RFID Read Four Times Test for Container Management

DENSO WAVE INCORPORATED

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Date	Tuesday, November 20, 2007
Location	Denso Anjyo Plant

1. Experiment Purpose

    Read the RFIDs for container management attached to the forklifted containers.

2. Results

    100% read the 54 (6 x 9 tiers) returnable boxes (TP342) moving at 10km/h

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3. Test Equipments

   (1) Returnable Box
      - TP342 (503 x 335 x 195mm)

   (2) Tag
      - Alien ALL-9440-02 (98 x 11 mm)

   (3) Reader/Writer
      - DENSO WAVE UR-400
        * Send antenna: UR-A410 (linearly
          polarized wave)
        * Receive antenna: UR-A410 (linearly
          polarized wave)

Container

Tag   Reader/writer
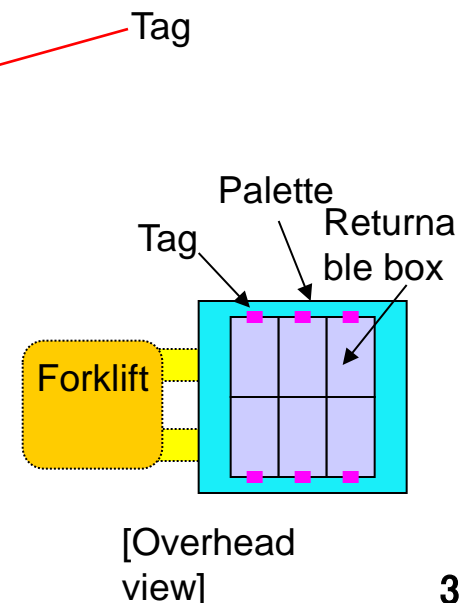
4. Test Method
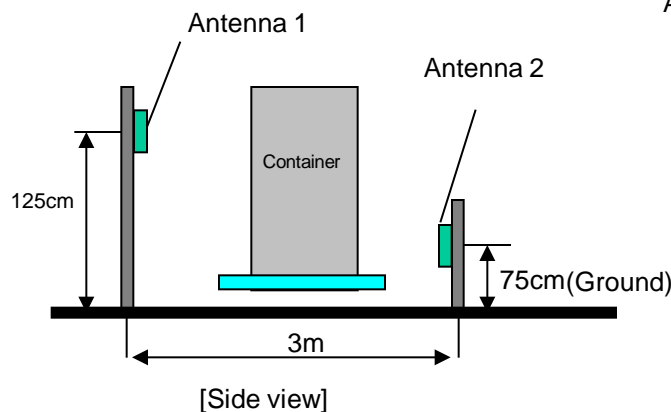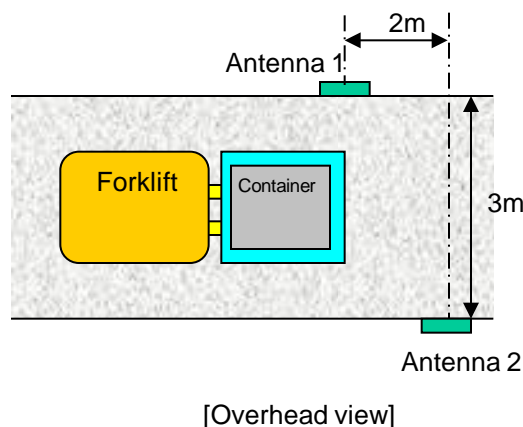
   (1) Tag Pasting Position
      - Paste tags returnable box's shorter side
       (The tag direction coincides with the
        send antenna polarized wave plane)

   (2) Container Stack Method
      - 54 returnable boxes are stacked (3 x 2 x
       9 tiers)
      - All tags are oriented outside

Tag

Palette
Tag
Returnable box
Forklift

[Overhead view]

3

5. Antenna Layout

[Overhead view]

[Side view]

Antenna 1

Antenna 2

Forklift

Container

2m

3m

125cm

3m

75cm(Ground)

6. Test

(1) Forklift Speed
- Forward: 5km/h (Front field of vision
                          is blinded)
- Backward: 10km/h

Video ▶

(2) Result

Speed		Read number (**Reading rate**)		
		1st	2nd	3rd
5km/h	**Forward**	54 (**100%**)	54 (**100%**)	54 (**100%**)
10km/h	**Backward**	54 (**100%**)	54 (**100%**)	54 (**100%**)

Reference Materials

Characteristic Comparison between UHF and Microwave

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Item		UHF Band	Microwave Band
Frequency		- 920.5 - 925.5 MHz (trial)	2450 MHz band
		RFID-only	For general use
Maximum output		2W erp	Unknown
International standard		ISO/IEC 18000-6	ISO/IEC 18000-4
Communication distance	No battery	up to 4m	up to 1m
	With battery	up to 20m	up to 5m (10mW)
Advantages		(1) Because of dedicated band, not interfered with other systems (2) Long communication distance even without battery (Wide communication area)	(1) Smaller tag due to short wavelength
Disadvantages		(1) Larger tag due to long wavelength (2) As radio wave reflects off the floor, wall, and metal, a null point (unreadable area) emerges (3) As absorbed into water a lot (not so much as microwave), not suitable for human carrying-about purpose	(1) As general purpose frequency, interfered with wireless LAN, Bluetooth, electronic oven, and so on (2) A null point emerges due to radio wave reflection (not so much as UHF) (3) As absorbed into water a lot, not suitable for human carrying-about purpose

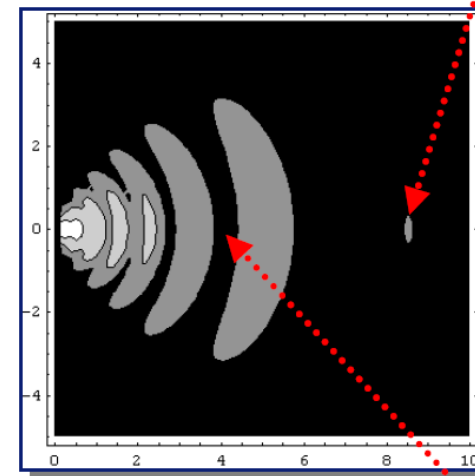Reader/Writer — Direct wave — Null point — Reflected wave

field-holes
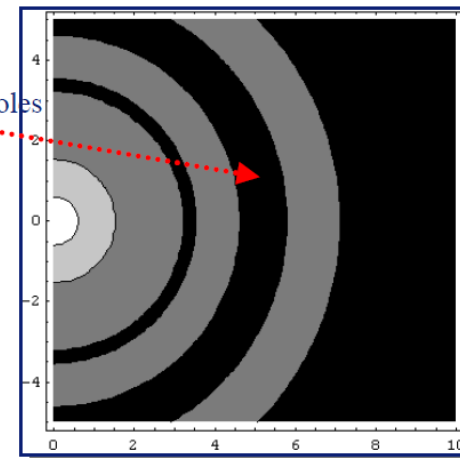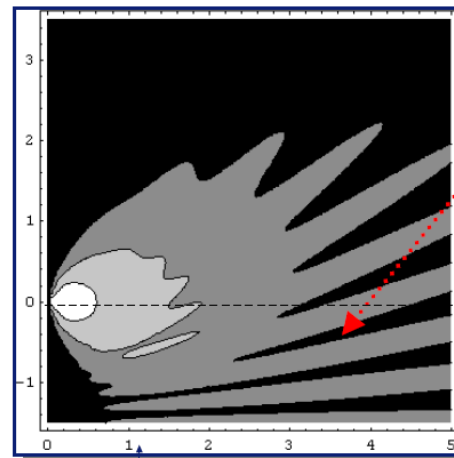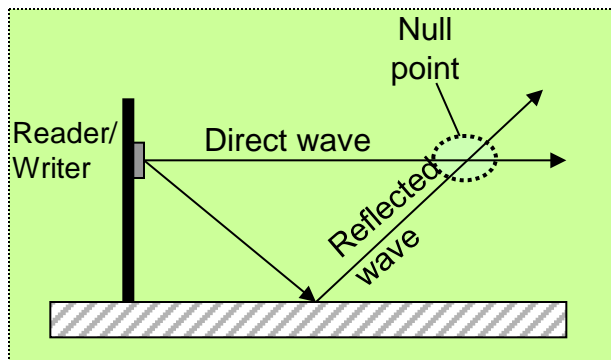
Idealized linear polarized dipole
Polarisation: z - axes
Picture left: zy - plane / Picture right: xy - plane

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(1) Because direct and reflected waves negate each other, an incommunicable point (null point) emerges

(2) Because direct and reflected waves reinforce each other, readable point (hot spot) emerges 8m ahead.
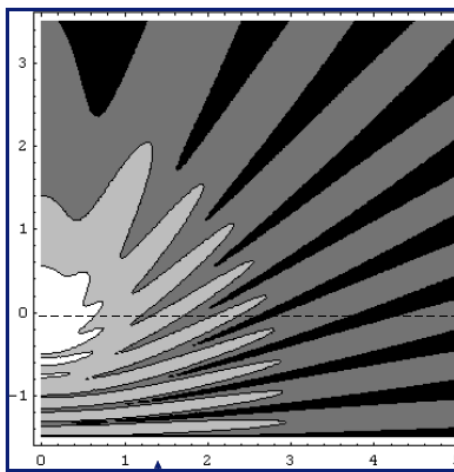

super-range

field-hole

Idealized linear polarized dipole
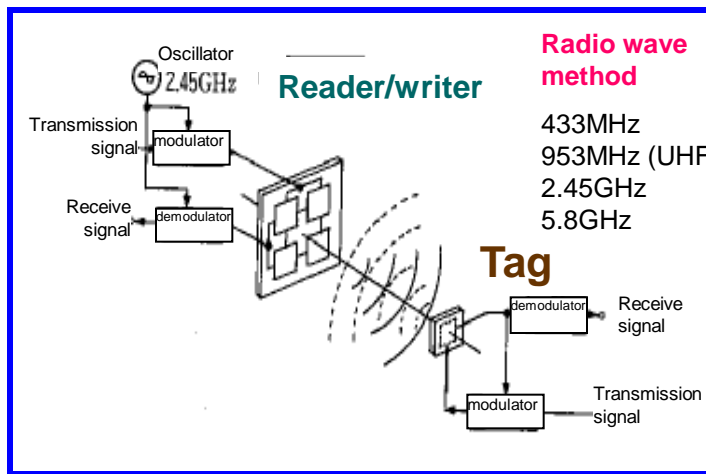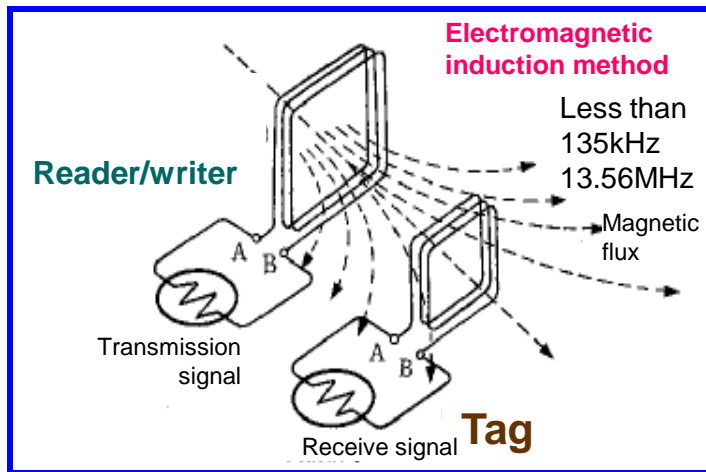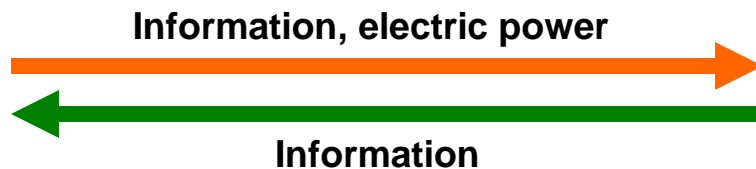Polarisation: y - axes
Picture left: xz - plane / Picture right: xy - plane

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RFID System Construction
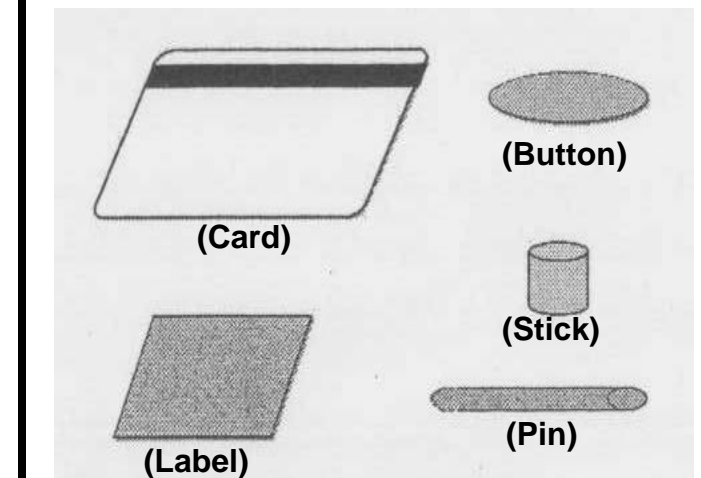
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[System Construction]

Information, electric power

Information

Reader/writer

Stationary type

Handheld type

Upper system

Electromagnetic induction method

Reader/writer

Less than
135kHz
13.56MHz

Magnetic flux

A B

Transmission signal

A B

Receive signal

Tag

Radio wave method

Oscillator
2.45GHz

Reader/writer

Transmission signal — modulator

Receive signal — demodulator

433MHz
953MHz (UHF)
2.45GHz
5.8GHz

Tag

demodulator — Receive signal

modulator — Transmission signal

Tag

(Card)

(Button)

(Stick)

(Label)

(Pin)

[Tag Construction]

Semiconductor chip

(Battery)

| Memory unit | Transmit unit |
| Power rectifying unit | Receive unit |

Antenna

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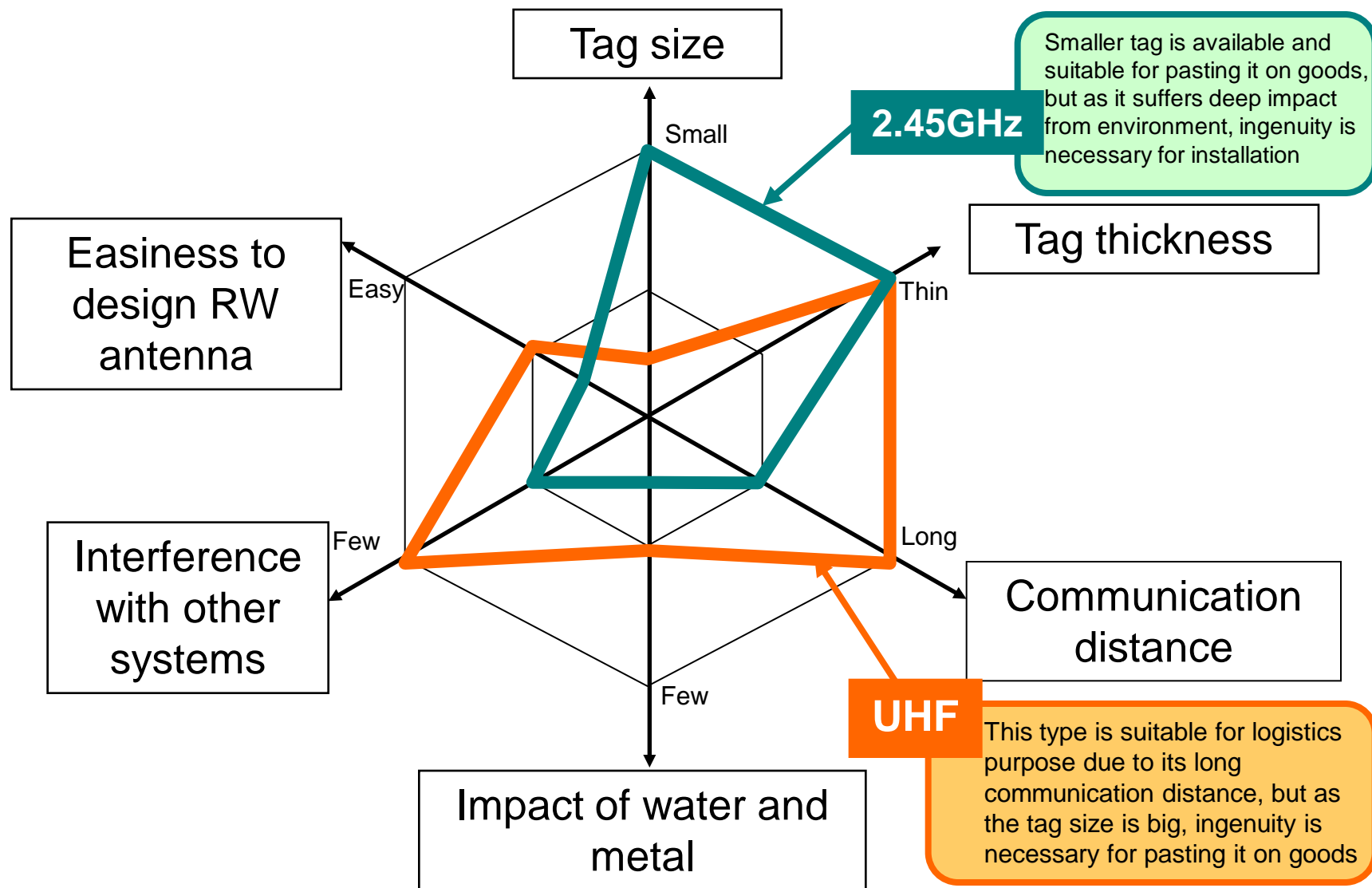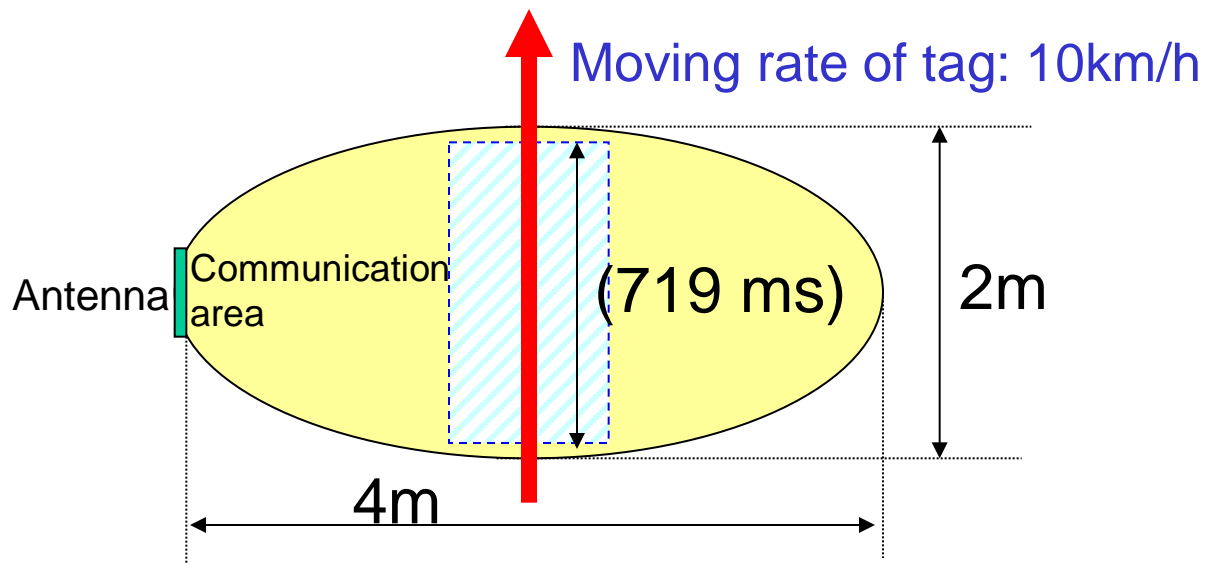|		Communication method	
		Reflection (Returns received radio waves)	**Emission** (Radiates radio waves by itself)
Power supply method	Radio waves	**Passive method** - 13.56MHz (Suica) - 2.45GHz（World expo ticket） - 953MHz (UHF band) A tag itself does not have a battery, but it activates its circuit by taking energy out of the radio waves received from reader/writer. Also, as for reply, the tag does not radiate radio waves, but it reflects the radio waves received from reader/writer	**(Semiactive method)** - 134.2kHz A tag takes energy out of the radio waves received from reader/writer and stores electricity in capacitor of the tag, and radiates radio waves using the energy [Capacity recharge method]
	Battery	**Passive method with battery** **(Battery Assisted Passive method)** - 2.45GHz A tag activates the circuit using its own battery, but as for reply, similar to the passive method, it reflects radio waves received from reader/writer instead of radiating radio waves	**Active method** - 300MHz band (Weak radio waves) - 433MHz - 5.8GHz (ETC) A tag activates the circuit using its own battery, and as for reply, it radiates radio waves This type of tag is a kind of radiotelephone

Characteristic Comparison of Each RFID Frequency


(Typical system characteristics of passive type)

Tag size

2.45GHz — Smaller tag is available and suitable for pasting it on goods, but as it suffers deep impact from environment, ingenuity is necessary for installation

Tag thickness

Small / Thin / Long / Few

Easiness to design RW antenna

Easy

Interference with other systems

Few

Communication distance

UHF — This type is suitable for logistics purpose due to its long communication distance, but as the tag size is big, ingenuity is necessary for pasting it on goods

Impact of water and metal

Number of Processing Tags

Moving rate of tag: 10km/h

Antenna | Communication area

(719 ms)

2m

4m

[Ideal State]

(1) Pass-by time in area: 719 ms

(2) tag's RF communication time: 3 ms
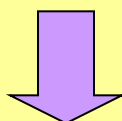
(3) Number of processing tags during pass-by: 240

[Realistic State] (Assumed)

Constraint condition

- PC/reader processing time, retry

- Pass-by location/height

- Tag's direction, each other's
  interference, et al.

x 1/2

(4) Number of processing tags during pass-by: **120**