Released

K-Band
Doppler Sensor Module

RF Frequency: 24.05 to 24.25 GHz

Model No. NJR4265R series

Frequency Line-up:	F1: 24.05 to 24.25 GHz
	F2: 24.15 to 24.25 GHz
	F3: 24.075 to 24.175 GHz
Software Version:	C1: Original Release

Specifications
Rev.01 January 27, 2016

K-Band Microwave Intelligent Motion Sensor for Short Distance, Low Speed Applications

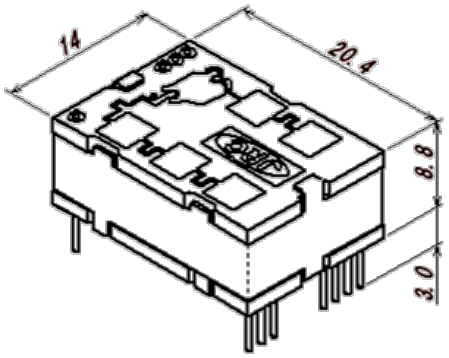
NJR4265R is intelligent motion sensor that is designed for the sensing of short distance low speed movement object of pedestrian etc. The steady sensing of moving object is realized by embedded software. It is suitable for the built-in use of the sensing function to various equipments as all functions are integrated in a small package and it can easily control from PC/MCU by UART interface. Further, stand alone operation is also possible.

Features:

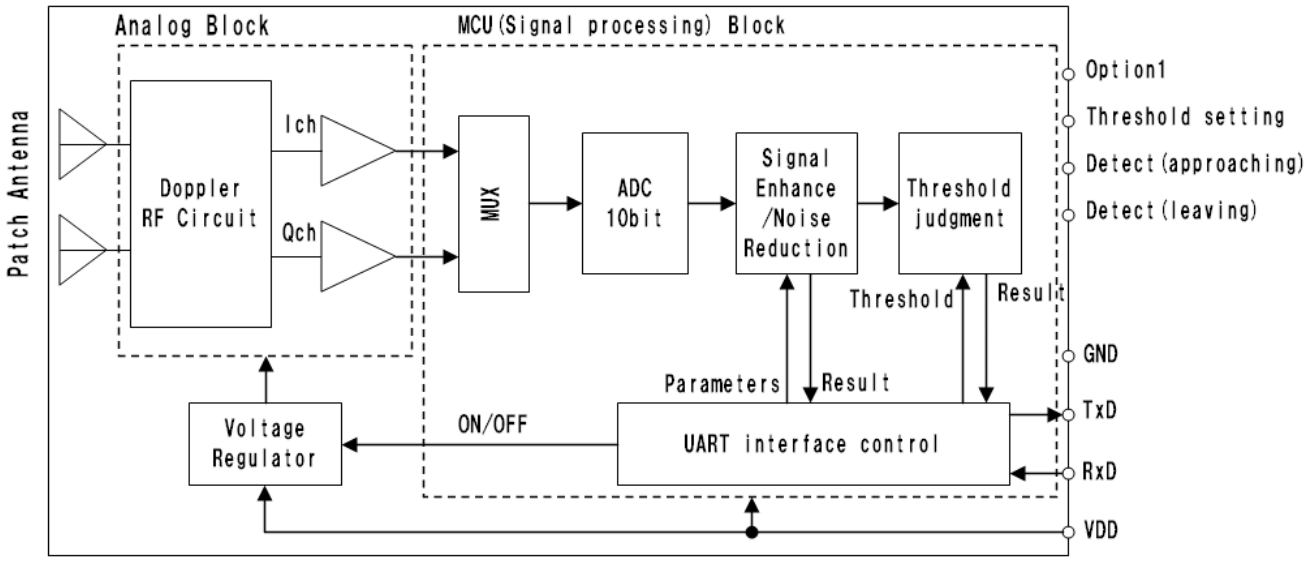
- Motion sensor using the 24GHz Microwave Doppler
- Antenna, RF circuit, IF amp, MCU and voltage regulator are integrated in a small package (14x20.4x8.8mm)
- Communication with PC/MCU is available by UART interface and stand alone operation is also possible
- Signal processing software for the steady sensing
  - Enhancing the signal from movement object and decreasing random noises
  - Decreasing the mutual interference between sensors
  - Identification of movement direction (approaching and leaving).
- Low voltage operation and low power consumption
- Sleep mode for reducing power when unnecessary

Applications

- Various equipment control by human sensing
  - Energy saving management
  - Entrance and exit management
  - Safety and Security



Functional Brock diagram



Model Number

- **Numbering System**

NJR4265RF1C1

- Software Version:
  - C1: Original Release
- RF Frequency:
  - F1: 24.05 to 24.25 GHz / EU except specific regions
  - F2: 24.15 to 24.25 GHz / All of EU resions
  - F3: 24.075 to 24.175 GHz / United States
- Product Series Number

- **Line-up**

Model No.	RF Frequency	Software Version	Region	Certification
NJR4265RF1C1	24.05 to 24.25 GHz (F1 type)	Original Release	EU except specific regions (UK, Frence, etc)	EU Certification R&TTE Directive 1999/5/EC
NJR4265RF2C1	24.15 to 24.25 GHz (F2 type)		All of EU regions	
NJR4265RF3C1	24.075 to 24.175 GHz (F3 type)		US	FCC Part 15.245

1. Absolute Maximum Rating:

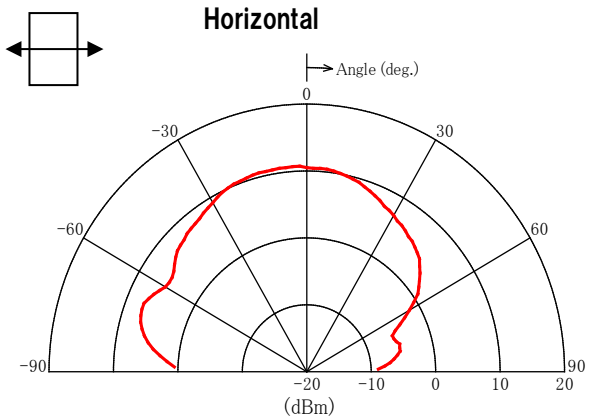
PARAMETER	MIN.	TYP.	MAX.	UNITS	REMARKS
Supply Voltage	0	–	6.5	V	
Operating Temperature	-40	–	+85	deg.C	
Storage Temperature	-40	–	+85	deg.C	

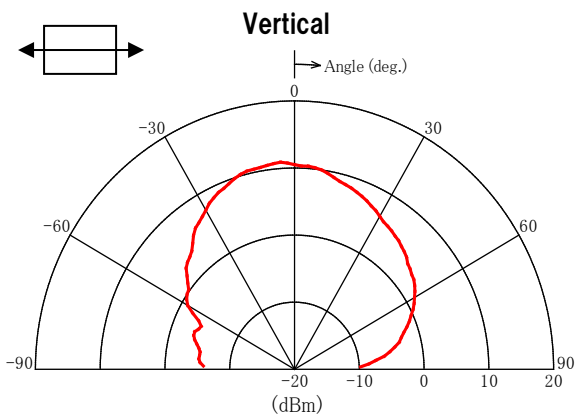
2. Specification:

2.1. Electrical Characteristics (Common measure condition Ta= +25 deg.C)

PARAMETER	MIN.	TYP.	MAX.	UNITS	REMARKS
Power Supply					
Operating Voltage	3.0	3.3/5.0	5.25	V	
Operating Current					
Sensing mode	–	60	–	mA	
Sleep mode	–	4	–	mA	
Sensor RF					
Conformity Standard	● EU Certification R&TTE Directive 1999/5/EC ● FCC Part 15.245				
Operating Frequency					
F1 type	24.05	–	24.25	GHz	EU Certification
F2 type	24.15	–	24.25	GHz	
F3 type	24.075	–	24.175	GHz	FCC Certification
Frequency Stability (Temp.)	–	+/-0.2	–	MHz/deg.C	Ta=-20 to +60 deg.C
Output Power (E.I.R.P.)	8.2	–	13	dBm	
2nd Harmonics (E.I.R.P.)	–	–	-30	dBm	
Antenna					
-3dB beam width (Horizontal)	–	70	–	deg.	
-3dB beam width (Vertical)	–	54	–	deg.	
Side lobe suppression (Horizontal)	–	–	–	dB	No Side lobe
Side lobe suppression (Vertical)	–	–	–	dB	No Side lobe

2.2. Typical Radiation Pattern





3. Environmental characteristics

PARAMETER	SPECIFICATION
Operation Temperature	-20～+60 deg.C
Storage Temperature	-40～+80 deg.C
Humidity	0～95% @+30 deg.C
Vibration	49.03m/s^2 (5G) 30 to 50 Hz, 10 minutes, XYZ direction
Shock	196.13m/s2 (20G) Half sine, 11 msec, XYZ direction, 3 times

4. Sensing Performance

(Common measure condition Ta= +25 deg.C)

PARAMETER	PERFORMANCE	UNIT	REMARKS
Speed Range of target	0.25 to 1.0	m/sec	
Maximum Distance in the front	10	m	
Detectable Angle	+/-35	deg.	

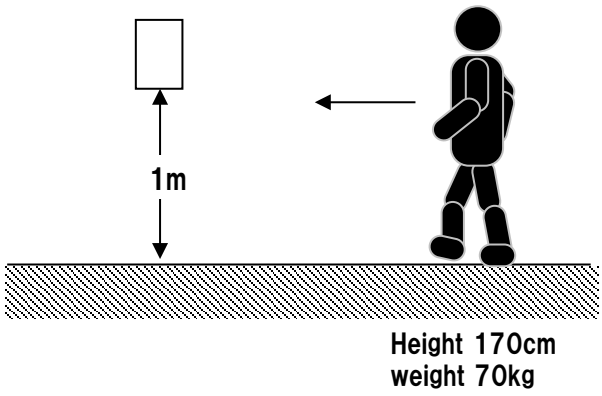
Note) This is not the specification to guarantee the performance of this product. As for the specification of the product, the electric characteristic standard is applied. Sensing performance shown here is an example of the result of being likely to obtain it when this product is used on the following conditions.
Actual sensing performance would be greatly different in each environment used. Please do enough confirmation in the environment actually used,

Definition of Sensing Performance

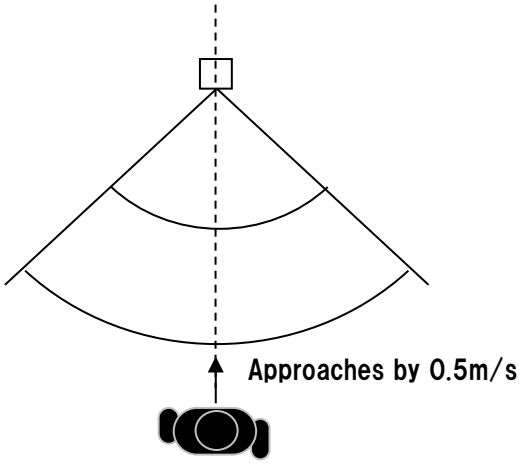
- Speed Range of target — The range of the speed that the detection distance become 70% of the detection distance of 0.5 m/s
- Maximum Distance in the front — Detectable distance that can be detected in front of sensor when a threshold value set to [999] or when VDD is added to a threshold setting terminal
- Detectable Angle — Angle where detection distance becomes 70% of the front

Measurement condition of detection performance

- Temperature — Ta=+25 deg.C
- Target of measurement — An adult of 170cm/70kg approaching at the rate of 0.5m/s from the front of sensor
- Installation of a sensor — Sensor is installed as the antennas horizontal horizontally in a height of 1 m from the ground



Side view



Top view

5. Signal processing for the steady sensing of moving object (Environmental noise reduction)

This product is embedding software for the steady sensing of moving object. It is enhance the signal from movement object of pedestrian etc. and is reduce random noise and sudden signal which caused an incorrect detection by using the signal from IQ mixer. The following effects are expectable.

Note) This signal processing function assumes the following noises are reduced, and pedestrian's movement is emphasized. However, it is likely to become a counterproductivity for a signal outside assumption.

Expectable results

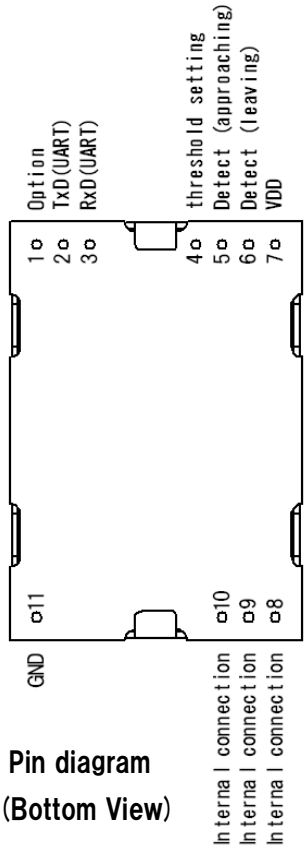
- Reduction of false detection by random movement such as the shakes of plant by wind or the noise of rain etc.
- Reduction of the false detection by sudden movement such as the insect etc. which cross just before a sensor
- Steady detection of movement objects such as pedestrian under the environment where the above-mentioned noise exists.
- Reduction of the mutual interference of sensors
- Identification of direction of movement (approach and leaving)

6. Interface

6.1. Pin assignment

No.	Name	I/O	Description
1	—	—	Option *1
2	TxD	O	UART TxD
3	RxD	I	UART RxD
4	Threshold setting	I	Threshold voltage *2
5	Detect (approaching)	O	H: Detect
6	Detect (leaving)	O	L: No detect *3
7	VDD	I	VDD input
8	—	—	For Internal connection
9	—	—	*4
10	—	—	
11	GND	—	GND

*1 Option pin is not assigned at NJR4265R. Keep it in electrically open state
*2 Threshold is able to set by the voltage applied to this pin
*3 pin5 or 6 is changed to H level respectively when the movements of approaching or leaving is detected. (Output current < 5mA)
*4 Pin8, 9 and10 are used for internal connection. Those must be electrically open independently. These pins must use the via holes of an independent pad when the sensor install on a PCB.
Do not connect also between these terminals too.



Pin diagram
(Bottom View)

6.2. Asynchronous Serial Data Bus (UART) Interface

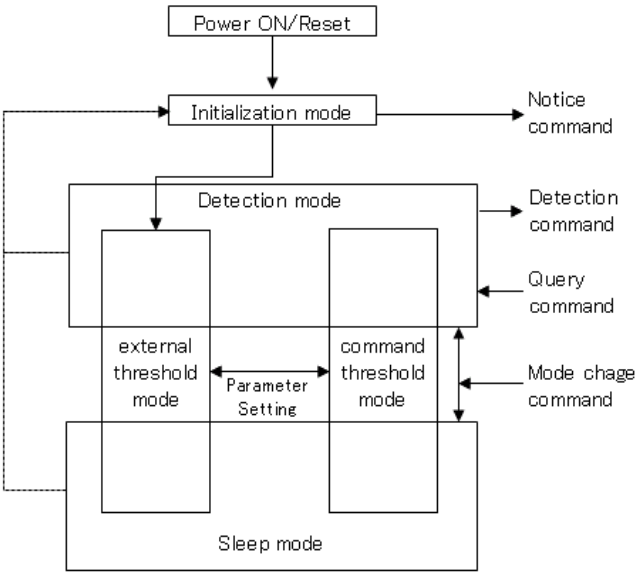
NJR4265R is able to control of sensor mode, set of threshold level, acquisition of detection result and acquisition of various information of sensor states from PC or MCU, etc. by using UART Interface

PARAMETER	FORMAT	UNIT	REMARKS
Signal Level	CMOS level	—	Internally pulled-up by 10 kohms
Communication Parameters			
Baud Rates	9600	bps	
Data Bits	8	bits	
Stop Bits	1	bits	
Parity	odd	—	
Handshake	non	—	

7. Operational mode

MODES	DESCRIPTION
Power ON/Reset	CPU Reset.
Initialization	Initialize and wait until sensor is stabilized. Notice command is sent out after the completion of initialization.
Detection	Detection command is sent when following changes arise in the state of the sensor detection. 1. detect approaching object 2. detect leaving object 3. state change from detection to no-detection
Sleep	Shutdown of all analog circuit for reducing the current. When returning to detection mode, about one second needs for stabilization of the sensor.

Note: When the watch dog timer overflows, it is reset from any mode



State Transition Diagram

State	Event: Power ON	Self test	Mode change command (Sleep)	Mode change command (Detect)	Reset command	Watch Dog timer
Reset	Initialization mode	Setting disable	Setting disable	Setting disable	Setting disable	Setting disable
Initialization mode	Setting disable	Detection mode	ignore	ignore	ignore	Reset
Detection mode	Setting disable	Setting disable	Sleep mode	ignore	Reset	Reset
Sleep mode	Setting disable	Setting disable	ignore	Detection mode	Reset	Reset

State Transition Table

- Threshold mode of the Power-on or CPU reset is analog threshold mode. It is possible to change to the command threshold mode by sending threshold setting commands. (@SP,@SM and @SC)
- The @SA command is effective when changing from the command threshold to an analog threshold mode.
- When mode is changed to sleep mode or is resumed from sleep mode, the threshold mode is preserved. Moreover, the change of the threshold mode in sleep mode is also possible.

8. Communication command

8.1. Outline

COMMANDS	DIRECTION	DESCRIPTION	EFFECTIVE MODE
Detection	Sensor➔ Host	Sending from sensor when movement is detected	Detection
Mode Change	Host➔ Sensor	Change the sensor mode	Detection Sleep
Parameter Setting	Host➔ Sensor	Setting and change of threshold parameters	
Query	Host➔ Sensor	Reading of state of sensor (mode , parameters)	
Reset	Host➔ Sensor	Reset of sensor	
Start Notification	Sensor➔ Host	Sending from sensor when initialization is completed	Initialization
Error Response	Sensor➔ Host	Sending from sensor when error occurs	All mode

8.2. Communication command list

Sensor->Hosts and Hosts->sensor, both uses the following formats.

@ XXX xx <CR><LF>

@: command header
XXX: command characters, alphabet 1-3 characters. (capital letter and small letter are distinguished)
xx: command/configuration parameters (numerical value or alphabet one character or "?")
<CR><LF>: delimiter (CR+LF)

CONTENTS/EFFECTS	XXX	DIRECTION	FORMAT	REMARKS
Detection Commands				
Detected Approaching movement	C	Sensor→Host	@C<CR><LF>	
Detected Leaving movement	L	Sensor→Host	@L<CR><LF>	
Becomes undetected from detected	N	Sensor→Host	@N<CR><LF>	
Mode Change Commands				
Change to Detection mode	T	Host→Sensor	@T<CR><LF>	Initial state
Change to Sleep mode	U	Host→Sensor	@U<CR><LF>	
Parameter Setting Commands				
Setting an Approaching threshold	SP	Host→Sensor	@SP**xxx**<CR><LF>	*1
Setting a Leaving threshold	SM	Host→Sensor	@SM**xxx**<CR><LF>	*1
Change to Analog threshold mode	SA	Host→Sensor	@SA<CR><LF>	
Change to Command threshold mode	SC	Host→Sensor	@SC<CR><LF>	
Query Commands				
Acquire the present detection.	Q1	Host→Sensor	@Q1?<CR><LF>	
Response of present detection		Sensor→Host	@C<CR><LF> @L<CR><LF> @N<CR><LF>	approaching leaving no detection
Acquire the present mode	Q2	Host→Sensor	@Q2?<CR><LF>	
Response of present mode		Sensor→Host	@T<CR><LF> @U<CR><LF>	Detection mode Sleep mode
Acquire the present threshold mode	Q6	Host→Sensor	@Q6?<CR><LF>	
Response of present threshold mode		Sensor→Host	@SA<CR><LF> @SC<CR><LF>	Analog threshold Command threshold
Acquire the Approaching threshold	SP	Host→Sensor	@SP?<CR><LF>	
Response of Approaching threshold		Sensor→Host	@SP**xxx**<CR><LF>	*1
Acquire the Leaving threshold	SM	Host→Sensor	@SM?<CR><LF>	
Response of Leaving threshold		Sensor→Host	@SM**xxx**<CR><LF>	*1
Acquire the Analog threshold	SV	Host→Sensor	@SV?<CR><LF>	Value of ADC
Response Analog threshold		Sensor→Host	@SV**xxxx**<CR><LF>	Value of ADC
Acquire the software version	V	Host→Sensor	@V?<CR><LF>	
Response of software version		Sensor→Host	@Vx.xx<CR><LF>	x.xx: version number
Reset Command, Start Notification Command				
Reset Command	R	Host→Sensor	@R<CR><LF>	
Start Notification	W	Sensor→Host	@W<CR><LF>	
Error Response Commands				
Notification of Self test error	ES	Sensor→Host	@ES<CR><LF>	
Notification of Communication error	ER	Sensor→Host	@ER<CR><LF>	
Notification of watch dog timer error	EW	Sensor→Host	@EW<CR><LF>	

*1 Capable threshold setting range is Integer 1-999.
The relation between the threshold value and the detection distance can be shown by the following expressions

Da =SP/100, Dl = SM/100

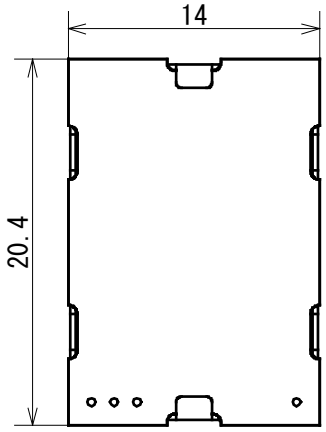
In this expression, [Da] is approaching detection distance, [Dl] is leaving detection distance, (units: m)

Note) Detection distance assumes the case that an adult of 170cm/70kg approaches at the rate of 0.5m/s from the front

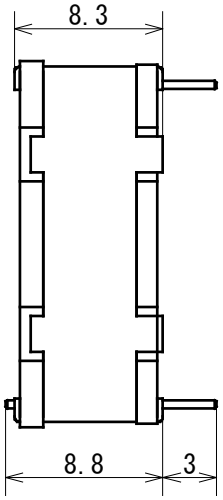
9. Outline Drawing

9.1 Product Outline

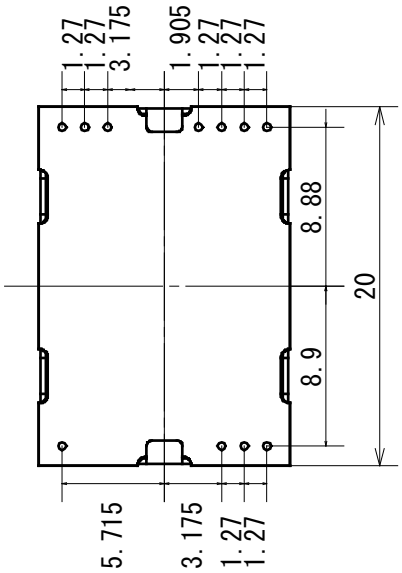
Top view (Antenna Side)



Side view



Bottom view



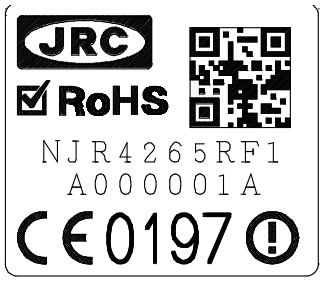
Pin diameter: ϕ0.45

Recommended diameter of via hole: ϕ0.75

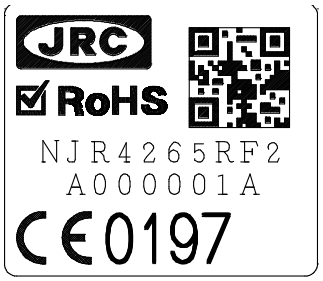
(Tolerances +/−0.5mm)

9.2 Label

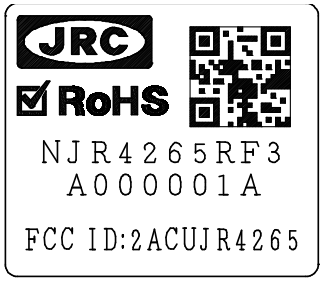
1) NJR4265RF1C1



2) NJR4265RF2C1

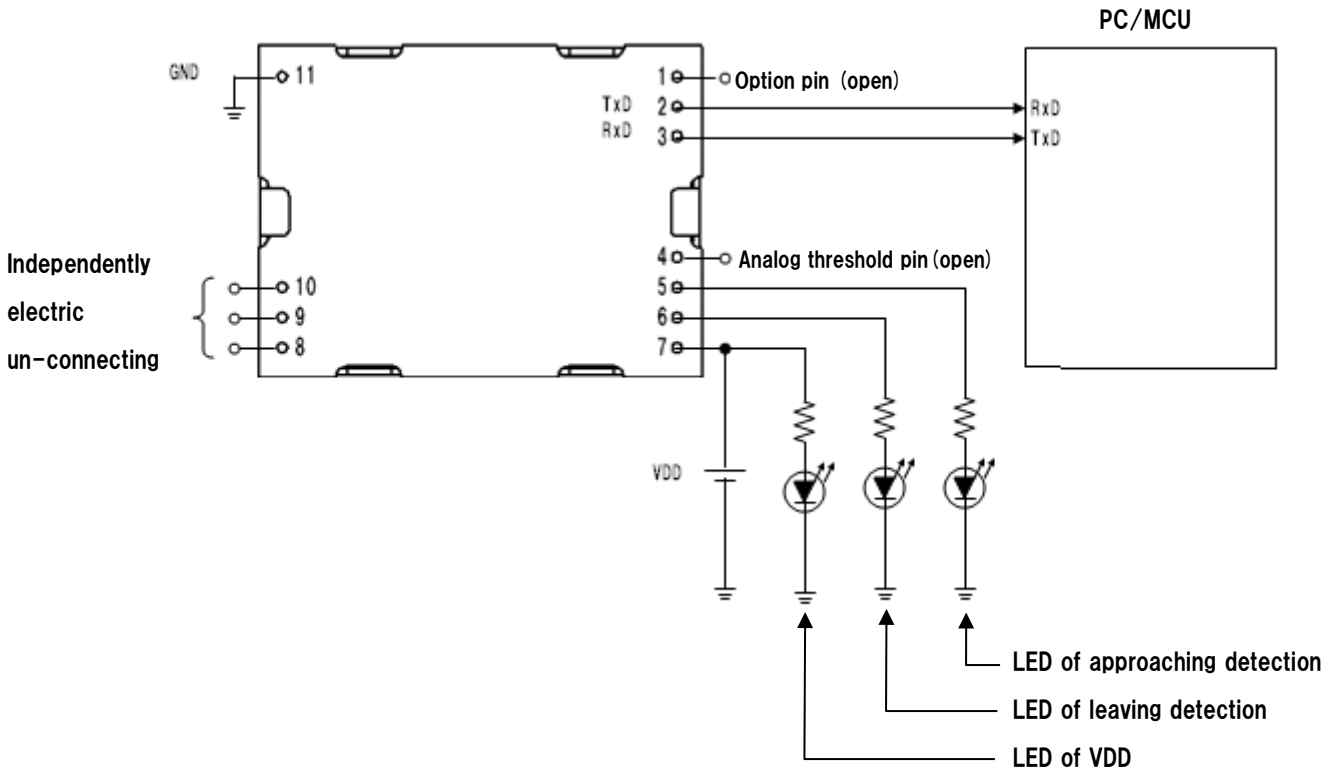


3) NJR4265RF3C1

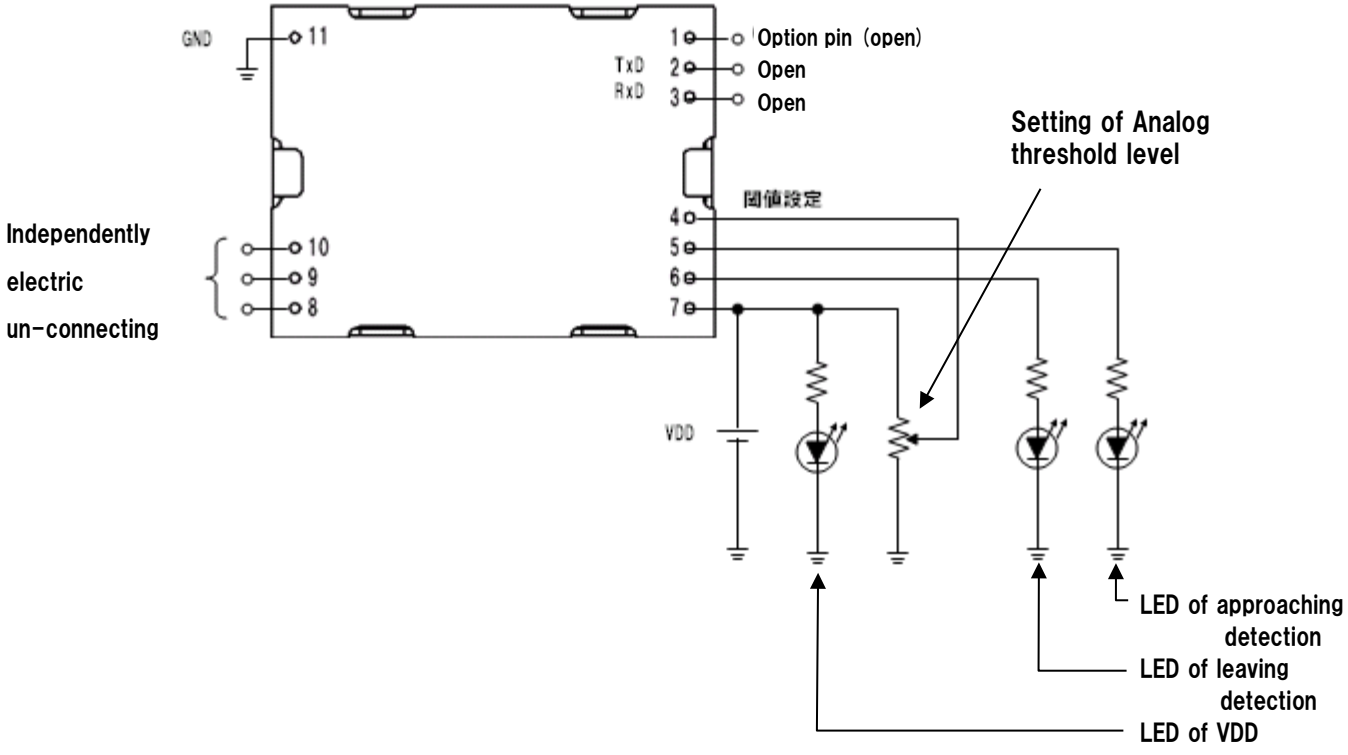


10. Example

10.1. Example when connecting with PC or MCU



10.2. Example when using it by stand-alone



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5. The products listed in the catalog and specification sheets may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office or sales representatives before using the products in any of the following types of equipment.
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   * Equipment Used in the Deep Sea
   * Power Generator Control Equipment (nuclear, steam, hydraulic)
   * Life Maintenance Medical Equipment
   * Fire Alarm/Intruder Detector
   * Vehicle Control Equipment (automobile, airplane, railroad, ship, etc.)
   * Various Safety Equipment

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