A Review on Circular Polarized Microstrip Patch Antenna 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 circular 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 circular microstrip patch antenna 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—**Circular Microstrip Patch Antenna,RFID applications,RFID Reader,CST tool,UHF.**

I. INTRODUCTION

The most versatile features of the circular microstrip patch antennas (CMPA) 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. Circularly polarized 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. RELATED WORK

Due to the modern technological advances, the technical demands for RFID systems have increased in various industries. The demand for low cost and low profile antennas for RFID applications can be met by microstrip patch antennas. Demand for RFID systems has become tremendous in the recent years in many fields specially in manufacturing, retail, supply chain, transportation etc. Radio Frequency Identification (RFID) is a radio communication based tagging and identifying system of an object. Generally, there are four common bands for RFID systems. They are the low-frequency (LF) band of 125 kHz to 134 kHz, high-frequency (HF) band for 13.56 MHz, ultra-high frequency (UHF) for 860MHz to 960 MHz and microwave (MW) band for 2.45 GHz or 5.8 GHz. The microwave bands are popular than other RFID bands in many areas because of its high readable range, fast reading speed, large information storage capability and low cost. An inset fed micro-strip patch antennawas designed and simulated at resonant frequency of 865-868MHz.

HFSS-based design and fabrication of a 2.4 GHz microstrip patch antenna for WLAN applications. HFSS software is used to construct a rectangular microstrip patch antenna in this paper. The developed antenna has a 2.4 GHz resonant frequency and can be used in a Wireless Local Area Network (WLAN). This document depicts the proposed antenna's design considerations as well as its simulated results. The design is printed on FR-4 Epoxy, which has a dielectric constant of 4.4 and a thickness of 1.5mm and is utilised as a dielectric medium. The proposed antenna is then built based on the HFSS simulation software's simulated design.[1]

An AND gate-shaped microstrip patch antenna array with several company feeding techniques is shown in this paper. This paper also includes a comparative examination of these feeding techniques. The proposed antenna can be used for RFID applications and is designed for a 5.8 GHz operating frequency. The results include parametric analyses that varied the substrate's dimensions as well as the length of the ground. At the resonant frequency of 5.8 GHz, this patch antenna has a peak gain of 5.24 dB.[2]

They presented the design of an RFID reader antenna array to detect automobiles in a limited region in this study, with the ISM (Industrial, Scientific, and Medical) band as the frequency band for this application: This antenna array, which operates between 2.4GHz and 2.483GHz, is made up of four radiating elements that enhance gain and directivity in a direct proportion to range. In any design, choosing the right substrate for the frequency of usage is critical, thus we went with the FR4 substrate (r=4.6, H=1.6mm, and tan=0.018) for cost and performance. ADS (Advanced Design System) software is used to design and simulate the antenna array.[3]

With the development of various modelling tools, efficient designs of MSA's in diverse patch configurations are being practised, considering different substrate /superstrate combinations at identified microwave frequencies of interest at recognized microwave frequencies of interest. The performance characteristics of a circular patch microstrip printed antenna at 3.5 GHz, which is appropriate for WiMAX applications, are investigated in this dissertation.[4]

For radio frequency identification (RFID), a single layer coaxially fed rectangular microstrip slotted antenna with circular polarisation (CP) is proposed. Along the diagonal axis of a square patch, two triangular shaped slots and one rectangular slot have been implanted. With a 4.04 percent reduction in the size of the microstrip antenna, good circular polarisation quality was achieved thanks to a slotted structure along the diagonal axis and less surface area. The performance of circular polarisation radiation has been investigated by varying the size and angle of diagonally slotted devices. At the resonant frequency of 910 MHz, the experimental result for 10 dB return loss is 44 MHz with 10 MHz of 3 dB Axial Ratio (AR) bandwidth. The total size of the proposed antenna, including the ground plane.[5]Today, GPS receivers are mostly utilised for satellite navigation of vehicles, aircraft, and ships, as well as cellular communication. Patch and quad helix antennas are the two most common types of antennas used in GPS receivers. Because of their minimal weight, ease of installation, single hemisphere radiation pattern, and low profile, microstrip patch antennas are ideal for GPS receivers. The goal of this study is to design and build a new type of inset feed Circular Microstrip Patch Antenna (CMPA). Patch antenna characteristics can be improved by placing a circular slit in the ground plane's centre. The improvement of the antenna construction at 1.8 GHz was prioritised using simulation programme CST Microwave Studio. It is based on simulation and measured outcomes.[6]

This work discusses and presents a circular microstrip patch antenna with a single band notch feature that uses one U slot on the radiating patch. The ground plane has been altered by truncated ground at the top corners. Microstrip feed and a modified ground plane are employed. The frequency range of this circular ultra wideband antenna is 2.3086 to 12.0056 GHz, with a single band notching range of 3.2457 to 3.1029 GHz. This ultra wideband antenna can be used for applications in the C band (between 4 and 8 GHz), upper S band (between 2 and 4 GHz), X band (between 8 and 12 GHz), ITU uplink satellite communication band (between 8.1 and 8.4 GHz), RFID (between 6.6 and 7.1 GHz), and WLAN (between 5.2 and 5.8 GHz).[7]

This paper presents the design and analysis of a wideband microstrip patch antenna performance for Industrial, Scientific and Medical (ISM) band (2.45 GHz) applications e.g., Radio Frequency Identification Application (RFID) applications. A Flame Retardant-4 (FR-4) material is used as substrate and the size is $29\times46mm^2$.This antenna has a gain of 3.019dB with VSWR of almost 1.3 and sHPBW of about 111.3 deg. This antenna has an ultra-wide bandwidth of about 21.67% with resonant frequency at 2.4 GHz. The performance of the proposed antenna is analyzed as well as compared with various RFID reader antennas at ISM band. It is designed and simulated in CST Microwave Studio software.[8]

The design of a passive RFID tag antenna operating at 2.45 GHz is presented in this study. For design and simulation, CST electromagnetic simulation software is utilised. The read range performance (up to 5 m) was satisfactory, with a high gain (5.842dB), good impedance matching with the microchip (- 30.0 dB Return Loss), and a high gain (5.842dB). One method to RFID tag design is to make the tag less sensitive to different sorts of things. By positioning the tag antenna against metallic, rubber, glass, and wood surfaces, the effects of barriers on antenna characteristics were explored. The simulation results show minor deviations that are within the acceptable range.[9]

This work presents a microstrip patch antenna for a passive radio frequency identification (RFID) tag that operates in the ultra high frequency (UHF) range of 865 MHz to 867 MHz. The proposed antenna is intended and suitable for marking metallic boxes in a warehouse environment in the United Kingdom and Europe. The simulation findings are used to supplement the design. Furthermore, the influence of the antenna substrate thickness and ground plane on the suggested antenna's performance is explored. The results reveal that the thickness of the antenna substrate has no effect on performance.[10] This paper describes the theoretical analysis and experimental testing of three compact microstrip patch antennas developed for RFID (Radio Frequency Identification) readers in the ultra high frequency (UHF) band from 865 to 868 MHz. The characteristics and performance of the new miniature antennas are compared to traditional 1/4 wavelength patch antennas and improved truncated square patches with short-circuit pins. The proposed patch antenna is compact and measures 80mmx70mm when combined with the ground plane. Double circular polarization provides a reading range of up to 9 feet in the horizontal and vertical tag orientations. This article presents a simple and innovative way to miniaturize antennas for an increasing number of RFID applications.[11] Design of UHF microband micro-patch antenna for RFID readers with center frequency 867MHz as specified in European Gen2 protocol standard. Patch antenna printed on FR4 material with a dielectric constant of 4.55 with dimensions of 10 x 12 cm, from measurements at 867 MHz, S11 was observed at -22 dB with an input impedance of 42.4Ω.[12]

III EXISTENCE METHODOLOGY:

TABLE I shows the comparison of the RFID reader and tag antennas at UHF band. Comparing the parameters, it can be realize that the proposed antenna has high gain than the reference antennas. Also, the return loss and VSWR are good compared with other RFID antennas. After all, the antenna results reveal the suitability of RFID applications at UHF band.
The figure 1(a) shows the return loss against the UHF frequency of the microstrip patch antenna[10]. And figure 1(b) shows theobtained VSWR of microstrip pacth antenna[8].

I. TABLE- COMPARISON OF VARIOUS RFID ANTENNAS

Antenna Parameters	VSWR	Return Loss (dB)	Frequency Range(MHz)	Gain (dB)
Proposed Antenna (2.4GHz)	<1.8	-25	865-868	5
Ref [5]	-	-10	889-933	-
Ref [8]	<1.31	-17.43	-	3.019
Ref [10]	-	-21.03	865-867	-
Ref[12]	-	-22	867	-

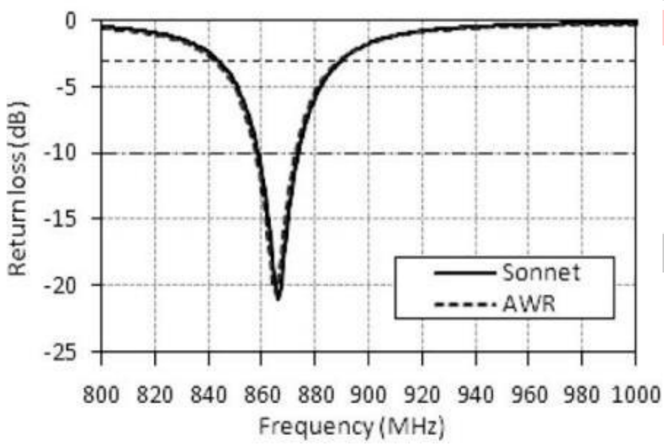

Fig1: (a)

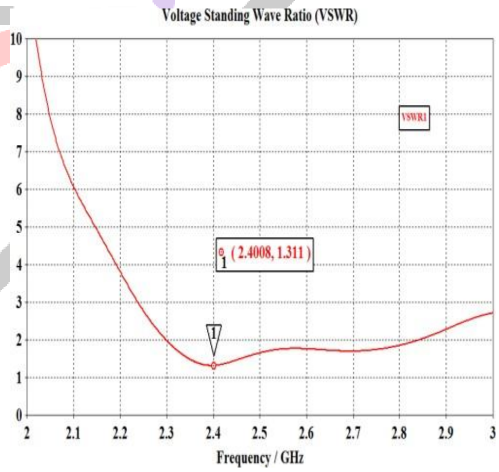

Fig1: (b)

Fig1(a): Return loss against UHF frequency for microstrip patch antenna [10]
Fig1(b): VSWR of antenna [8]

IV PROPOSED METODOLOGY

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 Circular Microstrip patch 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 specificationrequired.

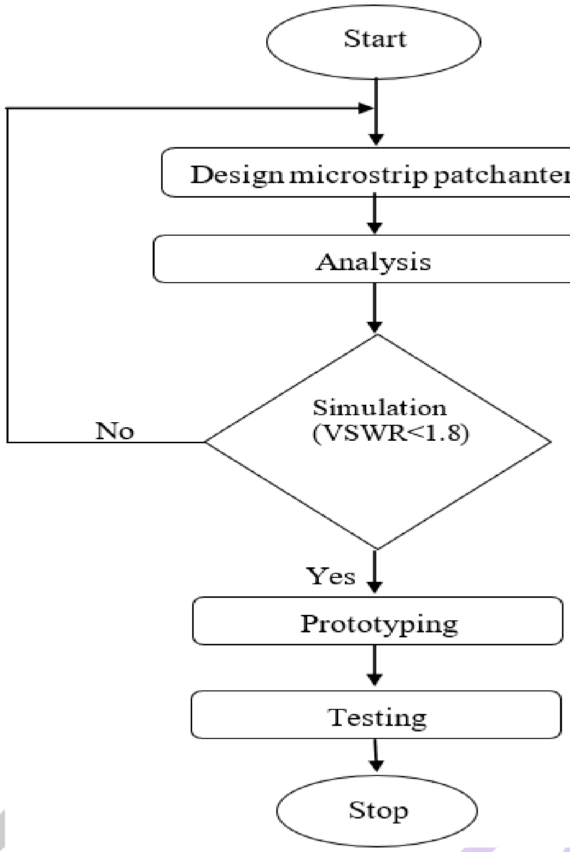

Fig 2: Flow chart of proposed methodology

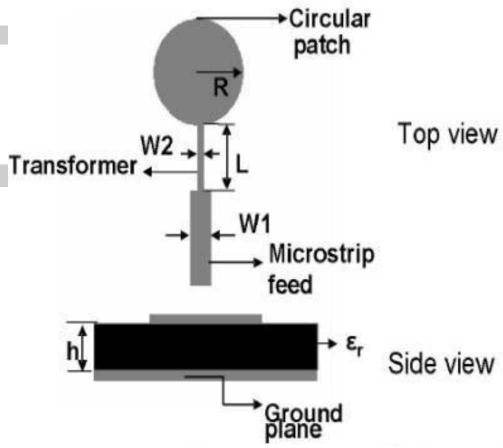

Fig 3: Edge feeding of Circular Microstrip Patch Antenna[4]

V TOOLS USED

CST offers accurate, efficient computational solutions for electromagnetic design and analysis. CST 3DEM simulation software is user-friendly and enables to choose the most appropriate method for the design and optimization of devices operating in a wide range of frequencies. Passive microwave & RF component design is a major application of CST STUDIO SUITE®, and supporting it is one of CST's core competencies. Design engineers use the exceptional performance of CST MICROWAVE STUDIO® (CST MWS) for developing a wide variety of applications, such as antennas, filters and couplers. CST STUDIO SUITE is characterized by its easy-to-use interface; diverse import filters, versatile parameterization capabilities and automatic optimization tools, and includes the powerful post-processing options that get your development process up to speed.

CST MWS offers a broad range of solver technologies, operating in the time and frequency domain and capable using surface meshes as well as Cartesian and tetrahedral volume meshes. To complement the general-purpose solvers, CST MWS also includes an integral equation solver, an asymptotic solver, an eigen mode solver and a T LM solver, each well-suited to different situations. With CST's ―Complete Technology approach to simulation, the best 3D EM solver for any given problem is just a mouse click away. EM/circuit co-simulation is also supported in CST STUDIO SUITE through CST DESIGN STUDIO™, as well as through links to third-party software such as NI AWR Software and Agilent's simulation tools. Thermal and mechanical analysis of electromagnetic losses is also possible, thanks to the seamless integration of CST MPHYSICS®STUDIO within the CST STUDIO SUITE design environment. Antennas never operate in isolation, but are attached to a feed network.CST DESIGN STUDIO™ (CST DS) allows the hybrid co-simulation of the effect of an attached circuit on the antenna performance. Installation of an antenna in a device or on a platform makes its analysis even more complex. The System Assembly and Modelling framework in CST DS allows the user to set up coupled simulations which can combine different solvers automatically by making use of field sources.

VI CONCLUSION

The research motivation for this paper is to design and develop a circular microstrip patch antenna for RFID application for thegiven specifications. The circular microstrip patch antenna will be designed using CST tool and is analyzed using network analyzer.

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