SONY®

FeliCa

Card IC

RC-S966 Series

Data Sheet

Version 1.2

No. M751-E01-20

Introduction

This document describes major function of RC-S966 series (i.e. RC-S966/1A, RC-S966/1C, and RC-S966/1S, hereinafter referred to as “RC-S966”), a chip for the contactless IC card that uses Sony's FeliCa technology. RC-S966 supports commands that FeliCa Lite-S products need.

You are advised to read this document if you are responsible for manufacturing of products which uses contactless IC card chip.

The authors assume that readers of this document are familiar with contactless IC card technology, electronic circuit and integrated circuit.

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1 Major functions and features

RC-S966 is a contactless IC card chip, based on Sony's FeliCa technology. The features of RC-S966 are described below.

Lower price

With simplified security functionality and an optimized file system, RC-S966 is offered at lower prices than conventional FeliCa chips (hereinafter referred to as "FeliCa Standard chips"). RC-S966 are suited for embedding in such low-cost products as sales promotion articles, membership cards, points cards, game cards, gift cards, and multi-use ticket.

Use of existing FeliCa infrastructure

RC-S966 is based on the same wireless communication method as conventional FeliCa Standard-compatible products and a command system compatible with that for conventional FeliCa Standard chips. Therefore, you can use your existing infrastructure, including FeliCa ports, and development environment without change.

You can issue and operate RC-S966 with only three commands: Polling, Read Without Encryption, and Write Without Encryption.

Mutual authentication function

RC-S966 has a mutual authentication function, which is different from that in conventional FeliCa Standard chips, for authentication with the Reader/Writer.

This function is suited for applications such as ID and Points cards.

Detection of falsification

RC-S966 can detect falsification by adding MAC (Message Authentication Code) to the data read out and written in.

Compliance with NFC Forum Type 3 Tag

RC-S966 is compliant with the Type 3 Tag defined by the NFC Forum. Therefore, they can communicate with any Reader/Writer that is compliant with the NFC Forum standard.

The RC-966 can be used for Handover and Smart Poster applications.

Reduction in chip size

RC-S966 has succeeded to achieve smaller chip size (0.99mm x 0.99mm (Typ.), after dicing) by adopting a fine process technology and only the command set of the minimum requirement, with suppressed memory capacity.

Communication system

The communication system of RC-S966 is based on inductive coupling.

Power-saving design

RC-S966 is a low-power consumption designed chip.

All significant functions of FeliCa contactless IC card are implemented into RC-S966, except antenna circuitry.

Because RC-S966 can operate at a low electromagnetic field density, you can use RC-S966 for stickers, smart posters, and other non-card media that have miniaturized antennas.

High data reliability

RC-S966 has highly-reliable NVM (Non-Volatile Memory) inside the chip. Write cycle endurance of memory cells is 50,000 when chip is used at Tj[*1] = 25°C, or 10,000 when used at Tj = 85°C.

[*1] Tj stands for Junction temperature.

IDm

RC-S966 has chip-unique IDm written in its NVM, which is written at the time of shipment.

Data transfer rate

RC-S966 supports automatic data transfer rate switching between fc[*1]/64 (approx. 212kbps, hereinafter referred to as “212kbps”) and fc/32 (approx. 424kbps, hereinafter referred to as “424kbps”) .

[*1] fc stands for frequency of carrier signal (13.56MHz).

Simple file system

Data can be written in block (16-byte) units into the on-chip memory of RC-S966.

The adaption of a non-hierarchical file system enables access to blocks using only a single service.

Each block can be set:

- to be write-protected
- whether or not authentication is necessary when the data is written-in to/read out of the block
- whether or not MAC is necessary when the data is written in to the block

Data protection function against power interruption (anti-tearing)

In RC-S966, the function to guarantee the data integrity at the command level is implemented.

If data write to NVM is interrupted due to power failure, the data is replaced by the previously stored data.

See "FeliCa Lite-S User's Manual" for detailed descriptions.

2 Specifications

This chapter describes general specifications and electrical characteristics of RC-S966.

2.1 General specifications

General specifications of RC-S966 are listed below.

- Model name :

Model name	Shipping form	Pad or bump[*1]
RC-S966/1A	Sawn wafer on wafer ring	Bump on pad
RC-S966/1C	Sawn wafer on wafer ring	Pad
RC-S966/1S	Unsawn wafer	Bump on pad

- Application : Contactless IC card based on FeliCa technology
- External dimensions : RC-S966/1A and /1C 0.99mm×0.99mm (Typ.) (After dicing)
  (Face) 980 (±50) μm x 980 (±50) μm
  (Back) 995 (±50) μm x 995 (±50) μm
  RC-S966/1S 1.08mm×1.08mm (Typ.) (Before dicing)
  (Size of die pattern)
- Thickness : RC-S966/1A and /1C 120 (±15) μm (After backgrinding)
  RC-S966/1S 725 μm (Typ.) (Before backgrinding)
- Communication system : Wireless communication based on inductive coupling[*2]
- Modulation system : ASK modulation
- Data transfer rate : 212kbps/424kbps
  automatically switchable
- User memory : 14 Blocks (1 Block = 16 Bytes)
- NVM cell performance : Data retention period : 10 years (at Tj = 25°C)
  5 years (at Tj = 85°C)
  Rewriting durability : 50,000 times (at Tj = 25°C)
  10,000 times (at Tj = 85°C)
- Shipping form : RC-S966/1A and /1C Sawn wafer on wafer ring (8”)
  RC-S966/1S Unsawn wafer (8”)
- Operating temperature : -25°C to +100°C[*3]
- Storage temperature : -55°C to +125°C
- Minimum operating current : 500μA (max.)

[*1] A conductive protrusion made on bonding pad for interconnecting die and circuitry by Controlled Collapse Chip Connection.

[*2] Complies with ISO/IEC 18092 (212/424 kbps Passive Communication Mode).

[*3] Quality and reliability are assured in the temperature range of -25°C ～+85°C

2.2 Electrical characteristics

2.2.1 Absolute maximum ratings

Item	Symbol	Rated value			Unit	Remarks
		Min.	Typ.	Max.		
Operating temperature (junction)	T_j	-40	—	+125	°C	
Storage temperature	T_{stg}	-55	—	+125	°C	
Input voltage	V_{ain}	—	—	15	V_{0p}	Between antenna terminals (AC)
Input current	I_{ain}	—	—	191	mA_{peak}	Antenna terminal instantaneous current value
	I_{ain_avg}	—	—	74.2[*1]	mA	Antenna terminal average of peak current value

[*1] Under the condition that carrier signal of 13.56MHz sine wave is inputted.

2.2.2 Recommended operating conditions

Item	Symbol	Rated value			Unit	Remarks
		Min.	Typ.	Max.		
Operating temperature (junction)	T_j	-25	—	+100	°C	Quality and reliability are assured when the operating temperature is within the range of -25°C to 85°C
Input current	I_{ain_avg}	0.5	—	66[*1]	mA	Antenna terminal average of peak current value
Input frequency	f_c	—	13.56	—	MHz	

[*1] Under the condition that carrier signal of 13.56MHz sine wave is inputted.

2.2.3 Chip operating characteristics

These are characteristics of recommended operating conditions when not mentioning them specially.

Item	Symbol	Rated value			Unit	Remarks
		Min.	Typ.	Max.		
Current consumption	I_{CC}	—	—	500	μA	T_j = -25°C to +85°C
Reset start voltage[*1 *2]	V_{ARSTA}	2.84	3.19	3.54	V_{0p}	Between antenna terminals (AC) @T_j = +25°C
Reset release voltage[*3 *4]	V_{ARSTN}	3.19	3.54	3.89	V_{0p}	Between antenna terminals (AC) @T_j = +25°C
Input capacitance	C_{IN}	14.79	17.00	19.21	pF	Capacitance value between antenna terminals (designed value)

[*1] Voltage amplitude that resets the chip when the voltage amplitude between antenna terminals is decreased from the chip operating state.

[*2, *4] It is guaranteed that Reset release voltage is always higher than Reset start voltage

[*3] Voltage amplitude which releases the chip reset when the voltage amplitude between antenna terminals is increased from the chip reset state.

2.2.4 NVM cell characteristics

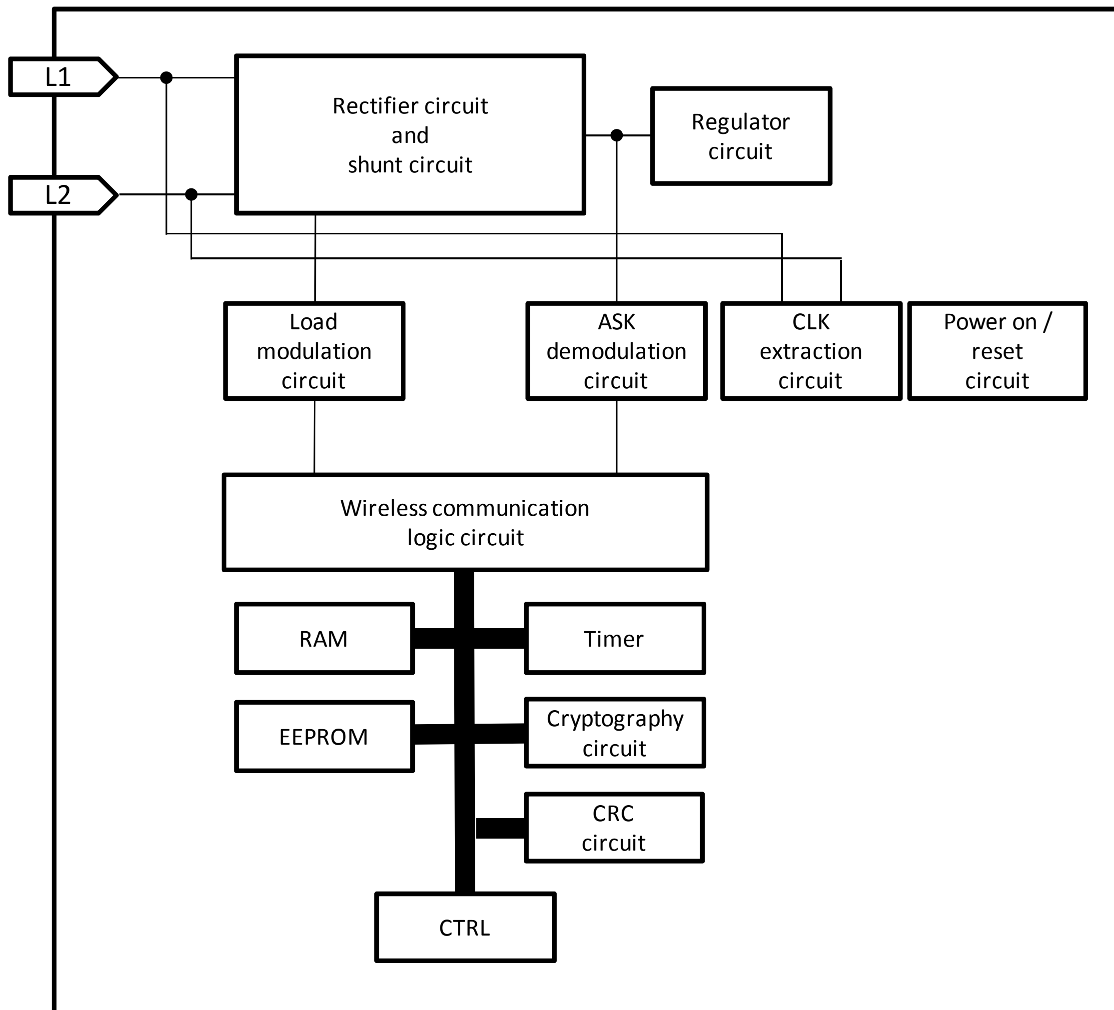
Item	Symbol	Rated value	Unit	Remarks
Data retention period	t_{ret}	10	Year	Tj = +25°C
		5	Year	Tj = +85°C
Number of rewrite	N_{end}	5×10^4	Cycle	Tj = +25°C
		1×10^4	Cycle	Tj = +85°C

2.2.5 ESD tolerance

Item	Symbol	Rated value			Unit	Remarks
		Min.	Typ.	Max.		
Electrostatic stress	V_{ESDHBM}	2000	—	—	V	See "JEDEC JESD22". (100pF, 1.5kΩ)

3 Internal configuration

Internal configuration block diagram of RC-S966 is shown in Figure 3-1.



NOTE The diagram illustrates a conceptual image.

Figure 3-1 : Internal configuration block diagram

4 File system and command

This chapter describes file specification, supported Service and supported commands on RC-S966.

4.1 File specification

The number of usable Block and the simultaneously accessible Block are tabulated in the Table 4-1 and Table 4-2, respectively.

Table 4-1 : Number of usable Block

Item	Max. number	Remarks
Number of usable Block	15	Number of User Block (14 S_PAD blocks[*1] and 1 REG block[*2])

Table 4-2 : Simultaneously accessible Block

Item (Command)	Max. number	Remarks
Read Without Encryption	4	
Write Without Encryption	1	2 when Write-in with MAC[*3] is performed.

[*1, *2, *3] Please see “FeliCa Lite-S User’s Manual” for description of S_PAD blocks, REG blocks, and Write-in with MAC

4.2 Service

RC-S966 supports the following types of Service. Also, the relationship between Service and Block is shown in Figure 4-1.

Table 4-3: Service Supported by RC-S966

Service	Attribute
Random Service	Read/Write Access: authentication not required
	Read Only Access : authentication not required

NOTE Necessity for authentication can be set by another way (every each Block). Please see “FeliCa Lite-S User’s Manual” for details.

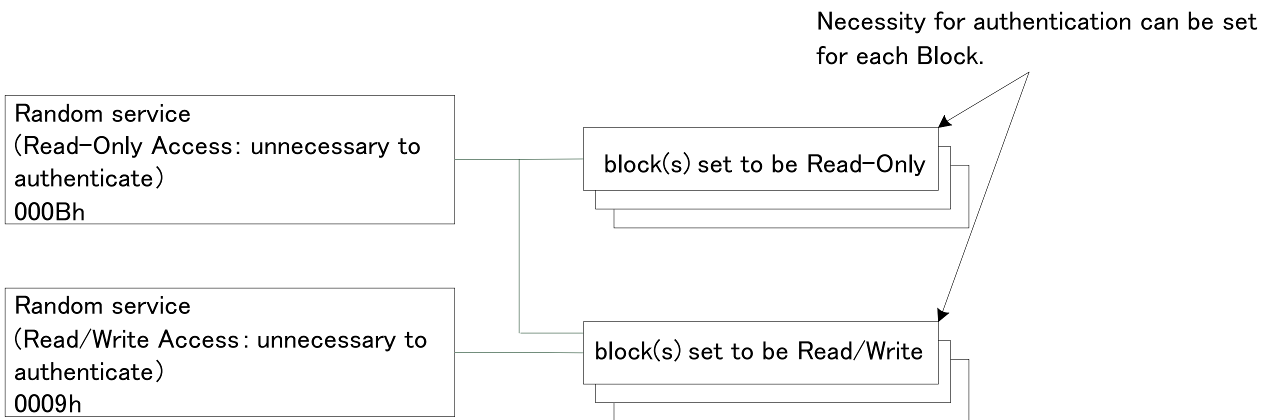


Figure 4-1: Service and Block

4.3 Command list

Table 4-4 provides a list of commands supported by RC-S966 and a brief description of each. For more details, see the "FeliCa Lite-S User's Manual".

Table 4-4: Command list

Command name	Function overview
Common commands	
Polling	Use this command to acquire and identify a card.
Read Without Encryption	Use this command to read Block Data from Service.
Write Without Encryption	Use this command to write Block Data to Service.

4.4 Command parameters specific to RC-S966

Table 4-5 provides a list of parameters specific to RC-S966, which is used in Command Packet Data and Response Packet Data supported by RC-S966.

Table 4-5: Parameters specific to RC-S966

Command	Parameter	Value
Polling	Request Code	00h：No request 01h：System Code request 02h：Communication performance request
	PMm	00F1000000014300h
	Request data when Request code RC-S966o Service..	0083h： 212kbps communication is possible 424kbps communication is possible Communication rate automatic detection compliant
Read Without Encryption	The maximum number of Blocks that can be read simultaneously	4 Blocks
Write Without Encryption	The maximum number of Blocks that can be written simultaneously	1 Block (2 Blocks in case of Write with MAC)

5 Security

RC-S966 has the following security functions.

- Mutual authentication (Internal Authentication/External Authentication)
- MAC generation, addition, and verification functions
- Tamper-resistance function

6 Die geometry

This chapter describes mechanical dimensions of RC-S966.

Details of pads of the RC-S966/1C, bumps of the RC-S966/1A and RC-S966/1S, and specifications common to RC-S966/1A, RC-S966/1C and RC-S966/1S are described in section 6.1 “Pads”, 6.2 “Bumps”, and 6.3 “Passivation layer” and following sections, respectively.

6.1 Pads

This section describes pads of the RC-S966/1C.

6.1.1 Number of pads

Antenna pads : 2

6.1.2 Pad material

All pads are made of aluminum.

6.1.3 Pad positions

Figure 6-1 shows a schematic view of pad positions. The central coordinates of each pad are as follows when the point of origin is set at the die center. Other than L1_P and L2_P, Pads for bumps (parts painted in grey in the Figure 6-1) are allocated. Because these pads for bumps of RC-S966/1C are processed specially for forming bumps, they cannot be used.

PAD	X	Y
L1_P	-424	-318
L2_P	424	-318

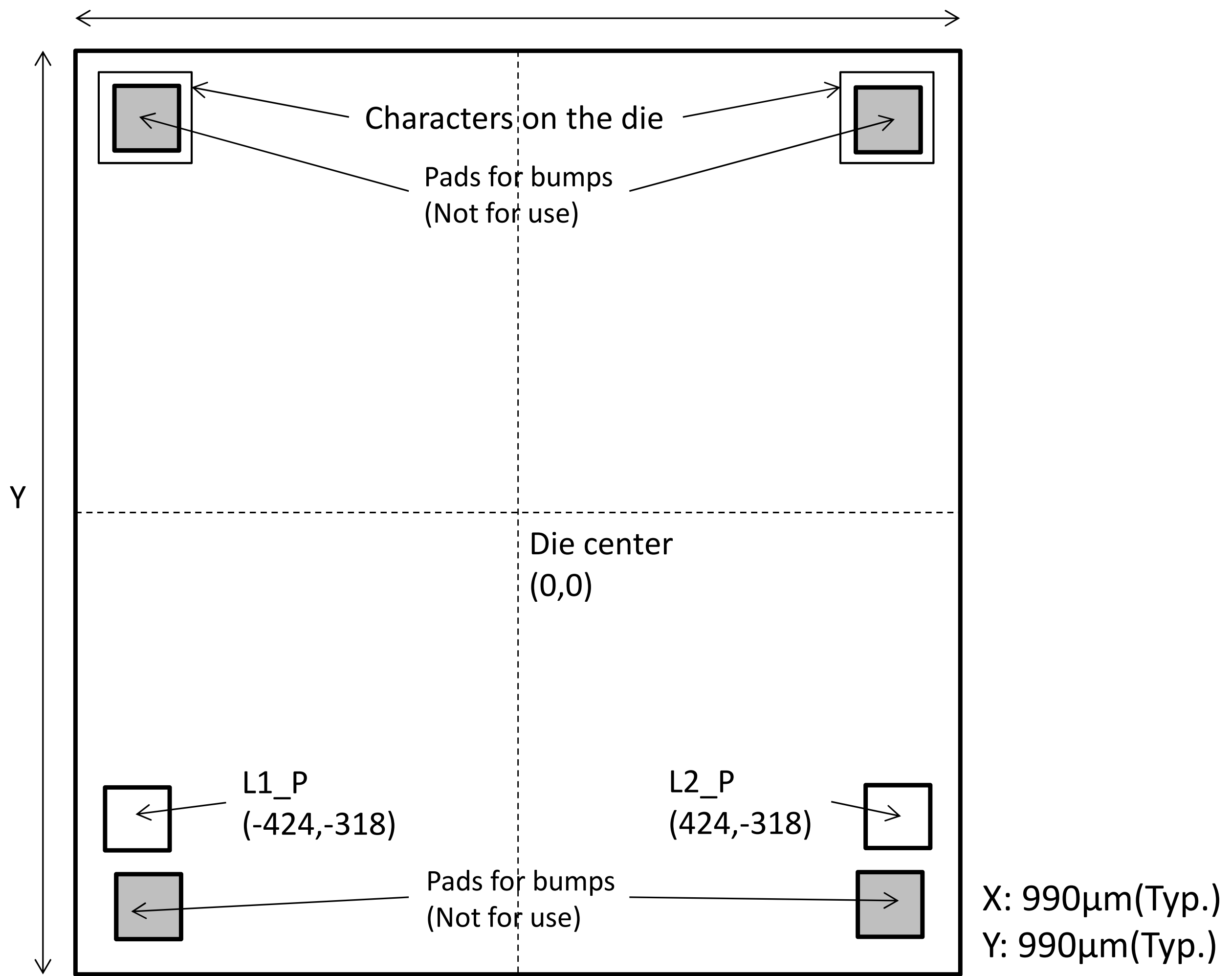


Figure 6-1: Pad positions

6.2 Bumps

RC-S966/1A and RC-S966/1S have a bump formed on each pad. These bumps are formed by means of electroplating. The positions of bump for antenna pads differ from antenna pad positions.

6.2.1 Bump position

Figure 6-2 shows a schematic view of bump positions.

The central coordinates of each bump are as follows when the point of origin is set at the die center.

Bump	X	Y
DMY 1	-410	410
DMY 2	410	410
L1_B	-410	-410
L2_B	410	-410

NOTE DMY1, DMY2 are not connected to the internal circuits. There is no problem to connect DMY1/DMY2 to L1_B/L2_B, respectively.

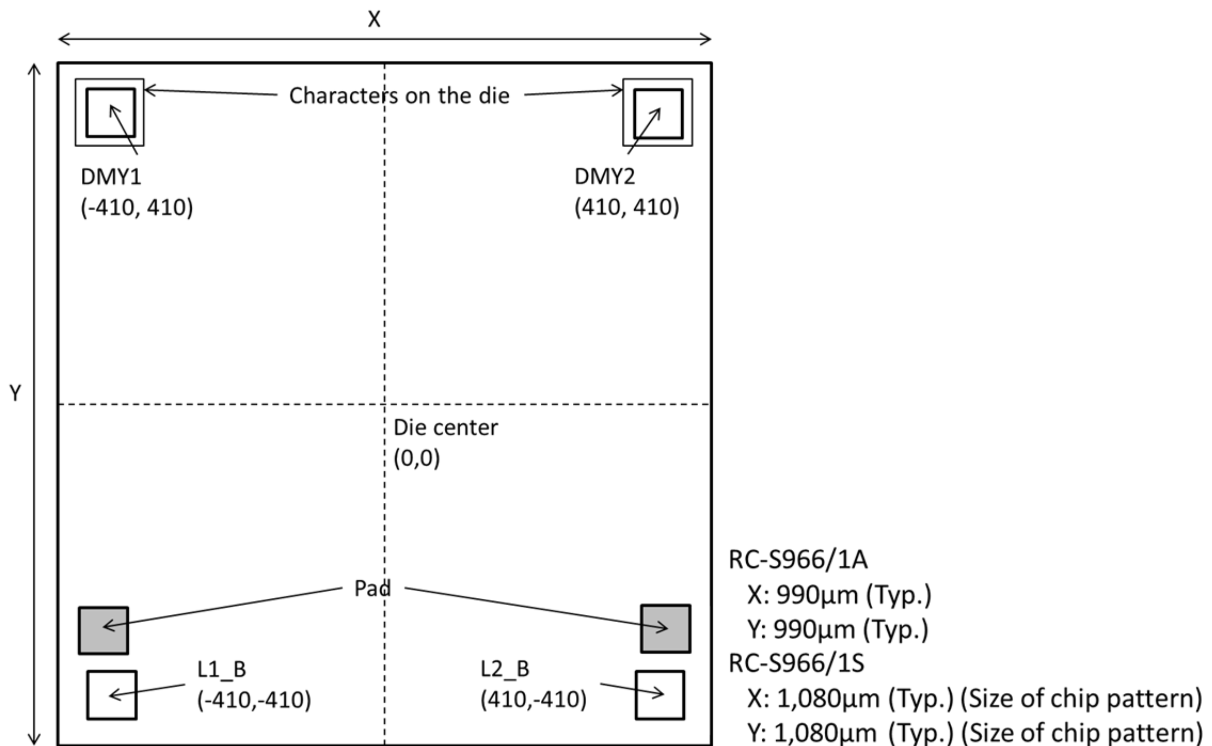
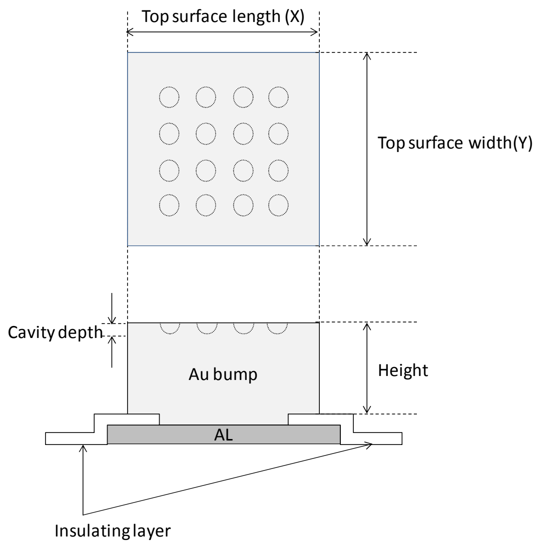


Figure 6-2: Bump positions

6.2.2 Bump dimensions

Figure 6-3 shows a schematic view and dimensions of bump.



Bump dimensions [μm]	
Top surface length (X)	70 to 85
Top surface width (Y)	70 to 85
Height	22 ± 4
Height variation (within a chip)	3 or less (evaluation value)
Cavity depth	1.5 or less

Figure 6-3：Bump dimensions

6.2.3 Bump material

All bumps are made of gold.

6.2.4 Bump hardness

Hardness of a bump is between 20 and 80 HV.

6.3 Passivation layer

The die surface is protected by a passivation layer (the shaded areas in Figure 6-4), except the pads and bumps, and the scribed area (die edge).

Thickness of the passivation layer: 4.0 µm ± 1.0 µm (reference value)

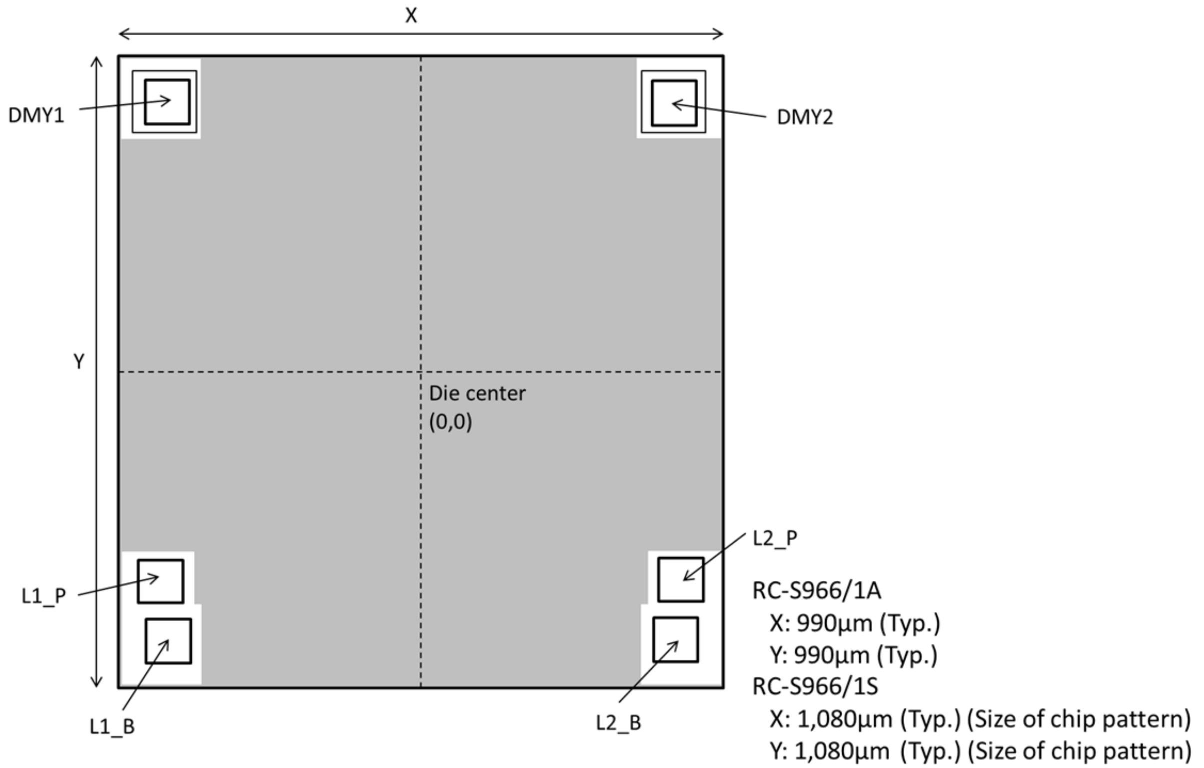


Figure 6-4: Passivation layer on die surface

6.4 Die thickness

RC-S966/1A and RC-S966/1C	:	120 μm ± 15 μm (After backgrinding)
RC-S966/1S	:	725 μm (Typ.) (Before backgrinding)

6.5 Die dimensions

RC-S966/1A and RC-S966/1C	:	0.99mm(X) x 0.99mm(Y) (Typ.) (After dicing)
		(Face) 980 (±50) μm x 980 (±50) μm
		(Back) 995 (±50) μm x 995 (±50) μm
RC-S966/1S	:	1.08mm(X) x 1.08mm(Y) (Typ.) (Before dicing, size of die pattern)

(See Figure 6-1 for XY directions.)

6.6 Characters on die

Following characters are allocated on the die surface (see Figure 6-1and Figure 6-2).

- Characters on die (example)
  SONY 2012
  CXD90003 04

7 Packing specifications

This chapter focuses on the packing specifications for wafers. Section 7.1 “Packing specifications for sawn wafers on wafer rings” is applied to RC-S966/1A and RC-S966/1C. And section 7.2 “Packing specifications for unsawn wafers” is applied to RC-S966/1S.

7.1 Packing specifications for sawn wafers on wafer rings

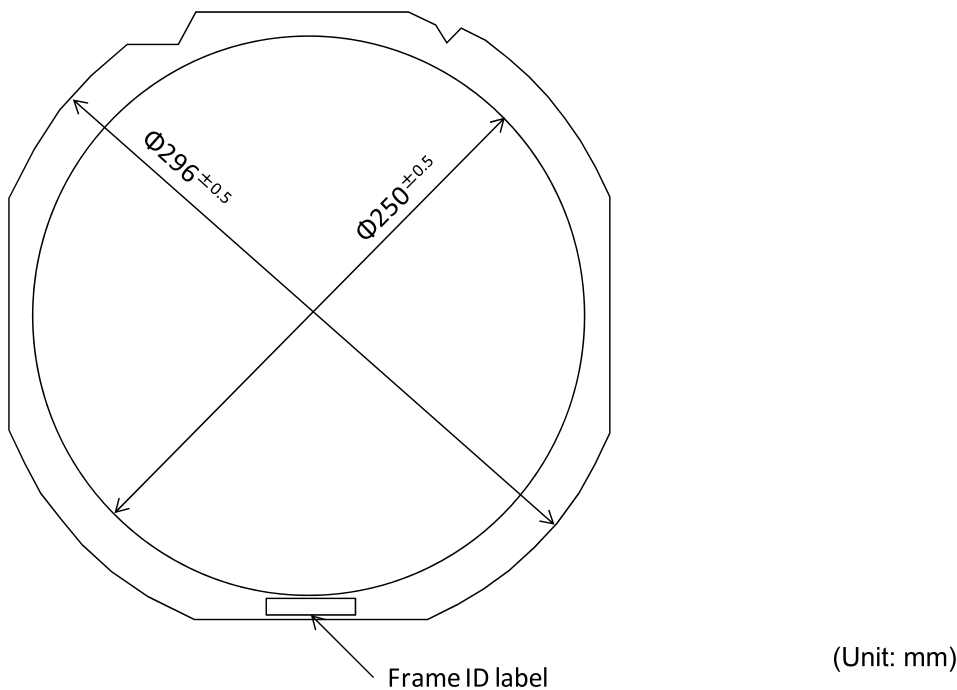
This section describes packing specifications applied to RC-S966/1A and RC-S966/1C.

7.1.1 Wafer ring

Ring dimensions are shown in Figure 7-1.

A FrameID label (see Figure 7-2) is attached on the lower side when the notched edge of the ring is placed on the upper side.

Ring is made of plastic.



(Unit: mm)

NOTE Please use this size for reference.

Figure 7-1: Ring dimensional drawing

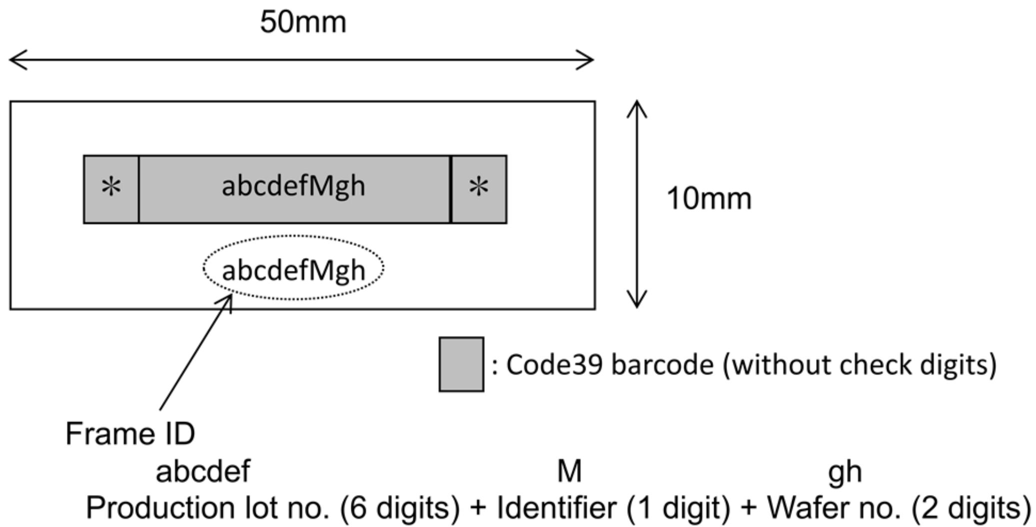


Figure 7-2: Frame ID label (example)

NOTE The barcode is inscribed by using CODE39 (without check digits). Readability of the barcode depends upon performance of the barcode reader, distance between the reader and the barcode, and scan angle.

RC-S966/1A and RC-S966/1C use Frame ID to take one-to-one mapping between a wafer and a map data.

The value on the Frame ID label (abcdefMgh) matches “the name of the map data” and “the value of Frame ID in the map data”.

7.1.2 Inner carton

The inner carton specification is as follows (See Figure 7-3).

1) Wafer rings, each holding a 200 mm (8”) wafer, are inserted into groove of the container. All wafers face the same direction and the notched edge of the frame comes to the upper position. Each container holds up to 25 wafers which fabricated in the same production lot.
2) Wafer container label (See Figure 7-4) is attached to the side of the wafer container.
3) The container is bagged in a moisture-resistant bag. The bag is then deaerated and sealed.
4) Identification label (See Figure 7-6) is attached to the sealed bag.
5) EIAJ C-3 label (See Figure 7-5) is attached to the side of the sealed bag.

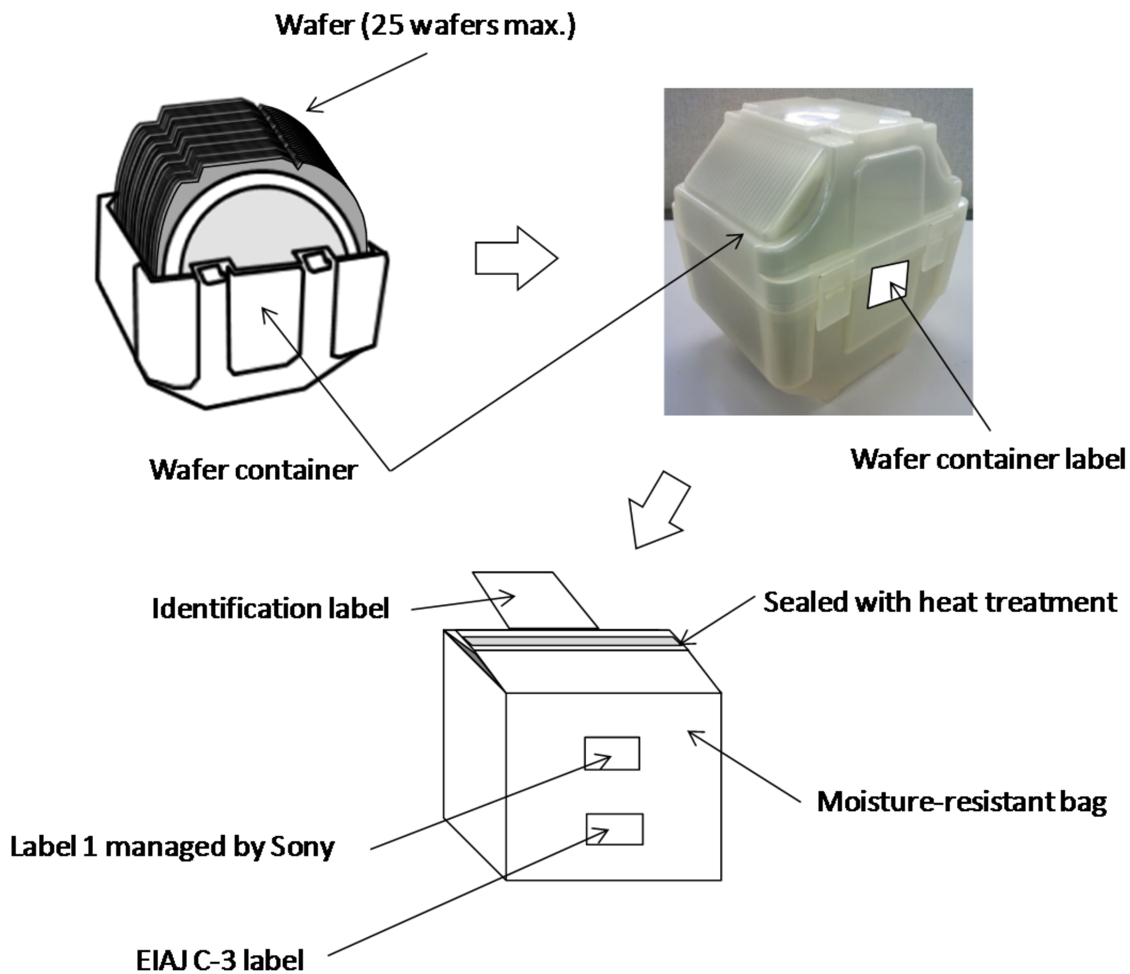


Figure 7-3: Inner carton

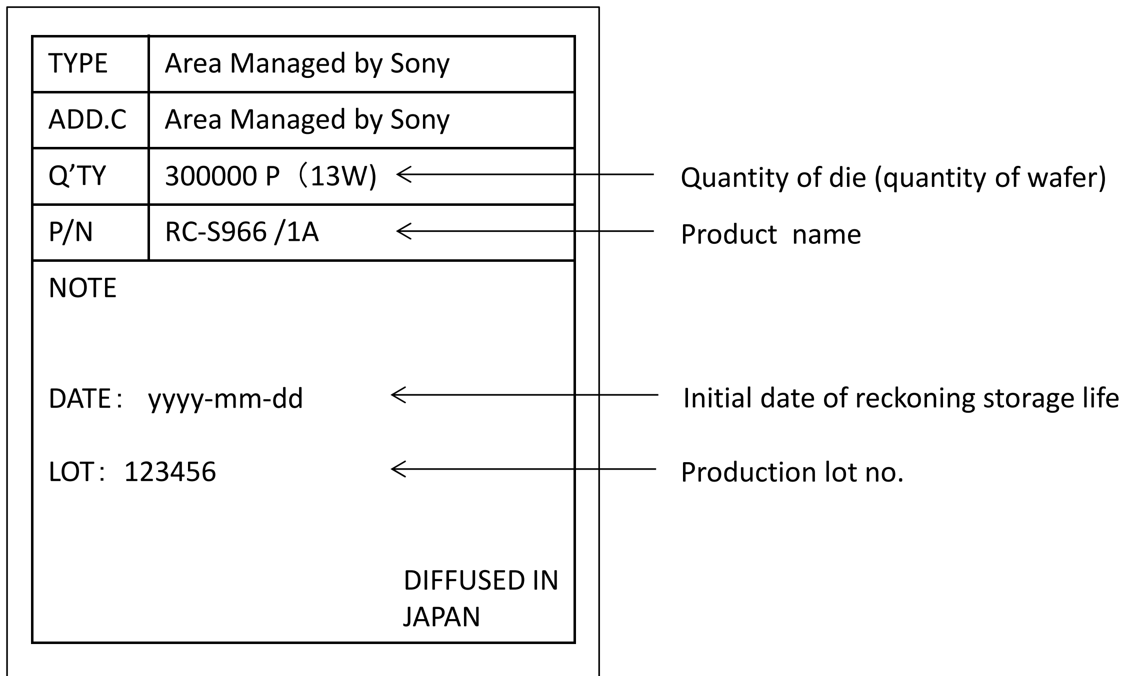


Figure 7-4: Wafer container label (example)

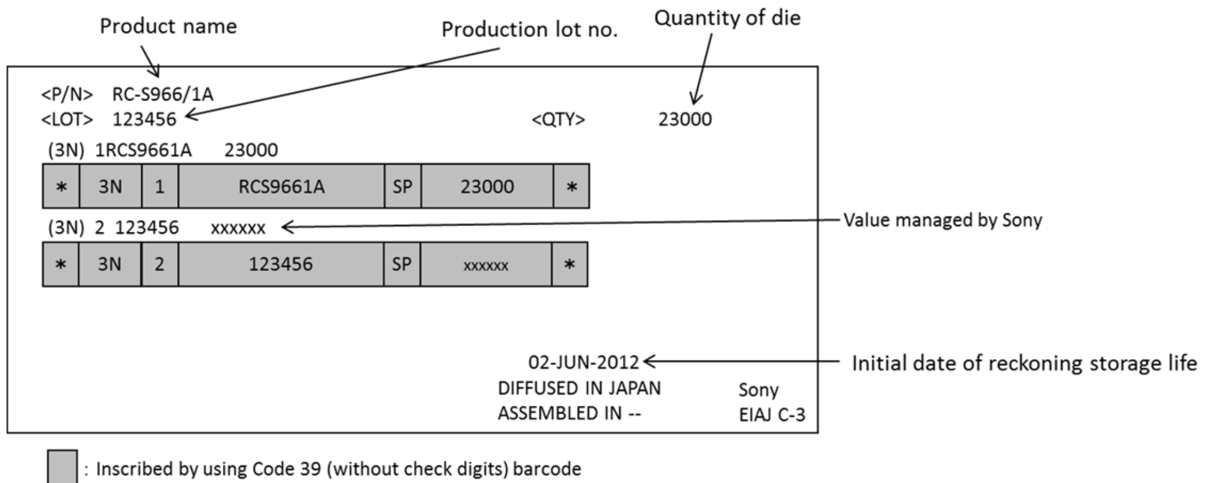


Figure 7-5: EIAJ C-3 label (example)

NOTE The barcode is inscribed by using Code39 (without check digits). Readability of the barcode depends upon performance of the barcode reader, distance between the reader and the barcode, and scan angle.

Identification Label
現品票

PRODUCT: RC-S966/1A ← Product name

LOT NUMBER: 123456 ← Production lot no.

WAFER QUANTITY: 13Wf ← Quantity of wafer

WAFER TOTAL QUANTITY: 300000pcs ← Quantity of die

DATE: yyyy/mm/dd ← Initial date of reckoning storage life

No.	QUANTITY	No.	QUANTITY ← Quantity of die per wafer
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11			
12			
13			TOTAL QUANTITY 300000 PCS
14			
15			

Figure 7-6: Identification label (example)

7.1.3 Outer carton package

Outer carton package specification is as follows (See Figure 7-7).

1) Each outer carton package contains one inner carton. Inner carton is protected with foam polystyrene cushion boards.
2) Outgoing inspection report that stipulates the shipping lot number (see Figure 7-8) is attached on top surface of the outer carton package.
3) EIAJ C-3 label (See Figure 7-5) is attached to the side of the outer carton package.

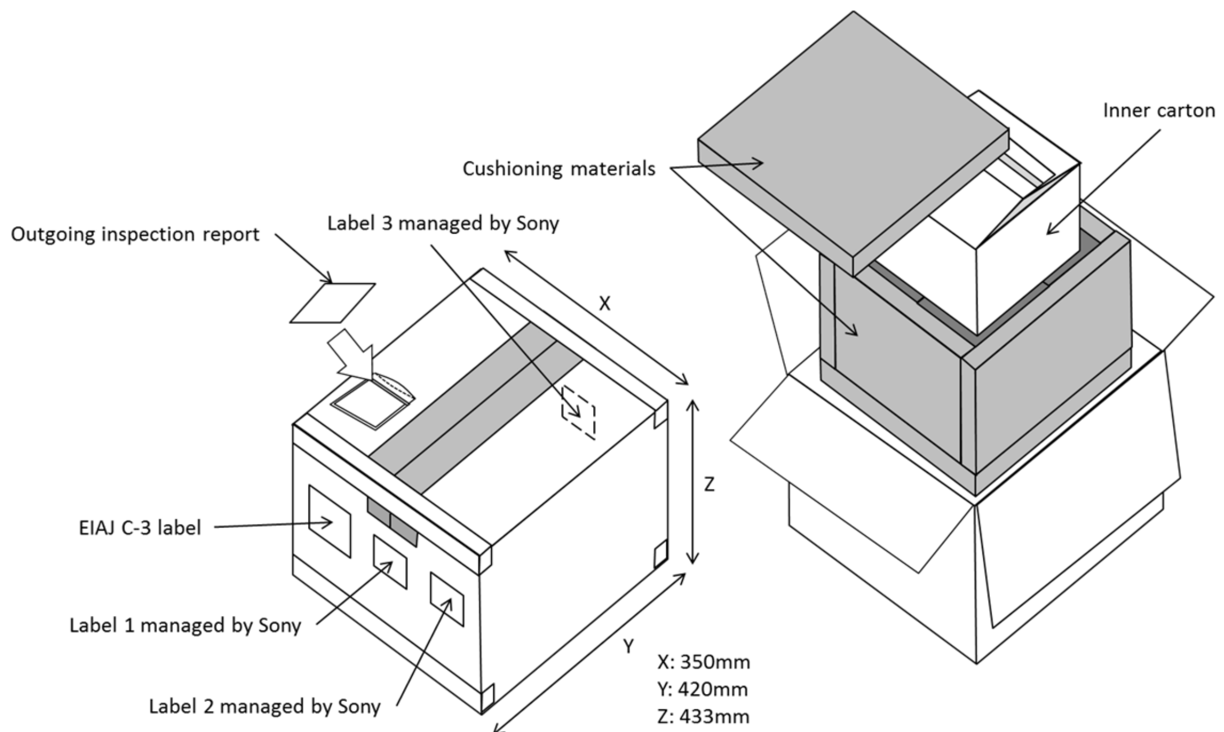


Figure 7-7: Outer carton package

Company name
（会社名）

Control No.: oooooooo
(管理 No.: oooooooo)

Outgoing Inspection Report（出荷検査成績書）

This is to certify that the following product has satisfied the delivery inspection standard as shown below.

Product name（品名） **: RC-S966/1A (WW)**

Quantity（出荷数量） **: XX,XXXpcs**

Shipping lot number（出荷 Lot No.） **: XXXXXXXX**

Inspection detail（検査内容） **:**

Inspection item（項目）	Inspection sampling size（検査数）	Pass criteria（基準）
Appearance（外観）	ANSI-ASQC Z1.4 Inspection level II. Normal inspection （ANSI-ASQC Z1.4 ナミ検査、検査水準Ⅱに準拠）	Acceptable Quality Level (AQL) =0.65%
Electrical characteristics（電気的特性）	Total sample (全数検査)	Pass all test items（全試験項目をパス）

Test results（試験結果）

(1) Appearance（外観） : **PASS**
(2) Electrical characteristics（電気的特性検査） : **PASS**

Judgment

Approved	Checked	Prepared

Sony Storage Media and Devices Corp.

Figure 7-8 : Outgoing inspection report (example)

7.1.4 Identification of defective dies

Defective dies are indicated by an ink mark specified below to identify them.

- Size (Diameter) : 350 μm ± 100 μm
- Color : Black
- Height : 30 μm or less

Identification of defective dies on each wafer is also possible by using electronic data (map data conforming to SEMI G85 specifications). For more information about the map data, contact Sony sales representative.

7.1.5 Maximum quantity of dies on a wafer

Maximum quantity of dies on a wafer differs by presence or absence of bump on pad. Maximum quantity of dies on a wafer of RC-S966/1A (bump on pad) is 23,908 dies, and Maximum quantity of dies on a wafer RC-S966/1C (pad) is 23,912 dies. The number of the good dies differs in each wafer.

7.1.6 Yield of wafer

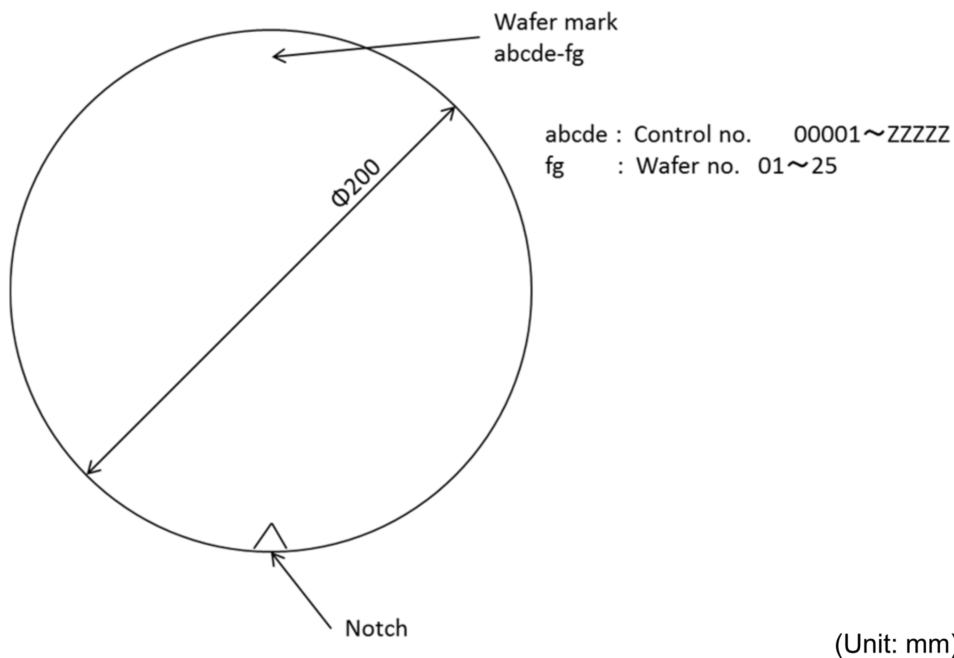
For wafers, a yield rate of more than 50% will be maintained.

7.2 Packing specifications for unsawn wafers

This section describes packing specifications applied to RC-S966/1S.

7.2.1 Wafer

External appearance of a wafer is shown in Figure 7-9.



(Unit: mm)

NOTE Please use this size for reference.

Figure 7-9: External appearance of a wafer

RC-S966/1S uses wafer mark to take one-to-one mapping between a wafer and a map data.

Wafer mark will correspond to the WaferID (the value in the map data) by replacing “-” to “M”.

(Example)	Wafer mark	:	00001-01
	Control no.	:	00001
	Wafer no.	:	01
	WaferID	:	00001M01

7.2.2 Inner carton

The inner carton specification is as follows (See Figure 7-10).

1) Wafers are inserted into groove of the container. All wafers face the same direction. Wafer no. corresponds to the number displayed on wafer container. Each container holds up to 25 wafers which fabricated in the same production lot.
2) Wafer container label (See Figure 7-11) is attached to the top surface of the wafer container.
3) The container is bagged in a polyethylene bag. The bag is then deaerated and sealed.
4) EIAJ C-3 label (See Figure 7-12) is attached to the top surface of the sealed bag.

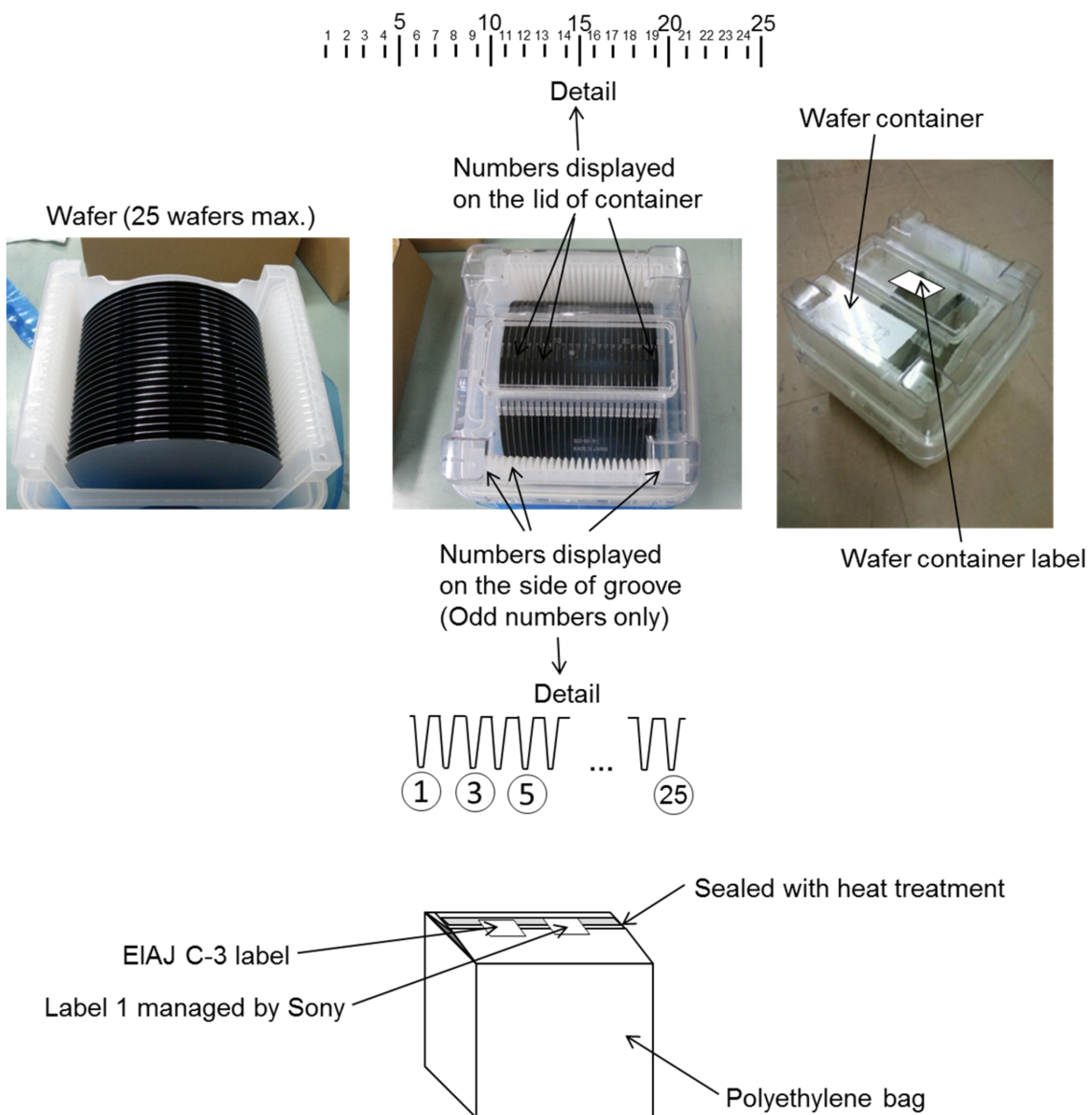


Figure 7-10: Inner carton

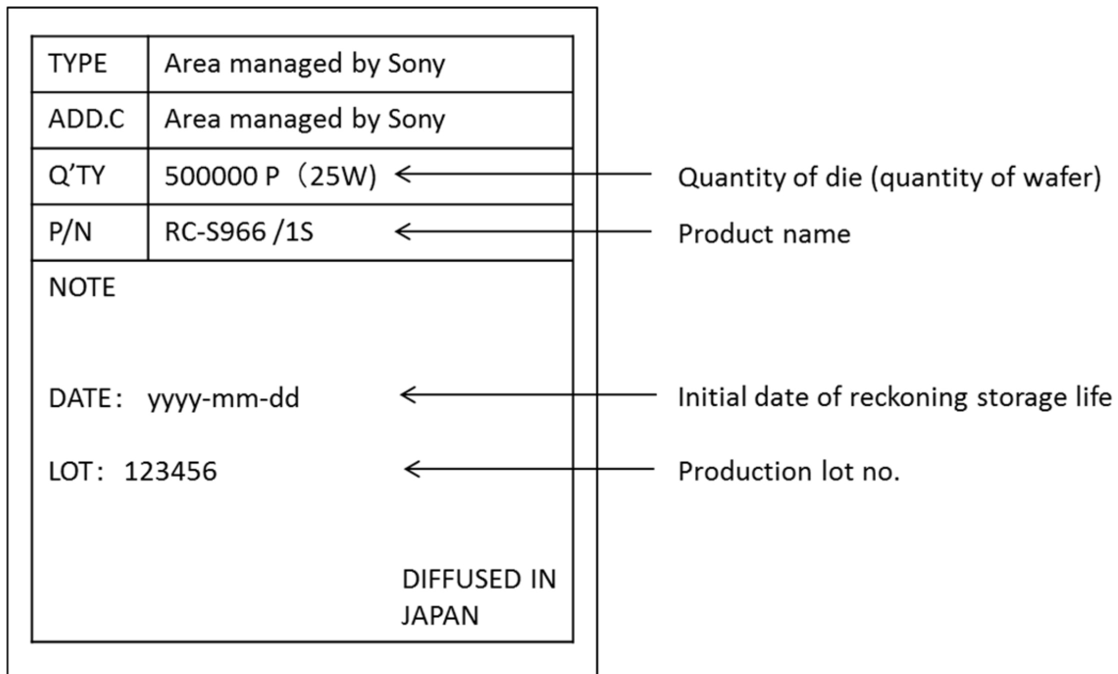


Figure 7-11: Wafer container label (example)

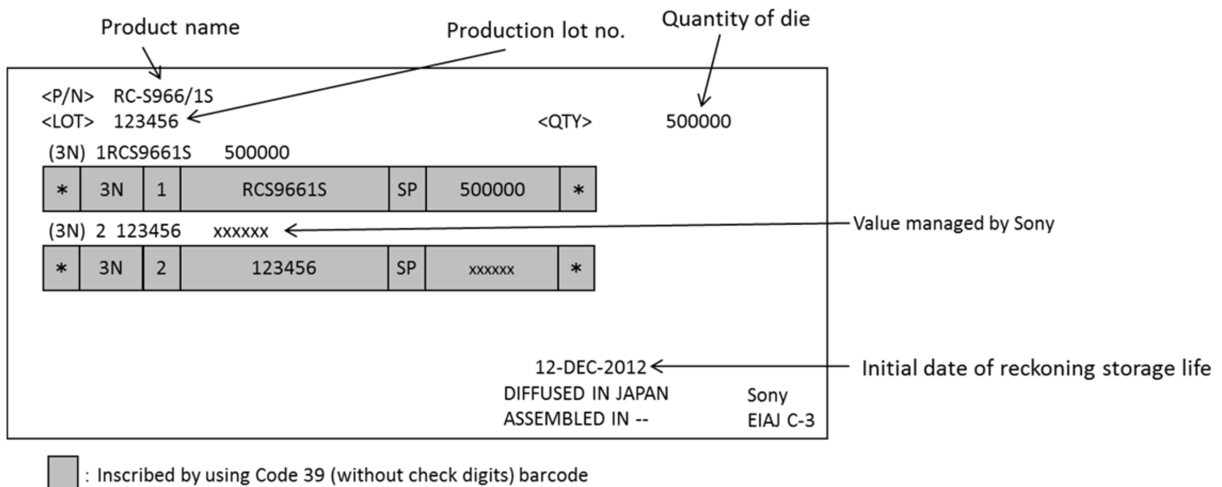


Figure 7-12: EIAJ C-3 label (example)

NOTE The barcode is inscribed by using Code39 (without check digits). Readability of the barcode depends upon performance of the barcode reader, distance between the reader and the barcode, and scan angle.

7.2.3 Outer carton package

Outer carton package specification is as follows (See Figure 7-13).

1) Each outer carton package contains one inner carton. Inner carton is protected with corrugated fiberboards. Identification label (See Figure 7-14) is enclosed in outer carton package.
2) Outgoing inspection report that stipulates the shipping lot number (see Figure 7-15) is attached to the top surface of the outer carton package.
3) EIAJ C-3 label (See Figure 7-12) is attached to the side of the outer carton package.

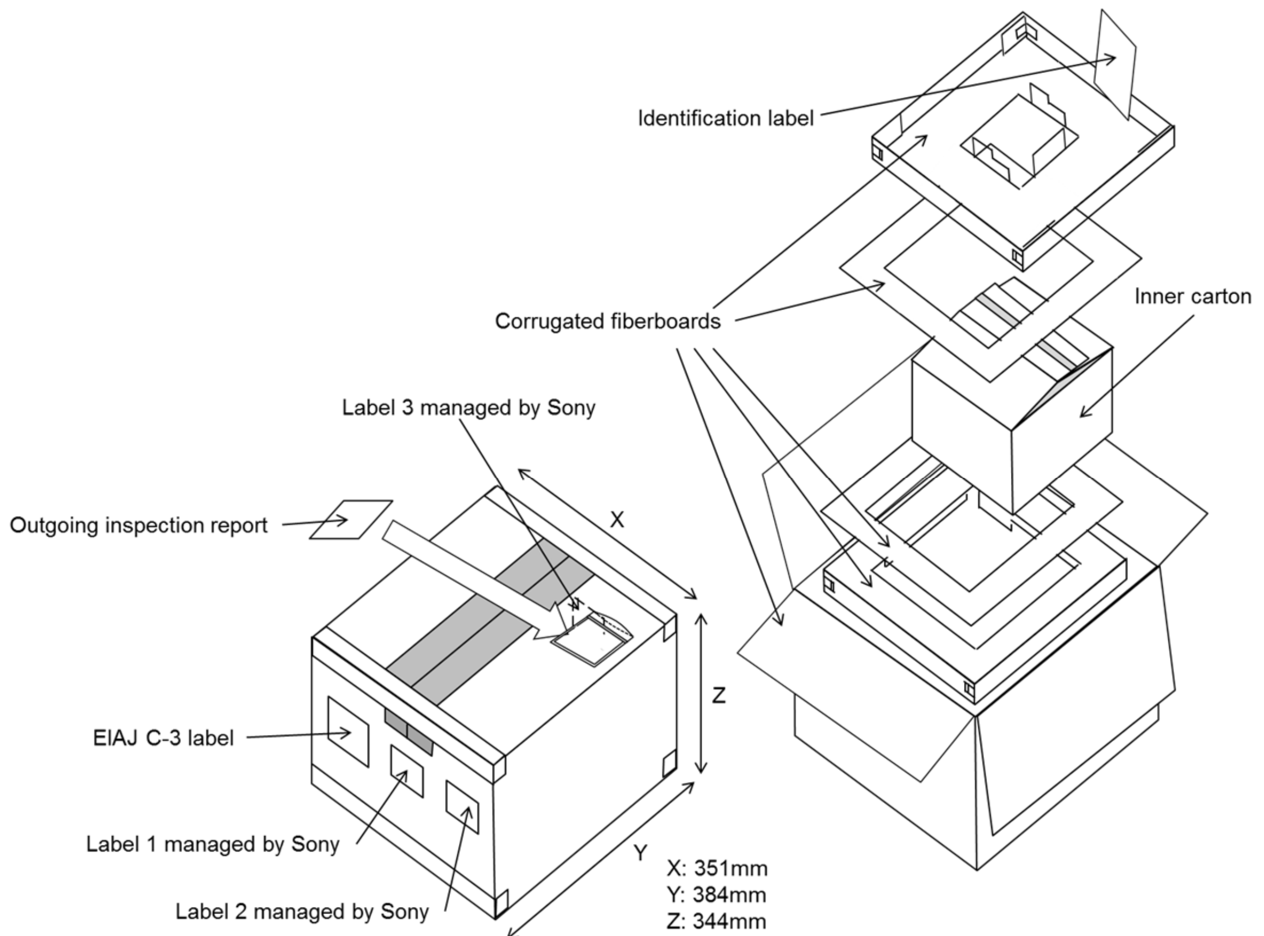


Figure 7-13: Outer carton package

Identification Label
現品票

PRODUCT: RC-S966/1S ← Product name

LOT NUMBER: 123456 ← Production lot no.

WAFER QUANTITY: 25Wf ← Quantity of wafer

WAFER TOTAL QUANTITY: 500000pcs ← Quantity of die

DATE: yyyy/mm/dd ← Initial date of reckoning storage life

No.	QUANTITY	No.	QUANTITY ← Quantity of die per wafer
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11			
12			
13		TOTAL QUANTITY	
14		500000 PCS	
15			

Figure 7-14: Identification label (example)

Company name
（会社名）

Control No.: oooooooo
(管理 No.: oooooooo)

Outgoing Inspection Report（出荷検査成績書）

This is to certify that the following product has satisfied the delivery inspection standard as shown below.

Product name（品名） : RC-S966/1S (WW)

Quantity（出荷数量） : XX,XXXpcs

Shipping lot number（出荷 Lot No.） : XXXXXXXX

Inspection detail（検査内容） :

Inspection item（項目）	Inspection sampling size (検査数)	Pass criteria (基準)
Appearance（外観）	ANSI-ASQC Z1.4 Inspection level II. Normal inspection （ANSI-ASQC Z1.4 ナミ検査、検査水準Ⅱに準拠）	Acceptable Quality Level (AQL) =0.65%
Electrical characteristics（電気的特性）	Total sample (全数検査)	Pass all test items（全試験項目をパス）

Test results（試験結果）

(1) Appearance（外観） : PASS
(2) Electrical characteristics（電気的特性検査） : PASS

Judgment

Approved	Checked	Prepared

Sony Storage Media and Devices Corp.

Figure 7-15: Outgoing inspection report (example)

7.2.4 Identification of defective dies

Identification of defective dies on each wafer is possible by using electronic data (map data conforming to SEMI G85 specifications). For more information about the map data, contact Sony sales representative.

7.2.5 Maximum quantity of dies on a wafer

Maximum quantity of dies on a wafer differs by presence or absence of bump on pad. Maximum quantity of dies on a wafer of RC-S966/1S is 23,908 dies. The number of the good dies differs in each wafer.

7.2.6 Yield of wafer

For wafers, a yield rate of more than 50% will be maintained.

8 Precautions

Unlike packaged devices, RC-S966 is small and easily susceptible to damage. They must be handled with special care, with the following precautions kept in mind.

8.1 Storage precautions

After unpacking the carton, make sure to protect the dies from any electrical, physical and mechanical effects caused by extreme temperature, excessive moisture, and/or contaminated air. It is recommended that you use desiccators for the storage of unpacked dies.

8.1.1 Shelf life of die

The storage period of the chip is as follows, counting from the "initial date of reckoning storage life" printed on the wafer container label, EIAJ C-3 label, and Identification label.

1) Before opening the package

   6 months at ambient temperature of 15°C to 35°C and relative humidity of 45% to 75%

2) After unpacking the package

   20 days in dry air or dry nitrogen (dew point of below -30°C)

3) After unpacked or removed from the dry air or dry nitrogen environment

   7 days at ambient temperature of 15°C to 35°C and relative humidity of 45% to 75%

8.1.2 UV tape adhesivity

When RC-S966 is shipped as sawn wafer on wafer ring, UV tape is used to adhere and secure dies. The shelf life of UV tape depends on the die detaching method and environment. For more information, contact your Sony sales representative. While the quality is not affected in any way, some chips may differ in color from other chips when observing the wafer from the back side. We have confirmed that this will not result in any issues when picking up the chips.

8.2 Temperature profile

Figure 8-1 shows the temperature profile for bonding RC-S966.

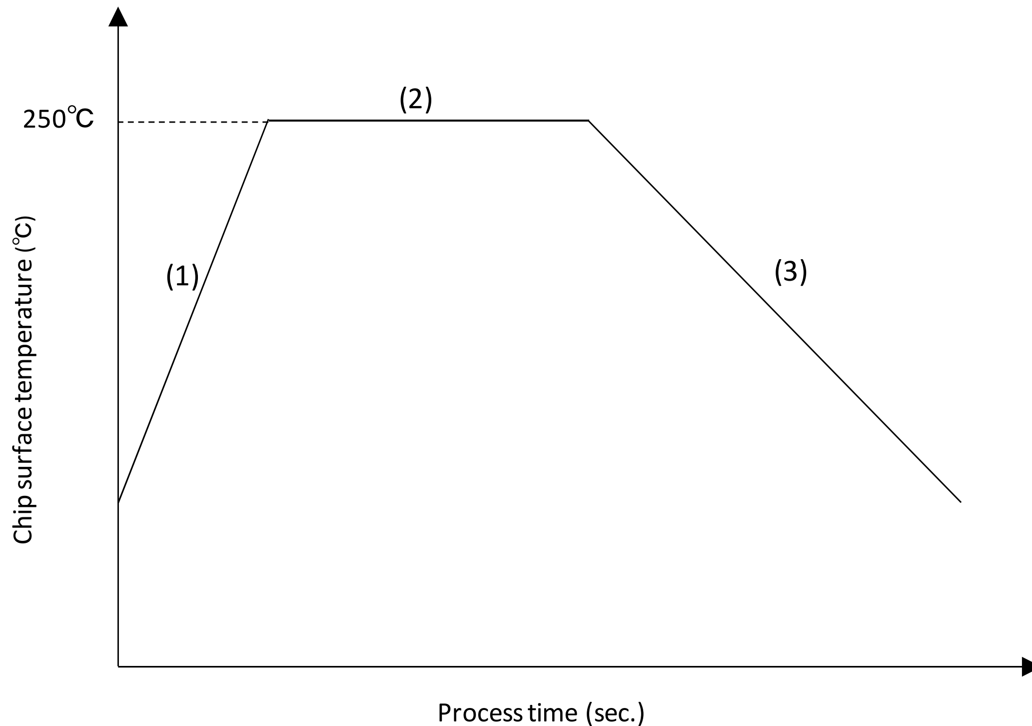


Figure 8-1: Temperature profile for bonding

Item	Description	Value	Unit
(1) Heating rate	Allowable maximum rise speed of chip surface temperature during chip bonding	+200	℃/s
(2) Constant temperature	Allowable temperature of chip surface including temperature variation during chip bonding	See Figure 8-2	—
(3) Cooling rate	Allowable maximum fall speed of chip surface temperature during chip bonding	-200	℃/s

Heating rate : Heat quantity (time x temperature) must be below the heating condition illustrated in Figure 8-1.

Constant temperature : The chip surface temperature must be held at below 250°C including temperature variations. Conditions for presetting the temperature are shown in Figure 8-2.

Cooling rate : The drop in heat (time x temperature) must be below the cooling condition illustrated in Figure 8-1.

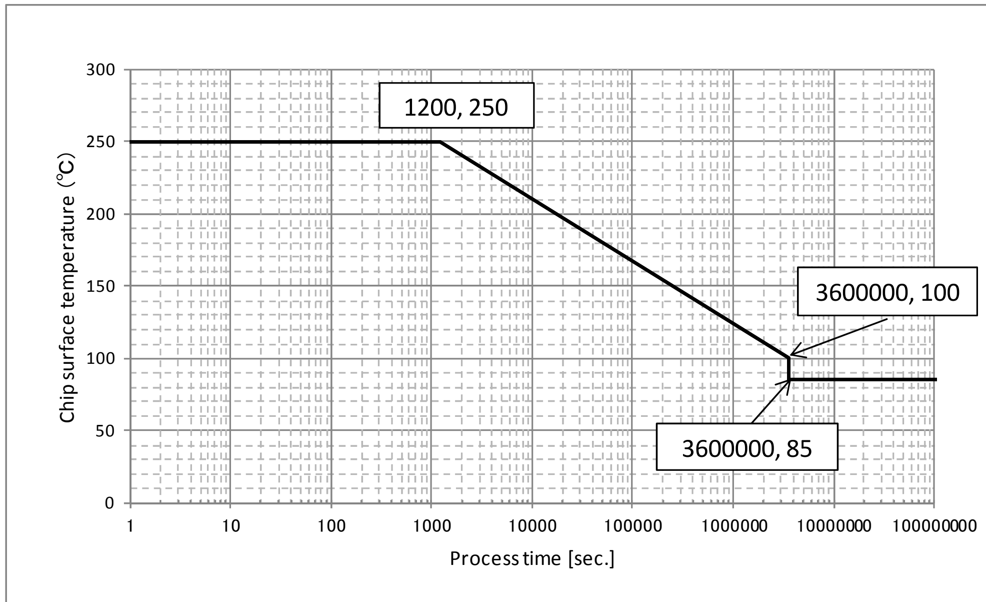


Figure 8-2: Constant Temperature

8.3 Bonding precautions

The antenna must be assembled so that it does not touch the cross-sectional surface of the chip edge.

8.4 Pressure applicable to the chip surface

It depends on the bonding method and equipment. Determine the optimum conditions for your system by performing pressure tests in advance. The following data represents the mechanical characteristics from the test results.

- Bump shear strength : Over 40MPa (0.20N)

8.5 Antenna design

RC-S966 may generate heat when placed in a strong magnetic field after assembled with antenna. When designing an antenna with RC-S966, chip's operational temperature, including the generated heat, has to be taken into consideration.

8.6 Handling precautions

RC-S966 must be handled carefully, keeping the following precautions in mind.

1. Make sure not to cause any chemical or physical damage.
2. Use adequate assembly techniques so that optimum electrical, thermal and mechanical characteristics can be obtained.
3. Do not expose the chip surface to a contaminated environment or material
4. Ground all workers' bodies, as well as jigs, workbenches and machines, to protect the chips from electrostatic charges.

8.7 External appearance of a sawn wafer

When RC-S966 is shipped as sawn wafer on wafer ring, it is possible that chips located on the outermost portion of a wafer which have been excluded from any outgoing inspection are missing when the package is shipped.

9 Dicing an unsawn wafer

RC-S966/1S is shipped as unsawn wafer. When wafer dicing process is executed, it must be handled carefully, keeping the following precautions in mind.

1. After dicing RC-S966/1S, GND (substrate) level will appear on the cross-sectional surface of the die. To avoid causing die defect by forming short circuit, which will occur when conductive material touching both pads/bumps and the cross-sectional surface of the die, make sure no dicing dust remains.
2. Metal layers of the die are located on the inside of the PSG layer edge, but some elements are located on the dicing line (see Figure 9-1). To avoid occurrence of edge touch, make sure dicing lines are completely removed by the dicing process. When the edges of die are located within the area between the dicing lines and the edges of PSG layer after dicing process, no metal layers are exposed on the cross-sectional surface of the die.
3. When the edge of die are located nearby the edge of PSG layer after dicing process, the die may have chipped off or cracked.

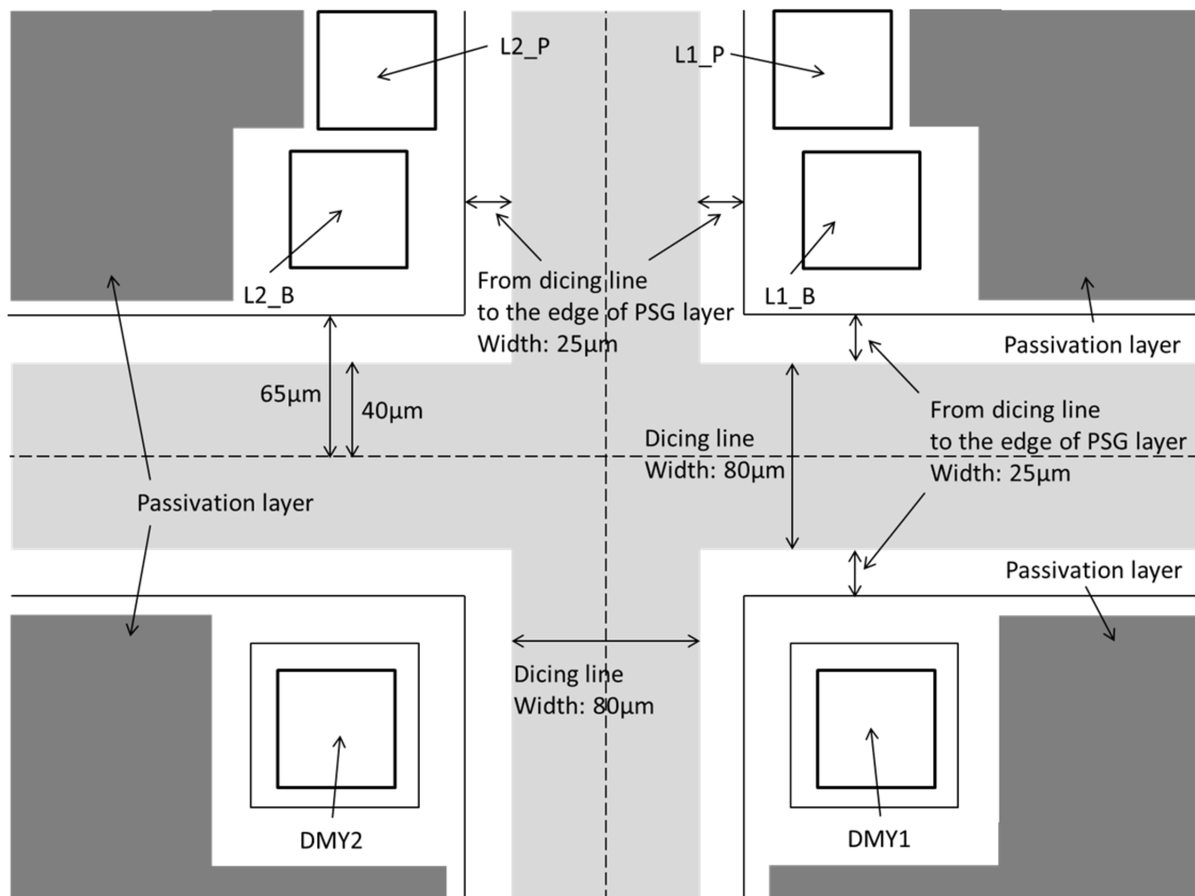


Figure 9-1: Dicing lines and around

Appendix A FeliCa Terminology

This appendix contains definitions of important abbreviations and terminology used in this publication.

A.1 Abbreviation

IDm	Manufacture ID
PMm	Manufacture Parameter

A.2 Glossary

<B>

Block	The minimum unit of data written to or read from memory.
Block Data	1. Data to be written to or read from Block. 2. Data to be stored to Block.

<C>

Chip IDm	IDm, which is written when the chip is shipped.

<M>

Manufacture ID (IDm)	The value that comprises Manufacturer Code and Card Identification Number. The Reader/Writer uses this value to identify each card with which to communicate.
Manufacture Parameter (PMm)	Card-specific information that is set by the card manufacturer.

<R>

Random Service	Service that enables read operations or write operations by specifying Block.

<S>

Service	The concept that identifies both the method of access to Block Data and a set of Block Data.

Card IC

RC-S966 Series Data Sheet Version 1.2

April 2012 First Edition FeliCa Business Division
December 2012 Revision

Sony Corporation

No. M751-E01-20

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