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Microstrip Patch Antenna Array for RFID Applications

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***Abstract*—** Radio-frequency identification (RFID) is an expanding technology that enables radio detection and recognition of the objects associated with an identification code carried by an electronic chip which is attached to tag. RFID belongs to group of technologies which is referred as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify the objects, collect the data, and analyze the data from the object. RFID's being extensively used in different kinds of applications and is one of the most promising in the field of IoT (Internet of Things). The design of the RFID system deals with mainly two components which are RFID tag and the RFID reader, both the system contains an antenna in it. The microstrip patch antenna is designed for UHF Gen-2 item-level tagging systems. And it is optimized to read near-field tags placed on products with a variety of packaging options. The microstrip patch antenna array for the RFID applications is designed for a particular range of frequency 865-868 MHz using a tool called CST and it will be fabricated on a Printed Circuit Board (PCB) for the required specifications.

***Index Terms*—** Microstrip Patch array antenna, RFID applications, RFID reader, CST tool, UHF.

I. INTRODUCTION

The most versatile features of the microstrip patch antennas are its simplicity, lightweight, low fabrication cost and strong ability to integrate into feed network. For an antenna, the patch shapes are chosen accordingly to match the resonant frequency, polarization, signal pattern, and impedance. The distribution of the energy into the various antenna elements can be achieved by different feeding configurations. Improvement of the efficiency, directivity, and gain for the radiating system is achieved by the array arrangements of microstrip antennas.

The RFID (Radio Frequency Identification) has become very popular which is an electronic identification technology that uses radio EM waves to exchange data between reader and tag antennas i.e., an object basically used in commercial applications. The common examples are UHF band (840-960MHz) RFID systems becoming more attractive for many applications such as supply chain, tracking, bioengineering, inventory management, large information storage capacity, logistics etc., Generally the UHF tag antennas are linearly polarized but the orientations of tag antennas are random, so actual application and requirement of RFID tag antennas are circularly polarized systems. Microstrip antenna reduces the multipath effect generated by misalignment of reader and tag antennas and becomes most effective and efficient RFID system. Therefore recently, RFID antennas are usually circularly polarized. The total frequency range of UHF band used for RFID system is 840-940 MHz. However, the frequency band for RFID application is different for different countries. In America, operating band is 902-928 MHz, in Europe 865-867 MHz, in India 865-867 MHz, in China 840.5-844.5 MHz and 920.5-924.5MHz, in Japan 952-955 MHz.

II METHODOLOGY:

The antenna is designed for the operation that enable reading of an Item Level Tag which works with UHF Gen2 RFID tags that incorporate an inductive near-field component with high performance, low cost antenna solution which can be mounted top or bottom of the table. The proposed methodology is depicted in the below flowchart, here the Microstrip patch array antenna is designed which operates at the frequency band of 865-868 MHz. The design parameters like length, width and thickness of ground, substrate and antenna are formulated. The orientation, shape and feeding technique of an antenna is designed using CST tool. The designed microstrip patch antenna is then analyzed with respect to VSWR, return loss and other specification required.

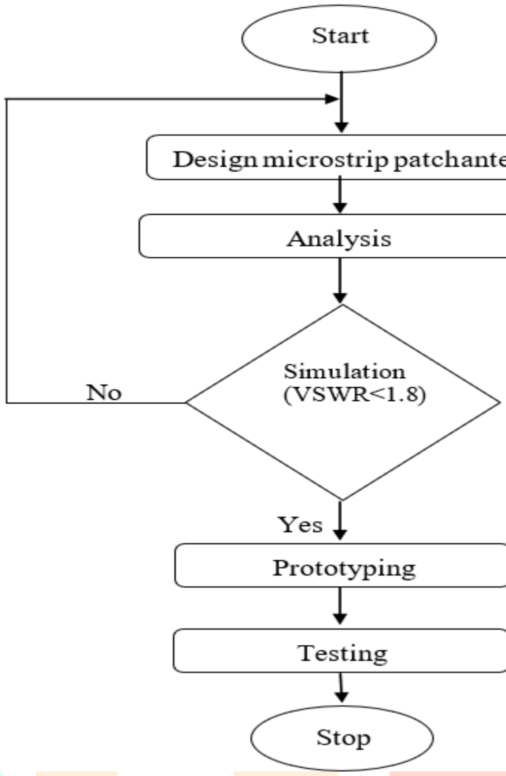

Fig 1: Flow chart of proposed antenna

III DESIGN OF PROPOSED ANTENNA

Microstrip antennas are very flexible and are used in an array to synthesize a desired pattern which cannot be obtained with a single element. We use an array to extend the performance of the antenna, scan the radiation pattern beam of an antenna system, enhance the directivity and gain which would be better compared to that of a single element. The elements can be fed by single line or by multiple lines in a feed network arrangement. The important parameter for the design of a microstrip patch antenna is the Frequency of operation (f_r). The resonant frequency of the antenna should be chosen appropriately. The RFID frequency range from 865-868MHz. Hence the designed antenna must be competent to function in this frequency range.

The resonant frequency chosen for our design is 866.5 MHz. the chosen value of the substrate (FR4 epoxy) relative Dielectric constant (ε_r) is 4.4 and the substrate thickness (h) is 1.6mm. The antenna is designed using CST tool and the results are analyzed. The designed antenna is developed on Printed Circuit Board using FR4 substrate. Then the designed antenna is tested by Vector Network Analyzer.

Fig 2: Proposed 1x2 Microstrip Patch antenna

IV RESULTS AND DISCUSSION

Voltage Standing Wave Ratio" [VSWR] is very important parameter, which is used to measure how well the antenna impedance is matched to the transmission line. The lower the VSWR is better the antenna is matched and large amount of power is delivered. The VSWR values vary from one to infinite, but VSWR value below 2 in practical implementation is acceptable for the best antenna based applications. The figure 3 depicts that the value of VSWR is less than 2 for the entire range of frequency band of 865-868MHz.

$$\text{VSWR}=\frac{1+\Gamma}{1-\Gamma}$$

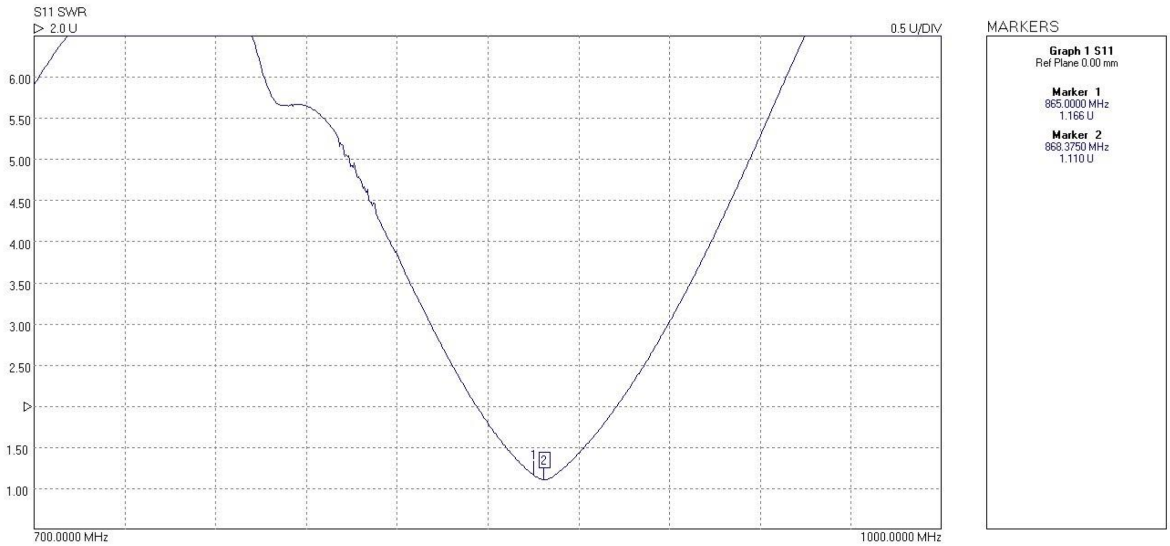

Fig 3: Voltage Standing Wave Ratio

Return Loss (RL) is another specification of interest for an antenna design that indicates the proportion of radio waves arriving at the antenna input that are rejected as a ratio against those that are accepted. It is specified in decibels (dB). Basically the return loss should be less than -10dB, which is shown in the figure 4 below. The figure 5 and 6 shows the directivity and gain plot of an antenna designed.

$$r=\frac{\text{VSWR}-1}{\text{VSWR}+1}$$

$$\text{RL}=-20\text{Log}_{10}(r) \quad \text{Where } r=\frac{\text{VSWR}-1}{\text{VSWR}+1}$$

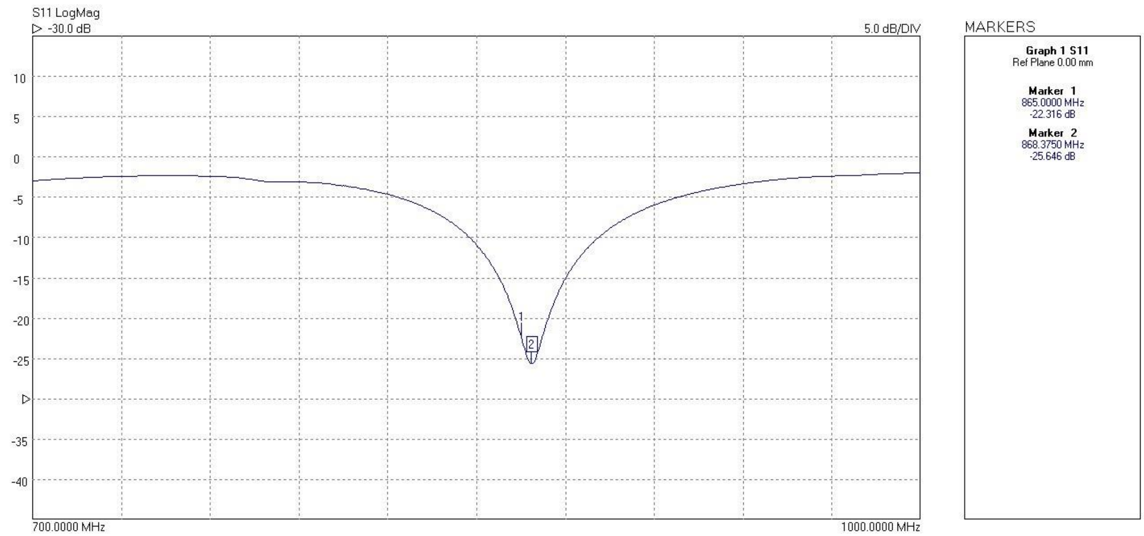

Fig 4: Return loss of Microstrip patch Array Antenna

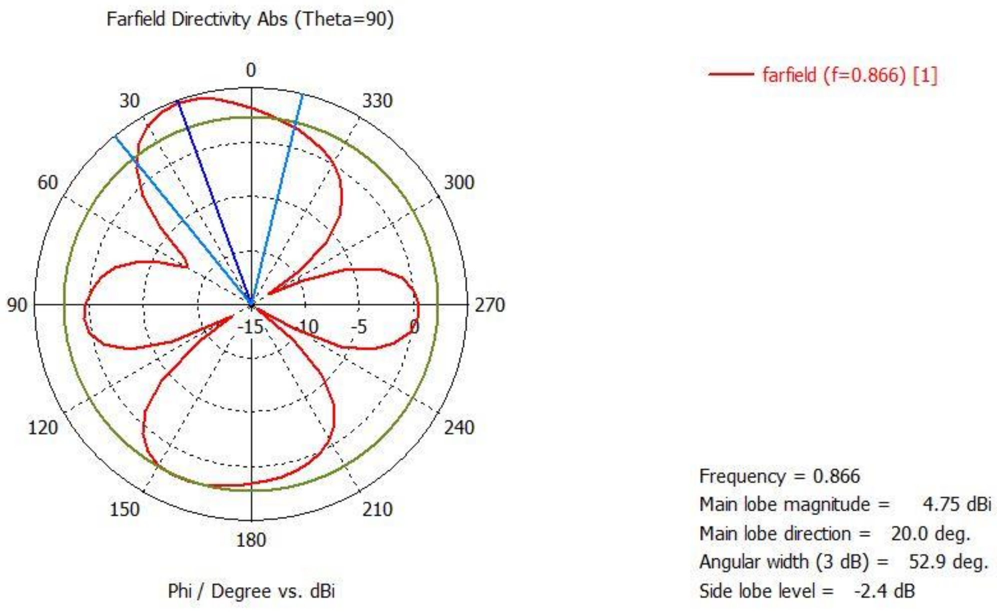

Fig 5: Directivity Plot

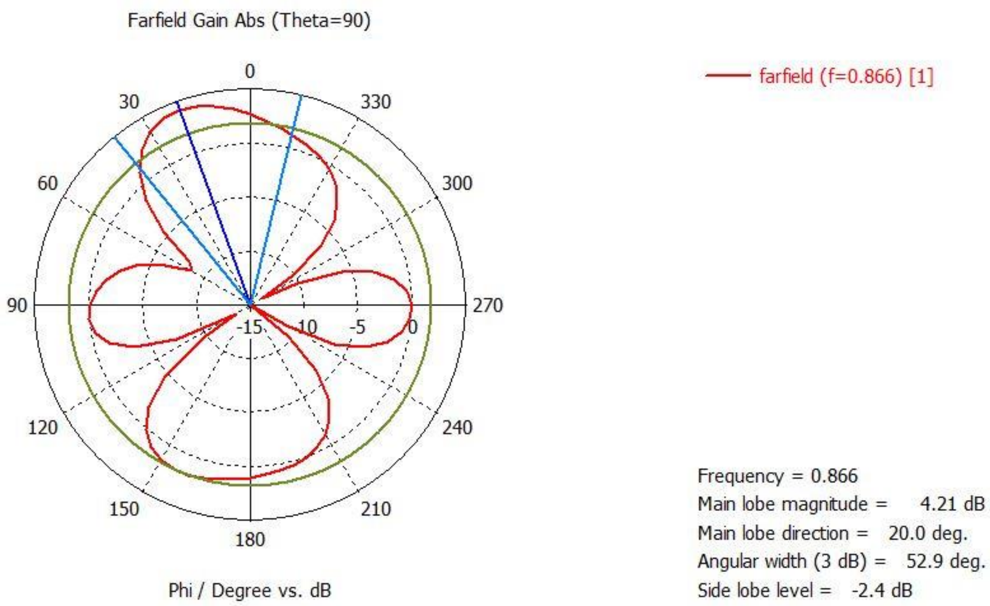

Fig 6: Gain Plot

V CONCLUSION

The microstrip patch array antenna for RFID application for the range of 865-868MHz with VSWR less than 2 and return loss of less than -10 dB is designed using CST tool and it is analyzed using network analyzer. The designed antenna is fabricated on Printed Circuit Board and tested based on required specifications.

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