# *Design and Analysis of Circularly Polarized UHF Antenna for RFID Application*

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***Abstract*-A broadband circularly polarized square patch antenna is proposed for ultrahigh frequency (UHF) RF identification (RFID) applications. It could be worked at universally. The antenna is composed of three corner truncated patches and a suspended microstrip line with open circuited termination. The main patch is fed by four probes which are sequentially connected to the suspended microstrip feed line. The measurement shows that the antenna achieves a return loss of -15 dB, gain of 8.4 dBic, axial ratio (AR) of 2.1 dB, and over the UHF band of 818–964 MHz .Therefore, the proposed antenna is universal for UHF RFID applications worldwide at the UHF band of 840–960 MHz. In this, RFID application to improving the gain and coverage of the antenna that can operate universally.**

***Index terms- RF identification (RFID); ultrahigh frequency (UHF); axial ratio (AR); broadband antenna, circularly polarized (CP); sequential feed.***

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## I. INTRODUCTION

RF IDENTIFICATION (RFID), which was developed around World War II, the allied wanted to distinguish its own aircraft from the enemy aircraft. At that time they developed the Identification Friend-or-Foe (IFF) system. The IFF system was developed so that a transponder was attached to an allied aero plane. This transponder received a signal and sent an adequate signal back. This technology is the basis for the world is air traffic control systems today. Because of the high cost and large size of components, the early use of radio identification through the 1950.s was generally limited to the military and research labs. When more compact and cost-effective technologies, for example IC and the microprocessor, arrived, RFID as it is known today were developed. In the late 1960.s and 1970.s companies introduced new uses for RFID for less complex and more widely used applications.

The RFID technology that provides wireless identification and tracking capability. In recent years, RFID technology has been rapidly developed and applied to many service industries, distribution logistics, manufacturing companies, and goods flow systems [1], [2]. In an ultrahigh frequency (UHF) RFID system, the reader emits signals through reader antennas. When an RFID tag comprising an antenna and an application specific integrated circuit (ASIC) is located in the reading zone of the reader antenna, the tag is activated and interrogated for its content information by the reader. The querying signal from the reader must have enough power to activate the tag ASIC to perform data processing, and transmit back a modulated string over a required reading distance. Since the RFID tags are always arbitrarily oriented in practical usage and the tag antennas are normally linearly polarized, circularly polarized (CP) reader antennas have been used in UHF RFID systems for ensuring the reliability of communications between readers and tags [3], [4].

Globally, each country has its own frequency allocation for UHF RFID applications, e.g., 865-867 MHz in India, 840.5–844.5 and 920.5–924.5 MHz in China, 866–869 MHz in Europe, 902–928-MHz band in North and South of America, 866–869and 920–925 MHz in Singapore, and so on, so that the UHF RFID frequency ranges from 840.5to 955 MHz (a fractional bandwidth of 12.75%) [5]. Therefore, a universal reader antenna with desired performance across the entire UHF RFID band would be beneficial for RFID system configuration and implementation, as well as cost reduction. In this paper, we propose a sequentially fed stacked CP patch antenna for UHF RFID applications.

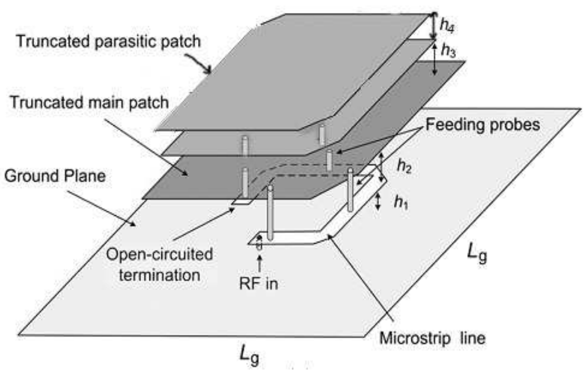
The antenna comprises three suspended truncated patches and a suspended microstrip line. The main patch is sequentially fed by four probes which are connected to the microstrip line. A parasitic patch is positioned right above the main patch for enhancing the bandwidth. The corners of the patches are truncated to enhance the axial ratio (AR) performance. The proposed antenna is designed to cover the UHF RFID band of 840–960 MHz with acceptable performance in terms of gain, AR, and impedance matching. Meanwhile, the antenna configuration is simple and easy for fabrication.

The remainder of this paper is organized as follows. Section II describes the geometry of the proposed antenna. The simulated results, analysis, and discussion are presented in Section III. Section IV presented antenna conclusion and discussion.

## II. ANTENNA CONFIGURATION

CP antennas can be realized when two orthogonal modes of equal amplitude are excited with a 90 degree phase difference [6]. In general, the feeding structures of CP antennas can be categorized into single and hybrid feeds. A single feed of a CP antenna has the advantages of simple structure, easy manufacture, and small size in arrays. However, the single fed single patch CP antenna in its simple form has inherently narrow AR and impedance bandwidths of 1%–2% [7]. To improve the bandwidth, a variety of CP antennas have been studied, where in the bandwidth of AR, impedance matching, and gain have been enhanced, e.g., by modifying the radiator shape, designing feeding structures, and optimizing antenna or array configurations [8]–[17]. Usually, a CP antenna with the hybrid feed features a wide AR bandwidth, but suffers a complicated structure, expansive manufacture, and increased antenna size.

Fig.1.shows the configuration of the proposed antenna. The antenna comprises four layers of conductor, which include three suspended radiating patches, a suspended microstrip feed line, and a finite size ground plane. Air substrate is used in this configuration to achieve higher gain, broader bandwidth, and lower cost. The microstrip feed line of a width of 24 mm is suspended above the ground plane (250 mm x250 mm) at a height of h1=5mm. One end of the feed line is connected to an RF input, while the other one is open circuited, which simplifies the antenna structure. The main radiating patch of 156 mm x156 mm and with a truncation of ΔL1 =24.5 mm at two diagonal corners is placed above the feed line at spacing of h2=20mm.




(a)

Fig.1.Configuration of the proposed antenna. (a) Exploded view.

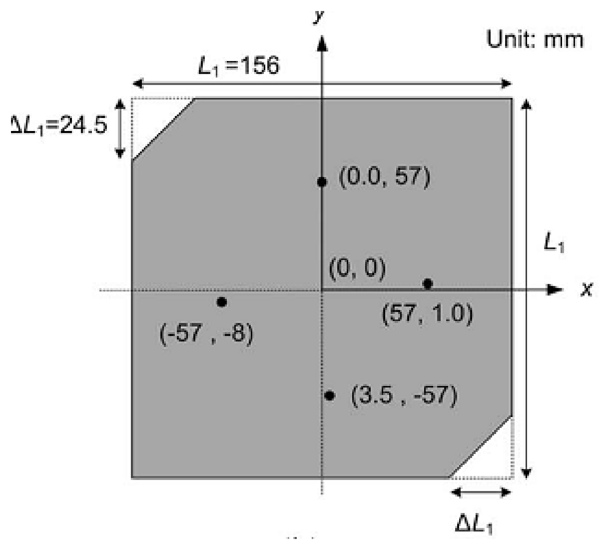
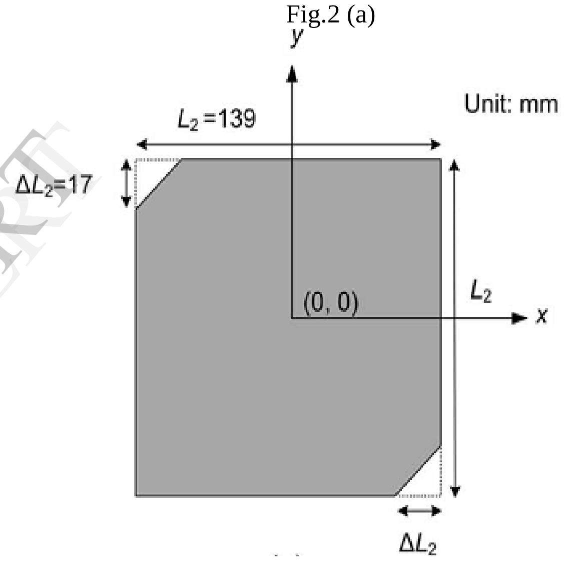
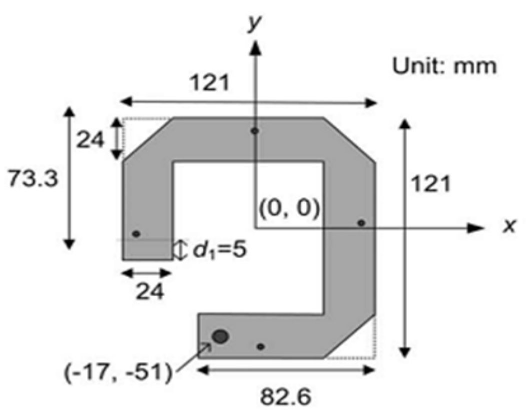



Fig.2 (a)




(b)

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(c)

Fig.2.Antenna detailed dimensions(a)Mainpatch (b) Parasitic patch (c) Microstrip feed line.

The main patch is fed by four probes which are connected to the microstrip line. The probes are of diameter of d=2.2 mm, to enhance the bandwidth, two truncated parasitic patch with a both dimension of 139 mm x139 mm. The truncation of ΔL2 of 17 mm and ΔL3 of 12mm is placed right above the main patch with the spacing of h3=10mm and h4=5mm.The truncated patches produce additional degenerating modes necessary for widening the AR bandwidth and aid of simulation by ADS Agilent technologies, which is based on the method of moments, the antenna is optimized and then prototyped. The prototype and detailed dimensions are shown in Fig. 2. The truncated patches, feed line, and ground plane are all made of copper and fixed using plastic spacers. Four metallic screws are used as the probes to connect the microstrip feed line and the main patch. A coaxial cable is directly connected to the microstrip feed line to simplify the assembly of the antenna, where the coaxial cable is split into two wires(screen and core) and the wires are soldered to the suspended feed line and the ground plane separately.

## III. RESULTS AND DISCUSSION

The antenna was designed for simulation processing only; it will become fabrication and here after measuring all the parameter by using network analyzer.

Fig. 3(a) shows the simulated of S-parameter and return loss of the antenna -15dB. Exhibits the simulated AR at bore sight. The simulated 2.1dB AR bandwidth of 818–964 MHz is obtained. The simulated S –parameter is illustrated.

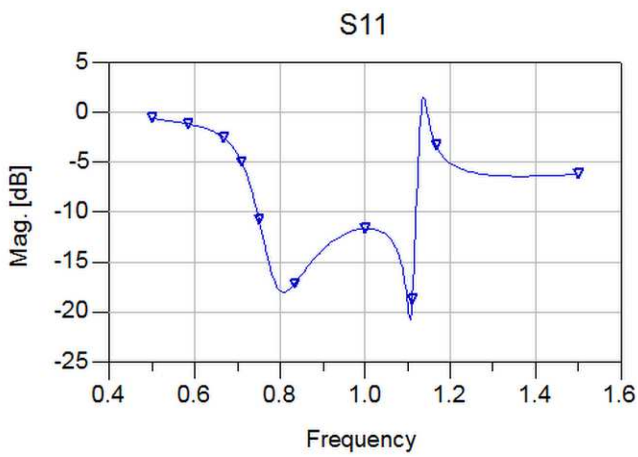


Fig.3 (a) S-parameter

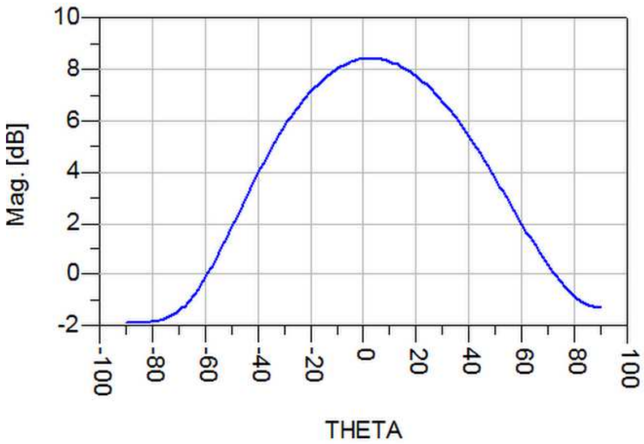


Fig.3 (b) Simulated antenna gains for the proposed antenna

Fig.3 (b) shows the simulated graph of antenna gain and directivity at more than 8.3dB, the operating frequency of UHF band at different bandwidth in generally reader antenna depends on gain value; it becomes high gain with covering good reading and distance.



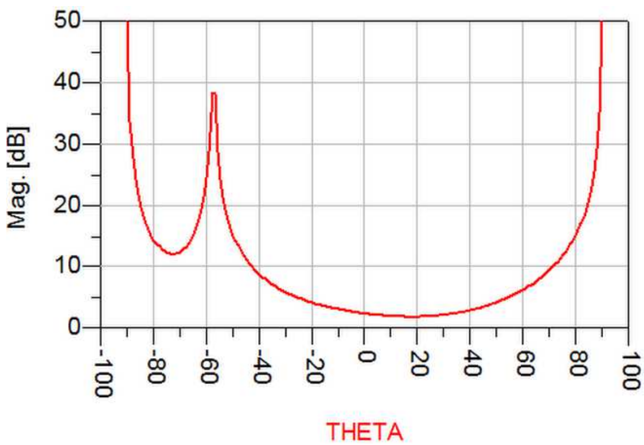


Fig.3 (c) Simulated axial ratio for the antenna studied

The axial ratio for simulated antenna should be less than 3dB. Fig.3 (c) shows that, the axial ratio is only 2.1dB. Therefore, we can achieve circular polarization.

## IV. CONCLUSION

In this paper, a broadband sequentially fed CP stacked patch antenna has been presented for universal UHF RFID applications. By using a simple feeding structure and combining several band broadening techniques, the optimized antenna has achieved the desired performance over the UHF band of 840–964 MHz with the gain of more than 8.4 dB, AR of less than 3 dB, return loss of less than -15dB. Therefore, this universal design can be applied to all the UHF RFID applications worldwide. The reading range measurement has validated that the proposed antenna can be incorporated into the multiband RFID readers or and readers operating at different RFID bands to achieve desired reading range.

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