First Test Report

October 2007
DENSO WAVE INCORPORATED

Title	**RFID Read Test for Container Management**
Date	Thursday and Friday, October 11 and 12, 2007
Location	Head office of DENSO CORPORATION

1. Experiment Purpose

    Checks the reality of container management using RFID.

2. Conclusion

  When reading 100 containers pasted with UHF tags,
    (1) We verified that laying antennas on each side enables 100% of reading and moving at about 2km/h. (It takes about 5 sec. to read 100 tags)
    (2) When moving rate is about 4 km/h, 1 to 3 tags remained unread.

3. Experiment Equipments
 (1) Container
    Sanko Sanbox #5A-2 (322 x 198 x 100 mm)
 (2) Tag
    Alien ALL-9440-02 (98 x 11 mm)
 (3) Reader/Writer
    DENSO WAVE UR-400 (Software: Console 802_3)
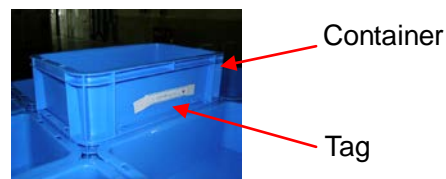 * Transmit antenna: UR-A410 (linearly polarized wave)
 * Receive antenna: UR-A400 (circularly polarized wave)

Container

Tag   Reader/Writer

4. Experiment Method
 (1) Tag Pasting Position
- Pastes a tag on the container's longitudinal side (The tag direction coincides with the antenna polarized wave plane)

Container

Tag

 (2) Container Stack Method
   (1) 3 x 3 x 11 tiers + 1 = 100

Antenna

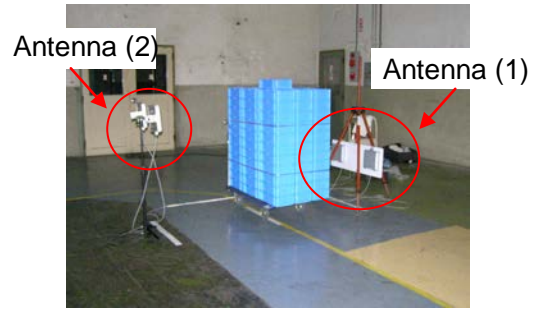Tag: Parallel to antenna

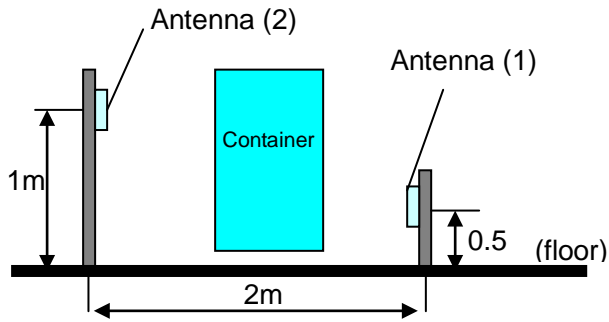   (2) 5 x 3 x 6 tiers + 10 = 100

Antenna

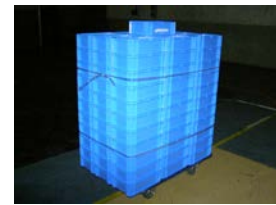[Tag: Parallel to antenna]   [Tag: Vertical to antenna]

(3) Antenna Layout

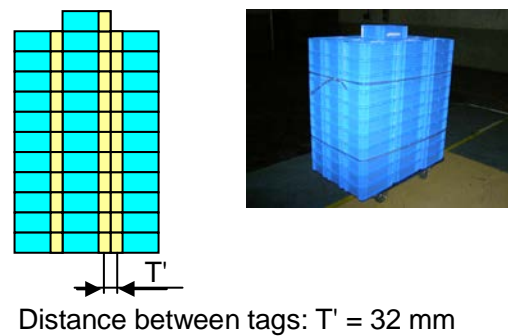## (4) Tag Direction

(1) Same Direction

Distance between tags: T = 198 mm

(2) Face-to-Face (Opposed)

Distance between tags: T' = 32 mm
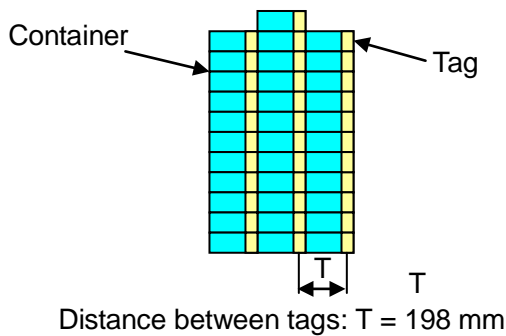
4. Results

| No | Conditions | | | | Read number/total [= Reading rate/%] (Read time**) | | | | | | |
	Container stack	Tag direction	Antenna	Moving rate	1st	2nd	3rd	4th	5th	6th	7th
1 *	(1) 3x3x11+1	(1) same	both sides	about 2km/h	**100**	**100**	100				
2				about 4km/h	99	97	**100**	98	99	99	**100**
3				about 6km/h	93						
4		(2) opposed		about 2km/h	**100**	**100**					
5 *		(1) same	either side (1)	about 4km/h	96	97	96				
6 *	(2) 5x3x6+10	(1) same (parallel to antenna)	both sides	about 2km/h	**100**	**100** (7.2s)	100 (4.3s)				
7 *				about 4km/h	99 (4.5s)	98 (4.8s)	100	99 (4.8s)	99 (4.4s)	**100** (4.5s)	98
8				about 8km/h	87						
9		(1) same (vertical to antenna)		about 2km/h	**100** (4.1s)	**100** (7.8s)					

(*: Video, **Read time: The time starts 0.5m prior to antenna, and after passed, continues until tag reading ends)

5. Consideration

When the tag moving rate is about 2km/h, we verified that 100% of reading of 100 tags is enabled by laying antennas on both sides. Also, when the distance between tags is shortened by 32mm, or even when a container is stacked so that a tag is vertical to the antenna plane, we verified that 100% of reading is enabled with the above condition without any impact on reading.

However, when the tag moving rate becomes about 4km/h, we verified that unread tags emerged and the reading rate became 97 to 99% with the above condition.

Note that in order to read stably even during moving quickly, it is estimated that such ingenuities are effective as to sum up the data obtained by two reader/writers by installing two sets of reader/writers toward the tag moving direction and getting through a container continuously.