Tag performance parameters and test methods

Chia-Mei Peng [1], # I-Fong Chen [1], Ching-Wen Hsue [2] and Chang-Yu Wu [1]
[1] Dept. of Electronic Engineering, Jinwen University of Science and Technology.
[2] Dept. of Electronic Engineering, National Taiwan University of Science and Technology.

1. Introduction

The performance characteristics of the Tag and Reader devices may vary drastically due to application factors as well as the particulars of the RF air interface (frequency, modulation, inventory algorithm, etc.). Of key concern is the matching of the various performance characteristics to the user application. Additionally, in an open environment users of RFID technology demand multiple sources fir the devices from technology providers. A key challenge is a method of evaluating the differences between various technology providers' products in a consistent and equitable manner. In this literature specifies the Tag performance metrics and producers for measuring them. Tags are passive-backscatter devices and operate within an Interrogator-talks-first, RFID system operating in the 13.56MHz frequency range. The system comprises Readers-also known as Interrogators, and Tag-also known as Labels. The active component of a Tag is the Tag IC which determines all of the functional properties of the Tag as well as many of its performance parameters. The following standards contain provisions which, through reference in this text, constitute provisions of the part of ISO/IEC 14443. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 14443 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. ISO and IEC maintain registers of currently valid International Standards [1-5].

(a).ISO/IEC14443,Identification cards-contactless integrated circuit(s) cards - Proximity cards.

(b).ISO/IEC 10373, Identification cards - Test methods.

(c).ISO/IEC 7816-2, Identification cards -Integrated circuit(s) cards with contacts - Part2: Dimensions and location of the contacts.

Various air interface modulation and coding schemes are permitted by the Protocol [1]. The measurement methods of power and bi-directional communication between Reader and Tag are presented as below section.

2. RFID Measurement Application

For the purposes of this International Standard, the definitions given in ISO/IEC 14443-1 and ISO-10373, the measurement means as below:

(a). Modulation Index

Defined as [a-b]/[a+b] where a and b are the peak and minimum signal amplitude respectively. The data bit rate for the transmission during initialization and anti-collision shall be fc/128 (~106 kbit/s). Example: ISO/IEC 14443 type A, Communication between PCD (Proximity Coupling

Device)---Reader and PICC (Proximity Card)---Tag takes place using the modulation principle of ASK100% of the RF operating field to create a “pause” as shown in Figure 1.

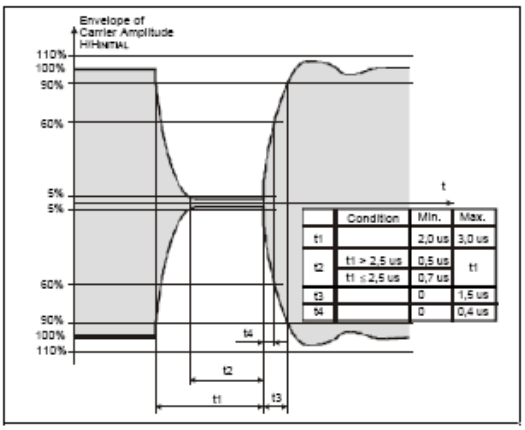

Fig. 1. ISO/IEC 14443 type A modulation waveform.

The envelope of the PCD field shall decrease monotonically to less than 5% of its initial value HINITIAL and remain less than 5% for more than t2. This envelope shall comply to Fig. 1. If the envelope of the PCD field does not decrease monotonically, the time between a local maximum and the time of passing the same value before the local maximum shall not exceed 0.5µs. This shall only apply if the local maximum is greater than 5% of HINITIAL. Overshoots shall remain within 90% and 110% of HINITIAL. The PICC shall detect the ”End of Pause” after the field exceeds 5% of HINITIAL and before it exceeds60% of HINITIAL.

(b). Field Strength

For 13.56MHz passive Tag applications, the voltage transfer between Reader and Tag coils is accomplished through inductive coupling between the two coils. For verifying the operation of a Tag or a Reader according to ISO/IEC 14443-2, the test apparatus includes: Calibration coil, Test Reader assembly, Reference Tag, Digital sampling oscilloscope. The calibration coil is a loop antenna. When the space is 6cm between Reader and Tag, the magnetic field strength (H) is at least 1.5A/m, and the strength is not over 7.5A/m on 0cm. The test method is shown in Fig. 2. The loop antenna is put between the reader and tag. The magnetic field strength (H) is given by:

$$H = N \times \frac{(X + L)/Z}{C} \quad (1)$$

Where N, C and Z are turns, circum and input impedance of loop antenna. X is the Max. signal value from oscilloscope. L is the loss of oscilloscope probe.

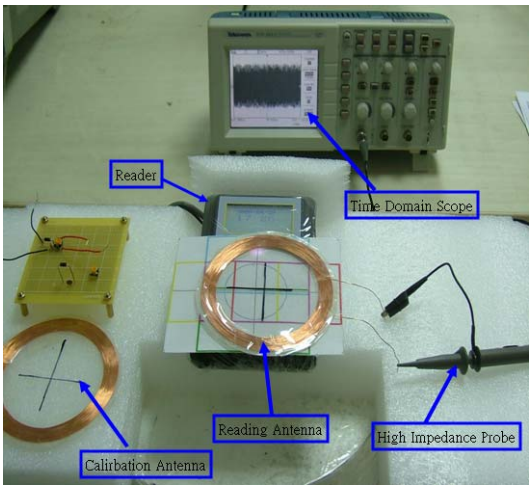

Fig. 2. Field strength measurement

3. RFID performance evaluation

The Tag shall be capable of communication to the Reader via an inductive coupling area where the carrier frequency is loaded to generate a sub-carrier with frequency fs. The sub-carrier shall be generated by switching a load in the Tag. The load modulation amplitude shall be at least $30/H^{1.2}$ mV (peak) when measured as described in the test methods, where H is the (rms) value of magnetic field strength in A/m. The physical case study as below: using RSA3408B Real Time Spectrum Analyzer to get the load modulation index (m), as shown in Fig. 3. Then to measure the magnetic field strength (H), the measurement result is shown in Table I. The load modulation amplitude (X) is at least small than $30/H^{1.2}$ mV (peak), then the signal can be de-modulated.

$$X = m \times 320/H \leq 30/H^{1.2} = Y \quad (2)$$

The final evaluation results for the physical RFID system in three distances (0cm, 3cm and 6cm) are shown in Table II.

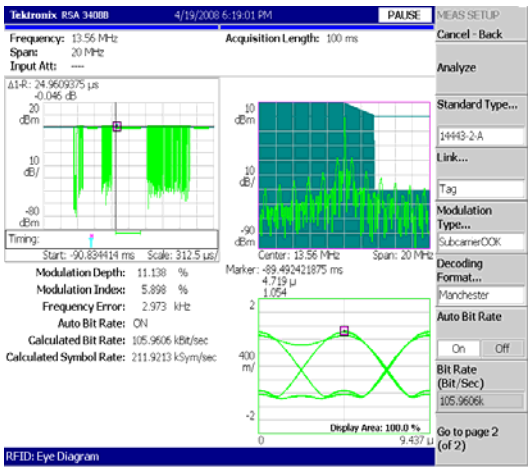

Fig. 3. Load modulation index measurement

Table I. Measured magnetic field strength

	Reading	Calibration	H (A/m)
0cm	1.40	2.15	2.99
3cm	0.45	1.20	1.67
6cm	0.25	1.00	1.64

Table II. The final evaluation results for the physical RFID system in three distances.

Modulation: 5.90%			
0cm	X=6.303592	Y=8.046394	Pass
3cm	X=11.29394	Y=16.19981	Pass
6cm	X=11.51981	Y=16.58938	Pass

4. CONCLUSION

This literature has provided systematic means for evaluating Tags and ultimately optimizing performance in the field. Experimental results are shown to verify the validity of theoretical work.

REFERENCES

[1] Standard: ISO/IEC14443, Identification cards-contactless integrated circuit(s) cards - Proximity cards.

[2] Standard: ISO/IEC 10373, Identification cards - Test methods.

[3] Standard: ISO/IEC 7816-2, Identification cards -Integrated circuit(s) cards with contacts - Part2: Dimensions and location of the contacts.

[4] Standard: ECMA-340,
Near Field Communication Interface and Protocol (NFCIP-1).

[5] Standard: ECMA-352,
Near Field Communication Interface and Protocol (NFCIP-2).