

**Reader/Writer Module
for
Coil-on-Chip RFID System**

ME-MR23(RS232C I/F)

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Maxell Seiki, Ltd.

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ME-MR23

1 Applicability

This specification applies to Reader/Writer Module for RFID, ME-MR23, which is delivered to Sega Corporation (Party A) from Maxell Seiki Ltd. (Party B) via Kaga Devices Co., Ltd.

2 Outline of Product

2.1 Outline of ME-MR23

The ME-MR23 is Reader/Writer Module for RFID, which transmits data to host computer via RS232C I/F (RS232C signal level I/F). It is intended to be connected with equipment prepared by Party A.

Its antenna is external type and connected via exclusive extension cable.

Circuit block configuration of the ME-MR23 Module is shown below.

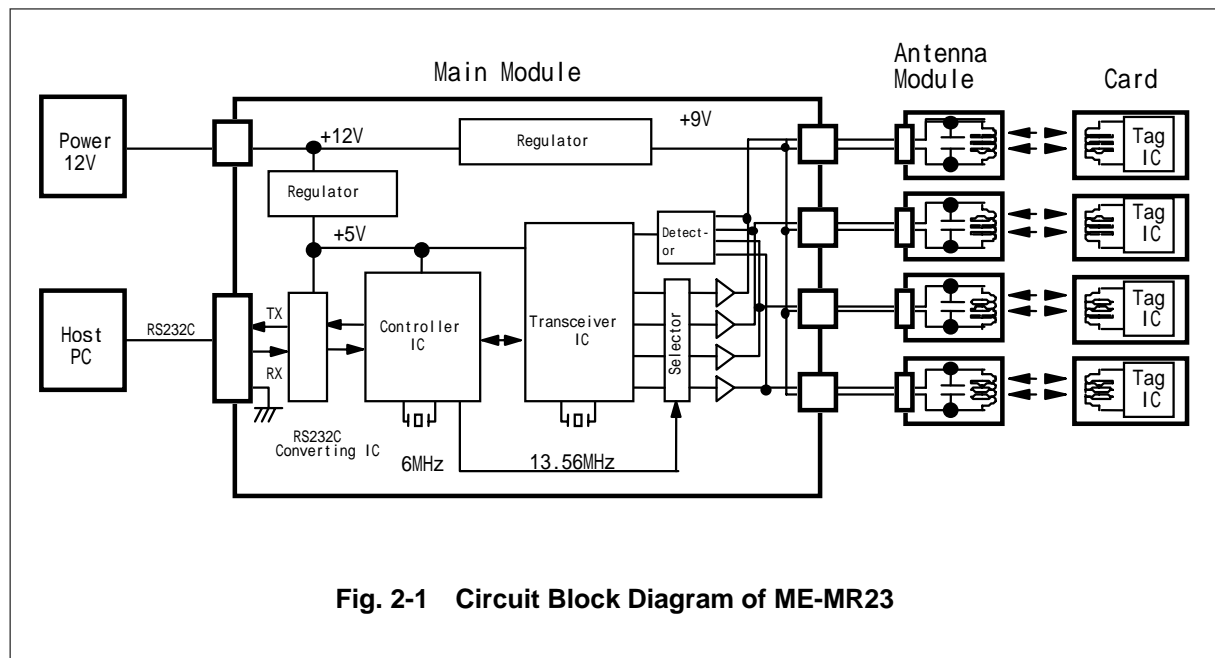


Fig. 2-1 Circuit Block Diagram of ME-MR23

2.2 Module Configuration

Configuration of ME-MR23 Module is shown below.

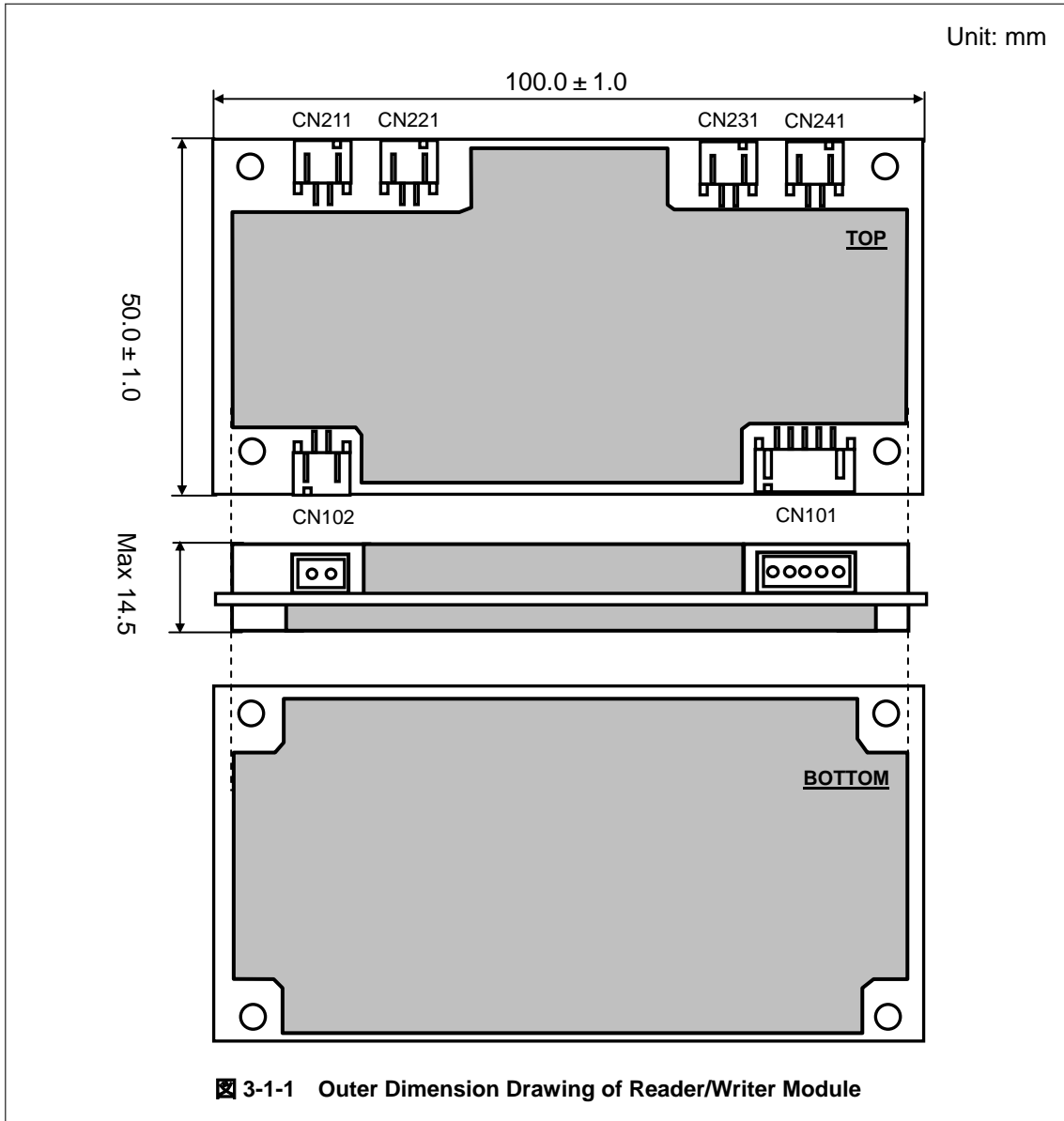
- (1) Main Module ··· 1 piece
- (2) Antenna Module ··· 4 pieces
- (3) Antenna Cable ··· 4 pieces (with ferrite core)

3 Outer Dimension

3.1 Outer Dimension Diagram of Reader/Writer Module

3.1.1 Reader/Writer Module

Outer dimension of ME-MR23 Module is as shown in the drawing below. Refer to the following table for type number of housings matching connectors CN101, CN102, CN211 to CN241.



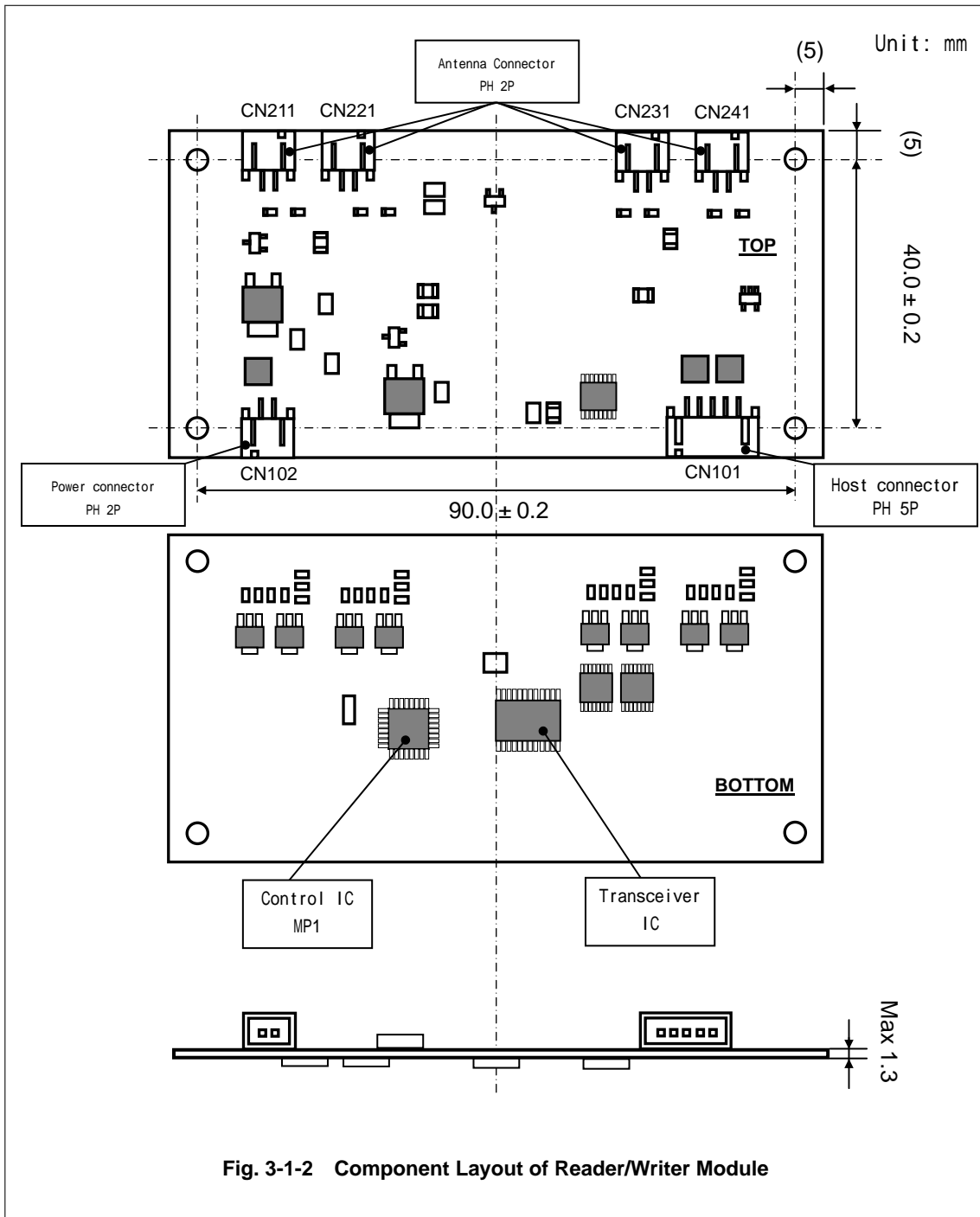
Module Dimension: 100mm × 50mm × 14mm (standard value)

Board Dimension: 100mm × 50mm × 1.2mm thick (standard value)

Dimension of Mounting Hole: 3.2mm × 4

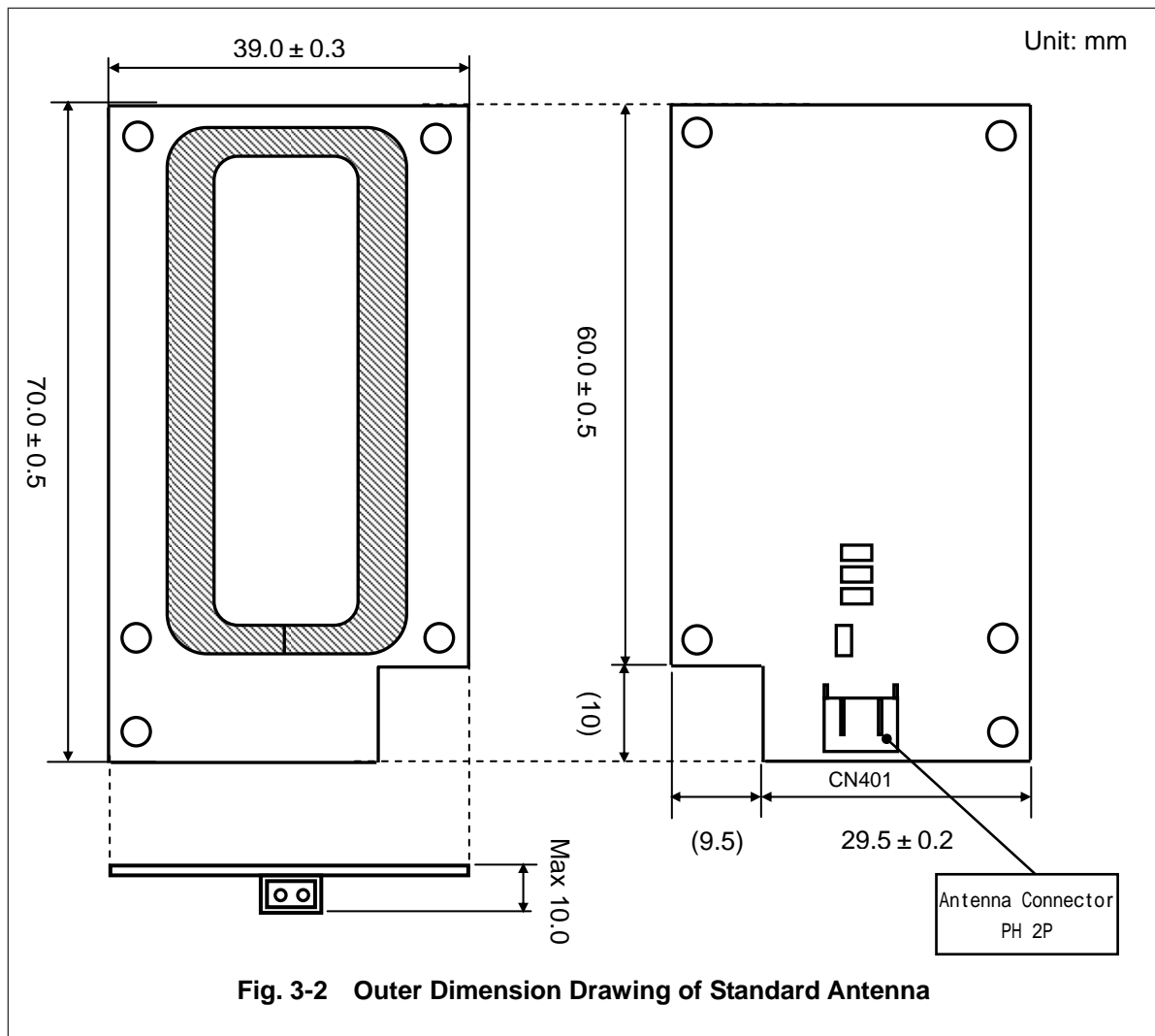
Connector No.	Equipped connector (post)	Matching plug
	Side entry type	Housing
CN101	S5B-PH-SM4-TB	PHR-5
CN102,CN211,CN221,CN231,CN241	S2B-PH-SM4-TB	PHR-2

3.1.2 Component Layout of Reader/Writer Module



3.2 Outer Dimension Drawing of Antenna

Outer dimension drawing of ME-MS01M-B-ANT is shown below.



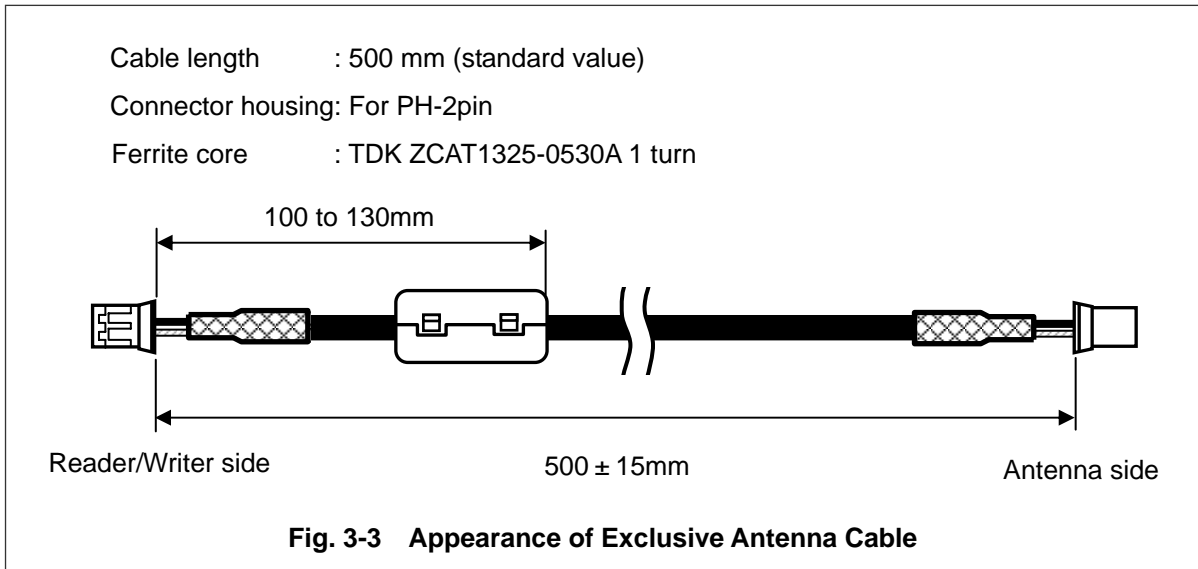
Module Dimension: 70mm × 39mm × 8mm (standard value)

Board Dimension: 70mm × 39mm × 1.2mm thick (standard value)

Mounting Hole Dimension: 3.2mm × 5

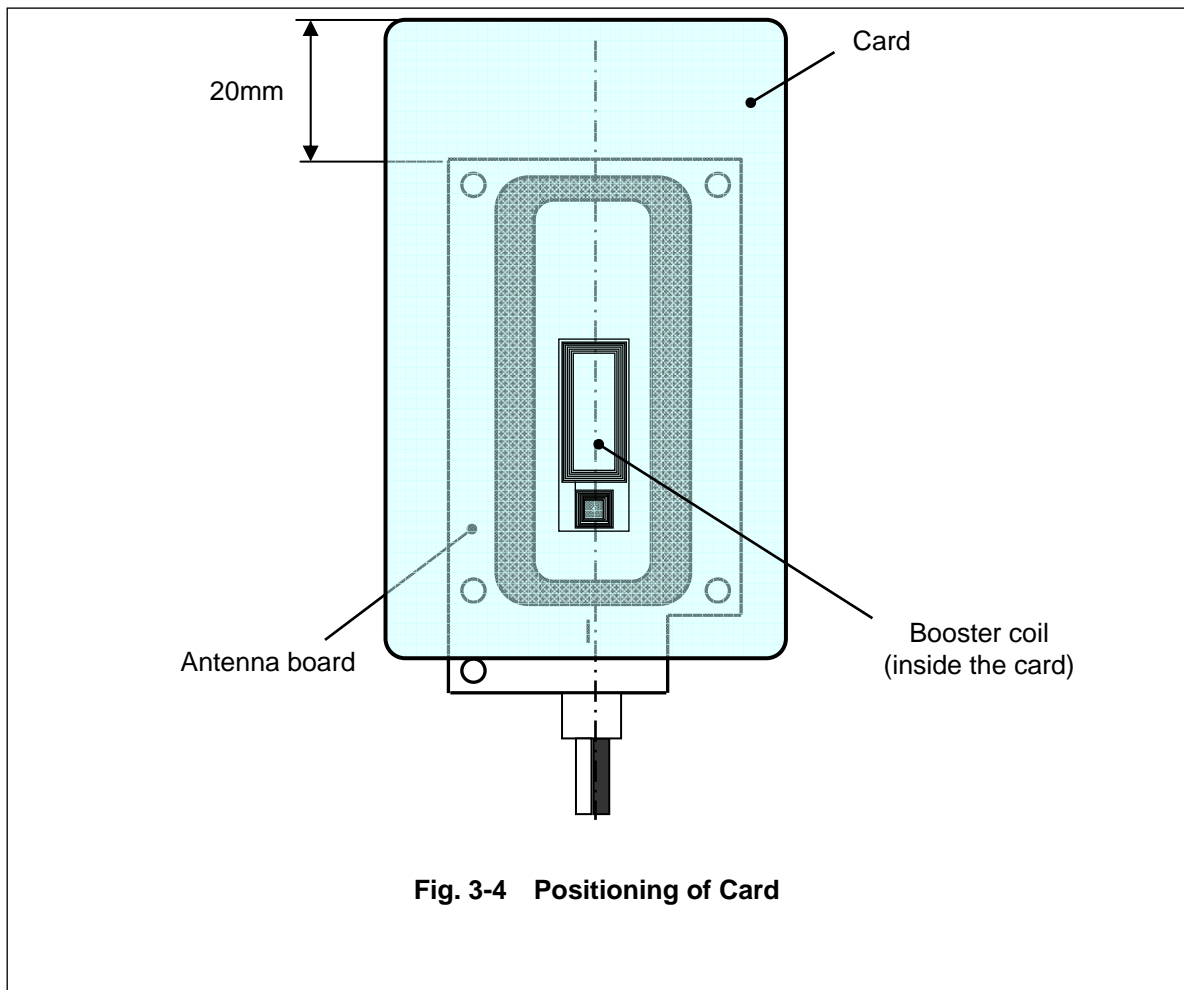
3.3 Appearance of Exclusive Antenna Cable

Appearance of exclusive antenna cable is shown below.



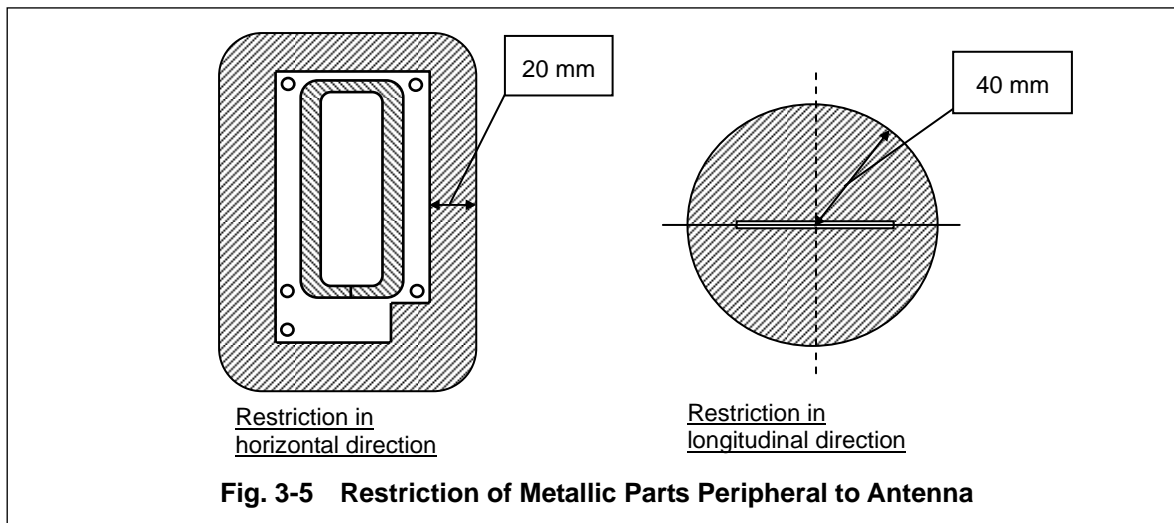
3.4 Positioning of Card

The card and antenna board shall be so positioned that the distance between the end of card and that of antenna board is 20 mm in longitudinal direction, and that the card and the board are centered in horizontal direction.



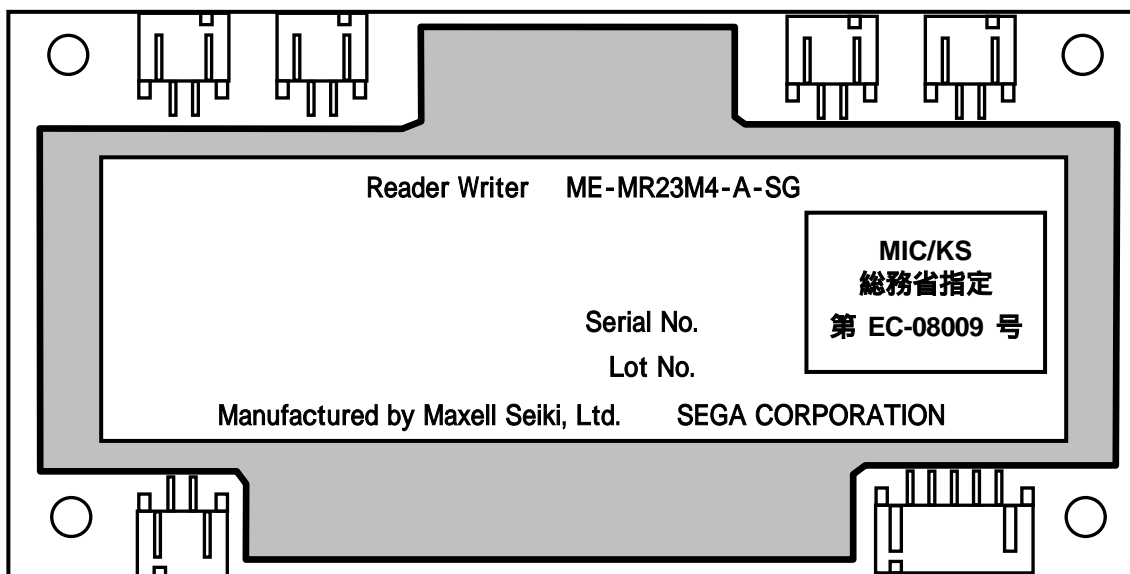
3.5 Restriction of Metallic Parts

Do not place metallic parts (magnetic materials) within the range of 20 mm from the end of antenna board in horizontal direction, and within the range of 40 mm radius from the center of antenna board in longitudinal direction (except for small metallic parts such as mounting screws)



4 Marking

Marking of nameplate shall be as shown below.



Color: White

Outer Dimension: 25.0 mm × 85.0 mm

Contents of Printed Characters

- Serial No.: Indicated in six digits
- Lot No.: Indicated in four digits
 - First digit: the last one digit of the year of manufacture in the Christian era
 - Second digit: month of manufacture (October: X, November: Y, December: Z)
 - Third and fourth digits: two digits of date of manufacture
- Indication of type designated by Ministry of Internal Affairs & Transmissions: No. EC-08009

5 Specifications of Reader/Writer Module

5.1 Environmental Characteristics

No	Item	Specification
1	Operating temperature	0 to 45
2	Operating humidity	20 to 80%RH (without condensation)
3	Storage temperature	-10 to 60
4	Storage humidity	20 to 80%RH (without condensation)

5.2 Physical Specification

5.2.1 Main board (1 piece)

No.	Item	Specification
1	Outer dimension	100mm (D) × 50mm (W) × 14mm (H max)
2	Material of board	Glass epoxy FR-4 t = 1.2mm 4-layer
3	Weight	45g ± 20% × 1 piece (with shield)

5.2.2 Antenna board (4 pcs.)

No.	Item	Specification
1	Outer dimension	70mm (D) × 39mm (W) × 10mm (H max)
2	Material of board	Glass epoxy FR-4 t = 1.2mm 2-layer
3	Weight	7g ± 20% × 4 pieces

5.3 Electrical Characteristics

5.3.1 Absolute maximum rating

Symbol	Parameter	Rating	Unit
VCC	VCC terminal	-0.3 to 20	V
VI	RXD terminal	± 13	V
VO	TXD terminal	± 13	V

5.3.2 Electrical Characteristics

(VCC = 12V, GND = 0V, Ta = 0 to 45 °C, unless otherwise specified)

Symbol	Parameter	Range			Unit
		Min.	Std.	Max.	
VCC	Power (+ 12V)	11.0	12.0	13.0	V
VOH	TXD H output voltage (load 3k Ω)	4.5	5.4	-	V
VOL	TXD L output voltage (load 3k Ω)	-	-5.4	-4.5	V
VIH	RXD H input voltage	2.4	5.4	13.0	V
VIL	RXD L input voltage	- 13.0	-5.4	0.8	V
Rin	RXD input resistor	3	5	7	k

5.3.3 Electrical Performance

Item	Standard
Supply voltage	12.0 ± 1.0V
Consumed current	1) Max. 200mA (Operation status: main condition is carrier ON) 2) Max. 40mA (Idle status: main condition is carrier OFF)
Carrier frequency	13.56MHz ± 15ppm or less
Data rate	26.48kbps
Quality of transmission	<ul style="list-style-type: none"> · Transmission distance Min. 3.0mm to Max. 5.0mm (in case of one/two IC card(s)) (from surface of coil on antenna board to surface of card) · Allowed horizontal displacement Longitudinal direction (longer side) ± 3.0mm / horizontal direction (short side) ± 1.0mm · Number of card for which transmission is available with one antenna Two cards at maximum (to be inserted in the arrowed direction of card design) <ul style="list-style-type: none"> 1) During transmission, amp gain shall be set at most suitable value at host computer. 2) Do not place metallic or magnetic materials around the antenna.
Number of antenna which can be connected	Four antennas
Antenna switching method	Host command method, carrier output for one antenna only (refer to 6.1 for details)
Setting of receiving circuit parameters	Register setting by command <ul style="list-style-type: none"> · Slice level setting: four steps · Amp gain setting: 16 steps (refer to 6.1.1 for details)
Percentage of carrier ON/OFF	Percentage of ON: 50% or less
Wait time until transmission	50ms after power on

* The above values are just for reference, not guaranteed values. They may vary depending on system operating environment. Evaluate in actual system environment and adjust transmission distance, gain setting, and horizontal displacement, etc. to ensure reliable transmission.

5.4 Interface Specification

5.4.1 Location of host connector terminal (CN101: PH-5pin)

Terminal	Name of terminal	Input/output	Function
1	TXD	Output	Transmitted data signal
2	GND	-	GND(0V)
3	RXD	Input	Received data signal
4	GND	-	GND(0V)
5	GNDS	-	GND for shield

5.4.2 Location of antenna connector terminal (CN211 to CN241: PH-2pin)

Terminal	Name of terminal	Function	Remark
1	SIGNAL	Analog signal	Core wire side
2	VANT	Power to antenna	Cable shield side

5.4.3 Location of external power supply connector terminal (CN102: PH-2pin)

Terminal	Name of terminal	Function	Remark
1	VCC	Power terminal (+12V)	
2	GND	GND (0V)	

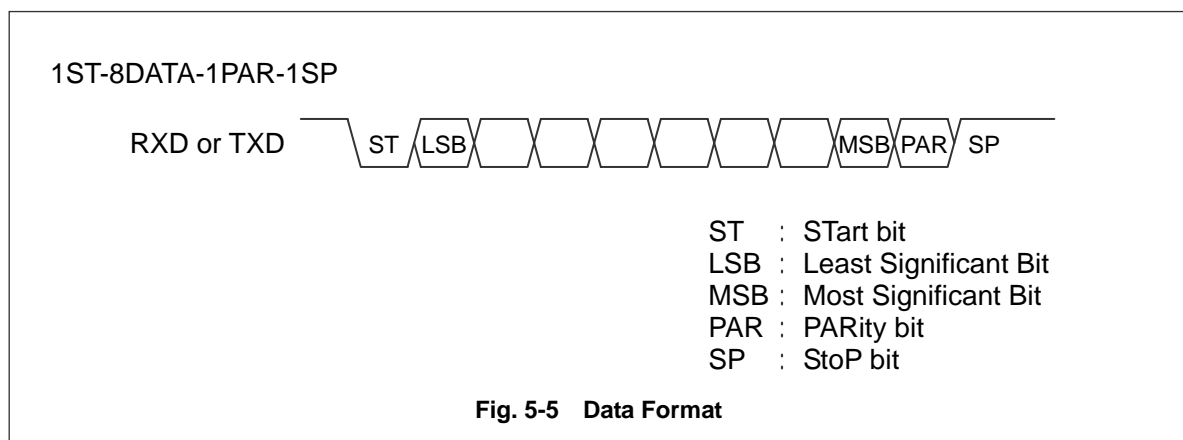
5.5 RXD / TXD Transmission Specification

Item	Specification
Transmission speed (actual speed ^{*1})	19,200 bps (18,750 bps) ² 38,400 bps (37,500 bps)
Transmission method	RS232C semi-double
Synchronization method	No synchronization
Flow control	None
Start bit rate	1-bit
Data rate	8-bit
Stop bit rate	1-bit
Parity bit rate	1-bit/even number

¹ Controller incorporated in this module employs 6MHz oscillator. Because transmission speed is generated by its frequency-dividing, actual speed in this module is the value in parenthesis.

² When supplying power (system reset), transmission speed is 19,200bps.

RXD / TXD data format

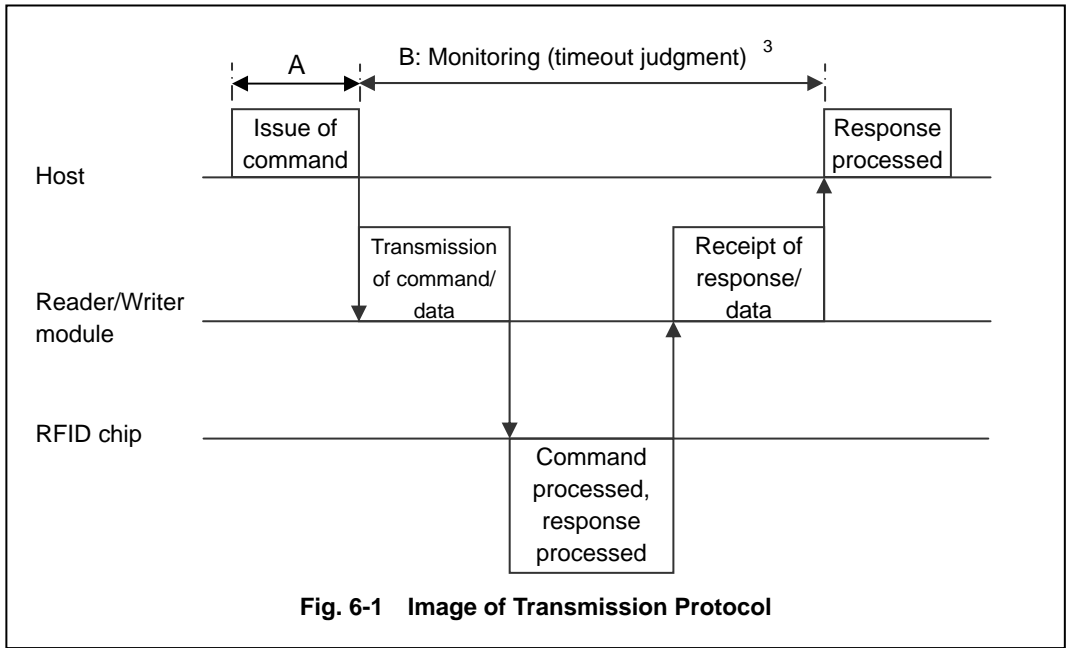


6 Description of Operation

6.1 Transmission Protocol

Image of transmission protocol between host computer, Reader/Writer Module, and RFID chip is shown in Figure 6-1.

Reader/Writer Module receives command and data from the host computer and transmits them to RFID chip. It also receives response and data from RFID chip, and judges whether transmission is completed or not, and then transmits the results to the host computer,



³ Keep the time shown in Table B as timeout own time at minimum (take margins into consideration for design).

Table A: List of receiving timeout times of multiple bytes command

Command	Frame configuration	Byte number	Timeout time [ms]
COUNT	COUNT+CT_NUM	2	5.0
CHANGE	CHANGE+BAUDRATE		
TEST	TEST+TEST_CODE	3	8.8
	TEST+RF_OFF		
WRITE	WRITE+DATA	5	15.3
WRITE_NOP	WRITE_NOP+DATA		
WRITE_ST	WRITE_ST+DATA		
HALT	HALT+UID		
SEL	SEL+UID+KEY	9	28.6

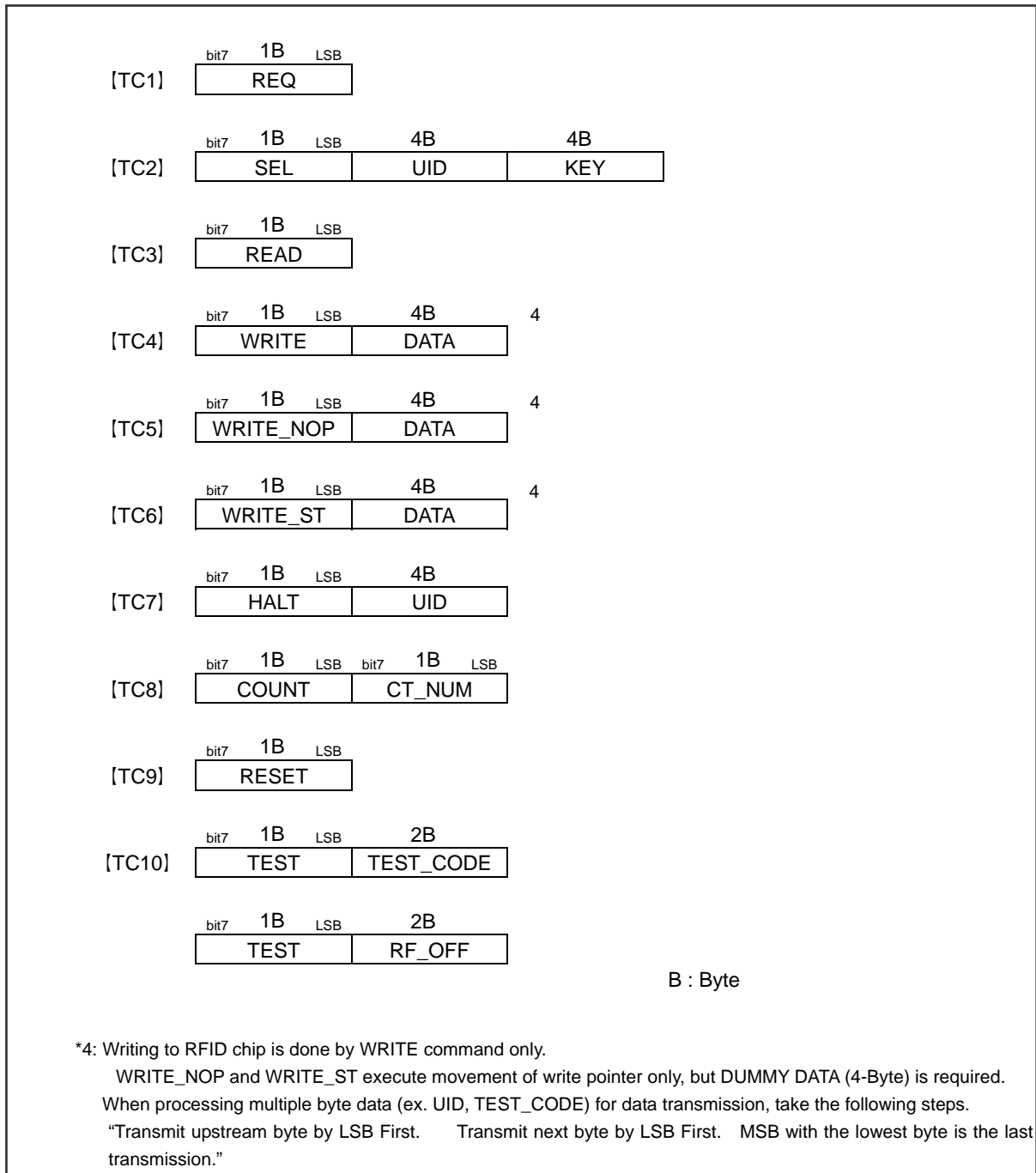
Table B. List of theoretical timeout values from transmission of command to receipt of response

Command	Timeout time [ms]
REQ	120
SEL	45
READ	80
WRITE	100
WRITE_NOP	40
WRITE_ST	100
HALT	40
COUNT	60
TEST	5
TEST(RF_OFF)	5
RESET	5

- Because reader/writer module is not set for timer between characters, complete transmission of designated byte rate within the timeout time indicated in Table A.
- Take an interval of more than 5ms between completion of receipt of response and start of next command transmission,

6.2 Command

Command frames from host computer to Reader/Writer Module and description of them are shown below.



Command to Reader/Writer Module

Command	Code[Hex]	Description of Functions
REQ	4E	Requesting communication with RFID chip. However in case of REQ command with carrier OFF, no response from RFID chip, because it serves as a command requesting carrier ON (transfer to operation status).
SEL	2E	Selecting a specific RFID chip.
UID	Existing (4-byte)	Unique ID of RFID chip. It is already written at factory and cannot be changed.
KEY	Random (4-byte)	Key of RFID chip (code). Checking KEY against SEL command, and executing access restriction depending on match or mismatch.
READ	0E	Reading memory of RFID chip (128-byte collectively)
WRITE	CE	Increasing write pointer of RFID chip with an increment (+1) and write to memory (4-byte unit).
DATA	Random (4-byte)	Data to be written. It may be invalid depending on access restriction, but 4-byte data is required
WRITE_NOP	8E	Increasing write pointer of RFID chip with increment (+1). Actual writing is not executed. But dummy data (4-byte) at transmission of command is required.
WRITE_ST	EE	Returning write pointer of memory to zero (position of Serial No.0). Writing to RFID chip is not executed. But data at transmission of command (4-byte, dummy) is required.
HALT	AE	Halting a specific RFID chip.
COUNT	6E	Decreasing down counter of RFID chip with decrement (-1).
CT_NUM	03	Specifying counter for decrement. Select one CT_NUM code corresponding any of Counter 1 to 4. Counter1: 03h, Counter2: 0Ch, Counter3: 30h, Counter4: C0h
	0C	
	30	
	C0	
RESET	7E	Initializing controller.
TEST	5E	Setting parameters of analog characteristics of transceiver/antenna selection. Transmission of carrier from module is checked by TEST command (TEST_CODE:00**). If the response is NOT (6Ah), the carrier is not transmitted.
TEST_CODE	F0** (2Byte)	Parameter of antenna selection. Shifting antenna to be activated with lower 1-byte (** mentioned on the left). 01h: select antenna to be connected with CN211 02h: select antenna to be connected with CN221 03h: select antenna to be connected with CN231 04h: select antenna to be connected with CN241
	00** (2Byte)	Parameter of receiving gain characteristic of transceiver. Shifting receiving gain with lower 1-byte (** mentioned on the left).
RF_OFF	80** (2Byte)	Stopping carrier by TEST + RF_OFF Lower 1-byte (** mentioned on the left) is at random.

6.2.1 Parameter of Analog Characteristic

Most suitable parameter of analog characteristic depends on transmission characteristic of each RFID chip and positional relationship between antenna coil on Reader/Writer Module and RFID chip. Estimate gain setting with least transmission error and set it as default value.

When accessing other RFID chip or repositioning (including insertion and withdrawal), optimize the parameter of analog characteristic to match with the receiving characteristic from RFID chip.

When transmission errors occurs and transmission is not possible despite of retrying, provide software processing to shifting set gain values up and down automatically. We recommend you should shift the set gain values above and below the default value, taking operating environment (supply voltage, ambient temperature), dispersion of transmission distance, dispersion of transmission performance of RFID chip into consideration.

• Recommended setting for evaluation

Default “29” 2A 28 2B 27 2C 26 (return to default value)

(retry for a few times at each gain)

Set gain values of receiving amplifier are shown below.

Set values of receiving amp gain

Parameter of analog characteristic	Amp gain	Parameter of analog characteristic	Amp gain
0020h	17 dB	0028h	33 dB
0021h	19 dB	0029h	35 dB
0022h	21 dB	002Ah	37 dB
0023h	23 dB	002Bh	39 dB
0024h	25 dB	002Ch	41 dB
0025h	27 dB	002Dh	43 dB
0026h	29 dB	002Eh	45 dB
0027h	31 dB	002Fh	47 dB

6.2.2 RESET command

It is possible to issue RESET command even in case of sequence of executing other command.

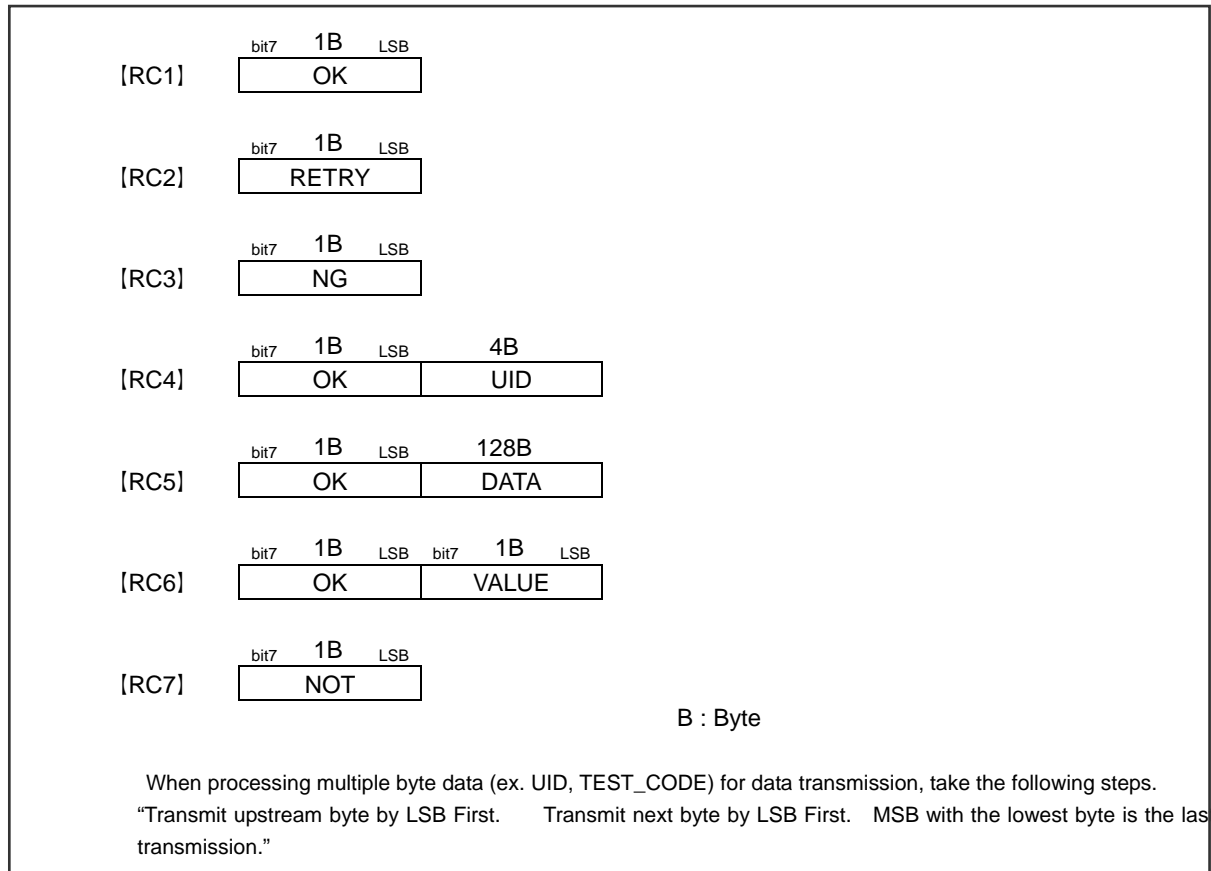
However, because all the transmission sequences are interrupted to respond to RESET command, we cannot guarantee internal operation, depending on the transmission sequence being executed. Therefore, issue RESET command after a considerable time elapsed since completion of the previous command transmission sequence.

We recommend that you should issue RESET command only in case of trouble, for example, when “response is not returned” as a result of waiting response from Reader/Writer Module.

You cannot do 40-second timer deactivation by RESET command after 40-second timeout (impossible to communicate with RFID chip). External reset or turning power off and on is required.

6.3 Response

Responses returned from Reader/Writer Module to host computer are shown below.



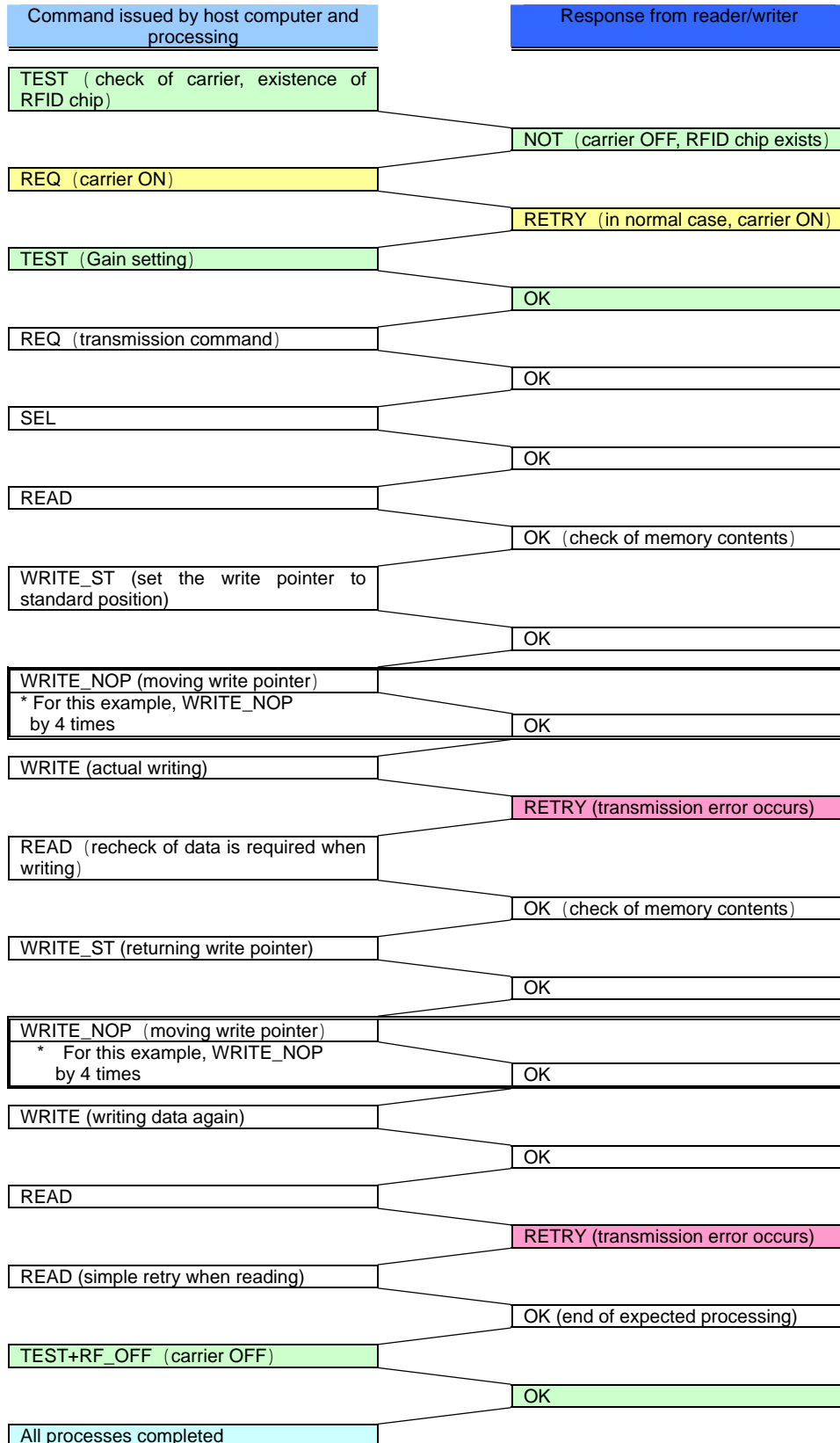
Response to Host Computer

Response	Code[Hex]	Description of Function
OK	0A	Response in case transmission is successful. Response is given when any of ATQ, ATQ_C, and ACK is received without transmission error or in case of processing command by controller.
RETRY	CA	Response requesting retry to send command when transmission error occurs.
NG	3A	Response in case /DETECT of Reader/Writer Module equals to 1. In case of /DETECT = 1, the Reader/Writer Module decides there is no RFID to communicate with and does not communicate with RFID chip.
UID	Prearranged (4-byte)	Unique ID of RFID chip.
DATA	Random (128-byte)	Data of RFID chip. If condition of access to memory is set in advance, the data is that after masking (the masking part is "0").
VALUE	Random (1-byte)	Counter value after decrease of down counter of RFID chip with decrement (-1).
NOT	6A	Response in case carrier is not transmitted from the module when giving TEST command (TEST_CODE:00**). Transmission of carrier from the module is checked by TEST command.

7 Example of Steps of Giving Commands

Example of giving commands for writing to DATA (data area) to RFID card is shown below.

Condition: Most suitable parameter of receiving gain characteristic is checked in advance and transmitted after reset.



8 Precautions Before Use

- This Reader/Writer Module itself may not meet EMI (Electromagnetic Interference) standard. Give consideration to conformity of the system to EMC standard as required for intended use and destination of your system.
- Do not place metallic parts between Reader/Writer Module and RFID chip. Keep antenna away from conductive objects such as metallic frame. If such object is close to antenna, it may impair transmission characteristic.

9 Precautions for Handling

- This Reader/Writer Module is precision apparatus. Do not disassemble or modify it. Otherwise, it may cause malfunction, failure, fire, or electric shock.
- Before handling the module, discharge electrostatic charge from your body. Do not drop, strike, bend, or give impact on the module.
- Do not touch with wet hand. Otherwise, it will cause failure.
- This module employs metallic shield plate. When you handle the module, do not touch its edge. The edge is sharp and your finger may get a cut.
- Use exclusive card compatible with this module only. Do not insert any object such as iron plate or coin. Otherwise, it may cause failure.
- Never remove cables during access to the card. Otherwise, it may cause collapse of data in the card or the card itself.
- Do not touch or remove the card during access to the card. Otherwise, it may cause collapse of data in the card or the card itself.

10 Cautions for Use

- When required transmission is completed, stop the carrier. If carrier output continues, RFID chip may generate heat. For safety, the Reader/Writer Module automatically stops carrier in about 40 seconds after the start of carrier output. If you turn off the power and turn it on again, the module is recovered.
- For safety, provide the host computer with power protection against overcurrent due to short-circuit of components in this module, etc.
- Be sure to carry out Read Verify check after writing.
- When retrying because of transmission error, readjust receiving amp gain.
- Do not use this module with reversed combination of antenna board and Reader/Writer board. Otherwise, it may impair transmission performance (excluding cables).
- Turn off the power before removing or inserting the card. Otherwise, it may cause failure.
- Do not bend this module at its portion close to the housing of antenna cable. Otherwise, it may cause breakage of conductor.
- Insert the card in the arrowed direction in such a manner that the face is visible. If the direction is wrong, transmission error may occur. In such case, insert it in correct direction.

Request with regard to safety design

- We make our best efforts to improve quality and reliability of our products. Nevertheless, semiconductor products may have trouble or malfunction. We request you to give enough consideration to safety design of your system, such as redundant design, anti-spreading-fire design, malfunction preventing design, to avoid injury, fire, social damage, etc. resulting from failure or malfunction of our semiconductor products.
- This Reader/Writer Module is designed for use in general electronic equipment (office use, telecommunications, measuring, household, etc.), but not designed and manufactured for use in equipment or system used in serious condition affecting people's lives. If you consider use of this module for equipment or system for special applications such as transportation, vehicular, medical, aerospace, nuclear control, or undersea data communication, please contact the sales contact person or authorized product distributor of Maxell Seiki Ltd.

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- Before starting actual product design, delivery specifications shall be exchanged with Maxell Seiki Ltd., and the product design shall be proceeded according to exchanged delivery specifications.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

This device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. The antenna used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.