenna for Wireless applications. An isotropic radiated planar antenna is designed with FR_4 as substrate. The thickness of conductor strip is 35 microns and the dielectric constant is 4.4 for the substrate. Due to low dielectric substrate, high bandwidth is achieved. The design issues were achieving isotropic radiation, Bandwidth, maintaining the size.

The design of isotropic radiated planar antenna for RFID applications for the frequency range of 2 to 3 GHz has been completed. They work in the ISM band frequency of 2.45GHz. The future work is to improve the bandwidth of the antenna to cover wider bandwidth. Also, improvement can be made to work in dual band of frequency with reasonable gain. Further the design can be improved by designing the proposed antenna, with some changes in the monopole and by removing the meanderlines.

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