NJR4267

This product is currently under development and specifications are subject to change without notice.

24GHz band Doppler Sensor Module High sensitivity, Moving object/human body detection sensor

Preliminary

Features

- Moving object/human body detection by 24GHz band microwave
- Small, low-profile package
- All-in-one from antenna to signal processing
- Equipped with optimal algorithms for detecting moving objects and human bodies
  - Detection of movements peculiar to the human body and detection of micro-vibrations
  - Signal processing to reduce random noise components
  - Identification of moving direction (approaching/separating) of target object
- Supports UART/PWM/Digital-Output interfaces
- Low power consumption by intermittent operation 1.5mA typ. @3.8V
- Antenna angle (half width) H plane/V plane
  - Antenna type A: ±40°/±55°
  - Antenna type B: ±42°/±33°
- Maximum detection range　Distance directly in front of the sensor (pedestrian)
  - Antenna type A:20m
  - Antenna type B:30m

Abstract

The NJR4267 is a microwave 24GHz Doppler sensor module in a small and low profile package measuring 17.2 x 25 x 3 mm.

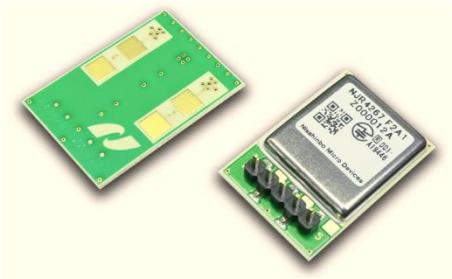
Despite its small size, it is an all-in-one module with built-in microwave circuit, antenna, and MCU for control and signal processing.

It is equipped with an algorithm that identifies moving objects and human bodies as detection targets, enabling customers to shorten their product development time.

The product has been certified as a stand-alone product for technical standard compliance in Japan, eliminating the need for customers to obtain additional radio wave certification.

Applications

- Lighting equipment
- Security equipment
- Monitoring equipment
- Human sensor for embedding in various equipment



Outline : 17.2mm x 25mm x 3mm

Product Line-up

N J R 4 2 6 7 F2 A 1

- Suffix:
  - 1: Built-in signal processing, human body/vehicle detection
- Antenna Type:
  - A: 1x1 Type (Detection Angle: 80°/110°, Detection Distance: 20m)
  - B: 2x1 Type (Detection Angle: 84°/66°, Detection Distance: 30m)
- RF Frequency:
  - F2: 24.150 ～ 24.250 GHz / Japan・EU
  - F3: 24.075 ～ 24.175 GHz / United States
- Product Series Number

1 List of Product Models

Table 1 List of Product Models

Model No.	RF Frequency	Antenna Type	Region / Regurations
NJR4267F2A1	24.15 to 24.25 GHz (F2 type)	1x1 type (Angle: 80°/110°, Distance: 20m)	JAPAN/ MIC Technical Conformity ARIB STD-T73
NJR4267F2B1		2x1 type (Angle: 84°/66°, Distance: 30m)	All of EU regions / *note
NJR4267F3A1	24.075 to 24.175 GHz (F3 type)	1x1 type (Angle: 80°/110°, Distance:20m)	US /*note
NJR4267F3B1		2x1 type (Angle: 84°/66°, Distance: 30m)	

*Note) Please contact our sales department for the status of certification in each country.

2 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings

Item	Specs			Unit	Remarks
	Min	Typ	Max		
Supply Voltage	0	—	6.0	V	
Multimode output pin Source current	—	—	15	mA	
Multimode output pin Sink current	—	—	20	mA	
UART RX pin input voltage	-0.3	—	Min(7.3, Vdd+4.0)	V	
AIN pin input voltage	-0.3	—	Min(4.0, Vdd+0.4)	V	
Each I/O pin injection current	-5	—	0	mA	If a voltage outside the specifications is applied to the pins
Operating temperature	-30	—	+85	°C	
Storage temperature	-40	—	+85	°C	

3 Electrical Characteristics

Common measurement conditions Ta= +25 °C

Table 3 Electrical Characteristics 1

Items	Specs			Unit	Remarks
	Min	Typ	Max		
Supply Voltage	3.8	5	5.8	V	
Consumption current (at power supply voltage 5.0V)					
Peak Current	—	75	90	mA	
Average current during normal operation (at digital output/UART output)					
Sampling rate 1kHz	—	1.5	1.8	mA	
Sampling rate 2kHz	—	2.6	3.1	mA	
Sampling rate 4kHz	—	52.5	63.0	mA	
Sampling rate 8kHz	—	53.2	63.9	mA	
Sampling rate 16kHz	—	54.6	65.6	mA	
Average current during normal operation (at PWM output)					
Sampling rate 1kHz	—	6.5	7.8	mA	
Sampling rate 2kHz	—	7.0	8.4	mA	
Sampling rate 4kHz	—	52.7	63.3	mA	
Sampling rate 8kHz	—	53.5	64.2	mA	
Sampling rate 16kHz	—	55.0	66.0	mA	
Current during sleep mode	—	560	728	uA	
Current during deep sleep mode	—	220	280	uA	
Input / Output Pin Characteristics					
AIN pin (AIN: Pin2)					
Input voltage range	0	—	3.3	V	
Connected device impedance	0	—	15	kΩ	
Multi-mode output pin (MMO: Pin3)					
High level output voltage	2	—	3.5	V	At 10mA source current
High level output voltage	2.8	3.3	3.5	V	At 0mA source current
Low level output voltage	0	—	1.3	V	At 10mA sink current
Low level output voltage	0	0	0.4	V	At 0mA sink current
Source current	0	—	10	mA	
Sink current	0	—	10	mA	
UART RX pin (UART RX: Pin4)					
High level input voltage range	2.31	3.3	5.5	V	
Low level input voltage range	-0.1	0	0.99	V	

Table 4 Electrical Characteristics 2

項目	規格			単位	備考
	最小	標準	最大		
RF Circuit Specifications					
Conforming standards*1	Japan / Ordinance Regulating Radio Equipment Article 49-14-11 EU/Radio Equipment Directive (RED)2014/53/EU USA / FCC Part 15.245 Canada / ISED RSS-210 Issue 9, Annex F				
Transmission frequency					
F2 type	24.15	—	24.25	GHz	Construction Design Certification RED 2014/53/EU *1
F3 type	24.075	—	24.175	GHz	FCC Part 15.245*1 ISED RSS-210*1
Output power	2.2	4.4	6.6	mW	Common to all antenna types
E.I.R.P. (reference value)					
A type antenna	7.75	10.13	12.51	dBm	NJR4267FxA1
B type antenna	10.25	12.63	15.01	dBm	NJR4267FxB1
Second harmonic level	—	—	-30	dBm	
Antenna Characteristics					
A type antenna (NJR4267FxA1)					
H-plane half width	—	80	—	deg.	
V plane half width	—	110	—	deg.	
Antenna gain	—	4.32	—	dBi	
B type antenna (NJR4267FxB1)					
H-plane half width	—	84	—	deg.	
V plane half width	—	66	—	deg.	
Antenna gain	—	6.82	—	dBi	

*1: Please contact our sales department for the status of certification acquisition.

4 Interface Specification

4.1 Pinout

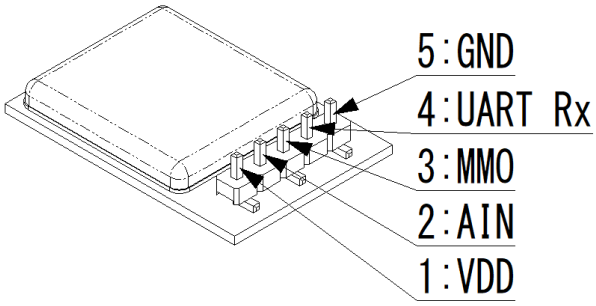


Fig. 1 Pinout Diagram

Table 5 Pinout

#	NAME	I/O	FUNCTION
1	VDD	—	Power supply
2	AIN	I	Analog input sensitivity setting
3	MMO	O	Multimode output
4	UART RX	I	UART reception (5V tolerant)
5	GND	—	GND

If the AIN pin (Pin2) is not used, connect it to GND.
If UART RX (Pin 4) is not used, apply High level voltage (2.31V to 5.5V). At that time, it is recommended to insert a pull-up resistor of about 10kΩ to protect the pin from fluctuations in the power supply voltage.

4.2 AIN Pin Specification

The detection sensitivity can be changed by applying a voltage to this terminal.
If you do not use this pin and want to set the detection sensitivity using UART commands, connect this pin to GND.
Refer to 3 Electrical Characteristics for the electrical specifications of the AIN pin.
For detailed functions of the AIN pin, refer to 9.4 Analog Sensitivity Setting Function.

4.3 MMO Pin Specification

The detection result can be output from the MMO pin.
There are 3 output modes, which can be selected by UART command.
Refer to 3 Electrical Characteristics for the electrical specifications of the MMO pin.
For detailed functions of the MMO pin, see 9.2 Multimode Output (MMO) Pin.

4.4 UART RX Pin Specification

This product can be set for operation from an external controller through the UART interface.
Also, by setting the MMO pin mode to UART TX, it is possible to read the detection state and setting values.
This product can receive UART commands regardless of the running mode or MMO pin mode settings.
This pin is a 5V tolerant pin and can be directly connected to a 5V MCU.
In addition, the UART receiver of this product has an 8-byte FIFO buffer.

4.4.1 Communication Parameters

This communication parameter is common for UART reception and transmission.

Table 6　UART Communication Parameters

Item	Specifications/standards	Unit	Remarks
UART communication parameters			
Baud rate	115200	bps	
Data bit length	8	bit	
Stop bit	1	bit	
Parity	None	—	
Handshake	None	—	
Bit logic	Idle High	—	
Bit order	LSB First	—	

4.4.2 Error Detection

This product detects various errors when receiving UART communication.

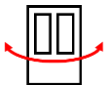
Table 7　List of UART error detection items

Item	Remarks
Noise error	A noise error is detected when the UART receiver samples the center of the start bit with a value of "1". A noise error is detected for each byte received. The data (1 byte) in which a noise error is detected is discarded. If an address byte has already been received, the received address byte is also discarded.
Framing error	A framing error is detected if the stop bit is not detected at the expected timing, such as when the baud rate is incorrect. Framing errors are detected for each byte received. Data (1 byte) for which a framing error is detected is discarded. If an address byte has already been received, the received address byte is also discarded.
Overrun error	An overrun error is detected when data is received and discarded when the internal 8-byte FIFO buffer is full. An overrun error is detected for each byte received. If an address byte has already been received, the received address byte is discarded.

Syntax error	A syntax error is detected when an incorrect communication syntax, unusable address, or unconfigurable parameter is received. Syntax errors are detected when a parameter byte (MSB:0) is received. Data (address byte and parameter byte) for which a syntax error is detected is discarded. The conditions under which a syntax error is detected are listed below. When any parameter byte is received while the address byte has not been received. When any parameter byte is received while an invalid address byte is received. When an illegal parameter byte is received while a normal address byte is received. Since syntax errors are detected when a parameter byte is received, syntax errors are not detected in the following cases When any of the address bytes (MSB: 1) is received multiple times in a row. In such cases, all bytes other than the last address byte received are discarded.
Noise error	A noise error is detected when the UART receiver samples the center of the start bit with a value of "1". A noise error is detected for each byte received. The data (1 byte) in which a noise error is detected is discarded. If an address byte has already been received, the received address byte is also discarded.

5 Antenna radiation pattern (measured value)

5.1 A Type Antenna



H-plane

V-plane

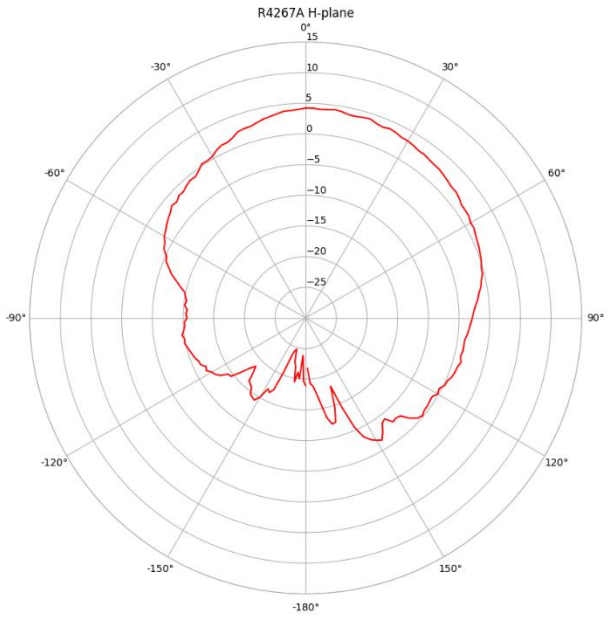


Fig. 3 A-type H-plane radiation pattern

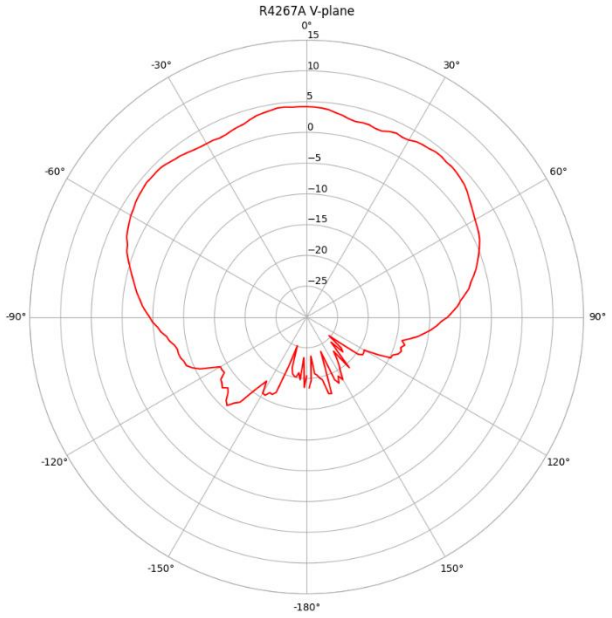
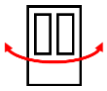


Fig. 2 A-type V-plane radiation pattern

5.2 B Type Antenna



H-plane

V-plane

Fig. 5 B-type H-plane radiation pattern

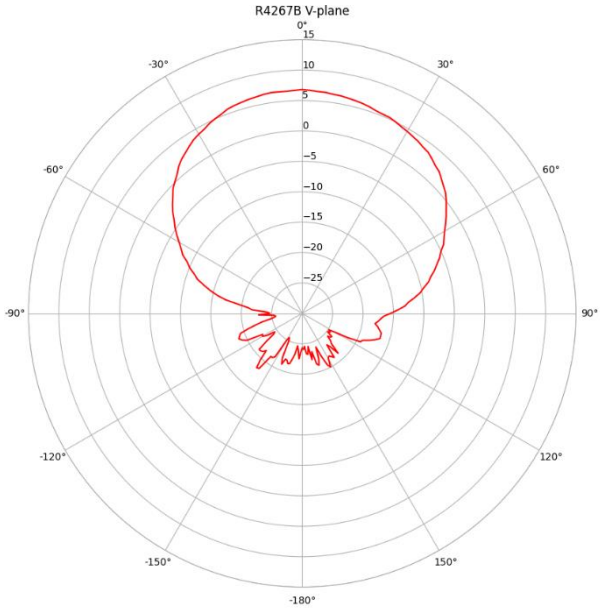


Fig. 4 B-type V-plane radiation pattern

6 Circuit Block Diagram

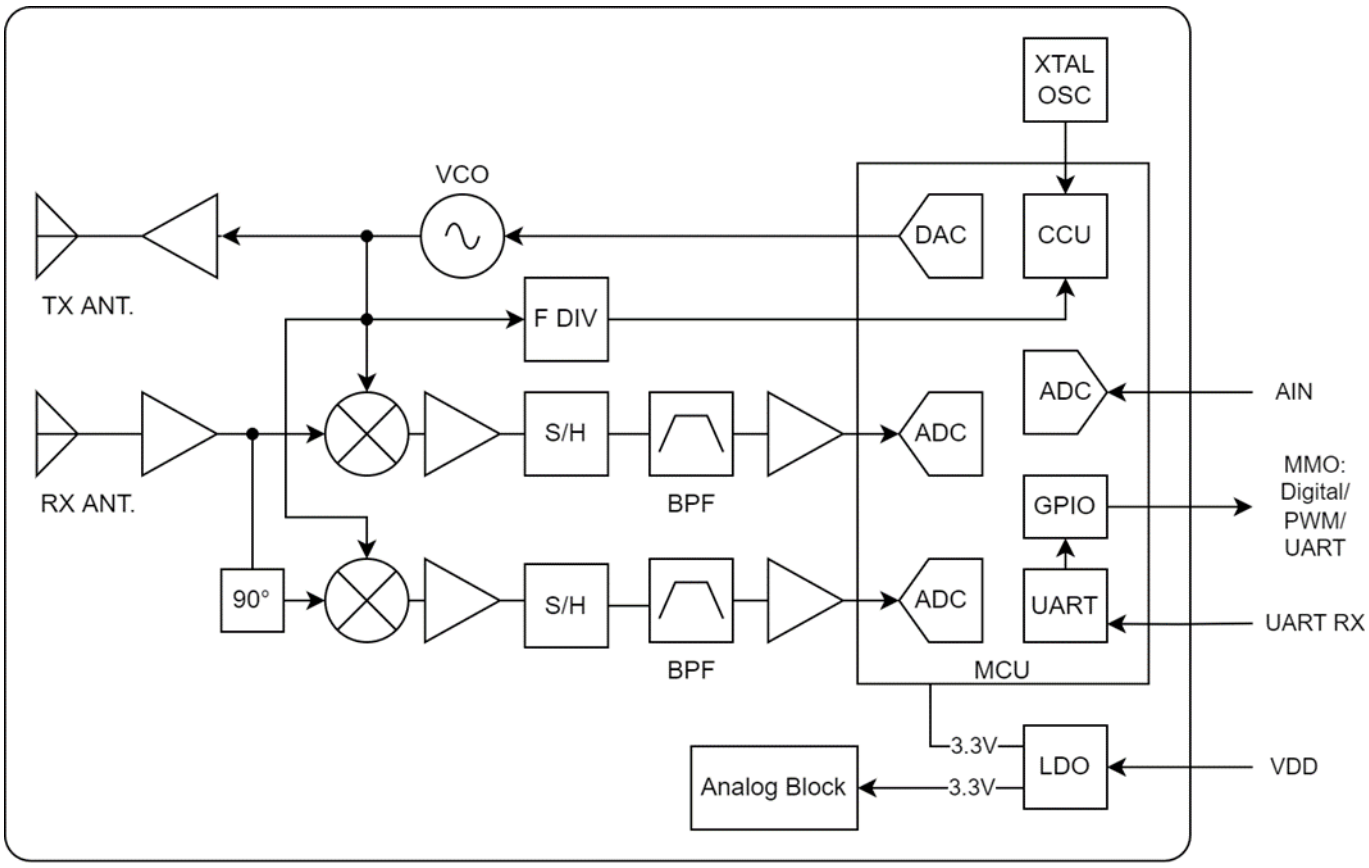


Fig. 6 Circuit Block Diagram

7 RF Timing Diagram

The timing diagram of RF transmission and reception during intermittent operation is shown below.
Ftx stands for intermittent rate. The intermittent rate is automatically determined from the sampling rate.
For details, refer to 9.5 sampling rate variable function.
When intermittent operation is disabled (CW operation), intermittent operation is not performed, so RF transmission/reception is always performed.

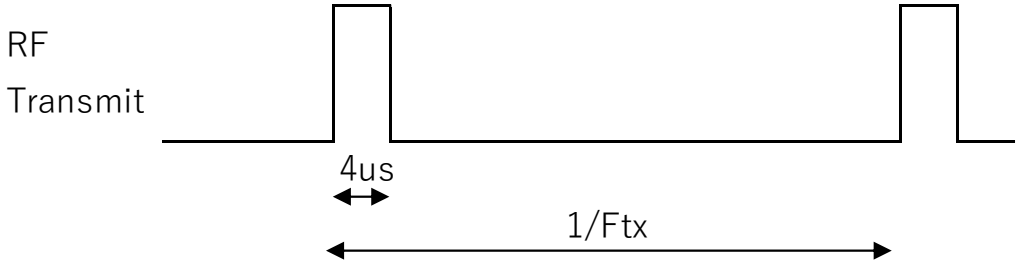


Fig. 7 RF timing diagram

8 Detection Performance (Reference Value)

Common measurement conditions Ta= +25 °C

Table 8 Detection Performance

Item	Reference value	Unit	Remarks
Detectable speed range	0.13 to 19.2	m/s	Common to all antenna types
Maximum detection distance in the front direction (when the detection target is a person)			
NJR4267FxA1	20	m	Actual value
NJR4267FxB1	30	m	Actual value

*1 The performance of this product is specified by electrical characteristics. The detection performance shown here is an example of the detection range when this product is used under the following conditions.
Since the detection performance varies depending on the environment in which it is used and the object to be detected, please check thoroughly in the actual usage environment.

Detection distance measurement conditions

Measured temperature: Ta = +25 °C

Detection object and movement: A person with a height of 170 cm and a weight of 70 kg approaches the sensor at 0.5 m/s

Sensor settings:

・MMO mode: UART
・Analog sensitivity setting: Disabled
・Proximity sensitivity: 100%
・Auto sampling rate mode: Enabled
・Target speed: 1.55m/s

Sensor installation: Place the H-plane of the antenna horizontally at a height of 1m from the ground to the center of the sensor.

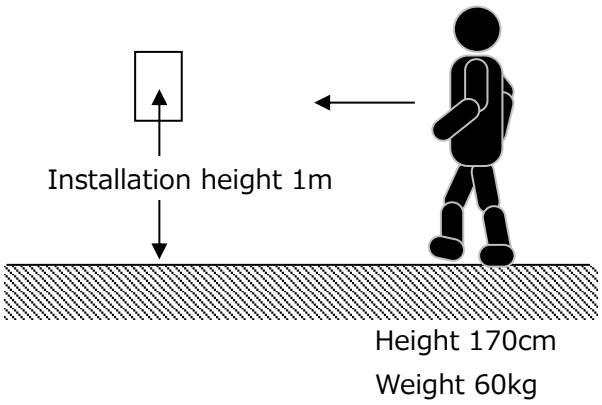


Fig. 8 Detection distance measurement condition 1

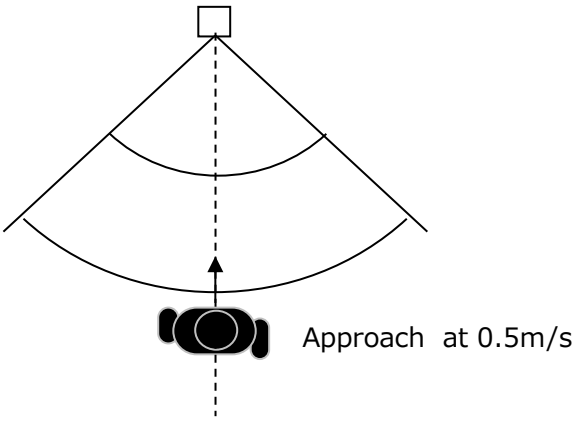
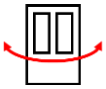


Fig. 9 Detection distance measurement condition 2

8.1 Detection area diagram (reference value)

The detection area below is an estimate of the detection area calculated from the radiation pattern of the antenna and the measured detection distance of pedestrians in front of the sensor.
Since the detection performance varies depending on the environment in which it is used and the object to be detected, please check thoroughly in the actual usage environment.

8.1.1 A Type Antenna



H-plane

V-plane

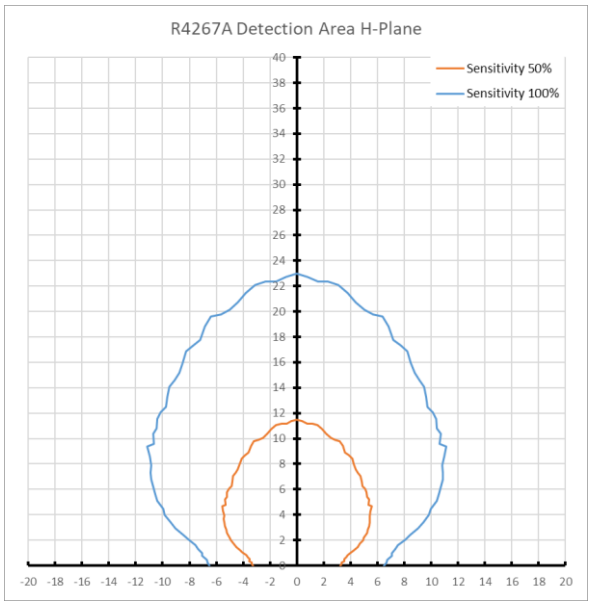


Fig. 10 A type H plane detection area

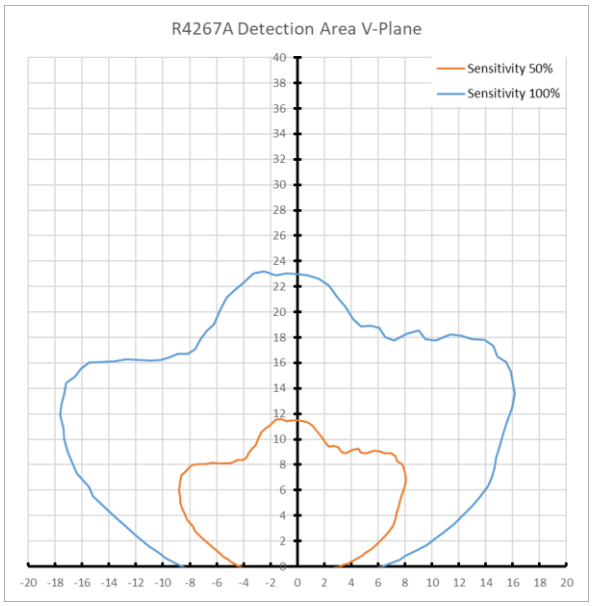
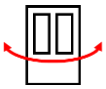
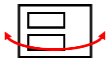


Fig. 11 A type V plane detection area

8.1.2 B Type Antenna



H -plane



V-plane

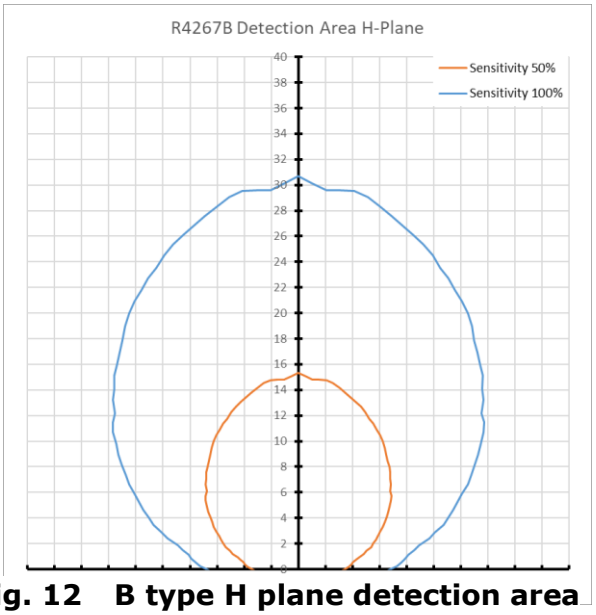


Fig. 12 B type H plane detection area

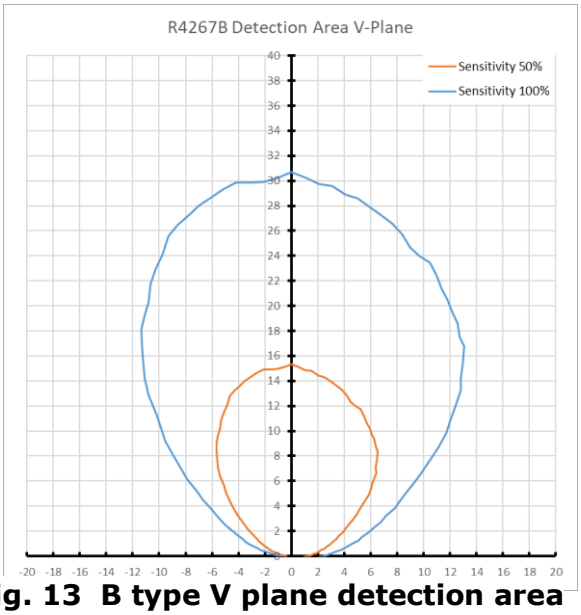


Fig. 13 B type V plane detection area

9 Function

9.1 Motion Detection

This product is a Doppler sensor module that detects moving objects using radio waves in the 24 GHz band, and is intended for detecting pedestrians, bicycles, vehicles, etc. Our proprietary signal processing reduces the detection of random and sudden movements, and can identify the moving direction (approaching/leaving) of a moving object.

9.2 Multi-mode Output (MMO) Pin

This product can output the detection result from the multi-mode output pin.
The output mode of the pin has three types of his digital mode / PWM mode / UART mode, and the mode can be selected by sending a UART command to the UART RX pin (Pin4).
The factory default setting is digital mode.

9.2.1 Digital Mode

In this mode, the detection result is output as a high and low digital voltage.
When a moving object is detected, it outputs a high voltage, and when it does not detect a moving object, it outputs a low voltage.
By UART command, it is possible to select the type of motion to be regarded as detection and non-reversal/reversal of detection judgment.
The output flow diagram in digital mode is shown below.

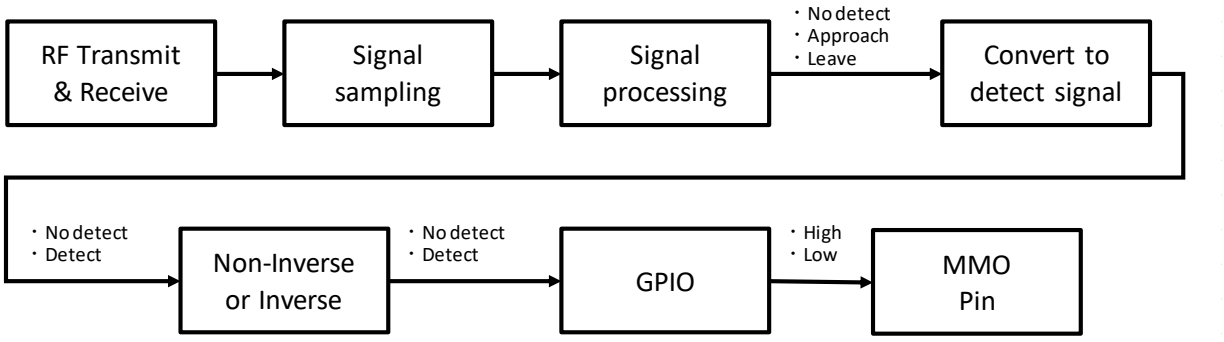


Fig. 14 Digital mode output flow chart

9.2.2 PWM Mode

This mode outputs PWM signals. Applications such as LED lighting control are assumed, and the PWM duty ratio can be varied with the detection signal as a trigger.
The output flow diagram in PWM mode is shown below.

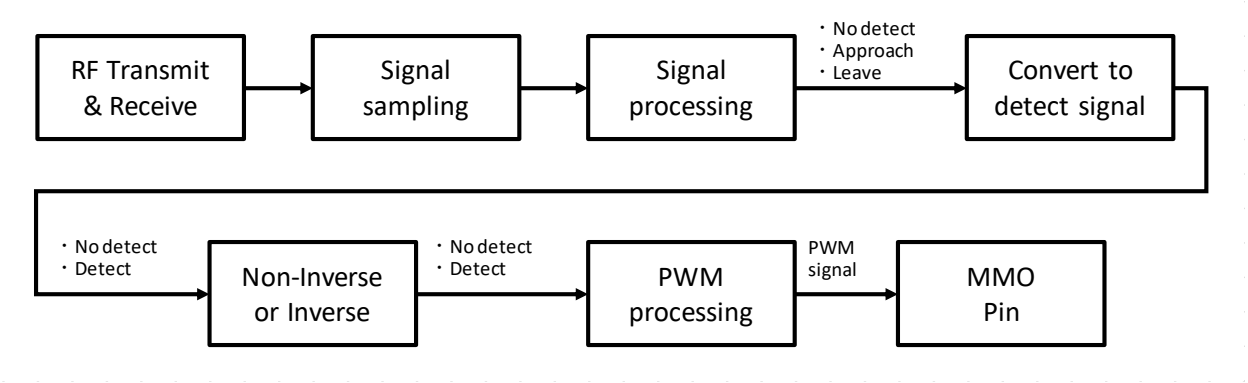


Fig. 15 PWM mode output flow chart

The following PWM parameters can be set by UART commands.

- ・PWM frequency
- ・Duty ratio at non-detection
- ・Duty ratio at detection
- ・Fade-in time
- ・Fade-out time
- ・Detection hold time

As an example, the figure below shows the transition of the duty ratio when the non-detection duty ratio is 5%, the detection duty ratio is 90%, the fade-in time is 1000 ms, the fade-out time is 4000 ms, and the detection hold time is 10 seconds.

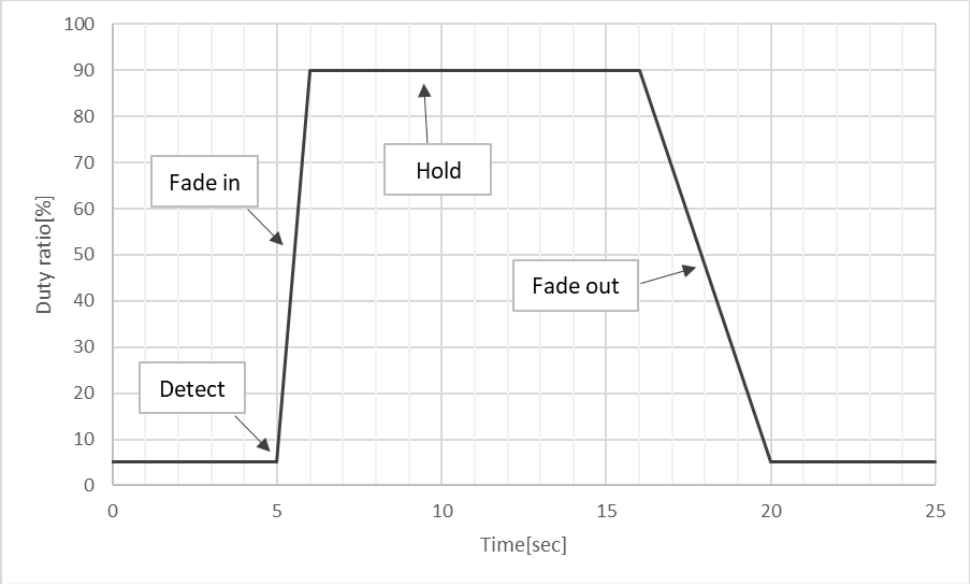


Fig. 16 Transition example of PWM mode duty ratio

9.2.3 UART Mode

Reading of detection status, reading of set values, and reading of operating status can be performed through the UART interface.

For communication specifications, see 4.4 UART RX pin specifications.

For details of communication commands, refer to 12 Communication Command Specifications.

9.3 Running mode

This product has three runing modes including two sleep modes, and the runing mode can be changed by UART commands.

The features of each mode are shown below. Refer to 3 Electrical Characteristics for current consumption in each mode.

The default setting is motion detection mode.

9.3.1 Motion Detection Mode

Normal operation mode. It can transmit/receive radio waves and detect moving objects.

9.3.2 Sleep Mode

Low power consumption standby mode. It does not transmit/receive radio waves and does not detect motion.

It takes about 100ms to transition from sleep mode to motion detection mode.

9.3.3 Deep Sleep Mode

In addition to the sleep mode, this mode shuts down the analog power supply inside the product and performs standby with low power consumption. It does not transmit/receive radio waves and does not detect motion.

It takes about 600ms to transition from deep sleep mode to motion detection mode and sleep mode.

9.4 Analog Sensitivity Setting Function

This product is equipped with an analog sensitivity setting pin (Pin 2), and you can set the detection sensitivity by connecting a potentiometer, DAC, etc. and applying an analog voltage. This function can be enabled/disabled by UART command.

It is enabled in the factory default setting.

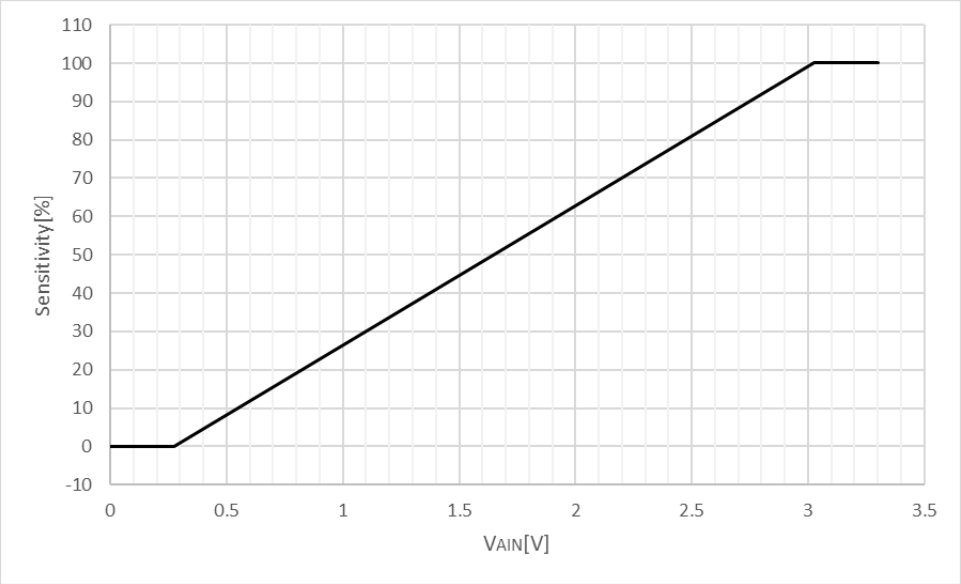


Fig. 17 Sensitivity vs AIN Applied Voltage

$$Sens_{AIN} = ceil\left(\frac{V_{AIN} \times 1.2}{3.3} \times 100 - 10\right) \ , \qquad 0\% \leq Sens_{AIN} \leq 100\%$$

Fig. 18 Analog sensitivity calculation formula

9.5 Sampling Rate Variable Function

This product can change the sampling rate when sampling the Doppler signal obtained by transmitting and receiving radio waves.
Also, the intermittent rate of radio wave transmission is automatically set according to the set sampling rate.
Increasing the sampling rate increases power consumption, but reduces the noise in the signal, reducing the possibility of false positives when the detection sensitivity is increased.
You can also set a higher target speed by increasing the sampling rate.
When the sampling rate is changed, the product's internal signal processing buffer is cleared, forcing non-detection, and the non-detection state continues for a maximum of reaction speed setting value + 160ms.
Sampling rate is recommended to use 9.6 automatic sampling rate control function.
If you are using the automatic sampling rate control feature and are getting false positives, you may be able to reduce false positives by manually setting the sampling rate to a higher value.

Below is a table showing the correspondence between sampling rate setting values and intermittent rates that are automatically set accordingly.

Table 9 Sampling rate and intermittent rate correspondence

Sampling rate setting value	Intermittent rate
1kHz	1kHz
2kHz	2kHz
4kHz	without interruption (CW)
8kHz	without interruption (CW)
16kHz	without interruption (CW)

When setting the sampling rate manually, there are combinations of target speed setting and sampling rate that are not configurable.
The table below shows the target speed setting value and the sampling rate that can be set at that time.

Table 10 Configurable sample rate and target velocity combinations

		Sampling rate setting value				
		1kHz	2kHz	4kHz	8kHz	16kHz
Target speed	0.39m/s	OK	OK	OK	OK	OK
	0.52m/s	OK	OK	OK	OK	OK
	0.77m/s	OK	OK	OK	OK	OK
	1.55m/s	OK	OK	OK	OK	OK
	3.10m/s	—	OK	OK	OK	OK
	6.20m/s	—	—	OK	OK	OK
	12.40m/s	—	—	—	OK	OK
	24.80m/s	—	—	—	—	OK

9.6 Automatic Sampling Rate Control Function

This product has a function to automatically set the sampling rate.

When this function is enabled, the sampling rate is automatically determined according to the set detection sensitivity and target speed setting value.

Unless there is a special reason, it is recommended to enable this function.

It is enabled in the factory default setting.

The table below shows the correspondence between detection sensitivity and target speed settings when automatic sampling rate control is enabled and the sampling rate that is automatically set accordingly. Of the two correspondence tables, the one with the higher sampling rate is applied.

Table 11 Target speed setpoint and automatic sampling rate

Target speed setpoint	Sampling rate
0.39m/s	1kHz
0.52m/s	1kHz
0.77m/s	1kHz
1.55m/s	1kHz
3.10m/s	2kHz
6.20m/s	4kHz
12.40m/s	8kHz
24.80m/s	16kHz

Table 12 Sensitivity settings and automatic sampling rate

Sensitivity settings	Sampling rate
0%～39%	1kHz
40%～54%	2kHz
55%～69%	4kHz
70%～84%	8kHz
85%～100%	16kHz

As an example, if the target speed setting is 3.10m/s and the detection sensitivity setting is 60%, the automatic sampling rate will be 4kHz.
When the analog sensitivity setting function is enabled, a 3% hysteresis is set on the downstream side to prevent frequent sampling rate changes due to noise.
For example, if the analog sensitivity value is changed from 39% to 40%, the sampling rate will be determined as 2 kHz, but if it is changed from 40% to 39%, the sampling rate will be determined as 2 kHz. If it remains and the analog sensitivity value drops to 36%, the sampling rate is determined to be 1 kHz.

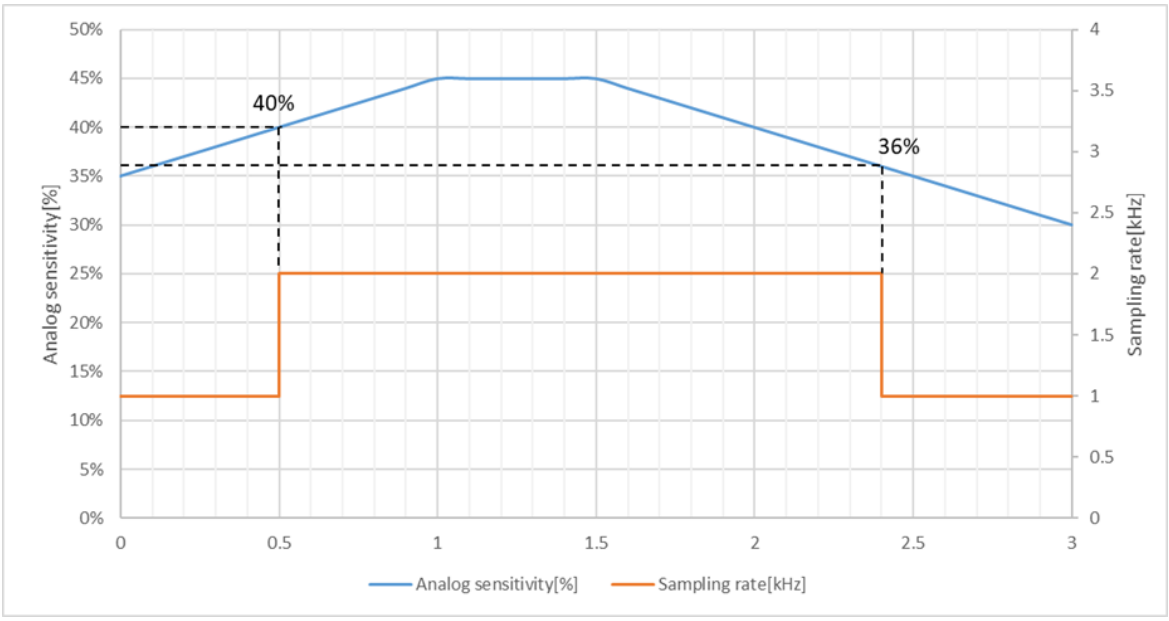


Fig. 19 Hysteresis when sampling rate determination is made from analog sensitivity

9.7 Transmission Channel Change Function

This product can change the transmission channel of radio waves, and when using multiple units at the same time indoors, etc., you can set different channels to reduce the risk of radio interference.
When using multiple units at the same time indoors or when installing multiple units in close proximity, it is recommended to operate with the transmission channel separated by 2CH or more.
The transmission channel can be changed manually, but by enabling the random channel function, a randomly generated channel can be applied when the product starts up.
The random channel function is enabled by default.

Table 13 Transmission channel list

Channel	F2 transmission frequency [GHz]	F3 transmission frequency [GHz]
CH0	24.164	24.089
CH1	24.172	24.097
CH2	24.180	24.105
CH3	24.188	24.113
CH4	24.196	24.121
CH5	24.204	24.129
CH6	24.212	24.137
CH7	24.220	24.145
CH8	24.228	24.153
CH9	24.236	24.161

9.8 Reaction Time Setting Function

When this product detects a moving object, it is possible to set how long the movement must continue for detection.
The reaction time can be set between 16ms and 2048ms in increments of 16ms, and if a moving object is detected for longer than the set reaction time, it will be judged as detected.
By setting the reaction time to an appropriate value, the probability of false positives can be reduced.
The factory default setting is 128ms.

If the response time is reduced to less than 128 ms, false detection may occur depending on the combination of settings such as detection sensitivity, sampling rate, and environmental noise reduction function. Please make the settings above.

For example, if the approach reaction time is set to 128ms and an approaching moving object is detected, if the approaching movement of the moving object continues for 128ms or longer, it will be judged as approach detection. If the moving object's approaching motion stops in less than 128 ms, or if it shifts to moving away, it will not be judged as approach detection.

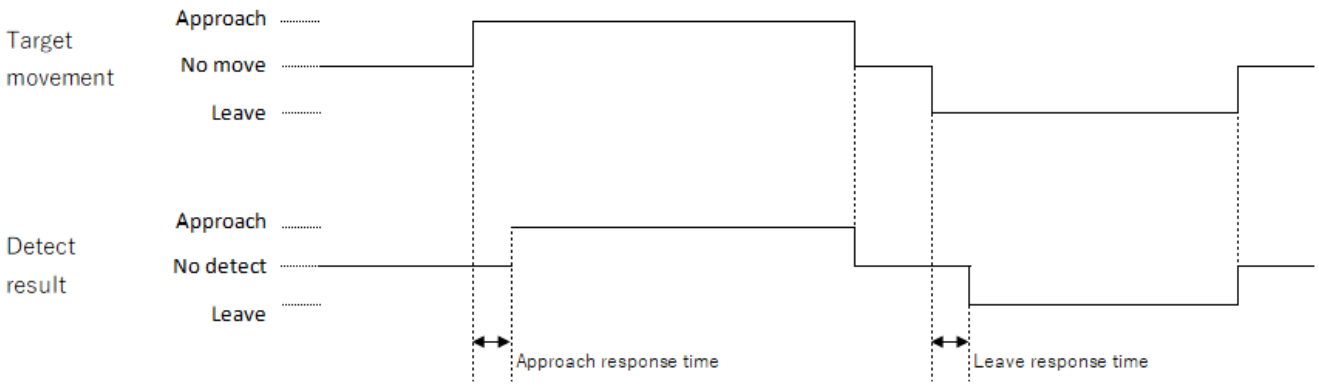


Fig. 20 Detection timing chart

9.9 Target velocity Setting Function

This product can change the characteristics of the filter with respect to speed. With this target velocity setting function, it is possible to set which velocity of the moving object is easier to detect.
If you do not use 9.6 automatic sampling rate control function, there are combinations of target velocity settings and sampling rates that are not configurable.
See Table 10 Configurable Sampling Rate and Target Velocity Combinations for configurable target velocity and sample rate combinations.
The factory default setting is 1.55m/s.

The filter characteristics for signal processing for each target velocity setting are shown below.

A velocity with a negative value for the sensitivity multiplier means that approaching and leaving are reversed and output.
Approach/leave information is unreliable when detecting a moving object with a velocity more than twice the target velocity setting.
Therefore, for applications that require strict approach/leaving information, set a value that is at least half the speed of the moving object that can be detected.
For example, when the target velocity setting value is 1.55m/s, when a moving object moving at 5m/s is detected, the approach/leave information is reversed, but if the target velocity setting value is set to 3.10m/s. approach/ leave information is correctly determined.

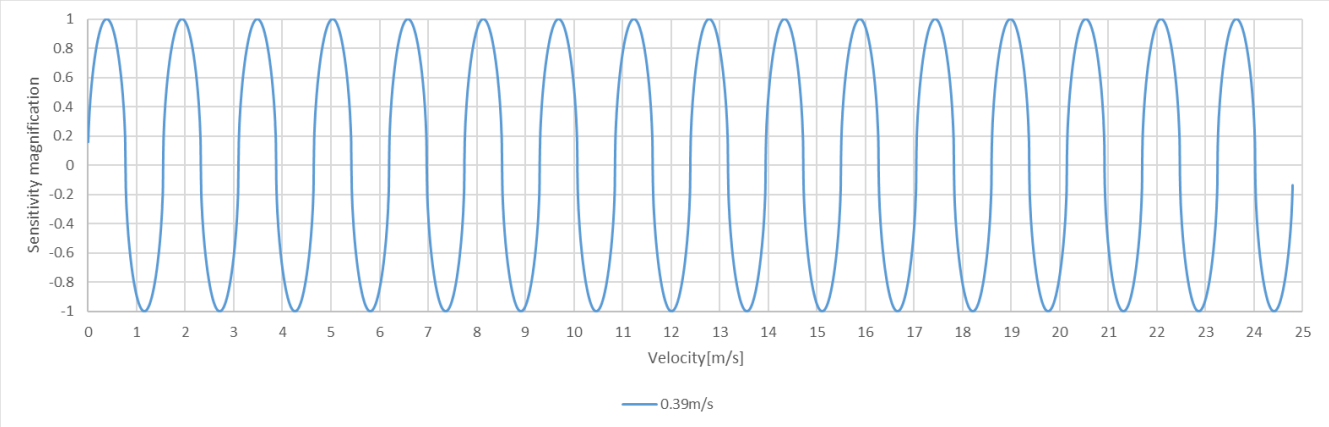


Fig. 21 Velocity filter characteristics (0.39m/s)

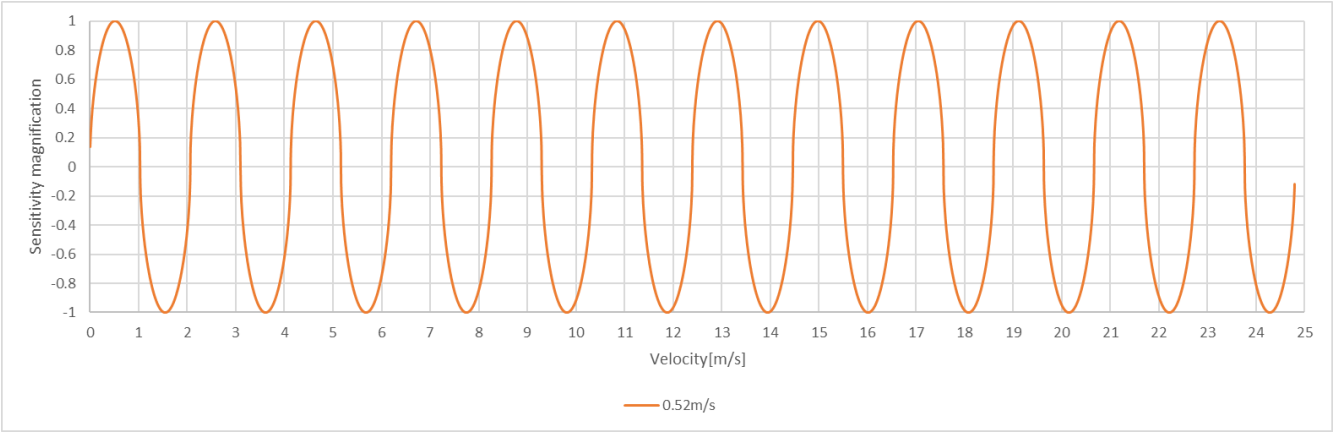


Fig. 22 Velocity filter characteristics (0.52m/s)

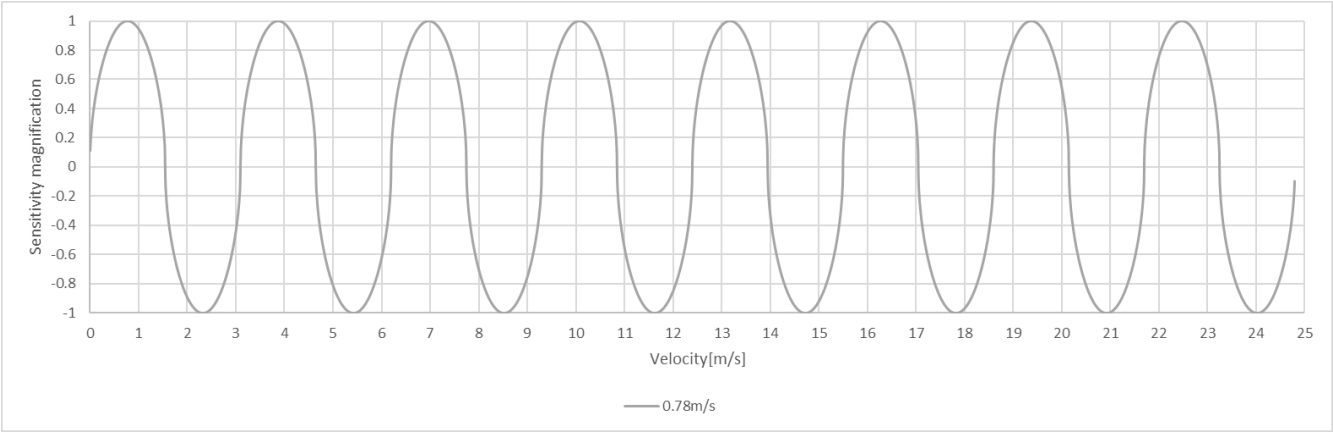


Fig. 23 Velocity filter characteristics (0.78m/s)

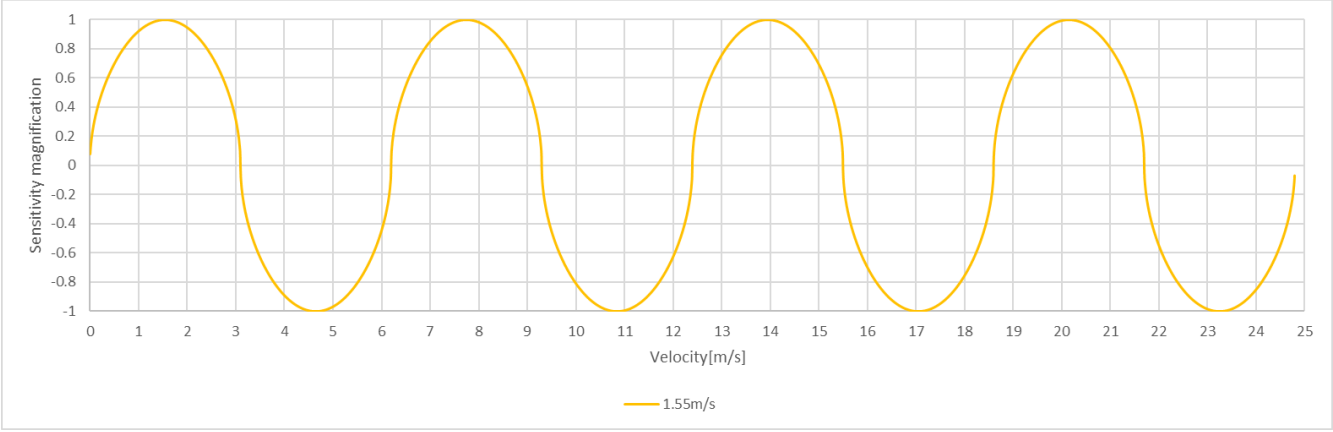


Fig. 24 Velocity filter characteristics (1.55m/s)

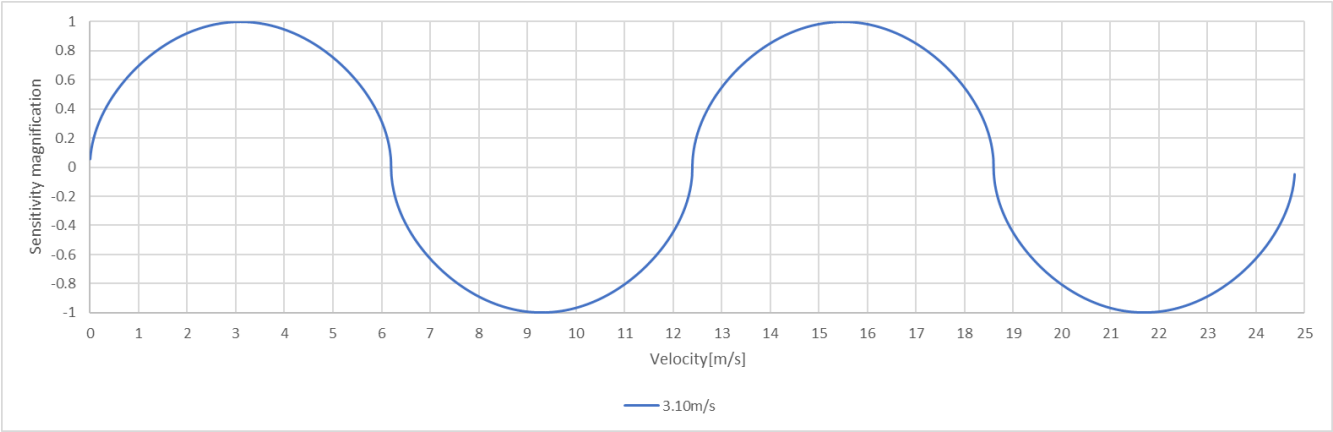


Fig. 25 Velocity filter characteristics (3.10m/s)

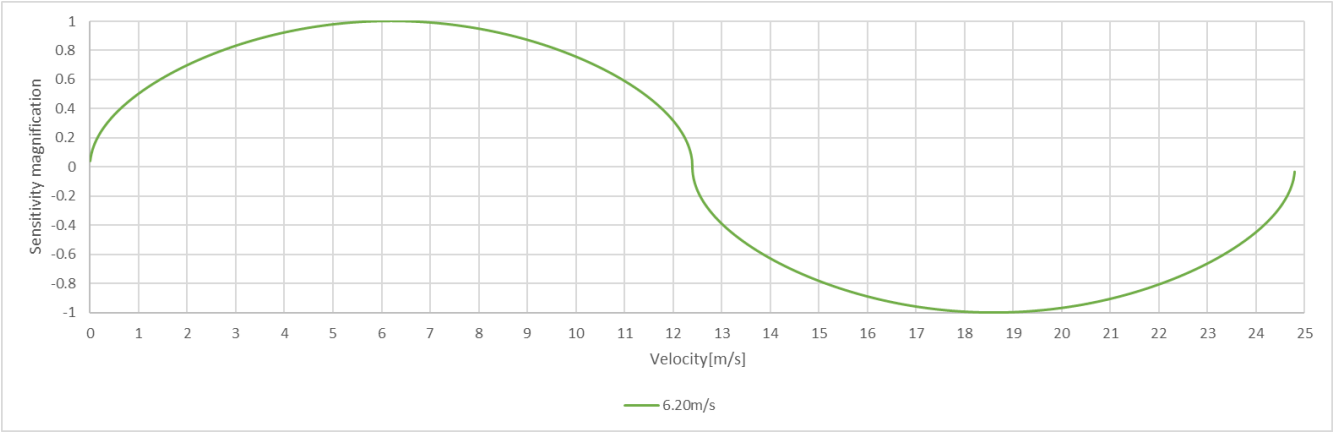


Fig. 26 Velocity filter characteristics (6.20m/s)

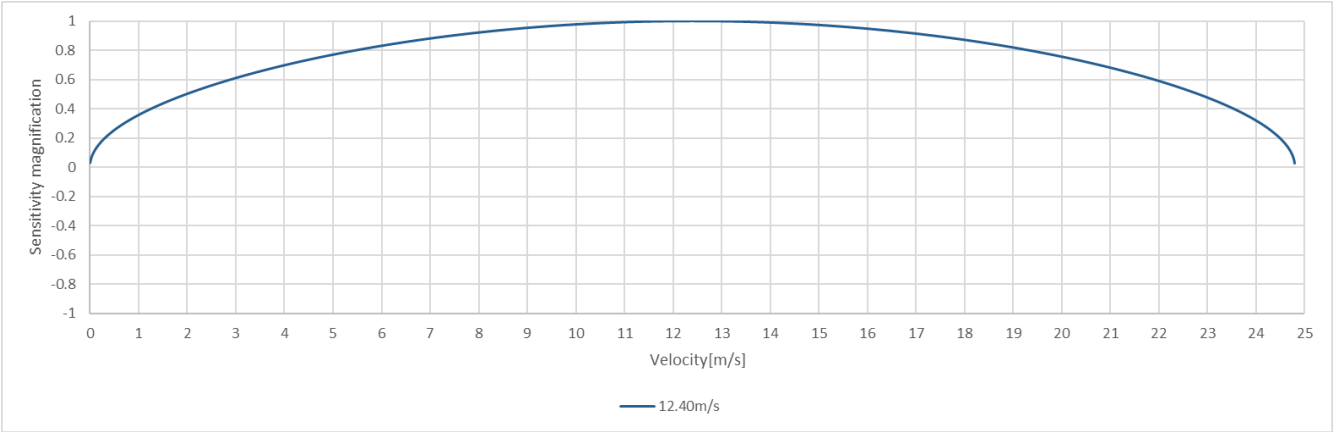


Fig. 27 Velocity filter characteristics (12.40m/s)

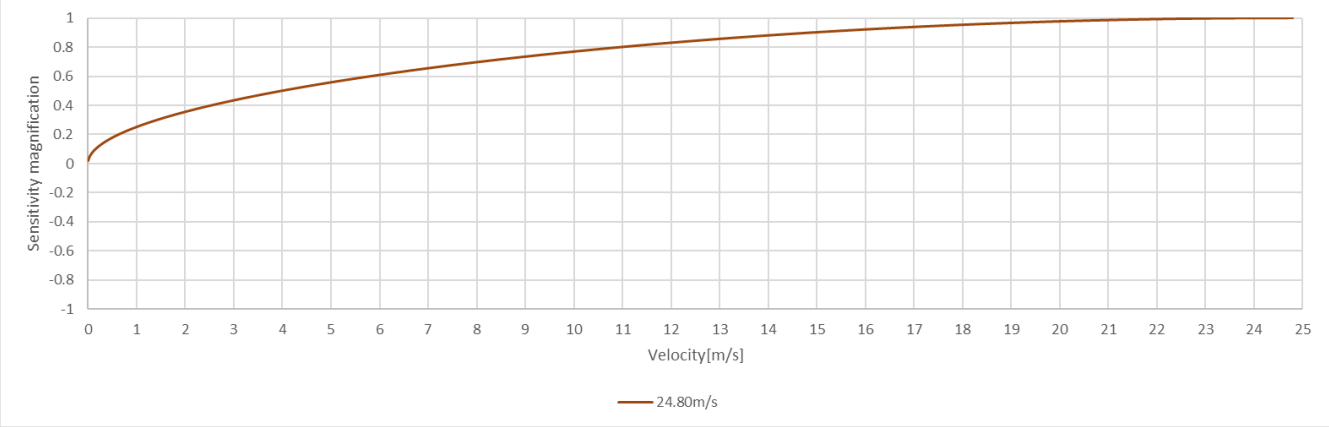


Fig. 28 Velocity filter characteristics (24.80m/s)

9.10 Environmental Noise Reduction Function

Unintended signal components originating from the installation environment are called environmental noise.

This product has high environmental noise elimination performance, but by enabling this function, the probability of false detection of environmental noise can be further reduced.

Examples of ambient noise include:

- ・Wall vibration
- ・Rainfall
- ・Swaying of plants, etc. caused by the wind
- ・Radio interference between sensors

This function can be enabled/disabled by command.

If this function is enabled, the detection sensitivity may decrease.

When this function is enabled, the reaction time will be delayed by an average of 56ms from the set value.

Unless there is a special reason, it is recommended to enable this function.

It is enabled in the factory default setting.

9.11 Set Value Save Function

This product has a function to save the values set by the command to the internal flash memory of the product.

After saving the settings, if you restart or reset the product, it will start up with the saved settings applied.

Setting values can be saved at least 10,000 times when used at room temperature (+25°C).

If the setting values cannot be written or read due to the life of the flash memory, etc., the factory settings will be used at the next reset or startup.

10 Running Mode Transition Diagram

Table 14 Running Mode List

Running mode/state	Explanation
Power ON/Reset	
Initialization mode	Wait for initialization and sensor stabilization time. Exiting the initialization mode takes about 600ms.
Motion detection mode	Motion detection is performed based on various settings.
Sleep mode	Stops radio transmission and suppresses operating current. It takes about 100ms to transition from sleep mode to motion detection mode.
Deep sleep mode	Shuts down power to internal analog blocks to further reduce operating current. It takes about 600ms to transition from deep sleep mode to motion detection mode.

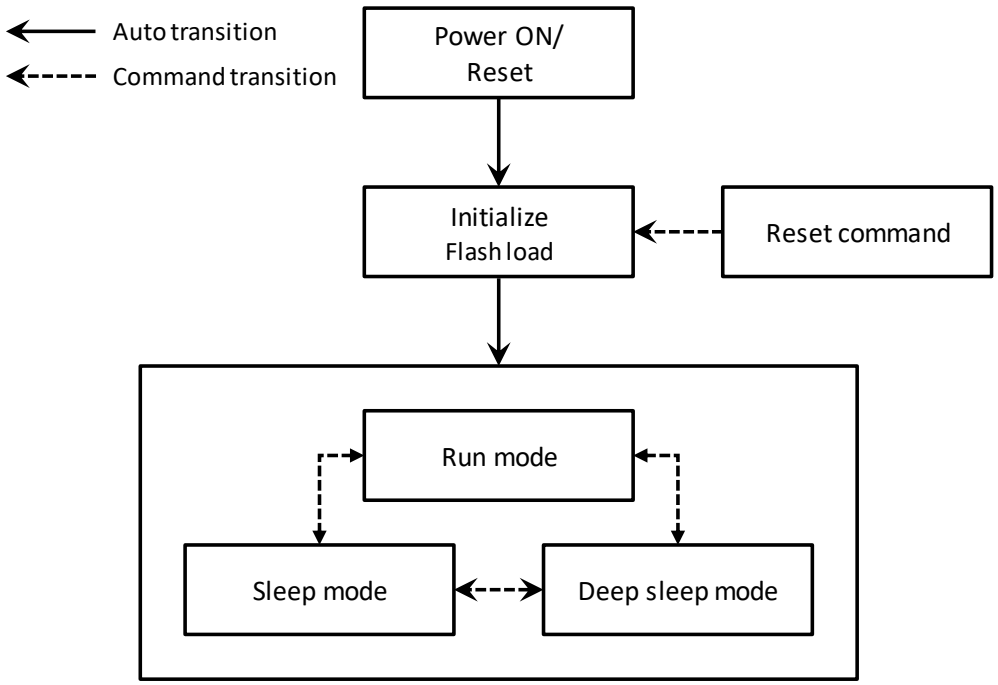


Fig. 29 Running Mode Transition Diagram

11 Application circuit example

An example of a circuit for using this product is shown.

11.1 When using MMO pin mode in Digital/PWM

11.1.1 When adjusting sensitivity with a variable resistor

The MMO pin mode is set to Digital in the factory shipment state, and the AIN pin is enabled, so it can be operated by the following circuit.

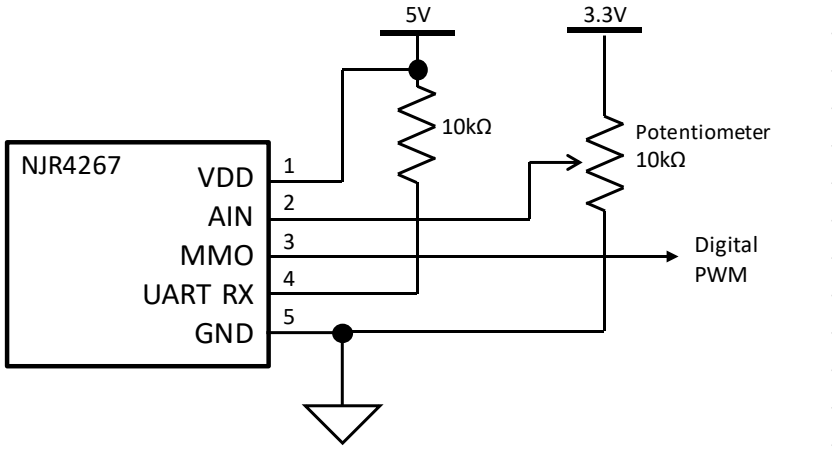


Fig. 30 Application circuit example Digital/PWM mode, variable resistor sensitivity adjustment

11.1.2 When sensitivity is set in advance by UART command

If the sensitivity is set by UART command in advance and the AIN pin is disabled, it can be operated by the circuit below.

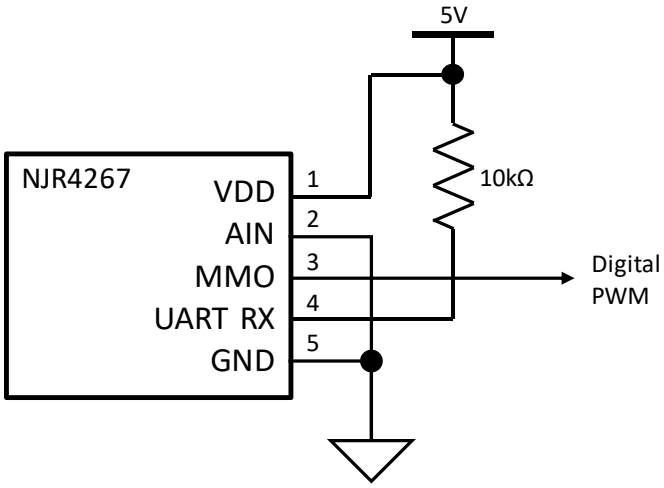


Fig. 31 Application circuit example Digital/PWM mode, AIN not used

11.2 When using MMO pin mode with UART TX

11.2.1 When connecting to MCU and adjusting sensitivity with variable resistor

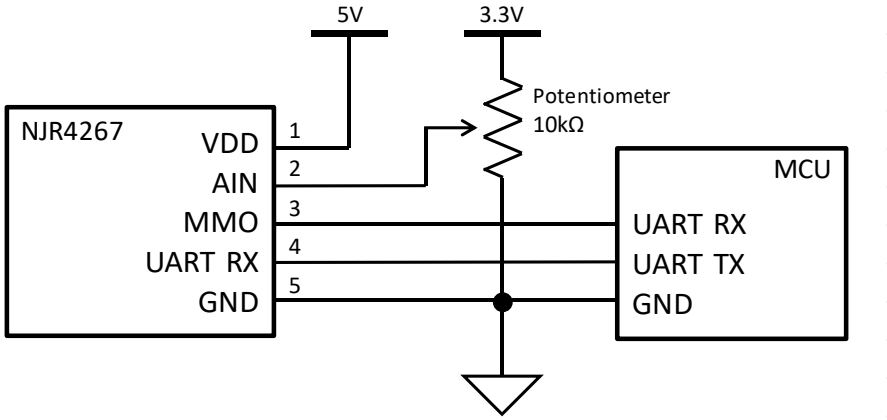


Fig. 32 Aplication circuit example UART TX mode, variable resistor sensitivity adjustment

11.2.2 When connecting to MCU and adjusting sensitivity with commands

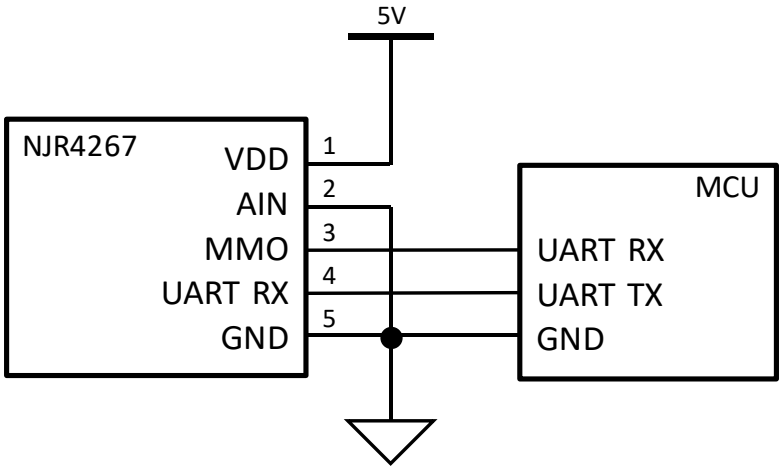


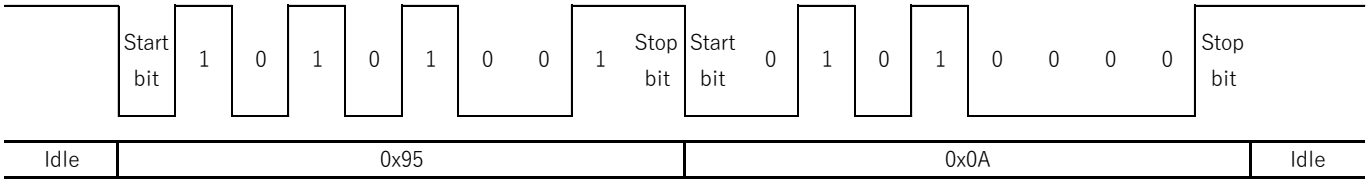
Fig. 33 Application circuit example UART TX mode, AIN not used

12 Communication Command Specifications

12.1 Command Format

The communication command of this product consists of 2 bytes, an address byte and a parameter byte. The MSB of the address byte is always "1" and the MSB of the parameter byte is always "0".
As an example, the write command to change the proximity sensitivity to 10% and the resulting UART communication waveform are shown below.

Send command (10% proximity sensitivity setting)		
Address byte (MSB:1)	Parameter byte (MSB:0)	Address byte + Parameter byte
1 0 0 1 0 1 0 1 0x95	0 0 0 0 1 0 1 0 0x0A	0x950A



12.2 Command Response

When the MMO pin mode is UART mode, a command response is sent when a valid combination of address byte and parameter byte is received.
If no error is detected in the received communication command, the received command is sent as is as the command response.
As an example, the command response when sending a command to change the running mode to sleep mode and no error is detected is shown below.

Command response (Running mode sleep setting)		
Address byte (MSB:1)	Parameter byte (MSB:0)	Address byte + Parameter byte
1 0 0 0 0 0 0 1 0x81	0 0 0 0 0 0 0 1 0x01	0x8101

12.3 Error Response

If an error is detected in the received communication command when the MMO pin mode is UART mode, an error code is sent as a command response. For details on detected errors, see 4.4.2 Error Detection. Error detection is performed each time a byte is received.

See 12.7.33 Error Code for the format of the error response.

As an example, the command response when a framing error is detected is shown below.

Error response (Framing error)																	
Address byte (MSB:1)									Parameter byte (MSB:0)								Address byte + Parameter byte
1	1	1	1	1	1	1	0	0xFE	0	0	0	0	0	1	0	0	0x04	0xFE04

12.4 Parameter read

If the MMO pin mode is UART mode, the current parameters can be read by using the parameter read command. Addresses from which parameters can be read are limited to those with the "R" attribute added in the R/W column of 12.5 Command List.

A parameter can be read by writing the parameter byte of the parameter read command with the MSB of the read destination address set to “0”. The read parameters are sent as command responses.

As an example, when the operation mode is sleep mode, the command to read the operation mode and the command response sent by it are shown below.

Send command (Read operation mode)		
Address byte (MSB:1)	Parameter byte (MSB:0)	Address byte + Parameter byte
1 1 1 1 1 1 1 1 0xFF	0 0 0 0 0 0 0 1 0x01	0xFF01

Command response (Read value)		
Address byte (MSB:1)	Parameter byte (MSB:0)	Address byte + Parameter byte
1 0 0 0 0 0 0 1 0x81	0 0 0 0 0 0 0 1 0x01	0x8101

12.5 Command List

Table 15 Command List

Content	Address byte (MSB:1)	Parameter byte (MSB:0)	R/W
Detection Status	1 0 0 0 0 0 0 0 0x80	0 0 0 0 0 0 X X 0x0X	R
Running Mode	1 0 0 0 0 0 0 1 0x81	0 0 0 0 0 0 X X 0x0X	R/W
MMO Pin Mode	1 0 0 0 0 0 1 1 0x83	0 0 0 0 0 0 X X 0x0X	R/W
Auto Detection Transmit	1 0 0 0 0 1 0 1 0x85	0 0 0 0 0 0 0 X 0x0X	R/W
Analog Sensitivity Setting	1 0 0 1 0 0 0 0 0x90	0 0 0 0 0 0 0 X 0x0X	R/W
Auto Sampling Rate Enable	1 0 0 1 0 0 0 1 0x91	0 0 0 0 0 0 0 X 0x0X	R/W
Random Channel Enable	1 0 0 1 0 0 1 0 0x92	0 0 0 0 0 0 0 X 0x0X	R/W
Approach Sensitivity	1 0 0 1 0 1 0 1 0x95	0 X X X X X X X 0xXX	R/W
Leave Sensitivity	1 0 0 1 0 1 1 0 0x96	0 X X X X X X X 0xXX	R/W
Approach Response Time	1 0 0 1 0 1 1 1 0x97	0 X X X X X X X 0xXX	R/W
Leave Response Time	1 0 0 1 1 0 0 0 0x98	0 X X X X X X X 0xXX	R/W
Target Velocity	1 0 0 1 1 0 0 1 0x99	0 0 X X X X X X 0xXX	R/W
Sampling Rate	1 0 0 1 1 0 1 0 0x9A	0 0 0 0 0 X X X 0x0X	R/W
Environment Noise Filter	1 0 0 1 1 0 1 1 0x9B	0 0 0 0 0 0 0 X 0x0X	R/W
Transmit channel	1 0 0 1 1 1 0 0 0x9C	0 0 0 0 X X X X 0x0X	R/W
Detection Condition for Digital/PWM	1 0 1 0 0 0 0 0 0xA0	0 0 0 0 0 0 X X 0x0X	R/W

Detection Inverse for Digital/PWM	1	0	1	0	0	0	0	1	0xA1	0	0	0	0	0	0	0	X	0x0X	R/W
PWM Frequency	1	0	1	0	0	0	1	1	0xA3	0	0	0	0	X	X	X	X	0x0X	R/W
PWM Duty for No Detection	1	0	1	0	0	1	0	0	0xA4	0	X	X	X	X	X	X	X	0xXX	R/W
PWM Duty for Detection	1	0	1	0	0	1	0	1	0xA5	0	X	X	X	X	X	X	X	0xXX	R/W
Fade in Time U	1	0	1	0	0	1	1	0	0xA6	0	X	X	X	X	X	X	X	0xXX	R/W
Fade in Time L	1	0	1	0	0	1	1	1	0xA7	0	X	X	X	X	X	X	X	0xXX	R/W
Fade out Time U	1	0	1	0	1	0	0	0	0xA8	0	X	X	X	X	X	X	X	0xXX	R/W
Fade out Time L	1	0	1	0	1	0	0	1	0xA9	0	X	X	X	X	X	X	X	0xXX	R/W
Detection Duty Hold Time U	1	0	1	0	1	0	1	0	0xAA	0	X	X	X	X	X	X	X	0xXX	R/W
Detection Duty Hold Time L	1	0	1	0	1	0	1	1	0xAB	0	X	X	X	X	X	X	X	0xXX	R/W
Analog Sensitivity Value	1	0	1	1	0	0	0	0	0xB0	0	X	X	X	X	X	X	X	0xXX	R
Auto Sampling Rate Value	1	0	1	1	0	0	0	0	0xB1	0	0	0	0	0	X	X	X	0x0X	R
Random Channel Value	1	0	1	1	0	0	1	0	0xB2	0	0	0	0	X	X	X	X	0x0X	R
Hardware Type	1	1	0	0	0	0	0	0	0xC0	0	0	0	0	0	X	X	X	0x0X	R
Frequency Type	1	1	0	0	0	0	0	0	0xC1	0	0	0	0	0	X	X	X	0x0X	R
Software Version	1	1	0	0	0	0	1	0	0xC2	0	X	X	X	X	X	X	X	0xXX	R
Parameter Save	1	1	1	1	0	0	0	0	0xF0	0	1	0	1	1	0	1	0	0x5A	W
Parameter Initialize	1	1	1	1	0	0	0	0	0xF1	0	1	0	1	1	0	1	0	0x5A	W
Reset	1	1	1	1	0	0	1	0	0xF2	0	1	0	1	1	0	1	0	0x5A	W
Error Code	1	1	1	1	1	1	1	0	0xFE	0	0	0	0	N	F	O	S	0xXX	-
Parameter Read	1	1	1	1	1	1	1	1	0xFF	0	X	X	X	X	X	X	X	0xXX	W

12.6 Initial Value List

Table 16 Initial Value List

Content	Initial value (HEX)	Initial value
Running Mode	0x00	Running Mode
MMO Pin Mode	0x00	Digital output mode
Auto Detection Transmit	0x00	Auto Detection Transmit Disable
Analog Sensitivity Setting	0x01	Analog Sensitivity Setting Enable
Auto Sampling Rate Enable	0x01	Auto Sampling Rate Enable
Random Channel Enable	0x01	Random Channel Enable
Approach Sensitivity	0x14	Approach Sensitivity20%
Leave Sensitivity	0x14	Leave Sensitivity20%
Approach Response Time	0x07	Approach Response Time128ms

Leave Response Time	0x07	Leave Response Time128ms
Target Velocity	0x03	Target Velocity1.55m/s
Sampling Rate	0x00	Sampling Rate1kHz
Environment Noise Filter	0x01	Environment Noise Filter Enable
Transmit channel	0x05	CH5
Detection Condition for Digital/PWM	0x00	Approach + Leave
Detection Inverse for Digital/PWM	0x00	Non-inverted
PWM frequency	0x04	PWM 5kHz
PWM Duty for No Detection	0x00	PWM 0% for No Detection
PWM Duty for Detection	0x5A	PWM 90% for Detection
Fade in Time U	0x07	1000ms for combination of U and L
Fade in Time L	0x68	
Fade out Time U	0x07	1000ms1000ms for combination of U and L
Fade out Time L	0x68	
Detection Duty Hold Time U	0x00	10s for combination of U and L
Detection Duty Hold Time L	0x0A	

12.7 Command Details

12.7.1 Detection Status

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Detection Status	1	0	0	0	0	0	0	0	0x80	0	0	0	0	0	0	X	X	0x0X	R

Parameter :

-0x00: Non-detection

-0x01: Approach detection

-0x02: Leave detection

Explanation:

The detection status is stored. Only reading is possible.

12.7.2 Running Mode

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Running Mode	1	0	0	0	0	0	0	1	0x81	0	0	0	0	0	0	X	X	0x0X	R/W

Parameter :

-0x00: Motion detection mode

-0x01: Sleep mode

-0x02: Deep sleep mode

Initial value :

-0x00: Motion detection mode

Explanation:

Change the Running mode. See 9.3 Running Modes for details.

12.7.3 MMO Pin Mode

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
MMO Pin Mode	1	0	0	0	0	0	1	1	0x83	0	0	0	0	0	0	X	X	0x0X	R/W

Parameter :

-0x00: Digital mode

-0x01: PWM mode

-0x02: UART mode

Initial value :

-0x00: Digital mode

Explanation:

Change the mode of the MMO pin. For details, see 9.2 Multi-mode Output (MMO) Pin.

12.7.4 Auto Detection Transmit

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Auto Detection Transmit	1	0	0	0	0	1	0	1	0x85	0	0	0	0	0	0	0	X	0x0X	R/W

Parameter :

-0x00: Auto detection transmit disable

-0x01: Auto detection transmit enable

-

Initial value :

-0x00: Auto detection transmit disable

Explanation:

If "Auto detection transmit enable", when the MMO pin mode is UART mode, 12.7.1 Detection status is automatically transmit when the detection status changes.

12.7.5 Analog Sensitivity Setting

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Analog Sensitivity Setting	1	0	0	1	0	0	0	0	0x90	0	0	0	0	0	0	0	X	0x0X	R/W

Parameter :

-0x00: Analog Sensitivity Setting disable

-0x01: Analog Sensitivity Setting enable

Initial value :

-0x01: Analog Sensitivity Setting enable

Explanation:

When "Analog sensitivity setting enabled", the detection sensitivity is set based on the voltage applied to the analog sensitivity setting pin. For details, see 9.4 Analog Sensitivity Setting Function.

12.7.6 Auto Sampling Rate Enable

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Auto Sampling RateEnable	1	0	0	1	0	0	0	1	0x91	0	0	0	0	0	0	0	X	0x0X	R/W

Parameter :

-0x00: Auto Sampling Rate Disable

-0x01: Auto Sampling Rate Enable

Initial value :

-0x01: Auto Sampling Rate Enable

Explanation:

When "Auto Sampling Rate Enable", the sampling rate automatically changes according to the detection sensitivity setting value and target speed setting value.

For details, see 9.5 Sampling rate variable function and 9.6 Automatic sampling rate control function.

When writing "Auto Sampling Rate Disable", if the combination of 12.7.12 Target Velocity and 12.7.13 sampling rate is set to an inapplicable combination, throw a syntax error and do not write the parameter. Refer to Table 10 Configurable sample rate and target velocity combinations that can be set for combinations with settable target speed settings.

12.7.7 Random Channel Enable

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Random Channel Enable	1	0	0	1	0	0	1	0	0x92	0	0	0	0	0	0	0	X	0x0X	R/W

Parameter :

-0x00: Random Channel Disable

-0x01: Random Channel Enable

Initial value :

-0x01: Random Channel Enable

Explanation:

If “Random Channel Enable”, a random channel generated at startup will be applied as the transmission channel.

12.7.8 Approach Sensitivity

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Approach Sensitivity	1	0	0	1	0	1	0	1	0x95	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Approach Sensitivity 0%

-0x01: Approach Sensitivity 1%

-0x02: Approach Sensitivity 2%

⋮

-0x64: Approach Sensitivity 100%

Initial value :

-0x14: Approach Sensitivity 20%

Explanation:

Sensitivity setting value applied when the analog sensitivity setting is disabled. Approach sensitivity and leave sensitivity can be set separately.

12.7.9 Leave Sensitivity

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Leave Sensitivity	1	0	0	1	0	1	1	0	0x96	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Leave Sensitivity 0%

-0x01: Leave Sensitivity 1%

-0x02: Leave Sensitivity 2%

⋮

-0x64: Leave Sensitivity 100%

Initial value :

-0x14: Leave Sensitivity 20%

Explanation:

Sensitivity setting value applied when the analog sensitivity setting is disabled. Approach sensitivity and leave sensitivity can be set separately.

12.7.10 Approach Response Time

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Approach Response Time	1	0	0	1	0	1	1	1	0x97	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Approach Response Time 16ms

-0x01: Approach Response Time 32ms

-0x02: Approach Response Time 48ms

⋮

-0x7F: Approach Response Time 2048ms

Initial value :

-0x07: Approach Response Time 128ms

Explanation:

Set reaction time. Detection occurs when an approaching moving object is detected for the time set here or longer. Please refer to 9.8 Reaction time setting function for details.

12.7.11 Leave Response Time

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Leave Response Time	1	0	0	1	1	0	0	0	0x98	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Leave Response Time 16ms

-0x01: Leave Response Time 32ms

-0x02: Leave Response Time 48ms

⋮

-0x7F: Leave Response Time 2048ms

Initial value :

-0x07: Leave Response Time 128ms

Explanation:

Set reaction time. Detection occurs when an leaving moving object is detected for the time set here or longer. Please refer to 9.8 Reaction time setting function for details.

12.7.12 Target Velocity

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Target Velocity	1	0	0	1	1	0	0	1	0x99	0	0	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Target Velocity 0.39m/s

-0x01: Target Velocity 0.52m/s

-0x02: Target Velocity 0.78m/s

-0x03: Target Velocity 1.55m/s

-0x04: Target Velocity 3.10m/s

-0x05: Target Velocity 6.20m/s

-0x06: Target Velocity 12.40m/s

-0x07: Target Velocity 24.80m/s

Initial value :

-0x03: Target Velocity 1.55m/s

Explanation:

Set the target velocity. Refer to 9.9 Target velocity Setting Function for details.

All parameters from 0x00 to 0x07 can be written when setting the target speed with this command when automatic sample rate control is enabled.

When setting the target speed with this command when automatic sampling rate control is disabled, if the combination with the sampling rate setting value is an inapplicable value, a syntax error will be sent and the parameter will not be written.

Please refer to Table 10 Configurable sample rate and target velocity combinations for combinations with settable sampling rate settings.

12.7.13 Sampling Rate

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Sampling Rate	1	0	0	1	1	0	1	0	0x9A	0	0	0	0	0	X	X	X	0x0X	R/W

Parameter :

-0x00: Sampling Rate1kHz

-0x01: Sampling Rate 2kHz

-0x02: Sampling Rate 4kHz

-0x03: Sampling Rate 8kHz

-0x04: Sampling Rate 16kHz

Initial value :

-0x00: Sampling Rate 1kHz

Explanation:

Sampling rate applied when Auto sampling rate is disabled. For details, refer to 9.5 sampling rate variable function.

When writing parameters with this command when Auto sampling rate is enabled, the parameters can be written even if the combination with the target velocity setting value is an inapplicable value.

When setting the sampling rate with this command when Auto sampling rate is disabled, if the combination with the target velocity setting value is an inapplicable value, a syntax error will be sent and the parameter will not be written.

Refer to Table 10 Configurable sample rate and target velocity combinations for combinations with settable target velocity settings.

12.7.14 Environment Noise Filter

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Environment Noise Filter	1	0	0	1	1	0	1	1	0x9B	0	0	0	0	0	0	0	X	0x0X	R/W

Parameter :

-0x00: Environment Noise Filter Disable

-0x01: Environment Noise Filter Enable

Initial value :

-0x01: Environment Noise Filter Enable

Explanation:

When "environmental noise filter is enabled", the effects of environmental noise are reduced by digital signal processing. For details, see 9.10 Environmental noise reduction function.

12.7.15 Transmit channel

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Transmit channel	1	0	0	1	1	1	0	0	0x9C	0	0	0	0	X	X	X	X	0x0X	R/W

Parameter :

-0x00: CH0

-0x01: CH1

⋮

-0x09: CH9

Initial value :

-0x05: CH5

Explanation:

Radio transmission channel applied when random channel is disabled. Please refer to 9.7 Transmission Channel Change Function for details.

12.7.16 Detection condition for Digital/PWM

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Detection condition for Digital/PWM	1	0	1	0	0	0	0	0	0xA0	0	0	0	0	0	0	X	X	0x0X	R/W

Parameter :

-0x00: Approach + Leave

-0x01: Approach

-0x02: Leave

Initial value :

-0x00: Approach + Leave

Explanation:

When the MMO pin mode is digital mode/PWM mode, you can set which detection state to react to.

12.7.17 Detection Inverse for Digital/PWM

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Detection Inverse for Digital/PWM	1	0	1	0	0	0	0	1	0xA1	0	0	0	0	0	0	0	X	0x0X	R/W

Parameter :

-0x00: Non-Inverse

-0x01: Inverse

Initial value :

-0x00: Non-Inverse

Explanation:

In the case of “Inverse”, when the MMO pin mode is digital mode/PWM mode, the detection state is inversed after the detection operation set in 12.7.16 Detection condition for Digital/PWM is judged.

12.7.18 PWM Frequency

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
PWM Frequency	1	0	1	0	0	0	1	1	0xA3	0	0	0	0	X	X	X	X	0x0X	R/W

Parameter :

-0x00: PWM Frequency 1kHz

-0x01: PWM Frequency 2kHz

⋮

-0x09: PWM Frequency 10kHz

Initial value :

-0x04: PWM Frequency 5kHz

Explanation:

You can set the PWM frequency when the MMO pin is in PWM mode.

12.7.19 PWM Duty for No Detection

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
PWM Duty for No Detection	1	0	1	0	0	1	0	0	0xA4	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Duty ratio 0%

-0x01: Duty ratio 1%

-0x02: Duty ratio 2%

⋮

-0x64: Duty ratio100%

Initial value :

-0x00: Duty ratio 0%

Explanation:

You can set the duty ratio when no moving object is detected. See 9.2.2 PWM mode for details.

12.7.20 PWM Duty for Detection

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
PWM Duty for Detection	1	0	1	0	0	1	0	1	0xA5	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x00: Duty ratio 0%

-0x01: Duty ratio 1%

-0x02: Duty ratio 2%

⋮

-0x64: Duty ratio 100%

Initial value :

-0x5A: Duty ratio 90%

Explanation:

You can set the duty ratio when a moving object is detected. See 9.2.2 PWM mode for details.

12.7.21 Fade in Time

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Fade in Time[ms]U	1	0	1	0	0	1	1	0	0xA6	0	X	X	X	X	X	X	X	0xXX	R/W
Fade in Time[ms]L	1	0	1	0	0	1	1	1	0xA7	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x0000: C 0ms

-0x0001: Fade in Time 1ms

⋮

-0x3FFF: Fade in Time 16383ms

Initial value :

-0x03E8: Fade in Time 1000ms

Explanation:

You can set the time to change the duty ratio when a moving object is detected in units of 1 millisecond. See 9.2.2 PWM mode for details.

Set with 14bit combining fade in time [ms]U and fade in time [ms]L. As an example, when setting the fade in time to 500ms (0x01F4), the command is as follows.

Fade in Time [ms]U : 0x03 (0x01F4 >> 7)

Fade in Time [ms]L : 0x74 (0x01F4 & 0x7F)

12.7.22 Fade out Time

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Fade out Time[ms]U	1	0	1	0	1	0	0	0	0xA8	0	X	X	X	X	X	X	X	0xXX	R/W
Fade out Time[ms]L	1	0	1	0	1	0	0	1	0xA9	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x0000: Fade out Time 0ms

-0x0001: Fade out Time 1ms

⋮

-0x3FFF: Fade out Time 16383ms

Initial value :

-0x03E8: Fade out Time 1000ms

Explanation:

You can set the time to change the duty ratio when the detection holding time has passed after the moving object is no longer detected in units of 1 millisecond. See 9.2.2 PWM mode for details.

Set with 14bit combining fade out time [ms]U and fade out time [ms]L. As an example, when setting the fade out time to 1000ms (0x03E8), the parameters are as follows.

Fade out Time [ms]U : 0x07 (0x03E8 >> 7)

Fade out Time [ms]L : 0x68 (0x03E8 & 0x7F)

12.7.23 Detection Duty Hold Time

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Detection Duty Hold Time[s]U	1	0	1	0	1	0	1	0	0xAA	0	X	X	X	X	X	X	X	0xXX	R/W
Detection Duty Hold Time [s]L	1	0	1	0	1	0	1	1	0xAB	0	X	X	X	X	X	X	X	0xXX	R/W

Parameter :

-0x0000: Detection Duty Hold Time0s

-0x0001: Detection Duty Hold Time1s

⋮

-0x3FFF: Detection Duty Hold Time16383s

Initial value :

-0x000A: Detection Duty Hold Time10s

Explanation:

You can set the time to hold the detection duty after the moving object is no longer detected in units of 1 second. See 9.2.2 PWM mode for details.

Set with 14 bits combining detection hold time [s]U and detection hold time [s]L. As an example, when setting the detection hold time to 100s (0x0064), the parameters are as follows.

Detection hold time[s]U : 0x00 (0x0064 >> 7)

Detection hold time[s]L : 0x64 (0x0064 & 0x7F)

12.7.24 Analog Sensitivity Value

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Analog Sensitivity Value	1	0	1	1	0	0	0	0	0xB0	0	X	X	X	X	X	X	X	0xXX	R

Parameter :

-0x00: Analog Sensitivity Value 0%

-0x01: Analog Sensitivity Value 1%

⋮

-0x64: Analog Sensitivity Value 100%

Explanation:

Stores the sensitivity setting value calculated from the voltage applied to the analog sensitivity setting pin.

When the 12.7.5 analog sensitivity setting is enabled, this value is applied as approach and leave detection sensitivity.

The value is updated even if the analog sensitivity setting is disabled.

This address is read only.

12.7.25 Auto Sampling Rate Value

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Auto Sampling Rate Value	1	0	1	1	0	0	0	0	0xB1	0	0	0	0	0	X	X	X	0x0X	R

Parameter :

-0x00: Sampling Rate 1kHz

-0x01: Sampling Rate 2kHz

-0x02: Sampling Rate 4kHz

-0x03: Sampling Rate 8kHz

-0x04: Sampling Rate 16kHz

Explanation:

See 9.6 Automatic Sampling Rate Control Function for how the automatic sampling rate is determined.

When 12.7.6 auto sampling rate enable, this value is applied as the sampling rate.

The value is updated even if automatic sampling rate control is disabled.

This address is read only.

12.7.26 Random Channel Value

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Random Channel Value	1	0	1	1	0	0	1	0	0xB2	0	0	0	0	X	X	X	X	0x0X	R

Parameter :

-0x00: CH0

-0x01: CH1

⋮

-0x09: CH9

Explanation:

A randomly generated radio transmission channel is stored when the product is started or reset.

This value is randomly generated and changes only when the product is booted or reset.

When 12.7.7 random channel enabled, this value is applied as the radio transmission channel.

The value can be read even if random channel is disabled.

This address is read only.

12.7.27 Hardware Type

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Hardware Type	1	1	0	0	0	0	0	0	0xC0	0	0	0	0	0	X	X	X	0x0X	R

Parameter :

-0x00: Antenna type A

-0x01: Antenna type B

-0x02: Reservation

-0x03: Reservation

-0x04: Reservation

-0x05: Reservation

-0x06: Reservation

-0x07: Reservation

Explanation:

The product's antenna type is stored. This address is read only.

12.7.28 Frequency Type

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Frequency Type	1	1	0	0	0	0	0	0	0xC1	0	0	0	0	0	X	X	X	0x0X	R

Parameter :

-0x00: Reservation

-0x01: Frequency Type F2(for Japan/EU)

-0x02: Frequency Type F3(for North America)

-0x03: Reservation

-0x04: Reservation

-0x05: Reservation

-0x06: Reservation

-0x07: Reservation

Explanation:

Stores the product frequency type.

This address is read only.

12.7.29 Software Version

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Software Version	1	1	0	0	0	0	1	0	0xC2	0	X	X	X	X	X	X	X	0xXX	R

Parameter :

-0x00: Ver0

-0x01: Ver1

⋮

-0x7F: Ver127

Explanation:

Stores the firmware version of the product.

This address is read only.

12.7.30 Parameter Save

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Parameter Save	1	1	1	1	0	0	0	0	0xF0	0	1	0	1	1	0	1	0	0x5A	W

Parameter :

-0x5A: Parameter Save

Explanation:

Saves all setting values with changed parameters to the built-in Flash memory.

If parameters are saved, the product will start with the saved parameters applied at the next start-up or reset.

In 12.5 Command List, settings with "R/W" in the "R/W" column will be saved.

This address is writable only.

The parameter byte should be 0x5A.

12.7.31 Parameter Initialize

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Parameter Initialize	1	1	1	1	0	0	0	0	0xF1	0	1	0	1	1	0	1	0	0x5A	W

Parameter :

-0x5A: Parameter Initialize

Explanation:

Returns the product settings to factory defaults.

Since the internal flash memory will not be initialized or erased after the settings are restored, if the contents of the flash memory also need to be initialized, it is necessary to write the 12.7.30 Parameter save command following this command. .

In 12.5 Command list, settings with "R/W" in the "R/W" column will be initialized.

This address is writable only.

The parameter byte should be 0x5A.

12.7.32 Reset

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Reset	1	1	1	1	0	0	1	0	0xF2	0	1	0	1	1	0	1	0	0x5A	W

Parameter :

-0x5A: Reset

Explanation:

Reset the product.

If the parameters have not been saved, the set parameters will be discarded.

This address is writable only.

The parameter byte should be 0x5A.

12.7.33 Error Code

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Error Code	1	1	1	1	1	1	1	0	0xFE	0	0	0	0	N	F	O	S	0xXX	-

Parameter :

-Parameter byte [3]: Noise error flag

-Parameter byte [2]: Framing error flag

-Parameter byte [1]: Overrun error flag

-Parameter byte [0]: Syntax error flag

Explanation:

When the product receives a command and detects an error, it is sent instead of the command response.

Refer to 4.4.2 Error Detection for details of the error.

This address is neither writable nor readable

12.7.34 Parameter Read

Content	Address byte (MSB:1)									Parameter byte (MSB:0)									R/W
Parameter Read	1	1	1	1	1	1	1	1	0xFF	0	X	X	X	X	X	X	X	0xXX	W

Parameter :

-0x00: 0x80 Address read

-0x01: 0x81 Address read

⋮

-0x7E: 0xFE Address read

-0x7F: Address read

Explanation:

By setting the MSB of the address to be read to "0" and writing it as a parameter byte, the target address and parameter are sent as a command response.

Addresses from which parameters can be read are limited to those with the “R” attribute added in the R/W column of 12.5 Command List.

Refer to 12.4 Parameter Read for details.

When 0x7F is specified in the parameter byte, all addresses with the “R” attribute are read in order starting from 0x80.

If you specify an invalid address or an address without the "R" attribute, a syntax error response will be sent.

By setting the MSB of the address to be read to “0” and writing it as a parameter byte, the target address and parameter are copied.

It is sent as a command response.

When 0x7F is specified in the parameter byte, all addresses with “R” attribute are read in order from 0x80.

If you specify an invalid address or an address without the "R" attribute, a syntax error response will be sent.

13 Outline

13.1 Outline Drawing Antenna Type A/B

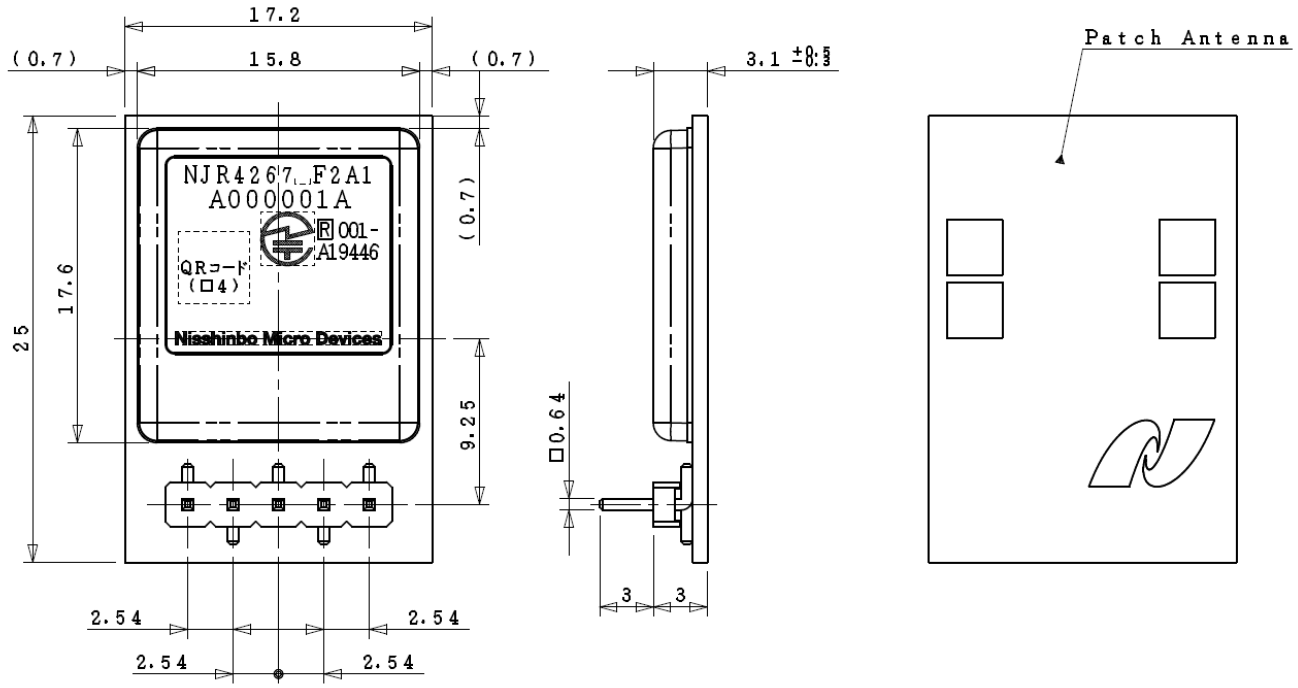


Fig. 34 NJR4267F2A1/B1 Outline drawing

13.2 Label Diagram

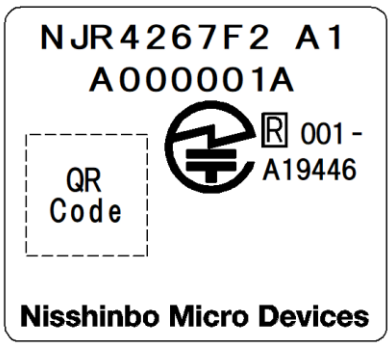


Fig. 35 NJR4267F2 A1 Label diagram

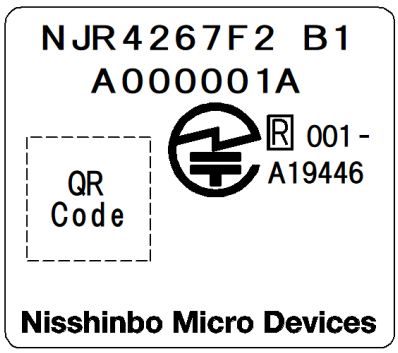


Fig. 36 NJR4267F2 B1 Label diagram

NJR4267F3A1, NJR4267F3B1 :TBD

13.3 Packing Specifications

500 pcs/box tray packing

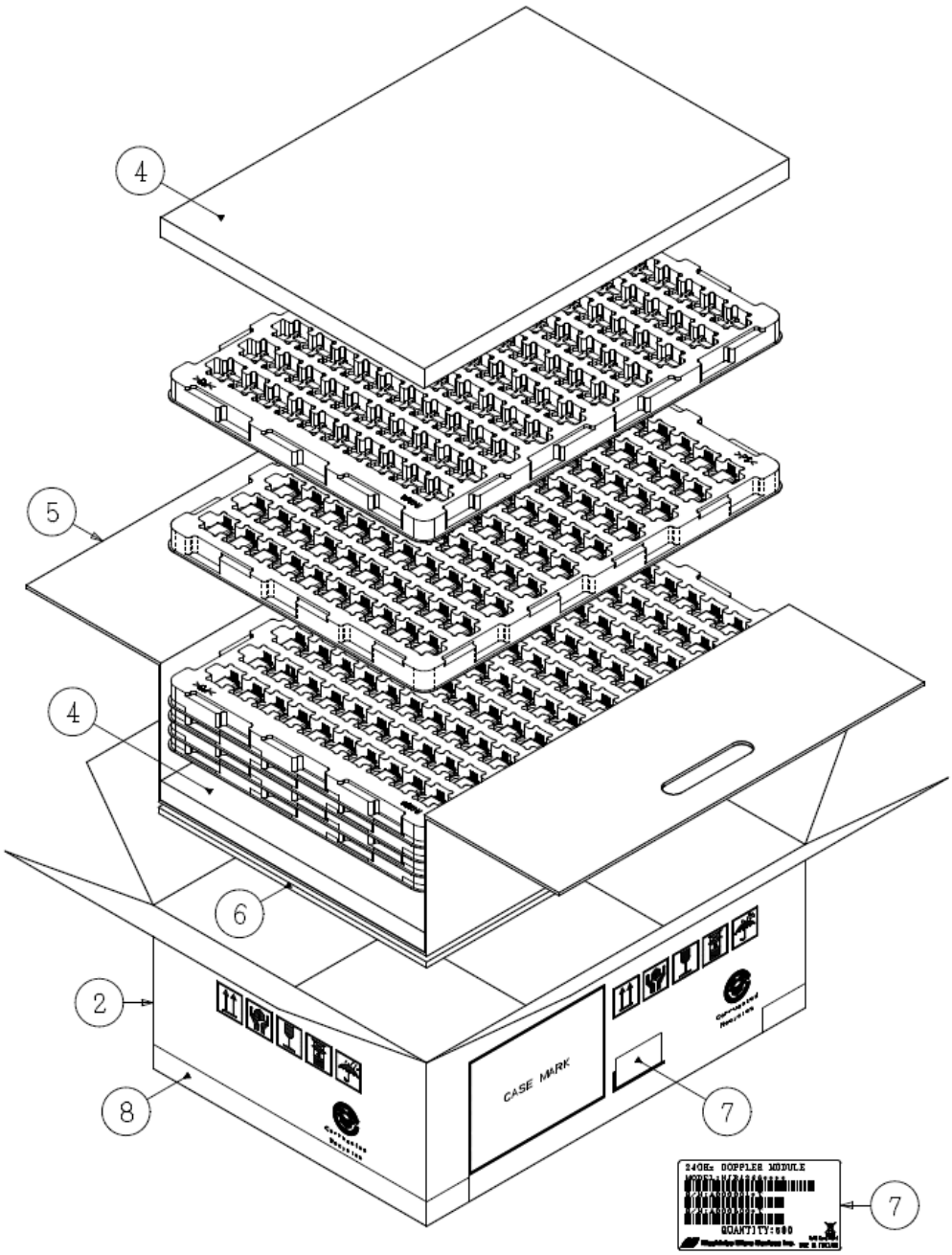


Fig. 37 Packing Diagram

14 Environmental performance

Table 17 Environmental Performance

Item	Specification
Operating temperature	-30 ～ +85°C
Storage temperature	-40 ～ +85°C
Humidity	0 ～ 95%RH @+30°C
Vibration	49.03m/s^2 (5G) Conditions: 30-50Hz, 10 minutes, XYZ axis
Shock	196.13m/s^2 (20G) Half sine, 11 msec, XYZ direction, 3 times

15 Recommended Mounting Conditions

15.1 Circuit Board Design Conditions

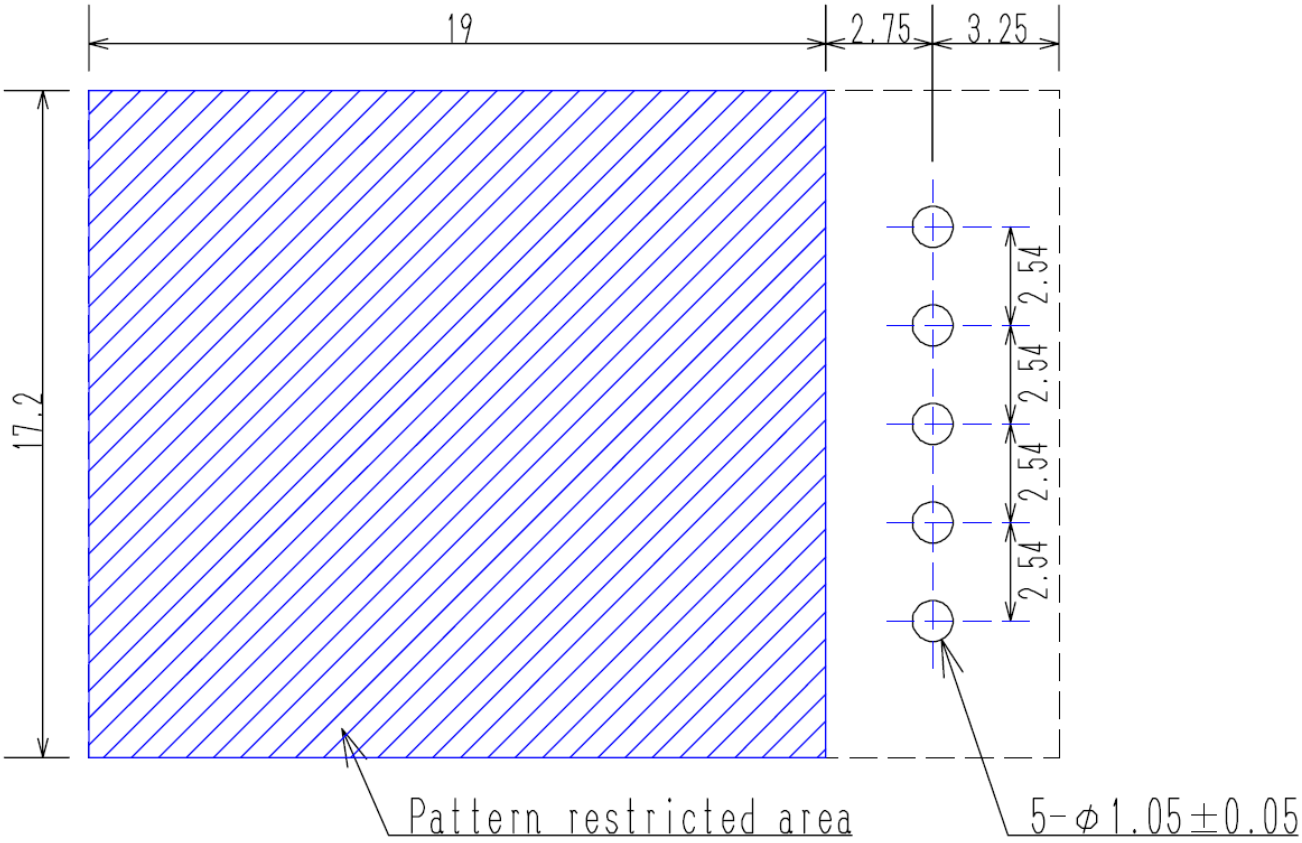


Fig. 38 Circuit Board Design Conditions

Board thickness: 1.6mm or less

*Note) In the actual design, please try to optimize it according to the circuit board design and mounting conditions.

15.2 Solder Mounting Conditions

- Soldering method: Soldering iron *Note
- Tip temperature: 350°C or less
- Time: As per table below

Table 18 List of Solder Mounting Conditions

Pin number	Name	Time condition
1	VDD	Within 3 seconds
2	AIN	Within 3 seconds
3	MMO	Within 3 seconds
4	UART Rx	Within 3 seconds
5	GND	Within 6 seconds

* Note) Ground the soldering iron to be used through a resistance of about 1MΩ.

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<Notes on using this product>

1. We are striving to improve the quality and reliability of our products, but there is a certain probability that microwave products will fail. It is the customer's responsibility to implement safety designs such as fail-safe design, redundant design, fire spread prevention design, malfunction prevention design, etc., and to ensure the safety of the equipment.

2. Please be sure to consult with our sales representative in advance when using this product in the following equipment that requires a particularly high degree of reliability.
   - ・Aerospace equipment
   - ・Submarine equipment
   - ・Power generation control equipment
   (nuclear power, thermal power, hydro power, etc.)
   - ・Medical devices for life support
   - ・Disaster/crime prevention equipment
   - ・Control devices for movable objects (automobiles, airplanes, railroads, ships, etc.)
   - ・Various safety devices

3. The following acts differ from the conditions at the time of application for this product, and are violations of radio wave laws and regulations, and are subject to severe penalties (fines, imprisonment, etc.).
   (1) Opening the product housing and modifying it.
   (2) Removal of product labeling.
   (3) Use this product outside of the power supply standard range and non-modulation.
   (4) In addition, perform construction work for changes based on the Radio Law and related laws.

   If you use this product under different conditions than when we applied for it, please separately obtain a technical standard conformity certification or construction design certification for your system. In addition, if there is such act, the display of this product must be removed as stipulated by the Radio Law.

4. When handling this product, be sure to take measures against static electricity, such as grounding the measuring system and human body. Also, please refrain from using the soldering iron for a long time when soldering the terminals. (Use of reflow oven is not allowed)

5. Please note that applying strong stress to the external shape will affect the local oscillation frequency. Also, please handle the product so as not to apply a shock exceeding the rated value.

6. When using multiple modules in the same area, please consider preventing interference.

7. Please do not use the product under conditions that deviate from the specifications listed in this specification, as this may lead to deterioration or destruction of the product. We are not responsible for any personal injury, disaster, social damage, etc., as a result of using the product under conditions that deviate from the specifications.

8. The contents of this specification are subject to change without notice. Before using the products, it is necessary to exchange delivery specifications.