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An Enhanced Broadband Micro strip Stacked Patch Antenna for RFID Applications

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***Abstract*—A compact and broadband micro strip stacked patch antenna with circular polarization (CP) for a mobile 2.45-GHz passive radio frequency identification (RFID) reader is presented. Radio Frequency Identification and is analogues to a bar code reader. Its inherent advantage over other similar applications is that no precise and accurate positioning is necessary though RFID can use antennas like slot , dipole , patch etc. Patch antenna is most suitable due to advantages of compact geometry, low profile and light weight so micro strip stacked patch antenna with Circular Polarization (CP) for a mobile 2.15- 2.6 GHz two stacked patches fed with an S-shaped Impedance-Matching Network (IMN), which is connected by a probe. With the proposed S-shaped IMN feed technique, a good impedance matching and symmetrical broadside radiation patterns could be obtained. Their operating frequencies are small less cost and provide better accuracy. Effects of polarization an antenna RFID performance is discussed and analyzed. Additionally, with four symmetric-L narrow slots on the patches, the compact operation could be obtained. The reader antenna of size 57×57×11mm3 has a 3-dB beam width of more than 910. The peak gain is optimized in the frequency range from 2.15 to 2.6 GHz of larger than 6 dBi, and it achieves 6.45 dBi in the center frequency 2.45 GHZ. The standing wave ratio (VSWR)<2 and impedance bandwidth is equal to 500 MHz The results are verified using Ansoft HFSS.**

***Index Terms*—Broadband, circular polarization (CP), micro-strip antenna, radio frequency identification (RFID) reader antenna.**

I. Introduction

RADIO frequency identification (RFID) has become a mainstream, and its various applications can be found in many industries ranging from defense to healthcare, from customer to enterprise, and from supply chain to value chain Compared to other means of identification, RFID has many advantages, such as the high recognition accuracy, high speed, and the ability to adapt to the environment. RFID can be classified into low frequency (LF), high frequency (HF), ultrahigh frequency (UHF), and microwave RFID systems, according to its use in different frequency bands. In recent years, RFID has developed rapidly especially in HF and UHF.

Wireless fidelity (Wi-Fi, indoor communication) will undoubtedly increase as smart phones and iPads become more and more popular. Therefore, it is also necessary to investigate antennas for these domains.

Generally, the antennas for the Microwave RFID reader should be characterized by high-quality circular polarization (CP) characteristic, high gain, wide impedance bandwidth, and beam width . For mobile environment, the above characteristics should still be satisfied although the antenna size gets significantly smaller. Thus, many researchers are currently studying ceramic and micro strip antennas, spiral antennas, dipole antennas, and inverted-F antennas for RFID readers Hence, the significance of high gain and broad band is highlighted. Microstrip antennas are popular for the well -known attractive features, such as low profile, light weight, low cost, and ease of fabrication and conformity. The main disadvantage is the limitation of impedance bandwidth.

In this letter, we propose a new type of feed technology for a micro strip antenna, which is the S-shaped impedance matching network (IMN) technology. A good impedance matching and symmetrical broadside radiation patterns could be attained with the S-shaped IMN. With the additional S-shaped IMN and two stacked patches , the antenna could obtain impedance bandwidth larger than 15.1%. The stacked patches have two resonance frequency points. When the two resonant frequency points are closed properly, the resonant circuit could be formed, and the bandwidth is enhanced greatly. Meanwhile, we regulate the S-shaped IMN's critical dimensions (feeder width WS , and S) to make the input impedance of the radiating patches and feeder's characteristic impedance matching in order to further expand antenna bandwidth. However, the introduced S-shaped IMN would lead to power loss, which meant the reduction of gain. An air dielectric layer and the parasitic patch with a lower dielectric substrate could improve the gain effectively. Thus, we think the reader antenna can be used in mobile vehicle identification, such as the community parking management system.

II. Design of Compact RFID Antenna.

Fig. 1 shows the prototype of the proposed compact RFID antenna for the ISM 2.45-GHz band (ISO 18000-4) in a well-matched condition. The conductor was fabricated on the three-layers square substrate, whose width was $G=57$mm, with a dielectric constant of $\varepsilon_{r1}=10$, and substrate thickness of $h1=1.57$ mm for the first and second dielectric layers. The dielectric constant of the third dielectric layer was $\varepsilon_{r2}=2.65$,

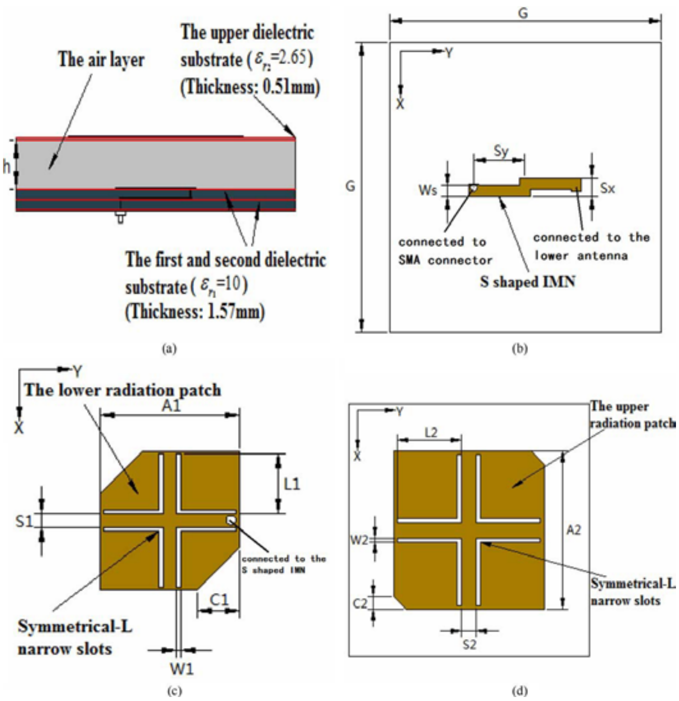

Fig. 1. (a)–(d) Geometry of the proposed compact antenna with circular polarization.

and the thickness of the substrate was $h2=0.51$ mm. In addition, with an additional air layer of the thickness h between the second layer and the third layer, and by adjusting the thickness h, the wider impedance bandwidth and higher gain could be obtained, as shown in Fig. 1(a). The antenna was fed by an additional S-shaped IMN (implemented on the first dielectric substrate), which had a signal strip of width W_s and x-direction length S_x and y-direction length S_y, as shown in Fig. 1(b), respectively. One end of the S-shaped IMN was connected to the main radiating patch by a probe, whereas the other end was connected to a coaxial connector. We could obtain a wide impedance bandwidth and good impedance matching by regulating the sizes of the S-shaped MIN: S_y and S_x

The lower square radiation patch (implemented on the second dielectric substrate) was connected to the S- shaped IMN by a probe, as shown in Fig. 1(c). The width of the patch A1 was to resonate at the center frequency of 2.45 GHz and two centrosymmetric diagonal comers of the right-angled isosceles triangle with the edge length $C1$ were truncated. Four additional symmetrical-L narrow slots placed on the patch with the width $W1$, length $L1$, and gap of width $S1$ were centrosymmetric. Meanwhile, the upper parasitic patch (implemented on the third dielectric substrate) of width A2 had a similar structure with the lower patch, as shown in Fig. 1(d). The additional four symmetrical-L narrow slots with the width $W2$, length $L2$, and gap of width $S2$ were placed on the patch center symmetrically. However, with the edge length $C2$ truncated, the two centrosymmetric diagonal comers were rotated 90° sequentially based on the lower patch. This could improve the circular polarization characteristic. With the structure, the proposed antenna obtained a wide impedance bandwidth and a high gain performance.

III. Experimental Result

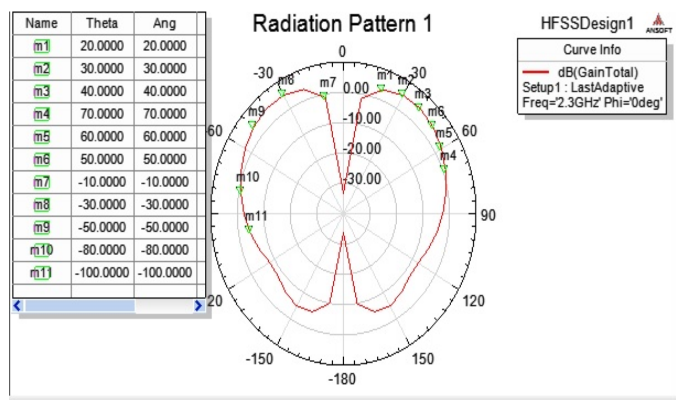

Fig 2. Radiation pattern

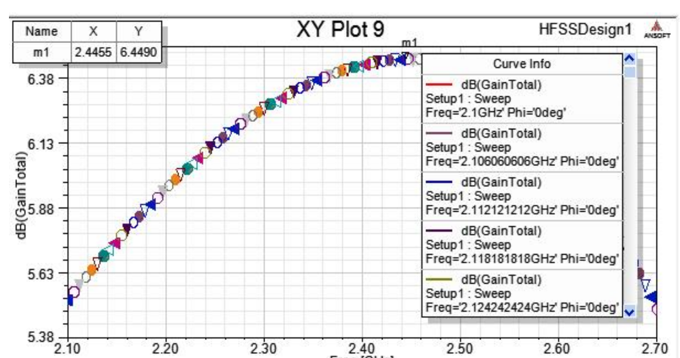

Fig 3.Gain

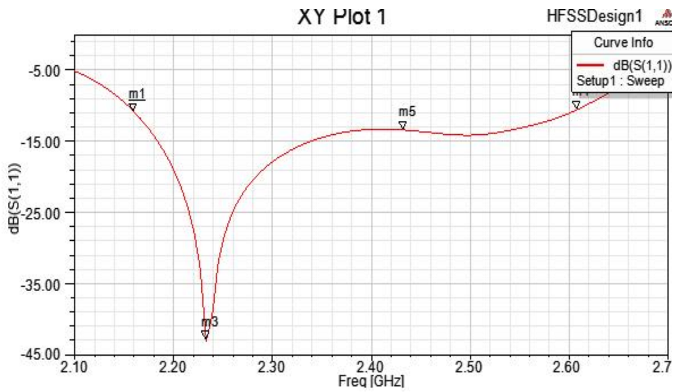

Fig 4.Return loss

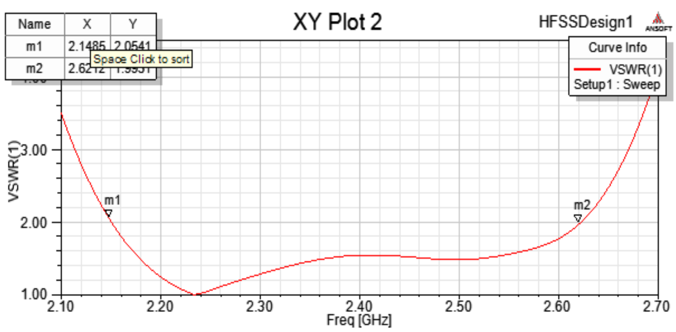

Fig 5.VSWR

The radiation patterns of the proposed antenna in both xz- and yz- planes at the center frequency 2.45 GHz, respectively. The antenna radiated almost the same amount of energy into both sides, which was obtained by S-shaped impedance matching network technology. Also, the proposed antenna had the directivity in zenith direction and the 3-dB beam width about 91° at the center frequency of 2.45 GHz.

III. RELATED WORK

The complete integration of PEDOT: PSS into RFID tag has been here reported for the first time aiming to design and test a passive radio-sensor suitable to monitor the local humidity. Communication, sensing performances and cyclic exposures have been jointly analyzed, leading to a fully working prototype, whose sensitivity and dynamic range can be controlled by the amount and the displacement of polymer into the sensing slots. In particular, laboratory experiments demonstrate that just a single polymer drop, deposited right behind the microchip, is able to provide more than 3 dB dynamic range and up to 0.12 dB/RH sensitivity at the price of a nearly negligible worsening of communication range (lessthan 20%).A commercial polymer formulation has been used, but for future research the polymer can be chemically modified with appropriate functional groups in order to increase the sensitivity (and then the resolution), the selectivity and the response/recovery time. Also different Pedot: PSS ratio should be analyzed for the optimization of the sensor.

85 A slot loaded circular patch antenna with CP radiation has been successfully performed both numerically and experimentally. By applying the L-shaped probe-fed technique into this circular patch, good CP bandwidth and impedance band width can be acquired. Since this proposed antenna is simple to fabricate and its total dimension is only, thus, it is a potential candidate for fixed UHF RFID reader application s applied to both indoor and outdoor environment that operates in the RFID UHF band 902–928 MHz.76A micro strip patch-type RFID tag antenna with excellent CP radiation has been successfully studied and implemented. The broad CP bandwidth (from 903 to 923 MHz) attained in this study is determined by applying two different techniques; namely, the dual-offset coupling feed and loading of perturbation element. From the experimental results, a slightly increased gain and reading range were observed when the proposed tag antenna was attached to a large metallic plate. Therefore, the proposed tag antenna is a good candidate for any on-metal RFID applications in the UHF band.

CONCLUSION

In radio frequency identification, compact size of the antenna with use of S- shaped impedance matching feeding technique is used to achieve the following parameters good impedance bandwidth, Enhance the Gain, Reduce the power loss, it also has the potential to be used in other wireless communication system, such as Wi-Fi.

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