

UHF IC Tag and Reader/Writer Products

OIKAWA Yoshinori

Abstract

As was pointed out in the “ICT International Competitiveness Enhancement Program” established by the Japanese Ministry of Internal Affairs and Communications in May 2007, it is an urgent task to prepare a networked environment for the utilization of IC tags in order to enhance the international competitiveness of the Japanese ICT industry. NEC TOKIN has been engaged in the RFID business from an early stage as a device manufacturer and has offered non-contact IC cards, IC tags and reader/writer since that time. At present, the company is focusing its efforts on UHF IC tags and reader/writers. These devices are expected to form the core of projected RFID businesses. This paper is intended to explain the newly developed UHF RFID products.

Keywords

RFID, IC tag, reader/writer, antenna, gate system, UHF

1. Introduction

Japan was highly regarded as “a major manufacturing country” in the 1980’s, however, it is presently facing severe competition in the manufacturing domain from neighboring Asian countries. This situation has come about due to various issues that are peculiar to Japan and which exist as core concerns within the social structure of the nation; these include delays in applying globalization, high production costs and a lack of human resources in the engineering field, etc. In response to such competitive pressures, the Ministry of Internal Affairs and Communications announced its “ICT International Competitiveness Enhancement Program” in May 2007. This program defines a basic strategy for enhancing the international competitiveness of the Japanese ICT industry¹⁾. The “Final Report of the ICT International Competitiveness Council”²⁾, which was proposed as the basis for the establishment of the program, stressed that the coming two years would be positioned as the “ICT International Competitiveness Enhancement Years” and that Japan should enhance its ICT industry in order to prepare for the year 2011. This is intended to be the “first year of the era of complete digitalization” for Japanese television broadcasting and broadband communications. The “ICT Productivity Acceleration Program (Draft Plan)” is a detailed proposal for this program that defines the “preparation of environments for the utilization of electronic tags using networking methods.” It identifies inadequacies in the current program, such as that the program has been so far mainly carried out only as an examination of the case studies and the

experimental demonstrations performed by individual companies. In order to progress further, it proposes the necessity of proceeding urgently to prepare environments that can make practical use of electronic tags by making better use of the available network functions and by verifying the possibility of introducing electronic tags beyond the barriers that currently exist between different business and industrial domains.

At NEC TOKIN, we expect that the RFID market will expand rapidly after the turning point that is likely to occur sometime around 2008. With this eventuality in mind we have been pushing forward with the development of IC tags (electronic tags) and reader/writers. This paper describes the latest UHF tag and reader/writer products that will trigger the breakthrough point of the RFID market.

2. RFID Products of NEC TOKIN

We began the mass-production of non-contact IC cards in 1998, and have been offering entrance/exit management cards at a rate of more than 10 million units per year. On the other hand, we began mass-production of the IC tags in 2000. The main products in the initial stage were the 125kHz IC tags attached to tableware for use in auto cash register machines employed in company restaurants. However, the IC tags that operated on other frequencies, mainly 13.56MHz, are currently spread among the clothing and amusements industries. More recently, the 2.45GHz IC tags that use the NEC-original chip “NETLABEL,” which feature a more compact size and extended communication distances are entering a practical stage³⁾.

Moreover, alongside the mass-production of IC tags, we have also been developing and introducing reader/writers (RFID interrogators) for use in RFID systems⁴⁾.







In the following sections, we discuss the newly developed UHF-band IC tags and reader/writer products on which we are focusing our development efforts in anticipation of their wider diffusion in the future.

3. UHF IC Tag

Standardization of UHF IC tags has been delayed compared to the HF-band (13.56MHz) IC tags. However, after the international standardization organization EPCglobal standardized the RFID protocol known as “Gen 2,” the ISO18000-C specifications were established in order that products complying with these standards might be released to the market. The use of the UHF (860 to 960MHz) in RFID systems is expected to be extensively adopted for use in the SCM (supply chain market,) especially for logistics and inventory management. Its commercial use is therefore being promoted strongly in the U.S. by government, industry and the universities. In Japan, the use of the UHF band in RFID products has been possible since the amendment of the Radio Law-related ministerial ordinance of January 2006. Following these events, NEC TOKIN has been promoting the development of UHF IC tags.

Table 1 lists our main UHF IC tag products.

Table 1 Main UHF tag products.

Item	Label tag	Metal-compatible tag	Resin-formed tag
Aspect			
Application example	 Label	 PC management	 Crate management
Communication distance (*)	Approx. 4m	Approx. 1m	Approx. 1m
Size	4 × 4 (inch) 4 × 6 (inch)	86 × 54 × 2 (mm)	108 × 29 × 4 (mm)

(*) When a 6-dBi circular polarized antenna is used.

3.1 Label Tag

Label tags are for general use, including for the management of physical distribution systems and have a size of 4 × 4 inches or 4 × 6 inches. The antenna is designed to deal with a relatively wide band. In the case of distances of more than 5m (with linear polarized waves) as a means of communication simulation, it will be possible to communicate up to 850 or even 990MHz, values that are not available for IC tags in Japan but are already used in Europe and North America. So, if these band widths should become available, the same IC tag may be applied in any location in Europe, North America and Japan⁴⁾.

3.2 Metal-Compatible Tag

When an IC tag is attached to an actual piece of communication equipment that has a metallic surface, it is effective to maintain a certain distance between the metallic surface and the antenna. Although increasing this distance can increase the communication distance (the effects of metal can be invalidated at a distance of 3mm or more), we set the distance at 2mm in consideration of the actual installation conditions. This course of action has made it possible to reserve a communication distance to the IC tag of 1 meter.

3.3 Resin-Formed Tag

This IC tag is formed from resin in order to improve rigidity and weather resistance under long or repeated periods of use. The resin-formed IC tag that is attracting particular attention is the one to be attached to reusable crates. When such crates are used for food transportation, they should withstand repeated high-temperature washing and also comply with the relevant food sanitation laws.

4. UHF Reader/Writers

Fig. 1 shows UHF reader/writers, including the stationary type and the portable type for in-plant radio stations and the CF card type for specified low-power radio stations. These types should be selected according to the required purpose.

- 1.(a) Stationary type
- 2.(b) Portable type
- 3.(c) CF card type

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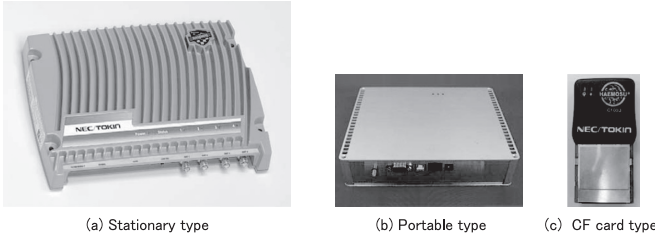


Fig. 1 UHF reader/writers.

Table 2 Specifications of UHF reader/writers.

Item	Stationary reader/writer	Portable reader/writer	CF card reader/writer
Protocol	UHF EPCglobal Class1 Gen.2 compatible		
Frequency	952-954MHz		952-955MHz
Channel	200kHz 9 channels		200kHz 14 channels
Output	30dBm (1 W)	27dBm (500mW)	10dBm (10mW)
Antenna terminals	x 4 (TX/RX common antenna)	x 1 (TX/RX common antenna)	x 1 (Built in)
Interface	LAN	USB/LAN/RS232C	CF card interface
Size	324 × 229 × 57 (mm)	180 × 174 × 40 (mm)	48 × 90 × 15 (mm)

4.1 Stationary-Type Reader/Writer

Fig. 1 (a) shows the external view and Table 2 shows the core specifications.

The most significant feature of this type is that it is the first Japanese reader/writer to be in full compliance with EPCglobal Gen 2, which has been standardized as the coding method for the UHF band and supports both the baseband (FM0) and Miller subcarrier systems. The data transfer rate is the highest in Japan at a maximum of 640kbps (tag → reader). This impressive performance has been made possible using the core technology developed by the Impinj, Inc., which is our U.S. partner.

With the conventional antenna system, two antennas are usually required to perform transmission and reception. With our stationary-type reader/writer, due to a circuit that is capable of the high-performance separation of transmission and received signals, a single antenna can perform both transmission and reception functions. This strategy provides an advantage in the market. Moreover, the system can control up to four antennas, which means that only four antenna terminals are required instead of the usual eight.

The cabinet of the reader/writer is compliant with IP54 and features an excellent dust- and splash-proof performance, mak-

ing it suitable for use on the dock door of warehouses, etc.

Fig. 2 shows an example of the results of a measurement of read distance using ordinary tags and circular polarized antennas (6dBiC). According to this result, communication is possible up to a distance of about 4 meters.

On the other hand, it becomes difficult to read all of the IC tags when their concentration increases. The results of a measurement example of the read success rate with respect to the density of the IC tags are shown in Fig. 3. These results show that the distance at which communication is 100% successful varies from 1 to 2 meters depending on the concentration of the IC tags. This phenomenon may be because the presence of IC

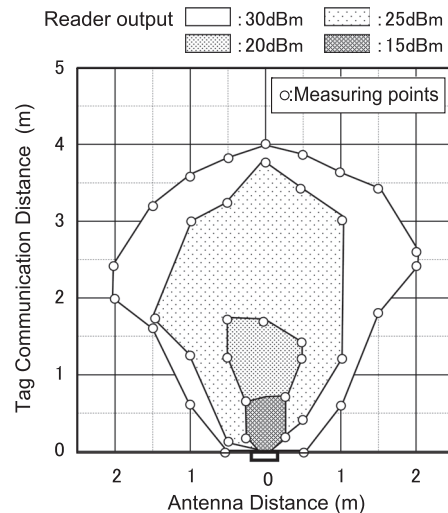


Fig. 2 Results of IC tag read distance measurements.

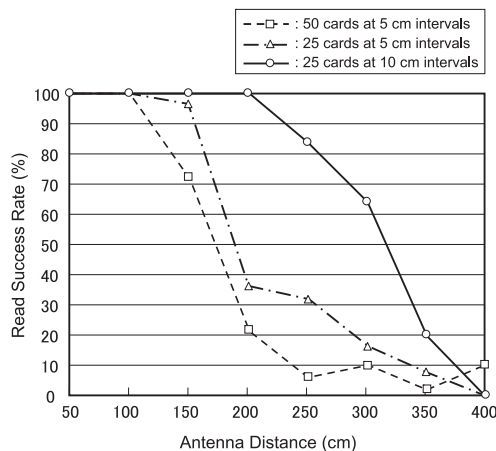


Fig. 3 Read success rate per IC tag density.

Table 3 Specifications of UHF antennas.

Item	Standard antenna	Weather-resistant Antenna	ILT antenna
Polarized wave	Circular (Right-and left-handed)	Circular (Right-and left-handed)	—
Antenna gain	≤ 6.0 dBiC (including cable loss)	≤ 6.0 dBiC (including cable loss)	≤ 3.0 dBiC (including cable loss)
Half-power angle	Approx. 65°	Approx. 65°	—
Connectors	SMA-J connectors, detachable	N-J connectors, detachable	SMA-J connectors, detachable
Size	214 × 214 × 36 (mm)	243 × 243 × 51.5 (mm)	∅230 dia. × 65 (mm)
Features	Tilted construction	Outdoor use	Electromagnetic wave + Radio wave

tags in close proximity destroys the impedance matching that of the IC tag antenna. When using IC tags, it is critical to design the number and positions of antennas optimally based on a thorough understanding of these properties.

4.2 Portable Reader/Writer

A portable reader/writer is often used in sizeable areas such as inventory rooms, warehouses, etc., however, a more compact reader/writer is required to be used in situations such as indoor systems for POS registers or libraries. We have developed a portable type aimed only at decreasing the size of the above described stationary type by using the inherited high performance of the core engine. The external view of the portable type is shown in Fig. 1 (b) and the main specifications are shown in Table 2. The major differences from the stationary type are as follows:

- Smaller size: Less than 1/3 (in volume) of the stationary type
- Output power: 27dBm (500mW)
- Antenna terminal: 1
- Interfaces: USB/RS232C/LAN

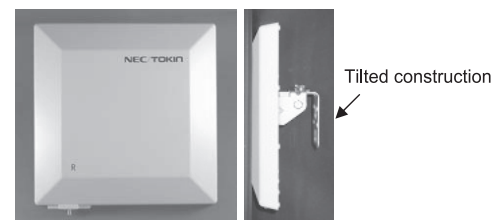
4.3 CF Card Reader/Writer

Japanese users tend to place the highest priority on read accuracy and from this standpoint derive the necessity for a handy terminal that can be used effectively for a final reading of the information of each tag. However, the handy terminals for RFID use have hitherto been relatively expensive. In order to resolve this issue and to permit easy applications according to customer needs, we have developed a CF card type reader/writer that can be used in combination with a PDA terminal.

The external view of the CF card type is shown in Fig. 1 (c) and the main specifications are shown in Table 2.

5. Antennas

Table 3 shows the specifications of the UHF antennas matching the above described reader/writers and Fig. 4 shows an external view. The standard circular polarized antenna has the mounting section in a tilted construction, which is therefore effective in solving site engineering issues. The antennae of item-level tags (ILTs) are used to read the compact IC tag of each individual product. As the antenna is capable of performing electromagnetic readings, it is hardly affected by



(a) Standard antenna



(b) Weather-resistant antenna



(c) ILT antenna

Fig. 4 UHF antennas.

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moisture, thus making it possible to reduce the IC tag sizes (to below 1cm).

6. Conclusion

This paper has described the newly developed UHF IC tags and reader/writer products among the RFID devices that are helping to build the foundations of the ubiquitous age. For the present the IC tags are still at a trial stage, but it is our intention to continue technological developments aimed at meeting the projected market needs of 2008, which is the year for which a technological breakthrough is anticipated.

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Author's Profile

OIKAWA Yoshinori
Senior Manager,
Research & Development Dept.,
Access Devices Division,
NEC TOKIN Corporation