Design and Implementation of Dual Polarized Printed Antenna for RFID Application

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Abstract: The Radio Frequency Identification (RFID) was introduced as a new technology of Barcodes. RFID is automatic identification technology which uses radio frequency electromagnetic field to identify object carrying tags when they come close to the reader. Antenna are utilized respectively at the reader and the tag namely, reader antenna and the tag antenna. The purpose of the reader antenna is to process a transmitting / receiving so the reader can identify the presence of one or several RFID tags. RFID tags features and electronic chip with an antenna in order to pass onto the interrogator. Since the tag antenna on normally linearly polarized, circularly polarized radiation of reader antenna is preferred in order to make the identification reliable and more efficient, regardless of the physical orientation of the tag antenna. One of the important things in RFID tag is reduce size with conserving a good read range. This is can be achieved through developing a small antenna with high gain. Antenna design has played a critical role in the increasing development of RFID technology. Microstrip antenna is the best form of the printed antenna was designed by ADS simulation tool a modification to prevailing design is tried out and comparable results are obtained. This paper present the Design of the patch antenna with the hybrid coupler where the Return loss, Gain, Directivity is discussed for same patch antenna with an increase in its slots. The size of the element is determined by the operating frequency, dielectric constant and height of the substrate. Later the antenna was measured by using VNA (Vector Network Analyzer) to perform the antenna measurements.

Keywords: ADS, Microstrip antenna, Hybrid Coupler, RFID.

I. INTRODUCTION

Antenna are the parts of modern tools of communication, this printed patch antenna find large application in the wireless communication .An RFID system is made up of three components, computer with an RFID application, a reader and a transponder .Data (identification number for instance) included in the electronic chip of the RFID label can be collected by the reader . This reader can also change the content of the label's memory. RFID tags generally feature an electronic chip with an antenna in order to pass information onto the interrogator (also known as base station or reader). The assembly is called an inlay and is then packed to be able to withstand the condition in which it will operate. This finished product is known as tag, label or transponder. The information contained within an RFID tag electronic chip depends on its application. It may be unique identifier (Union Item Identifier or EPC code, electronic product code etc) .once this identifier has been written into the electronic circuit, it can no longer be modified, only read. This principle is called WORM (Write Once Read Multiple). RFID has to be complained with local regulation (ETSI, FCC etc), Super high frequency 2.45GHZ. A patch or printer antenna is a type of radio antenna with a low profile, which can be mounted on flat surface. It consists of a rectangular sheet or patch of metal, mounted over a large sheet of metal called as ground plane. The patch is mainly square, Rectangular, Circular, Triangular some other usual shapes. A micro strip patch antenna consists of a radiating patch (Perfect Electric Conductor), substrate and ground. The micro strip patch antenna is widely used in the applications satellite communication, remote sensing, etc.
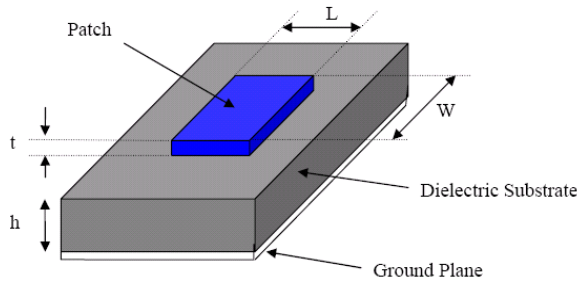
II. ANTENNA PROPERTIES

The performance of the antenna is determined by several factors such as input impedance, bandwidth, directivity, gain, polarization, return loss, radiation pattern etc.

Antenna impedance will vary with frequency. For an efficient transfer of energy, transceivers and their transmission line are typically designed for 50ohm impedance in order to avoid the mismatch. Bandwidth is the range of usable frequencies within the performance of the antenna, with respect to some characteristic, conforms to a specified standard. Directivity is the important parameter that shows the ability of the antenna focusing radiated energy. It is a measure of how directional an antenna's radiation pattern is an antenna that radiates equally in all the directions would have effectively zero directivity to, a relative measure of an antenna's ability to direct or concentrate radio frequency energy in a particular direction or pattern is a gain. The polarization of the antenna describes the orientation and sense of the radiated wave's electric field vector. The basic polarization types are linear, elliptical and circular. Return loss or reflection loss is the reflection of signal power from the insertion of the device in a transmission line or optical fiber. For an antenna to radiate effectively, the return loss should be less than-10db. The antenna pattern is the graphical representation in a three dimensional of a radiation of an antenna as the function of direction.
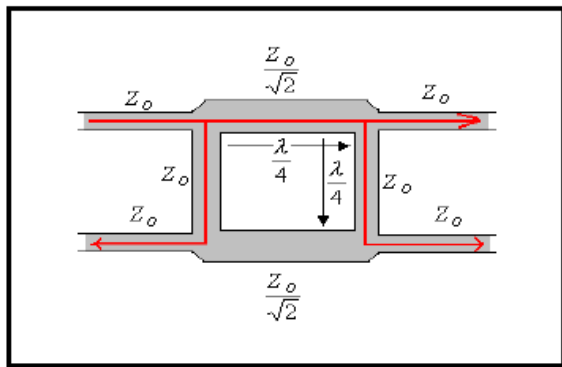
III. PATCH ANTENNA

Typical micro strip patch antenna that consists of a metal (patch) on the top of grounded dielectric substrate is shown. This patch can be made of different shapes rectangular being the most common shapes. Moreover, the patch antenna is fed by a micro strip transmission line. The patch and the fed lines are usually made from copper. The four feed techniques are micro strip line feed, coaxial probe feed, aperture coupling feed and proximity coupling.

IV. HYBRID COUPLER

Hybrid Coupler is the special case of a four-port Directional coupler and it is a passive devices. Here the input power is equally divided between the two output ports. In Hybrid coupler, the given input signal is made to split with the 90° phase shift between the output signals or it may be used to combine two signals .It is often used in creating the reflection phase shifter

V. NUMERICAL ANALYSIS

All of the parameters in a rectangular patch antenna design (L, W, h, permittivity) control the properties of the antenna. The length of the patch L controls the bandwidth. The proposed rectangular micro strip patch antenna as the substrate of FR4 with have the combination of epoxy resin and glass fabric, thickness of the substrate 1.6mm, dielectric constant value is 4.6, operating frequency 2,45GHZ, input impedance is 50ohm, tan δ =0.019 and both linear, circular polarization occur. Then to calculate width by using the for

$$W = \left(\frac{C}{2 \ f_0 \ \sqrt{\frac{(\varepsilon_r + 1)}{2}}} \right)$$

The effective dielectric constant is calculated based on the height, width and dielectric constant

$$\varepsilon_{eff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

By knowing the operating frequency and effective dielectric constant, we can find the effective length of the antenna

$$L_{eff} = \frac{C}{2 \ f_0 \ \sqrt{\varepsilon_{eff}}}$$

The length extension is found using effective dielectric constant, width, height of the antenna

$$\Delta L = 0.412h \ \frac{(\varepsilon_{eff} + 0.3) \left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{eff} - 0.248) \ \left(\frac{W}{h} + 0.8\right)}$$
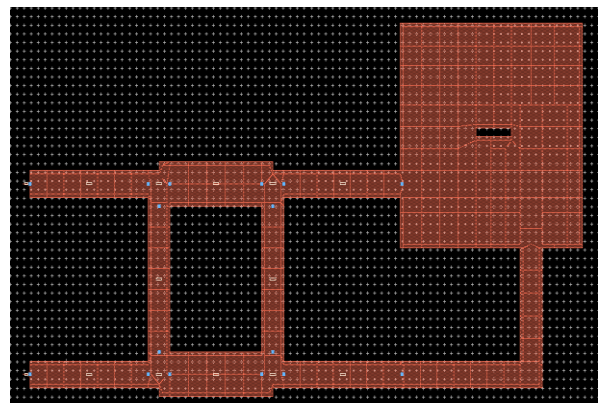
Finally, find the actual length of the patch antenna

$$L = L_{eff} - 2\Delta L$$

After calculation the final value is length 17.94 and width is 21.6, the values are implemented to ADS software tool and simulate it.
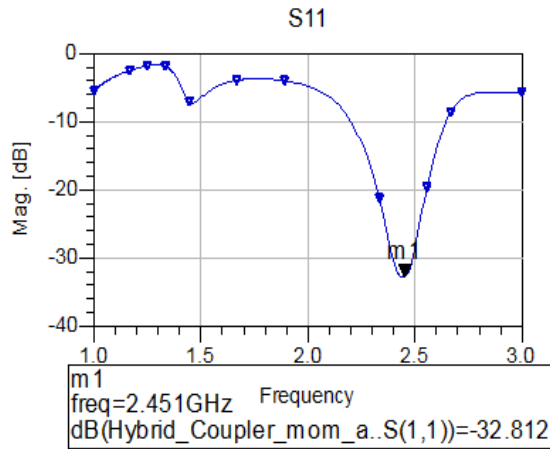
VI. SIMULATION PROCEDURE

Advanced Design System (ADS) is a powerful electronic design automation software system. It offers complete design integration to designer of products and also support system of RF designs Engineers. ADS run on pc and workstation, with complete file compatibility between platforms and across networks. To define the real dimension of a rectangular patch antenna at 2.45 GHZ, we have simulated with the approximate value of parameters of patch antenna such as length, width, substrate, thickness. Slot antenna consists of a metal surface, usually a flat plate, with a hole or slot cut out. The rectangular patch antenna above figure is slotted using plotting the coordinates of the antenna using software tool. Then simulate the patch antenna and get the return loss, operating frequency, etc. After the fabrication of the patch antenna, the parameter is measured using Vector Network Analyzer.
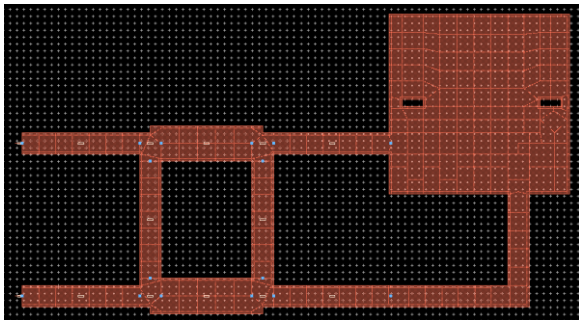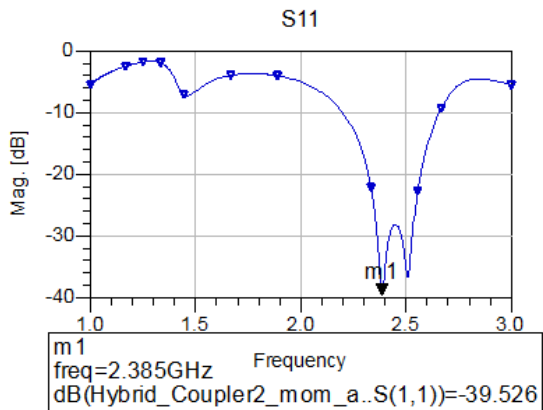
A. Design of Hybrid Coupler with single slot

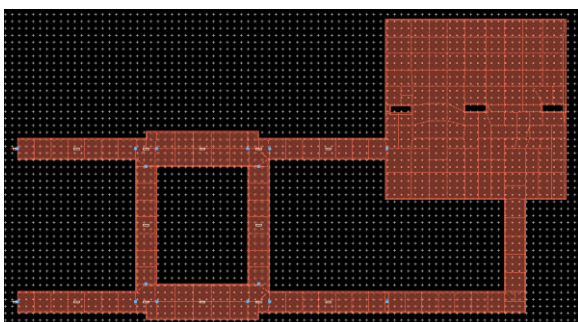**B. Simulated Output of Hybrid Coupler with Single slot**

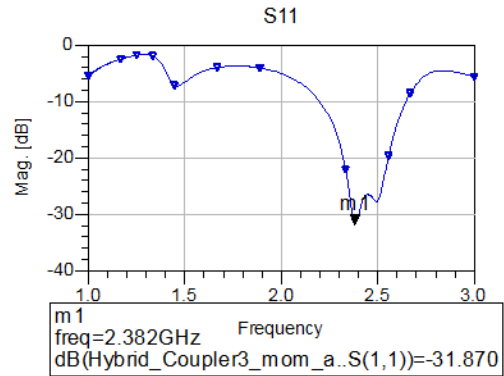**C. Design of Hybrid Coupler with Two slots**

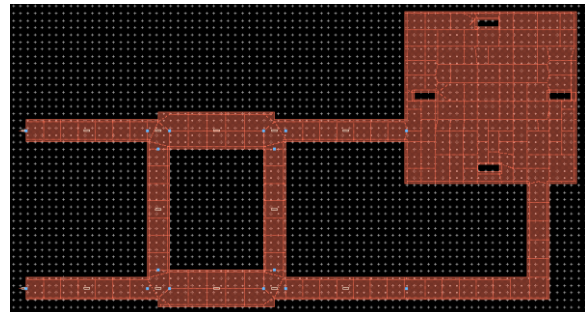
D. Simulated output of Hybrid coupler with two slots

E. Design of Hybrid Coupler with three slots
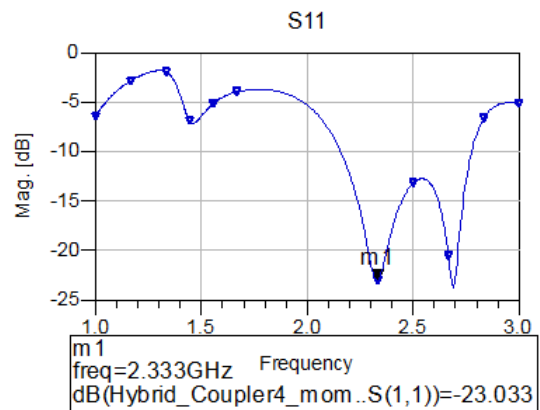

F. Simulated output of the Hybrid Coupler With Three slot

G. Design Of Hybrid Coupler with Four Slots

H. Simulated Output of Hybrid Coupler with Four slots

Table_1. Comparisons between the results obtained

Specification	Hybrid coupler with			
	1 Slots	2 Slots	3 Slots	4 Slots
Frequency	2.45	2.38	2.38	2.33
Substrate	FR4	FR4	FR4	FR4
Return Loss	-32.81	-39.5	-31.8	-23.0
Power Radiated	15.2×10^4	14.9×10^4	14.9×10^4	15×10^4
Effective angle	3.66	3.81	3.83	3.57
Gain	-4.4	-4.2	-4.1	-4.6
Directivity	5.34	5.17	5.15	5.45
Return Loss	-32.81	-39.5	-31.8	-23.0

Table 1 compares the result obtained by all the hybrid coupler of varying slot length. This shows that 3 db Hybrid coupler connected through ground plane to the square patch antenna having simulated return loss of about -32.81 at 2.45 GHz with one slot. This proposed technique has a directivity of 5.34

VII. CONCLUSION

In this paper 3 db hybrid coupler was chosen and the effect of various structure of microstrip antenna with the hybrid coupler of different slot is compared in terms of return loss, gain, Effective angle, Power etc. Good design of antenna can improve the performance of the system. It has been established that depending on the substrate used, there is a change in the size of the antenna. The Micro strip patch with the FR4 substrate is designed fabricated and its parameter are measured. A method of designing an affordable, small size 3 db hybrid coupler with different slots with its parameter is made effectively. The micro strip antenna resonates at 2.45 GHz and gives a good return loss , of about -32.81 dB .Return loss shows the impedance matching and best return loss is greater than 10 db, which is achieved in the proposed antenna The Hybrid coupler which is validated into simulation can also be used for ISM band application, RFID application. In addition, the proposed antenna has good radiation characteristic and impedance matching in the operating bands. The future work will focus on the improvement of the Gain for the betterment of the system's efficiency.

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