RFID Reader
(4 channel, Ethernet, 1st generation)

Operation manual

CTS-RFID-LF03 (V 1.3C)

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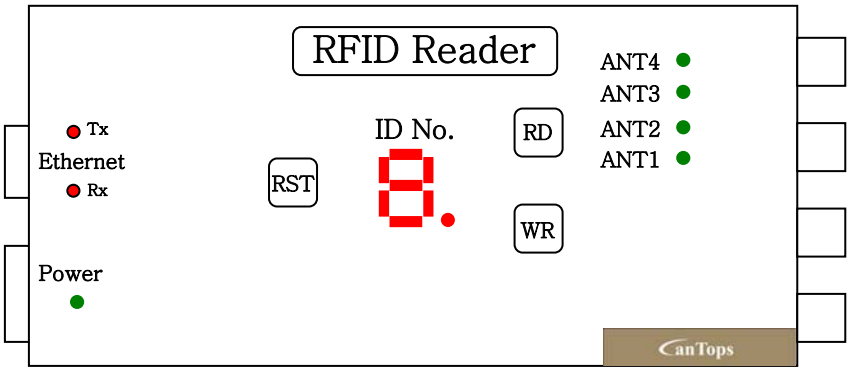
1. Descriptions of action for each part

1.1 ID number indicating section

In this product, 4 antennas can be conneted for use, and for the following 7 segments, individual numbers of the antennas currently used are indicated. Initial value is set up as 1, and if the setting up is to be changed, refer to the description of setting up section of the following ID numbers.



<Fig. 1> Outline drawing of RFID

<Table 1> Indicated details of 7 segments

ID No.	Indicated details	ID No.	Indicated details
0	0	8	8
1	1	9	9
2	2	10	A
3	3	11	b
4	4	12	C
5	5	13	d
6	6	14	E
7	7	15	F
O(No error)	o	X(Occurrence of error)	H

For the segment indicated with individual number, refer to the above <Table 1>. For the range of ID number, 4 numbers can be set up with 1~4.

1.2 Setting up method of ID number

Setting up of ID number can be revised through communication at high rank controller. For detailed information, refer to protocol specification.

1.3 Switch for tag test

In order to find optimum action condition when installing antennas of tag and RFID, it needs to be confirmed whether the functions of reading and writing of tag are normally conducted at RFID Reader. For these kinds of functional tests, RD (Read) and WR (Write) switches are used. When pressing RD switch, if data is normally received by sending the reading instruction to the tag, O. will be expressed at 7 segments for indicating ID No., and when error is occurred, X. will be lighted. When WR switch is pressed with identical method, abnormal state will be indicated after writing again the data value which has been read at the tag. WR will basically be progressed only when there isn't any abnormality after conducting the reading test. In addition, WR button is combined with the function of manually increasing the antenna number with the increment of 1. Therefore, when the antenna number is changed, WR button is supposed to be pressed until the antenna with desired number is selected. It shall be cautious that as this is acted together with WR function, when this function is used, the information of tag's last page can be changed into an arbitrary data.

1.4 LED for indicating data transmitting and receiving state: Tx, Rx

When transmitting data from Host to RFID Reader, Rx LED is lighted, and when receiving, Tx LED is lighted. Criteria of transmission and reception are judged with the basis of RFID Reader.

1.5 Ethernet connector

RJ-45 connector is used, and pin specification is as following <Table 2>.

<Table 2> Specification of RJ45 connector

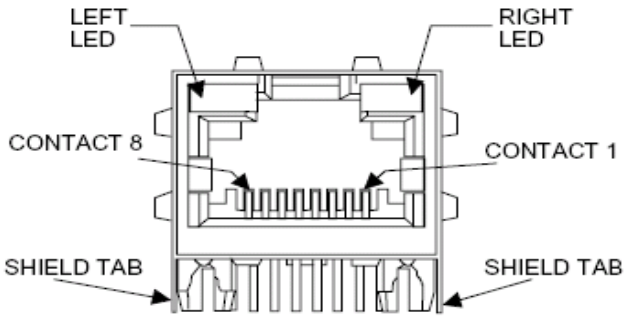
Pin number	1	2	3	4	5	6	7	8
Function	**Tx+**	**Tx-**	**Rx+**	x	x	**Rx-**	x	x

● Caution : **This product must be used Shield Cable as Ethernet cable in order to satisfy the FCC RULES.**

1.6 Indication details of Ethernet LED

When reviewing indication details of LED located at Ethernet connector, action status of RFID reader can be grasped. Specific details of action are as follows.

Left LED (connection related indication)		Right LED (action related indication)	
Turned off	Disconnected	Turned off	Action is not conducted
Amber	10MBPS	Amber	Half Duplex
Green	100MBPS	Green	Full Duplex



<Fig. 2> Photograph of Ethernet connector and LED action state

1.7 LED for indicating power

This is the LED activated when +24V power is supplied through power connector.

1.8 Power connector

Range of input voltage is 20~ 26V and specification of connector's pin is as the following <Table 4>. Connector to be used is SCK-12-2(R) of Samwoo Electronics, and the connector at opposite side is SCK-12-2(P). Power shall always be supplied after connecting the power connector, and when pulling out the power connector, it shall be done under the state of power being turned off. If power connector is attached and detached under the state of applied power, it can be the cause of damaging the parts.

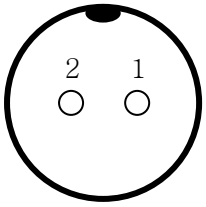
<Table 4> Specification of power connector pin

Pin number	1	2
Function	**+24V**	**24V GND**

SCK-12-2(P) SCK-12-2(R)

<Fig. 3> Photograph of power connector

Arrangement of connector's pin is as the following <Fig. 4>.



<Fig. 4> Arrangement of power connector pin

1. 9 ANT coupling connector

Antenna of RFID Reader is connected with BNC connector, and the antenna provided by this company shall be used to have the best performance, and if a general type antenna is connected, damage of product can be caused due to the abnormality generated at RF related circuit.

1.10 Indication of abnormal states

When the CPU at RFID Reader inside is abnormally activated by external environment such as static electricity, noise, and so forth, the dot of 7 segments shall be turned on as shown in the <Fig. 5> as the function of indicating this. Normal action can be maintained by RFID under the turned on state of this dot, however, if this phenomenon is continuously generated, unsafe elements such as peripheral appliance, cable, and so forth shall be removed before the use.

This dot will be turned off when RST, RD, or WR switch is pressed or when the power is normally turned on again after turned it off.

<Fig. 5> Indication details of micom during its malfunction

1.11 Installation environment and specification of action

<Table 5> Installation environment of RFID

Classification	Detailed item	Description
Reader	Frequency	134.2KHz
	Writing time	460mS/Page
	Reading time	170mS/Page
	Maximum reading distance *Note1	90±5 mm
	Maximum writing distance	40±5mm
	Number of channel	4 channels
Antenna cable (Option)	Diameter	3mm
	Bending diameter	45mm
	Length* Note 2	2m
	Material	PVC
Antenna core section (Option)	Size	62(Length)×13mm(Diameter), Tolerance: ±0.5mm 162(Length)×13mm(Diameter), Tolerance: ±0.5mm
	Material	Acetal, black color
	Connector	BNC
Type of tag	RI-TRP-DR2B	17Page×64bit, Read/Write
Environment	Storing environment	Temperature: -25 ~ 70°C Humidity: 5 ~ 95 %RH (However, no condensing phenomenon)
	Acting environment	Temperature: 0 ~ 50°C Humidity:35~85 %RH (However, no condensing phenomenon)
Power	Input voltage	DC 20V ~ 26V
	Current consumption	50mA
Size (W×H×D)		176×93.4×30mm (Excluding protruded section of connector)
Material of case		SCP1(Steel)
Weight		Approx. 430g

*Note 1) Characteristic of sensitivity will be differed in accordance with arrangement of Antenna and Transponder, and this is the value measured under the state of eliminating outside noise.

* Note 2) For changing the length of antenna cable and regarding the antenna with high efficiency, please contact with our company.

2. Declaration of Conformity

2.1 Federal Communications Commission (FCC)

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1) This device may not cause harmful interference and
2) This device must accept any interference received, including interference that may cause undesired operation.

FCC ID: RMN-CTS-RFID-LF03

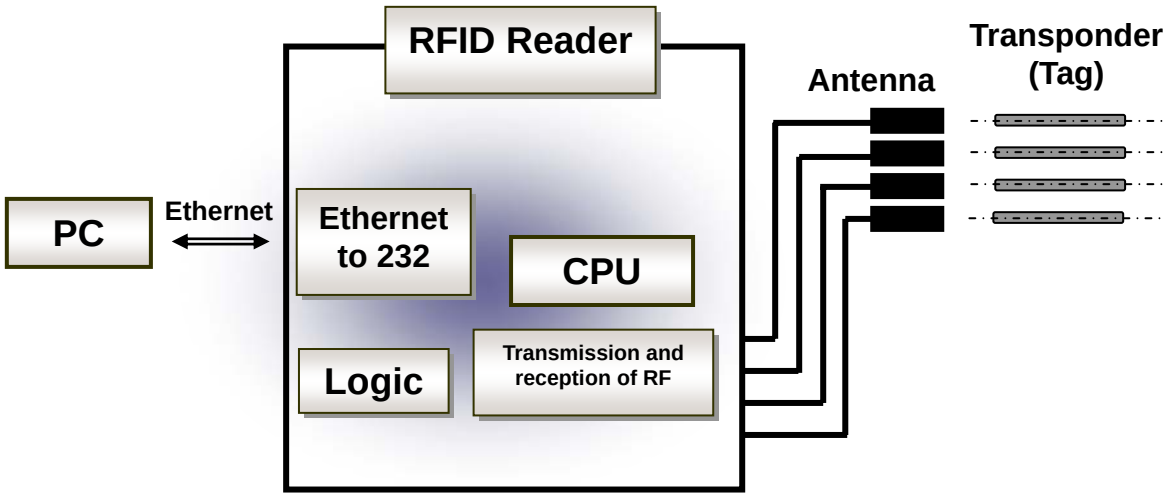
WARNING STATEMENT

"Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment."

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules.
These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.
This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Operation of this equipment in a residential area is likely to cause harmful nterference in which case the user will be required to correct the interference at his own expense.

3. Specification of protocol

With this protocol, MID(Material ID) information can be read at the tag connected to RFID Reader with RF by using Ethernet communication from the host, and various communication parameters and so forth can be set up. An item to be cautious about communication with RFID Reader is that if another instruction is sent while one received instruction is being executed, all of the subsequent instructions will be disregarded. Therefore, 4 antennas can't read the tag simultaneously, but they can read one tag by one tag in sequence.



<Fig. 6> Configuration diagram of RFID system

3.1 Setting up of Ethernet port

The Ethernet function used for this product is connected to the Host through Ethernet by using XPort of Lantronix (Ethernet to RS-232 converter), and it is connected to CPU with asynchronous communication method through this converter. For detailed setting up and using method related with Ethernet, refer to the technical data related with XPort of Lantronix (http://www.lantronix.com). Most of setting up work can be conducted with "DeviceInstaller_User Guide.pdf" of attached data, and for more detailed information, refer to "XPort_User Guide.pdf".

3.2 Structure of protocol

For basic communication, ASCII character string is used, and structure of transmitting and receiving instructions are as follows. Basic structure of frame is started with Device ID, and it is comprised of CheckSum 1Byte. Data is continuously sent without using special character between each of the parameters.

<Table 7> Structure of transmitting instruction

T_ID	CMD(Transmitting instruction)	D1D2 …. Dn	Check Sum
		Low rank -> High rank byte	
1Byte	**1Byte**	**Variable**	**1Byte**

<Table 8> Structure of receiving instruction

T_ID	CMD	STS	D1D2 … Dn	Check Sum	CR	LF
			Low rank -> High rank byte			
1Byte	**1Byte**	**1Byte**	**Variable**	**1 Byte**	**0x0D**	**0x0A**

1) T_ID(Target ID) : Function of antenna number selection

This is the setting up for selecting the channel (antenna number) of multi-channel RFID reader, and the antenna can be selected as follows. This function can be set up through communication instruction from Host, and it is comprised of 1Byte. The ASCII characters with the range of 0~4(0x30~0x34) are used. Initial setting up value at the time of product shipping is 1, and when reset is conducted with RST switch or through communication instruction, the value can be changed into the initial setting up value, 1. This setting up value is used to select antenna when R, W instructions are performed, and other instructions are disregarded.

<Table 9> ASCII code table of T_ID (antenna channel selection)

T_ID number	ASCII code	Antenna number
0	0x30	X
1	0x31	**1**
2	0x32	**2**
3	0x33	**3**
4	0x34	**4**
5 ~ 15	0x35~ 0x3F	X

*) X : This is the data which is not used, and all antennas are turned off.

2) CMD

This indicates instructions sent from Host to Reader, or from Reader to Host. For the type of instructions currently realized, refer to the section 2.3. Configuration and length of data will be differed in accordance with the type of these instructions.

3) D1 D2 …. Dn

Data related with each of the instructions and reply codes are used. Maximum length of data is limited within 9 bytes. For R and W instructions, the page information of 1 byte will be used to set up the page. For the setting up value of page, refer to the following types of instruction.

4) STS

This is the data to be used for sending various information such as communication state at RFID Reader, action state of product, etc. For details of information, refer to the section 2.4.

5) Check Sum

This is the function to be used for confirming any abnormality of transmission and reception data, and when calculating the Check Sum, all of the transmitted data are used, and the calculation formula is sent by converting into ASCII code 1 Byte in which 0x30 is added to low rank 4Bit of the resulting data which obtains XOR operation for each bit.

Example) When it is 0x35 0x37 0x38 0x0d 0x0a:

0x35	0011 0101
0x37	0011 0111
XOR	0000 0010
0x38	0011 1000
XOR	0011 1010
0x0D	0000 1101
XOR	0011 0111
0x0A	0000 1010
XOR	0011 1101 = 0x3**D** => Only low rank 4Bit+0x30="**0x3D**" is transmitted.

Example) When the data resulting from XOR is

0x5**6**: it will be transmitted by configuring frame with **0x36**=(0x56&0x0F)+0x30, or when it is

0x0**F**: it will be transmitted by configuring frame with **0x3F**=(0x0F&0x0F)+0x30.

3.3 Type of instruction

Instructions to be used between RFID and high rank PC are as follows, and in order to facilitate protocol embodiment while optimizing program code size, all functions of RFID are to be realized by minimizing instructions. For the sake of convenience of description, T_ID is assumed to be the state of setting up the basic setting up value as 1.

<Table 10> Type of instruction

Instruction	Details of processing	Direction of transmission and reception	Remarks
I	Requirement of RFID information (company name, version)	Host => Reader	
R	Reading the contents of tag's designated page	Host => Reader	
W	Instruction of writing the data at tag's designated page	Host => Reader	
C	Instruction of reset the program of reader	Host => Reader	

For setting up of tag's page to be used at R or W instruction, the page of 1~17 can be selected with the value of 1 Byte as follows. The ASCII to be used is 0x31~0x41.

<Table 11> Setting up value of page

Page No.	ASCII code	Character	Page No.	ASCII code	Character
1	0x31	1	10	0x3A	:
2	0x32	2	11	0x3B	;
3	0x33	3	12	0x3C	<
4	0x34	4	13	0x3D	=
5	0x35	5	14	0x3E	>
6	0x36	6	15	0x3F	?
7	0x37	7	16	0x40	@
8	0x38	8	17	0x41	A
9	0x39	9			

1) I instruction

This instruction is used with the purpose of checking communication state with Host and RFID Reader or confirming product information of RFID Reader.

Structure of instruction sent from Host to Reader is as follows.

T_ID	Instruction	Check Sum
1~4	I	1 Byte

Reply from Reader to Host is constituted as follows. When it is normally executed without error, STS=0.

T_ID	Instruction	STS	Data	Check Sum	CR	LF
1~4	I	1 Byte	8 Byte	1 Byte	0x0D	0x0A

Example) When hardware version is 1.1, and software version is 2.2, the data of reply frame are constituted with following character string. Currently selected antenna number is 1.

Transmission frame (Host -> Reader)

T_ID	Instruction	Check Sum
1	I	8

Configuration of reception frame (Reader -> Host)

T_ID	Instruction	STS	Data	Check Sum	CR	LF
1	I	0	1.1, 2.2	4	0x0D	0x0A

2) R instruction

This is the instruction for reading the details of tag's designated number of address, and the tag currently used has the memory of 17 Page(8Byte/Page) with which reading and writing can be conducted. Since the basic unit of reading and writing the data at the tag is the page, it is desirable to process with 8Byte of page unit when reading and writing the tag at high rank computer.

Structure of instruction sent from Host to Reader is as follows.

T_ID	Instruction	Page	Check Sum
1~4	R	1~A(1 Byte)	1 Byte

Reply from Reader to Host is constituted as follows. When it is normally executed without error, STS=0.

T_ID	Instruction	STS	Data	Check Sum	CR	LF
1~4	R	0	8 Byte	1 Byte	0x0D	0x0A

Example) When the data of '66666666' is stored at 6 Page of tag whose T_ID=1, if the data is read with R instruction, the transmission and reception frame are constituted as follows.

Transmission frame (Host -> Reader)

T_ID	Instruction	Page	Check Sum
1	R	6	5

Configuration of reception frame (Reader -> Host)

T_ID	Instruction	STS	Data(8 Byte)	Check Sum	CR	LF
1	R	0	66666666	3	0x0D	0x0A

3) W instruction

This is the instruction of writing data at designated page of tag, and the configuration of transmission and reception frame is as follows.

Structure of instruction sent from Host to Reader is as follows.

T_ID	Instruction	Page	Data	Check Sum
1~4	W	1~A (1 Byte)	8 Byte	1 Byte

Reply from Reader to Host is constituted as follows. When it is normally executed without error, STS=0. In addition, at data field, the data sent from Host is returned.

T_ID	Instruction	STS	Data	Check Sum	CR	LF
1~4	W	0	8 Byte	1 Byte	0x0D	0x0A

Example) When writing '12345678' at 1 Page of the tag whose T_ID=1, the transmission and reception frame are constituted as follows.

Transmission frame (Host -> Reader)

T_ID	Instruction	Page	Data	Check Sum
1	W	1	12345678	?

Configuration of reception frame (Reader -> Host)

T_ID	Instruction	STS	Data	Check Sum	CR	LF
1	W	0	12345678	>	0x0D	0x0A

4) C instruction

This is the instruction of resetting the program of reader, and T_ID is initialized as No.1, and outside sensor action mode is initialized as Disable mode, and the address of automatic reading mode by sensor is initialized as 01 number of address where MID is stored. All setting up values will be activated with new setting values from the next instruction after sending the reply by C instruction.

Structure of instruction sent from Host to Reader is as follows.

T_ID	Instruction	Check Sum
1~4	C	1 Byte

Reply from Reader to Host is constituted as follows. When it is normally executed without error, STS=0.

T_ID	Instruction	STS	Check Sum	CR	LF
1~4	C	0	1 Byte	0x0D	0x0A

Example) When resetting RFID Reader whose T_ID=1 to initial state, the transmission and reception data will be as follows.

Transmission frame (Host -> Reader)

T_ID	Instruction	Check Sum
1	C	2

Configuration of reception frame (Reader -> Host)

T_ID	Instruction	STS	Check Sum	CR	LF
1	C	0	2	0x0D	0x0A

5) Reply code when communication errors are generated

When communication error or serious error is generated at RFID Reader, data will be sent to host with following constitution of frame. The value of 0x31~0x38 will be returned to STS.

T_ID	STS	Check Sum
1	**1~8**	**1 Byte**

3.4 Type of status

As shown in the following Table, the status is comprised of 1 Byte.

<Table 13> Type of status

Code	Status	Remarks
'0'	When received data does not have abnormality and instruction is normally executed	
'1'	For received date, parity and check sum have abnormality	
'2'	Instruction with different or without T_ID number is received	
'3'	When received data is too long (Maximum 12Byte)	
'4'	When writing the data at the tag is failed	
'5'	When there is no tag	
'6'	If check sum error is generated at the tag when the type of the tag is different from that of received instruction's tag	
'7'	When received instruction cannot be executed under the status of set up variable, i.e., the value of variable has an abnormality	
'8'	Communication error with tag	

4. Type of tag

The tag currently used has the memory of 17 Page(8Byte/Page) with which reading and writing can be conducted. Since the basic unit of reading and writing the data at the tag is the page, it is desirable to process with 8Byte of page unit when reading and writing the tag at high rank appliance. Each of the pages is constituted as following shape.

<Table 14> Type of tag

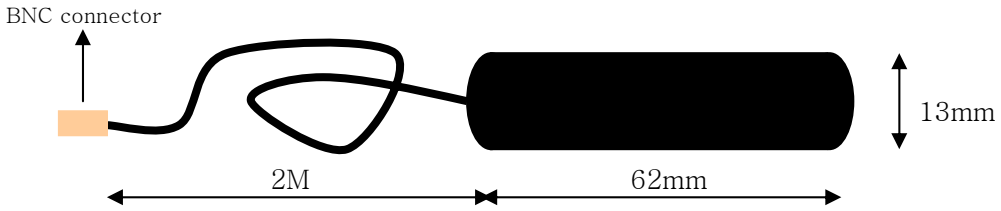
Page number	Application	Remarks
1	Low rank 8Byte of Material ID	MID information
2	High rank 8Byte of Material ID	
3~17	The area for reading and writing freely of fair information	NotePad area

When using the tag with different shape, it can be used with the revision of firmware.

5. Installation method of ANT

5.1 Specification of ANT

PVC is used as outer shell material, and length and thickness of cable can be changed in accordance with ordered specification, however, it is desirable to use the cable within the maximum length of 5 m. For the antenna to be used in this reading device, the two types of antennas shown in the following <Table 15> can be used as the standard, and the antenna with special specification can separately be manufactured. For the 162mm antenna, it will be the good antenna with fine reading performance when the tag is vertically placed at the side of the antenna rather than the one with the structure shown in the <Fig. 8>.



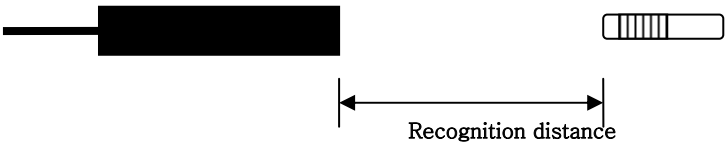
<Fig. 7> Dimension of circular antenna

<Table 15> Characteristic for each type of antenna

Type of antenna	Name of item	Recognition distance	Characteristic (Noise environment)	Example of use
62mm Stick	CTS-RFID-ANxx	90mm	Excellent	Stocker
162mm Stick	CTS-RFID-ALxx	85mm	Ordinary	OHT

The xx under the name of item of <Table 15> means the length with the unit of 10cm, and it is limited in the range from 01, which is 0.1m, to the maximum of 50, which is 5m.

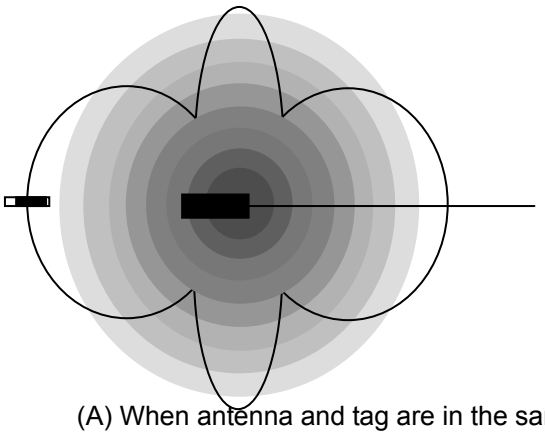
Recognition distance means the straight distance between the antenna end to tag as shown in the <Fig. 8>. The data measured under no-noise environment can be different from the one measured under actual using environment.



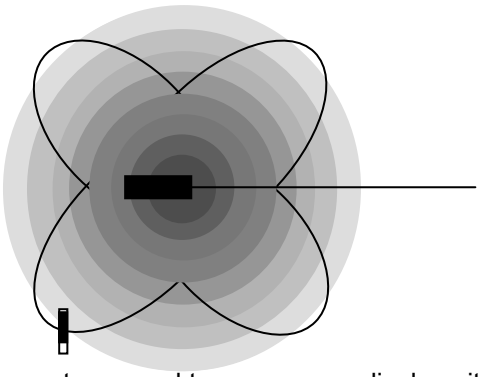
<Fig. 8> Standard of recognition distance

5.2 Setting up method of optimum location

1) As in the <Fig. 9-A>, the longest recognition distance can be used for the case of confronting the antenna of RFID Reader and the tag face-to-face with each other, and when the direction is deviated, the recognition distance will be shortened.
2) In order to prevent malfunction by the noise radiated from peripheral devices, installation shall be conducted so that interference with monitor, switching relay, adjacent transponder (tag), and so forth will not be generated. During the installation, if the noise source in the vicinity is located and eliminated, recognition distance and speed can largely be enhanced.
3) During the installation, it shall be careful not to have metallic part in the vicinity of antenna and tag. If there is any metallic part in the surroundings, recognition distance can be shortened due to the generation of abnormality at RF signal created from the antenna. Therefore, even in the case of the fixtures securing antenna, it is desirable for them to be processed with insulation material like acetal, and if existence of stainless steel or aluminum in the surroundings is unavoidable, the antenna with special shape or shielding method shall be required.



(A) When antenna and tag are in the same axis



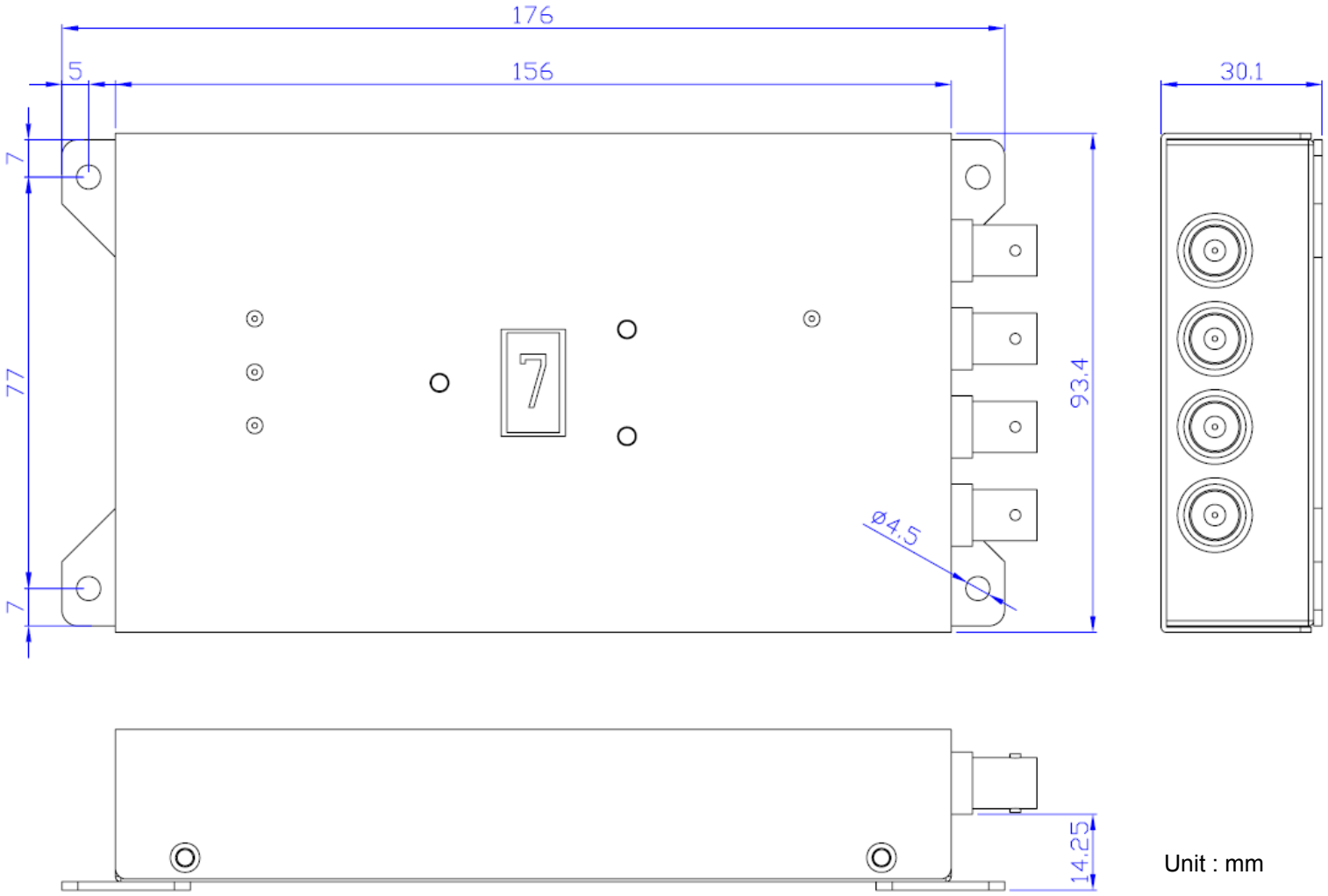
(B) When antenna and tag are perpendicular with each other

<Fig. 9> Recognition distance (Read) in accordance with arrangement of antenna and tag

5.3 Recognition distance

In order to raise recognition distance, locations of Tag and RFID Reader shall be arranged on a horizontal line, and it shall be careful not to make other metallic items placed near to the antenna and tag during installation. <Fig. 8> is a schematic which indicates the recognition distance in accordance with the arrangement of antenna and tag, and the most desirable arrangement is the one when the antenna and tag are placed on a same axis, and if they are placed in vertical arrangement, the tag is desirable to be installed not at the center but at the end section of the antenna body. For recognition distance, securing sufficient allowance is required, therefore, the allowance of recognition distance shall always be confirmed under the arranged state while testing normal reading state with read switch of the reader.

< Attachment> Specification of RFID Reader Case



Unit : mm

< Attachment> Photograph of RFID Reader