Design of Logo-Based Tag Antennas of RFID Applications

Chi-Fang Huang* Yueh-Ching Lin and Ming-Fu Kuo
Graduate Institute of Communication Engineering, Tatung University
40, Chungshan N. Rd., 3rd Sec., Taipei 104, TAIWAN
Tel: +886-937-008-883; Fax: +886-2-2599-1037
email: ras@ttu.edu.tw

1. Introduction

Even invented and applied initially during the World War II, RFID (Radio Frequency Identification) [1] has attracted much attention recently. Precisely speaking, RFID has been applied very widely in some proprietary or closed systems, for example, animal control, portal control (access badges), etc. in last decades. The main advantages of RFID application are, storing item data in an electronic way, data access by electromagnetic wave, and allowing multiple accesses to RFID tags. Based on the diverse applications, different spectrum bands are allocated, for example, LF (125 - 134.2 kHz and 140 - 148.5 kHz) for animal control, HF (13.56MHz) for electronic ticket, and UHF (868 MHz-928 MHz) for logistics, etc. Most of the frequencies are located in the ISM (Industrial, Scientific and Medical) bands [1].

Tags are small in size yet are playing the key roles of the RFID industry. Their cost determines the speed of the application spread of RFID, and their performance determines the domain size of application to be promoted. Usually, the antenna design for RFID tag is not as diverse as those used in the wireless communication industry, for example, antennas for mobile phones. That's because usually the tag antenna is not necessary to fit to any product's appearance. For any tag companies, it is enough to run a business with some types of tag only. However, antenna patent is still needed to protect business. It seems a good idea if the company's logo or brand names are embedded into the antenna shape of the tag. The work in [2] probably was the first paper showing a design embedding the Institution name into the tag antenna; see Fig. 1(a). Following this thought, Fig. 1(b) is a design including the brand name of Tatung Company, Taiwan [3]. Especially, this tag was designed by Tatung University, Taiwan, and was made by the screen printing process on paper. The material for the antenna is conducting ink which has only 6.6% conductivity or so of the copper's [4]. However, in achieving the optimal performance of tag antenna, it is impossible to gain the highest performance with the proper shape of antenna and keeping the original letter shapes unchanged simultaneously. Finding a way of breaking through this obstacle seems a good study topic in the future.

(a) (b)

Fig. 1 RFID tag's antenna based on the Institute's name

In addition to the consideration brand names, this paper is to show some other results based on the usage of institute logo into the tag antenna.

2. Basic Design Approach of Antenna of RFID Tag [5]

Referring to Figure 2, RFID tag antenna is a kind of planar antenna, in which the antenna metal layer is laminated on a dielectric substrate. Usually, even they look diverse in shape in RFID Tag industry; the type of dipole antenna is used for the tags operating at frequency for UHF band and for higher bands. In designing such a kind of tag, the material parameters, for example, the conductivity σ of the antenna metal and the dielectric constant ε_r, are necessary to be given in the simulation phase.

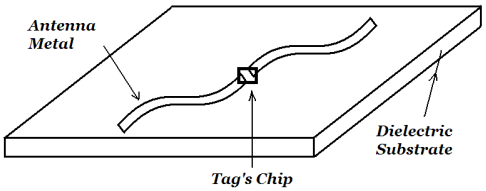


Fig. 2. The physical structure of a RFID tag.

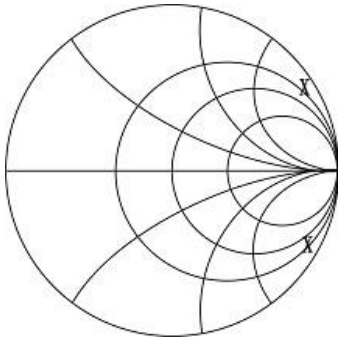


Fig. 3. Situation of complex conjugated impedance matching on the Smith Chart.

In ordinary antenna industry, the antenna is designed with a standard input impedance, for instance, $\mathbf{50\Omega}$ or $\mathbf{75\Omega}$, to have impedance match with transceivers or other RF devices. However, in the RFID Tag industry, for the purpose of cost-down, usually the match network inside the chip is not offered. Consequently, it needs a complex conjugated matching to ensure highest power transfer in between the chip and antenna, namely, to maximize the tag performance. Those two "X" marks show the input impedance positions of the chip and antenna on the Smith Chart in Figure 3. Most of the cases, chip's is the lower "X", and antenna's is the other one. That means, usually the chip is capacitive; and the antenna for being designed should be inductive. The present tag antenna is developed based on this theory.

3. Design Examples

a. HF tag for CD application

Fig. 4 A HF tag is embedded with "TTU" letters for CD application

Fig. 4 (a) shows the simulation model of a tag antenna operating at the frequency 13.56MHz, which is of the elementary configuration of loop antenna. It is worth to note that, three letters "TTU" (standing for TaTung University) is embedded in the antenna. The width of the circular traces is

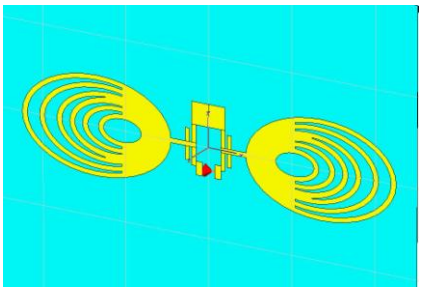
wider at the TTU-letter parts to enhance them. After being etched from a PCB, in Fig. 4, this tag is attached on a CD to demonstrate the RFID application for the copyright protection. Before been attached on the CD, the reading distance of this tag is about 10cm, and 5cm after been attached on a CD. Hence, the material of CD does affect the electromagnetic reception/radiation of the antenna.

b. Company logo as the arms of dipole

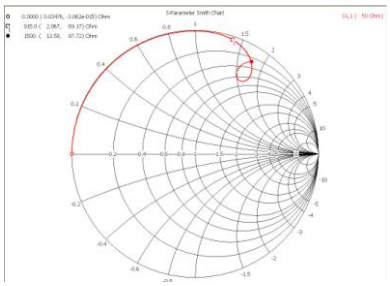
(a)

台灣積層工業股份有限公司
TAIWAN LAMINATION INDUSTRIES, INC.

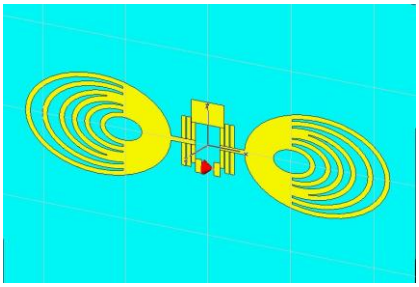
(b)



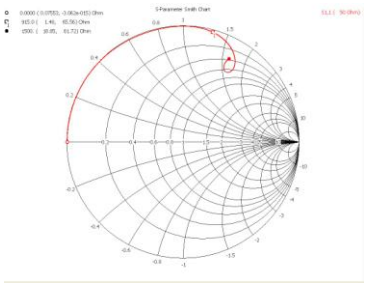
(c)



(d)



(e)



(f)

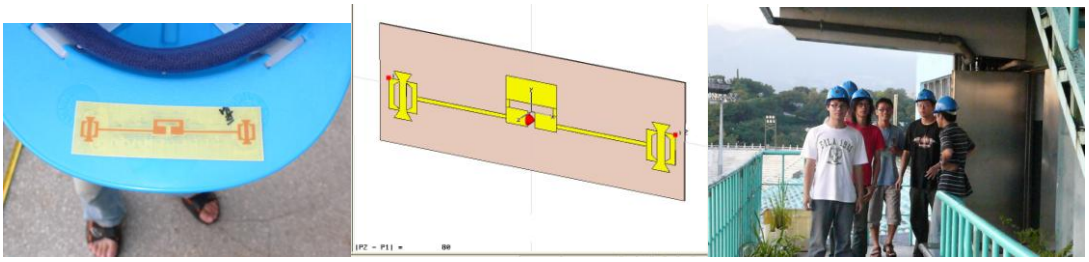
Fig. 5 A tag using the company logo as the arms of the dipole

The tag shown in Fig. 5(a) is an another example, in which the logo (Fig. 5(b)) of Taiwan Lamination Industries, Inc. [6], who is a gravure printing company, is to form arms of the dipole antenna. This tag is made by the hybrid method of gravure printing and vacuum deposition technology, and produced by Taiwan Lamination Industries, Inc. In such a design situation, the logo is supposed to be not changed much in the optimal procedure of simulation; therefore, some adjustable inductive elements are employed near the feeding port for matching purpose. Fig. 5 (c)~(f) show such a design skill. The CST EM tool [7] is used in this design.

c. Logo-based tags used for head count

Fig. 6 (a) (b) show another example of UHF tag using company logo which is of CTCI Corporation [8]. Logo is at the end of arm of dipole. In this application, the tag is to be attached on a helmet

such that the head-count is carried out when workers are passing through the control portal, referring to Fig. 6(c). Adjustment inductive part is also designed near the feeding part for the purpose of complex matching.



(a) (b) (c)

Fig. 4 A tag antenna using CTCI logo

4. Conclusion

This paper presents some design examples of RFID tags using the Institute logo as a part of antenna both for HF and UHF bands. Such an approach of designing tags has an advantage of protecting copyright. The tags mentioned in this paper were made by different manufacturing methods, for example, screen printing on paper, hybrid method of gravure printing and vacuum deposition technology and normal PCB process.

Acknowledgements

This series of RFID tag project have been granted by Tatung Company [3], Taipei, TAIWAN, Taiwan Lamination Industries [6], and CTCI Foundation [9]. Their financial support and technical guiding are deeply appreciated. Prof. T. Y. Hao of Shih Hsin University, Taiwan, is appreciated too for his coaching in the screen printing process for paper-based tags.

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