NJR4652JS2, NJR4652F2S2

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

60GHz Smart Sensor Micro Module Turnkey solution: Smart Entrance Counter

Preliminary

Features

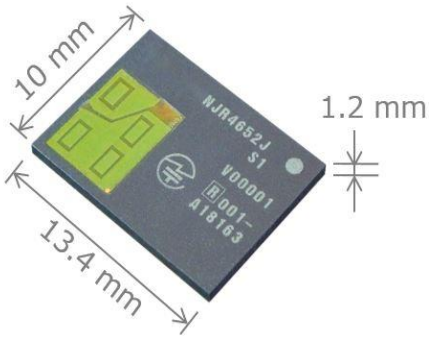
- Smart Entrance Counter sensor by 60GHz millimeter wave
- All-in-one from antenna to signal processing
- IC-like package compatible with SMT
- Low power consumption for intermittent operation 40mA @3.6V
- Application software included (turnkey solution) Presence Detection
- Supports UART/USB/GPIO interfaces
- FOV ±45° in V plane / ±45° in H plane
- Detection Range 0 to 1.6m
  - ●Ceiling-mounted: Maximum height: up to 3m
  - ●Side-mounted: maximum aisle width: up to 3m

Abstract

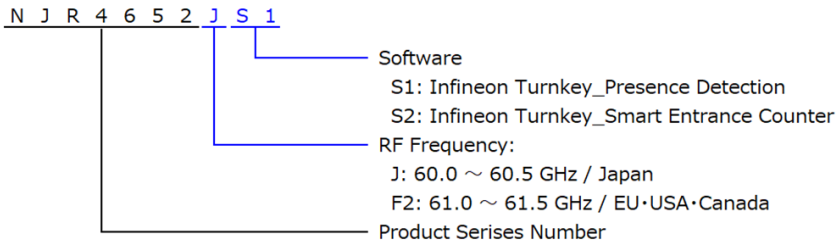
The NJR4652 is one of the world's smallest sensor modules, incorporating an Infineon's 60GHz radar sensor IC and MCU for control and signal processing in an ultra-compact IC-like package measuring 10x13.4x1.2mm. This product, which has multiple antennas, can simultaneously get both distance and position (angle) information to an object with high resolution. The product alone has the technical standards conformity certification available in Japan and FCC certification available in the United States (Note: in this case, the model includes turnkey solution), and does not require additional radio wave certification by the customer. In addition, Infineon's Smart Entrance Counter (this product) and Presence Detection (another product model name: NJR4652JS1, NJR4652F2S1) are available as turnkey solutions to shorten customers' product development time.

Applications

- Passerby count at entrances and exits
- Entry/exit status of meeting rooms, etc.
- Admission control at events
- Monitoring the flow of people at various gates, etc. Other human flow sensors for embedded devices



Product Line-up



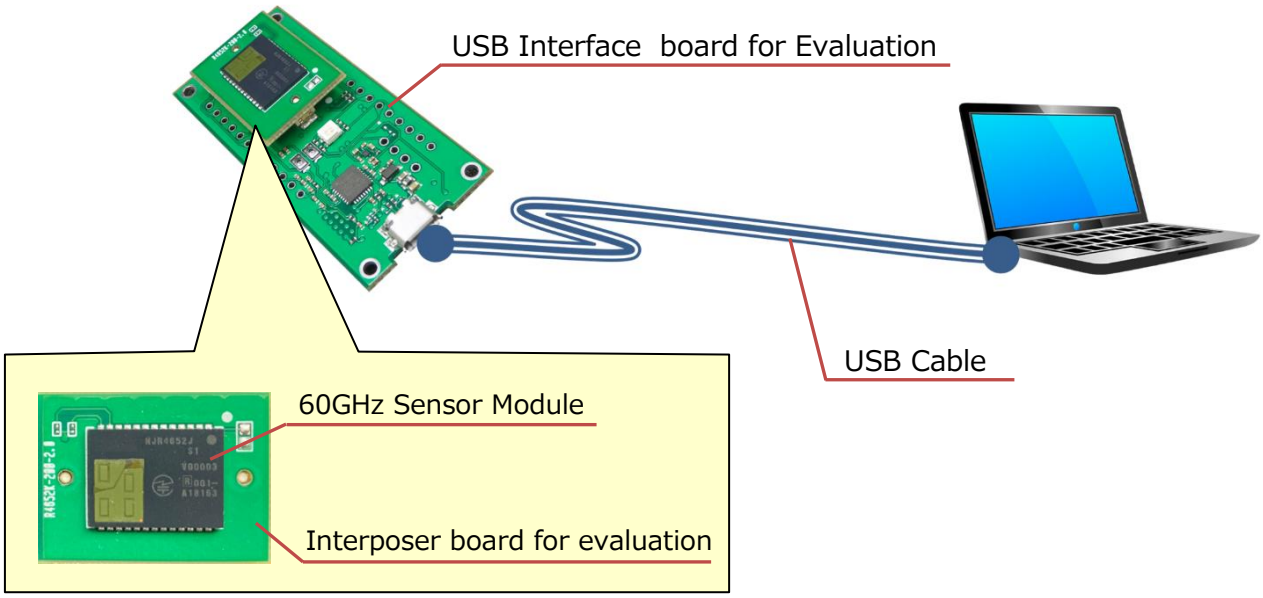
List of product models:

Model No.	RF Frequency	Software	Region / Regurations
NJR4652JS1	60.0 GH ～ 60.5 GHz (J type)	Presence Detection (Turnkey solution)	Japan / Technical conformity[certified]
NJR4652JS2		Smart Entrance Counter (Turnkey solution)	
NJR4652F2S1	61.0 GH ～ 61.5 GHz (F2 type)	Presence Detection (Turnkey solution)	Eu / CE-RE Directive [Compliance] USA / FCC Certification[certified] CAN / ISED certification [uncertified] *Note)
NJR4652F2S2		Smart Entrance Counter (Turnkey solution)	

*Note) Please contact us for the CE marking and FCC&ISED certification status of the product in question.

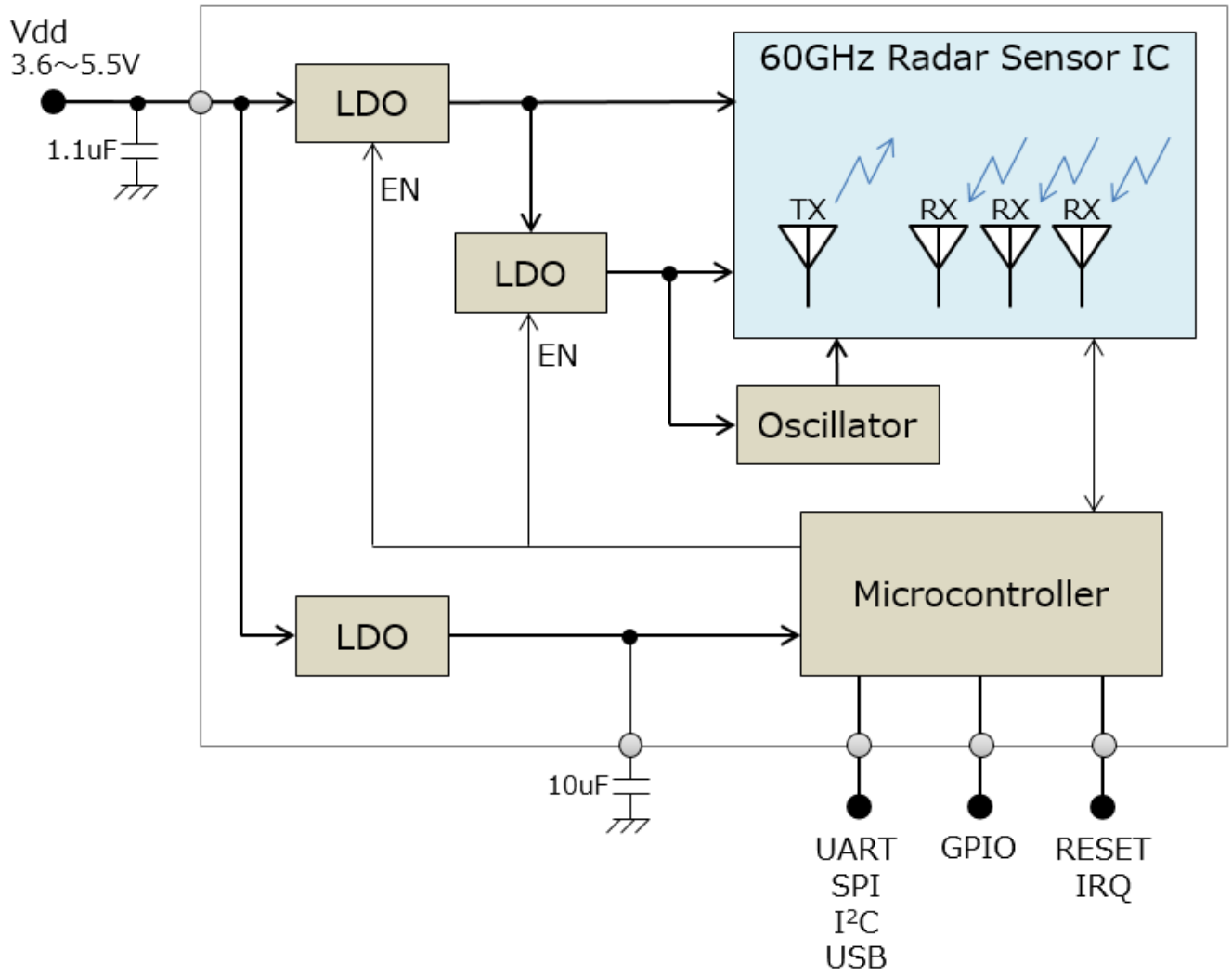
Evaluation Kit:

- Evaluation kits are available for the NJR4652 series. The evaluation kit consists of the following components
- Evaluation Kit Model Name: NJR4652F2S2EV
- Configuration
  1. Evaluation USB interface board (model name: NJR4652K)
  2. Evaluation interposer board (model name: NJR4652F2S2K)
  3. USB cable
  4. GUI application software (download from designated website)



Configuration Diagram of Evaluation Kit

Functional Block Diagram:



1. Absolute Maximum Ratings

Item	Specs			Unit	Remarks
	Min	Typ	Max		
Vdd_IN input voltage	-0.3	—	6.0	V	Vdd_IN pin
MCU_3V3 output voltage	-0.3	—	4.0	V	MCU_3V3 pin
Digital pin input	-0.5	—	3.8	V	
Digital pin current	-25	—	25	mA	
Injection current	-0.5	—	0.5	mA	
Electrostatic discharge (human body model)	2000	—	—	V	
Operating temperature	-20	—	+70	℃	Guaranteed performance temperature range
Storage temperature	-40	—	+85	℃	

2. Electrical Characteristics

Common measurement conditions Ta= +25 °C

Items	Specs			Unit	Remarks
	Min	Typ	Max		
2.1. Power Supply Specifications					
2.1.1. Supply Voltage	3.6	5.0	5.5	V	Vdd_IN
2.1.2. Current					
1) Detect ON(Counter detect ON)					
Average Current	—	40	—	mA	
Peak Current	—	155	185	mA	
2) Detect OFF(Counter detect OFF)					
	—	5	—	mA	
3) RFCW(Fixed frequency) *Note 1					
	—	160	190	mA	
4) Sleep Mode					
	—	TBD	—	mA	

* Note 1: Fixed frequency (no frequency sweep) is available for evaluation purposes. However, the presence detection result will not be output when using this mode. Also, we do not recommend using this mode for any purpose other than evaluation, as it will significantly reduce the product life time.

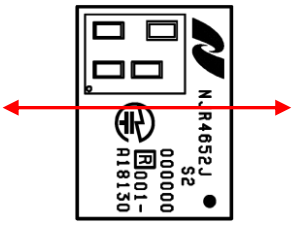
Item	Specs			Units	Remarks
	Min	Typ	Max		
2.2. Input / Output Pin Characteristics					
1）MCU_3V3 pin					
Output Voltage	-2%	3.3	2%	V	
2）Digital pin (GPIO, UART)					
High level output voltage range	MCU_3V3-0.5	—	—	V	Output current=8mA
Low level output voltage range	—	—	0.4	V	Output current=-8mA
High level input voltage range	2.0	—	—	V	UART_RX pin
Low level input voltage range	—	—	0.8	V	
3）Reset pin					
High level input voltage range	0.7xMCU_3v3	—	—	V	4.7 kΩ pull-up resistor built-in
Low level input voltage range	—	—	0.3xMCU_3V3	V	4.7 kΩ pull-up resistor built-in

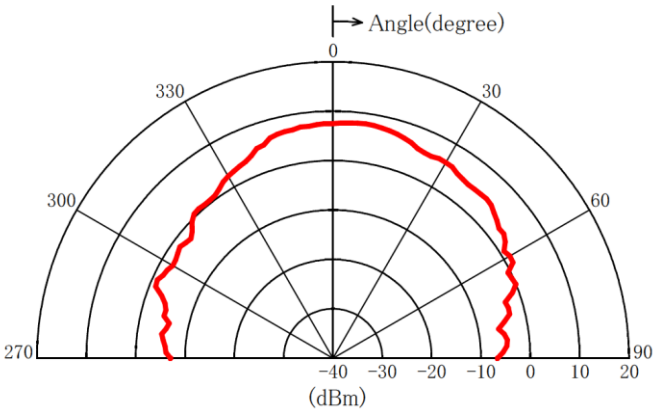
Item	Specs Min	Typ	Max	Unit	Remarks
2.3. RF Circuit Specifications					
Conforming standards	● Japan / Radio Law: Construction Design Certification ● EU / Radio Equipment Directive (RED) ＊Note 1 ● United States / FCC , Canada / ISED *Note 1				
Transmission frequency					
J type (Japan)	60.0	—	60.5	GHz	Construction Design Certification
F2 type (Europe･US･Canada)	61.0	—	61.5	GHz	RED *Note1 FCC *Note 1 ISED *Note 1
Transmission bandwidth	—	480	500	MHz	
Output power	0.54	1.78	2.67	mW	
E.I.R.P. (reference value)	1.6 2.2	5.6 7.5	8.3 9.2	mW dBm	
2nd Harmonic level (E.I.R.P.)	—	—	-30	dBm	
2.4. Antenna Characteristics					
Half width (H-plane)	—	65	—	deg.	
Half width (V-plane)	—	60	—	deg.	

* Note1: Please ask us about conformity to the other overseas standards.

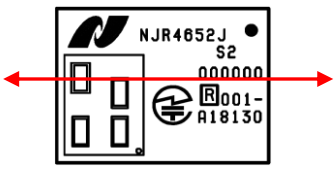
Antenna Pattern

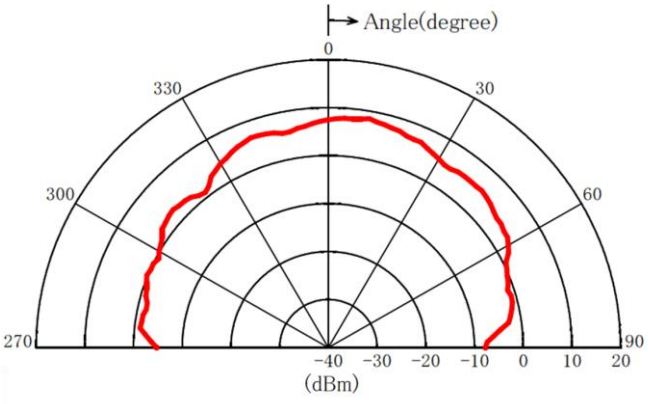
H-plane





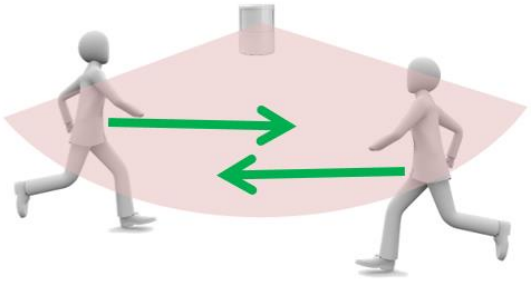
V-plane





3. Detection Performance

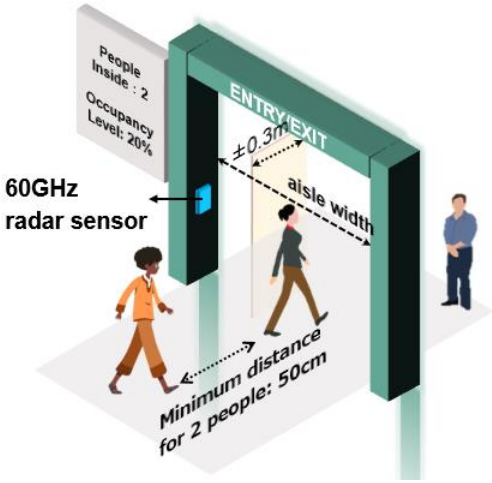
Can detect the frequency of entry and exit at entrances, etc. Since entry and exit can be identified separately, it can be used as a highly functional entrance sensor.



Reference Image Diagram

Two ways to install sensors (selectable via settings)

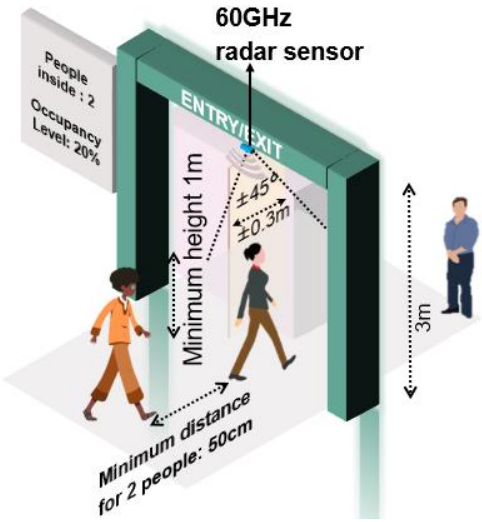
Side Installation



Setting item:
1. Aisle width up to 3m
2. Direction of detection *Note 1)
3. IN/OUT reverse
4. Passage zone
5. Detection sensitivity

Recommended condition:
Sensor height 1m
Horizontal orientation

Ceiling Installation



Setting item:
1. Mounting height Up to 3 m
2. Direction of detection *Note 1)
3. IN/OUT Reverse
4. Passage zone
5. Detection sensitivity
6. Minimum height for detection

Recommended condition:
Center of aisle width
Directly downward

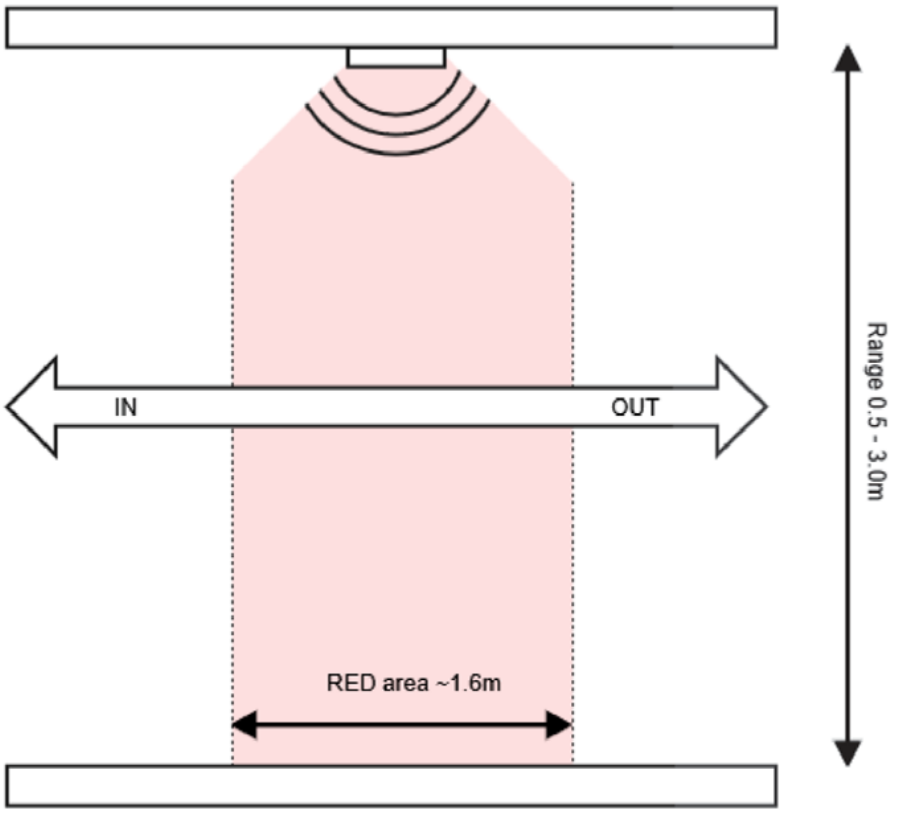
Common Precautions

- Number of people detected at one time: 1 person (multiple people cannot be detected at the same time side by side)
- Distance from the next person: 50 cm or more *For people going in the same direction
- Door condition: Open (Does not open or close when entering or exiting)
- People's movement: Passing straight (do not stop at the entrance or make a sudden turn)
- Movement speed: Walking speed (about 0.5 to 1.0 m/s)

- Support for shopping carts and strollers: Not supported (counted by cart, etc.)

Note 1)
The direction of detection (setting item 6.3.11) should be set according to the vertical and horizontal orientation of the sensor installation and the actual installation situation.
The setting should be appropriate for the actual installation situation.
The other items, including the other settings, may vary depending on the installation method and the surrounding environment. The other items, including the sensor setting, may differ from the detection performance depending on the installation method and the surrounding environment.
Please check the actual environment thoroughly.

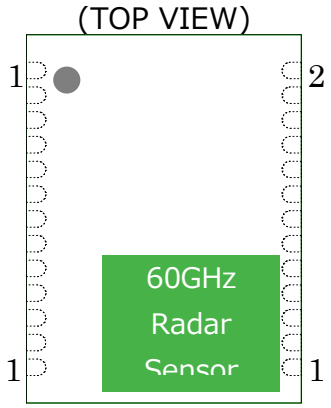
Detection area (common for both side and ceiling installation)



Note: For installation recommendations and field of view (FoV) details, please refer to the instruction manual of the evaluation kit "NJR4652JTK" (function: Smart Entrance Counter) for details on installation recommendations and field of view (FoV).

4. Interface

4.1. Pin assignment



Pin Assignment

#	Pin Name	I/O	Function
1	MCU_3V3	O	3.3V pin for pass-controlled placement for noise rejection purposes Recommended 10uF
2	USBDP_MCU	I/O	MICRO USB2.0 standard
3	USBDM_MCU	I/O	MICRO USB2.0 standard
4	SPI_CLK_CTRL	—	Not supported Open
5	SPI_MOSI_CTRL	—	Not supported Open
6	SPI_MISO_CTRL	—	Not supported Open
7	SPI_CSN_CTRL	—	Not supported Open
8	IRQ_CTRL	—	Not supported Open
9	Reset	I	Soft reset by switch, etc. Normal High, Low reset
10	UART_TX	O	UART TX
11	UART_RX	I	UART RX
12	I2C_SCL	—	Not supported Open
13	I2C_SDA	—	Not supported Open
14	GPIO_7		Not supported Open
15	GPIO_8		Not supported Open
16	GND	—	GND
17	NC		Not supported Open
18	NC		Not supported Open
19	GPIO_0	O	Default Low, when presence is detected, High
20	GPIO_1	O	Default Low, when presence is not detected, High
21	GPIO_2		Not supported Open
22	GPIO_3		Not supported Open
23	GPIO_4		Not supported Open
24	GPIO_5		Not supported Open
25	GPIO_9		Not supported Open
26	Vdd_IN	I	Supply voltage 3.6～5.5 V

4.2 UART Communication Interface Specifications

This product has a built-in microcontroller and can acquire various settings and detection information from an external microcontroller via UART.

Item	Specs	unit	Remarks
UART input level	TTL	—	
UART output level	CMOS		
UART communication parameter			
Baud rate	115200	bps	
Data bit length	8	bit	
Stop bit	1	bit	
Parity	None	—	
Flow control	None	—	
Bit order	LSB first	—	

4.3 USB communication interface specifications

- USB2.0 compliant
- Full-speed (12 Mbps) device interface
- Built-in transceiver

4.4 GPIO communication interface specifications

- Pins 19 and 20 output High or Low depending on detection status. Other pins are not used.

4.5 I2C/SPI communication interface specifications

- Not supported.

5 Operating Mode

5.1 Each operation mode

Operating Mode/ Status Description	Description
Presence detect ON	Normal use (presence detect function is in operation)
Presence detect OFF	
RFCW(fixed frequency)	3 frequencies available for radio wave characteristic evaluation (J type:60.02/60.25/60.48GHz,F2 type:61.02/61.25/61.48GHz)
Sleep mode	RF-IC and MCU go to sleep without detection

5.2 Detection Rise Time

- The time from power-on to the first output of detection results is 500 to 1000 ms.
- The time from detection OFF to the first output after detection ON is TBD ms.
- The time from sleep mode to the first output after detection ON is TBD ms.

Note: The rise time varies depending on the setting of the sensor module. The above values are for reference only.

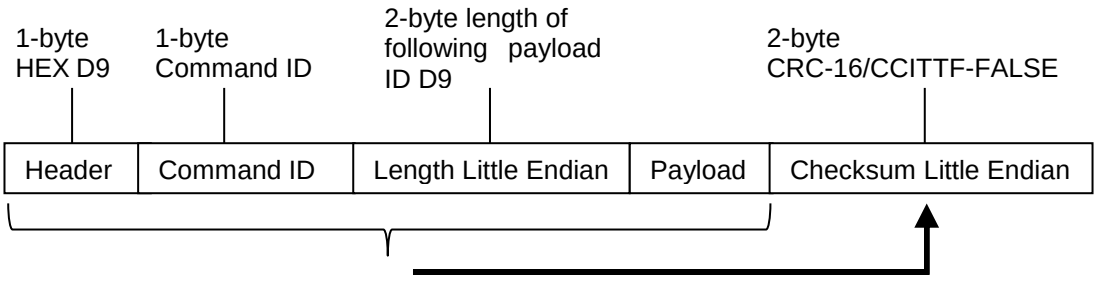
5.3 Operating sequence

1. Initial: GPIO 0 remains high (GPIO 1 is low at this time) when the system is open to traffic (when the number of people can be counted). 2.
2. When a person enters the "detection area": GPIO 1 switches from low to high (GPIO 0 goes from high to low at this time). 3.
3. Person stays in the "detection area": GPIO 1 remains high (GPIO 0 remains low). 4.
4. When the person leaves the "detection area": GPIO 0 returns to the initial state and goes high (GPIO 1 goes low at this time), and the count-up continues.

6 Communication Command

6.1 Command Structure

The structure of a binary command is shown in following diagram. Header is a fixed byte 0xD9.



Checksum: CRC16 of Header + Command ID + Length + Payload, in CRC-16/CCITT-FALSE format
Example of C code implementation of the checksum is shown below.

```
uint16_t crc16(uint8_t *src_data, uint32_t src_data_len) {
  uint16_t crc = 0xFFFF;
  for (int i = 0; i < src_data_len; i++) {
    crc = ((uint8_t)(crc >> 8) | (crc << 8)) ^ src_data[i];
    crc ^= (uint8_t)(crc & 0xFF) >> 4;
    crc ^= (crc << 12);
    crc ^= ((crc & 0xFF) << 5);
  }
  return (crc);
}
```

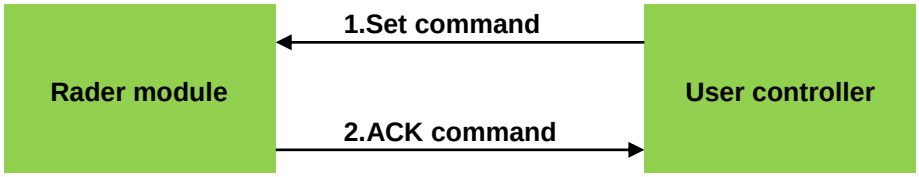
This function will return a 16-bit checksum (in little endian) for the input array.

6.2 Protocol Message Flow

Command messages are being sent back and forth according to the following conditions.

Set Command

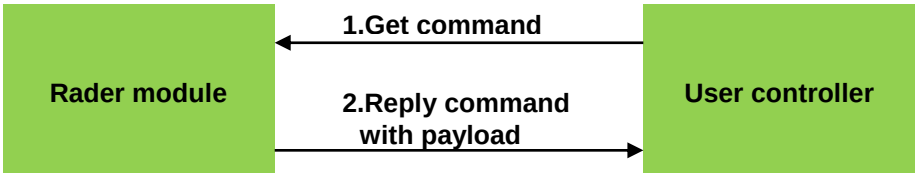
The user sends a set command to the radar module and the module returns with an ACK command whether the set was successful or failed.



Example: Entrance width set to 1.0 m
User Transmission : D9 14 04 00 00 00 80 3F EA 72
Module Response : D9 02 02 00 14 01 3B 94

Get command

The user sends a get command to read a specific status, and the module returns a command with the same command ID and payload. The get command is the same as the set command except that it does not have an internal payload.



Example: Read out the width of an aisle.
User Transmission : D9 14 00 00 17 40
Module Response (Entrance width is 1.0 m) : D9 14 04 00 00 00 80 3F EA 72

Event Command

The module actively sends commands to the user indicating changes in events such as detection or non-detection of presence.

Example : Counter IN event
Time : 436362ms
Type: Detect IN
IN Count : 4
OUT Count : 2
Module Transmission : D9 18 11 00 8A 06 00 00 00 00 00 00 04 00 00 00 02 00 00 00 F4 8B

6.3 Command List

The following commands are supported

6.3.1 Version（0x00）

Packet	Firmware version				
Command type	Get				
Comment	This command is used to get the firmware version of the firmware.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x00	N	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	string	version	Firmware version in string format		

6.3.2 ACK（0x02）

Packet	Acknowledge command				
Command type	Get				
Comment	This command is acknowledgement from radar module.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x02	2	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	ID	Set command ID to be acknowledged		
1	uint8_t	set_result	Set command result 0: fail 1: success 0xFF: unsupported command		

6.3.3 Reset (0x08)

Packet	Reset all configuration to default command				
Command type	Set				
Comment	This command will reset the setting saved in flash to default, and perform a system reset.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x08	0	NA	CRC16

＊float type is IEEE-754 single-precision floating-point number format.

6.3.4 Counter detect enable（0x0A）

Packet	Enable/Disable counter detection				
Command type	Set				
Comment	This command is used to enable/disable counter detection. Make sure to disable RFCW mode before enabling counter detection. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0A	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	status	Counter detection enable status 0: disable 1: enable		

6.3.5 FMCW (0x0B)

Packet	Set the radar to send out RF continuous wave				
Command type	Set				
Comment	This command is used to enable the RF test mode for FCC test. Make sure to disable presence detection before entering this mode.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0B	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	mode	Radar enable status 0: disable RFCW mode 1: RFCW output at 60.02GHz 2: RFCW output at 60.25GHz 3: RFCW output at 60.48GHz 4: RFCW test at 60.02GHz with TX off 5: RFCW test at 60.25GHz with TX off 6: RFCW output at 60.48GHz with TX off		

6.3.6 Radar self test (0x0C)

Packet	Set the system to test radar chip				
Command type	Set				
Comment	This command is used to execute self test on radar chip. Test result can be acquired in ACK command. Self test cover SPI interface checking and RF test utilizing internal test hardware. Make sure to disable presence detection before doing self test. Please also ensure to run the self test in an environment that there is an empty space of 50cm in front of the radar.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0C	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	test_item	Self test item (0 - 4)		

6.3.7 Radar chip temperature (0x0D)

Packet	Temperature in radar chip				
Command type	Get				
Comment	This command is used to get the temperature in radar chip, to check for overheat condition				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0D	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	temperature	Temperature of radar chip, in ℃		

6.3.8 Sleep Mode (0x0E)

Packet	Set module into sleep mode				
Command type	Set				
Comment	This command is used set the module into sleep mode to save power consumption. Module will wakeup when up coming command received. A preamble byte such as 0x00 is needed to add in the next command to have the command correctly received at the module (to compensate wakeup delay time).				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0E	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	sleep_mode	1: deep sleep		

6.3.9 Production Test (0x12)

Set command

Packet	Set the system to do production test				
Command type	Set				
Comment	This command is used to execute production test on radar chip. Test result can be acquired in reply command. Make sure to disable presence detection before doing production test.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x12	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	test_item	Production test item (0 - 8)		

Reply command

Packet	Production test result				
Command type	Get				
Comment	This is the result of production test. Test results are stored in several floating numbers, depending on the test item.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x12	N * 4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	test_result 1	Result 1		
4	float	test_result 2	Result 2		
…	float	test_result X	Result X		

6.3.10 Entrance width（0x14）

Packet	Entrance width of people counter detection				
Command type	Set/Get				
Comment	Valid range is 0.0-3.0. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length	Payload	Checksum
	0xD9	0x14	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	entrance_width	Entrance width, unit is meter		

6.3.11 Detection orientation（0x15）

Packet	Detection orientation of people counter				
Command type	Set/Get				
Comment	Placement orientation of the radar chip. The change will be saved in flash. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x15	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	orientation	0: portrait 1: landscape		

6.3.12 IN/OUT Count（0x16）

Packet	IN/OUT count number of people counter				
Command type	Set/Get				
Comment	Get the current IN/OUT count for the counter. Can use this command to reset count, by setting both numbers to 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x16	8	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint32_t	in_count	IN count		
4	uint32_t	out_count	OUT count		

6.3.13 IN/OUT Reverse（0x17）

Packet	Reverse IN/OUT detection of people counter				
Command type	Set/Get				
Comment	This command is used to set or get the reverse enable state of people counter. The change will be saved in flash. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x17	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	reverse	0: IN/OUT count not reversed 1: IN/OUT count reversed		

6.3.14 Counter Detection Event（0x18）

Packet	Event packet of people counter				
Command type	Event				
Comment	This event command will send out once for a change in counter detection event.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x18	17	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint64_t	event_time	Event time, in ms		
8	uint8_t	event_type	0: IN detected 1: OUT detected 2: Object detected in detection zone 3: No more object detected in detection zone		
9	uint32_t	in_count	IN count		
13	uint32_t	out_count	OUT count		

6.3.15 Position of radar sensor（0x19）

Packet	Set install position of radar sensor				
Command type	Set/Get				
Comment	This command is used to set or get the install position of radar sensor. The change will be saved in flash. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x19	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	install_pos	0: Ceiling mount 1: Door side mount		

6.3.16 Ceiling Height（0x1A）

Packet	Ceiling height setting for ceiling mount mode detection				
Command type	Set/Get				
Comment	Valid range is 0.0-3.0. The change will be saved in flash. Default is 2.5.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x1A	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	ceiling_heig	Ceiling height, unit is meter		

6.3.17 Minimum Person Height Detection（0x1B）

Packet	Minimum person height for ceiling mount mode detection				
Command type	Set/Get				
Comment	Valid range is 0.0-2.0. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x1B	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	min_person_heig	Minimum person height, unit is meter		

6.3.18 Traffic Zone（0x1C）

Packet	Set the zone size which the traffic light will be effective				
Command type	Set/Get				
Comment	Valid range is 0.0-1.0. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x1C	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	traffic_light_zon	Traffic light zone size, unit is meter		

6.3.19 Detection Sensitivity（0x1D）

Packet	Sensitivity of people counter				
Command type	Set/Get				
Comment	Valid range is 0.0-1.0. The change will be saved in flash. Default is 0.5.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x1D	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	counter_sensitivit	Counter sensitivity		

6.3.20 GPIO mode（0x1E）

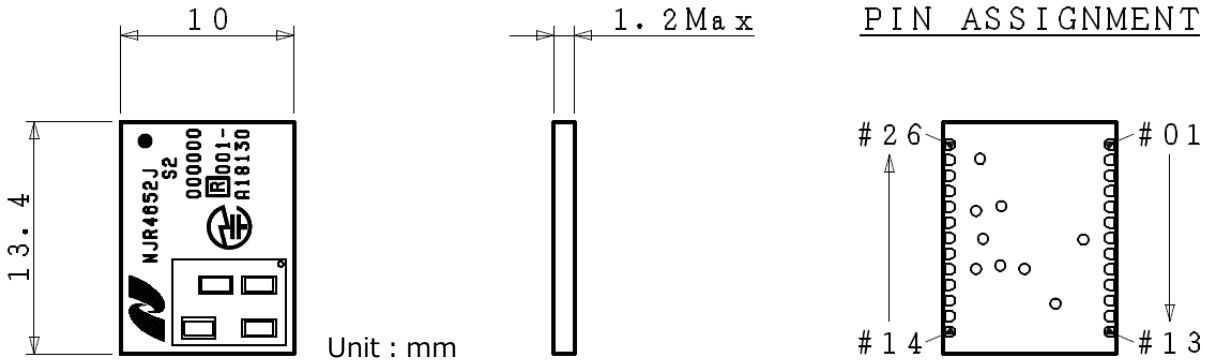
Packet	GPIO mode of people counter				
Command type	Set/Get				
Comment	This command is used to set or get the GPIO activity mode when a counter event exist. The change will be saved in flash. Default is “LED drive				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x1E	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	GPIO_mode	0: LED drive mode (GPIO0: green, GPIO1: red, GPIO2: blue) 1: GPIO active mode (GPIO1: a high pulse for IN count, GPIO2: a high pulse for OUT count, GPIO0: high for counter occupied and low for counter free)		

6.3.21 Unique ID（0xF7）

Packet	Get the unique ID of the module				
Command type	Get				
Comment	This command is used to get the unique ID of the module				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0xF7	8	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t x 8	unique_id	Module unique ID		

7 Outline

7.3 Outline Drawing

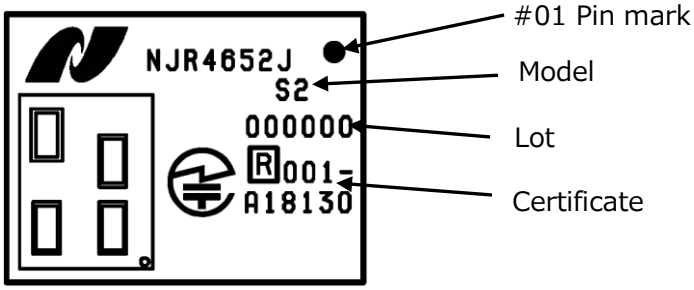


TOP VIEW

Unit : mm
Tolerance:±0.2mm
Thickness is Max.

BOTTOM VIEW

7.4 Printing Drawing



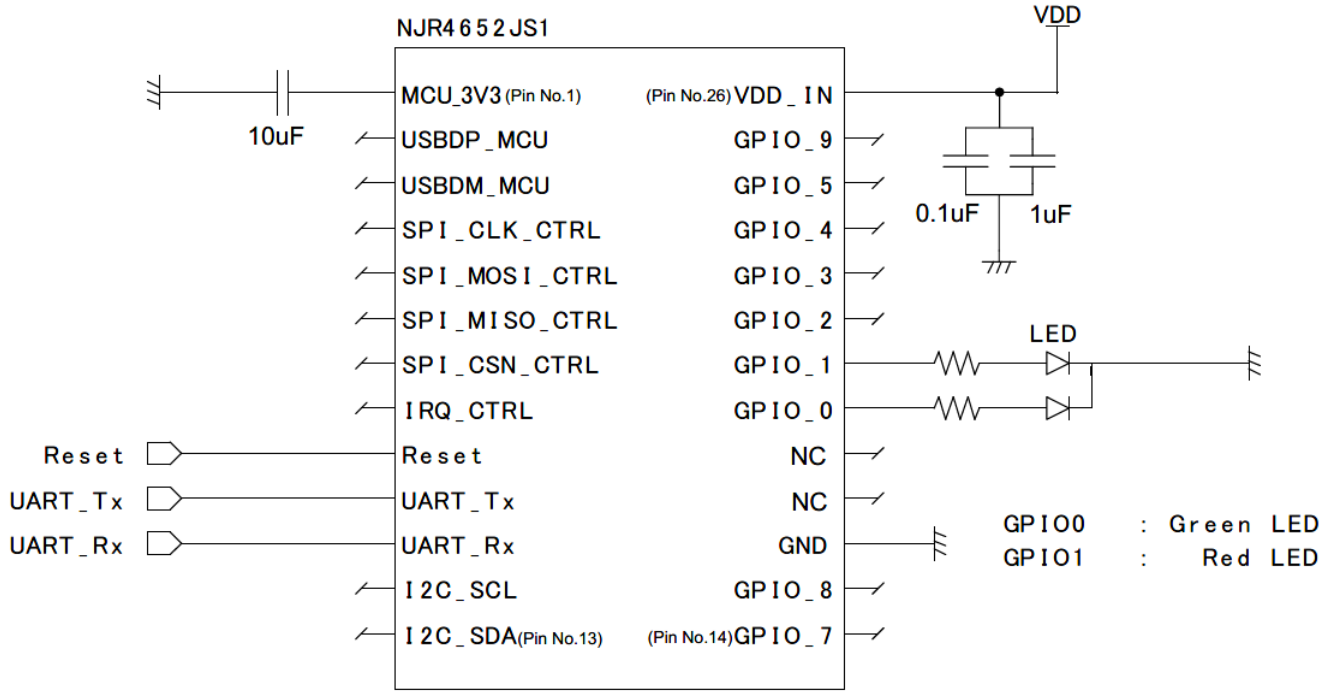
Note: NJR4652F2S2 for CE, FCC&ISED is under preparation

8. Environmental Performance

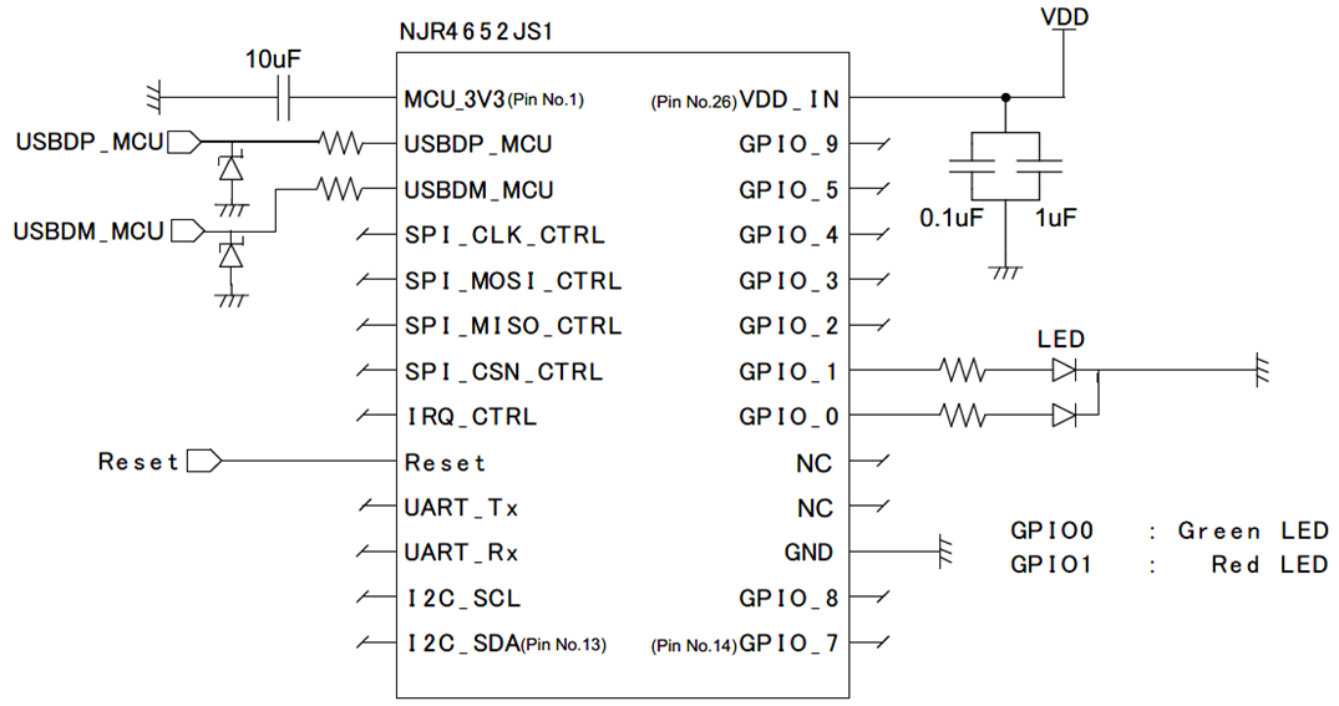
Item	Spec
Operating Temperature	-20 to +70°C
Storage Temperature	-40 to +85°C
Humidity	0 to 95%RH @+30°C
Moisture Sensitivity Level	MSL 3
Vibration	49.03m/s^2 (5G) Condition: 30 to 50Hz, 10 minutes, XYZ axes
Shock	196.13m/s^2 (20G) Condition: Half sine, 11msec, XYZ axes, 3 times

9. Reference Circuits

9.1. UART Connection Chart

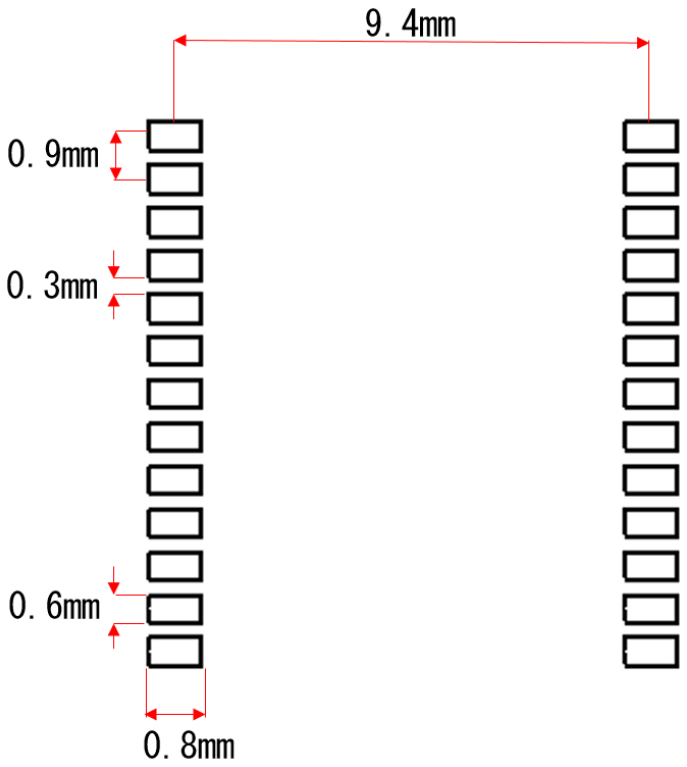


9.2. USB Connection Chart



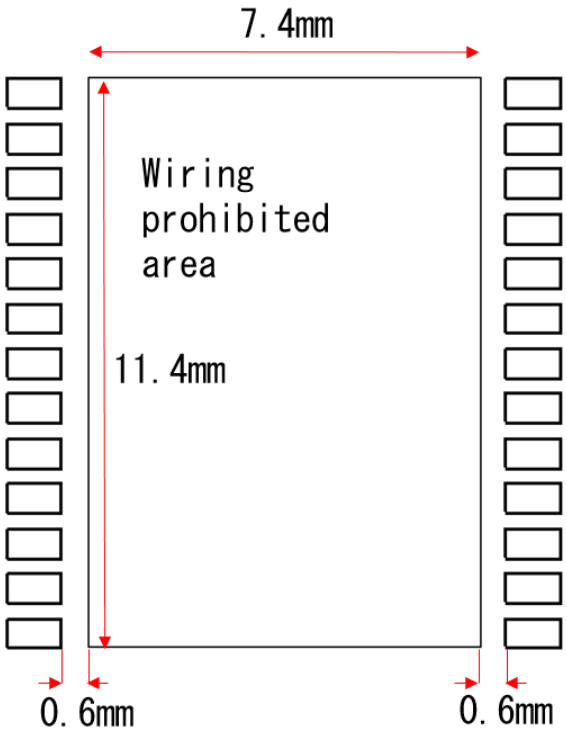
10. Recommended Footprint

10.1. Mounting Pattern



10.2. Wiring prohibited area

For surfaces where modules are mounted, the wiring prohibited area shown below is required to avoid contact with the module test points.



11. Baking and reflow conditions before mounting

11.1. Baking Condition

・This product is MSL3.

TBD

11.2. Reflow mounting temperature profile

TBD

12. Package

12.1. Tray (Small)

TBD

12.2. Tray (Large)

TBD

12.3. Reel

TBD

■ Revision History

Date	Revision	Contents of Change
Month day, year	Ver.	-
May. 15th, 2022	0.0e	Preliminary 0
Nov. 28th,2022	0.1e	Updated information about FCC certification
		Replaced the figure in P8

<Precautions for the use of this product>

1. Although we strive to improve the quality and reliability of our products, there is a certain probability that millimeter wave products will fail. To avoid any injury, disaster, or social damage resulting from a malfunction of our millimeter wave products, customers are requested to take sufficient care to ensure the safety of their equipment by implementing safety designs such as fail-safe design, redundancy design, fire spread prevention design, and malfunction prevention design on their own responsibility.

2. If this product is to be used in the following equipment, which requires particularly high reliability, please contact our sales office in advance.
   - Aerospace equipment
   - Submarine equipment
   - Power generation control equipment (nuclear, thermal, hydro, etc.)
   - Medical equipment for life support
   - Disaster prevention/crime prevention equipment
   - Control equipment for movable objects (automobiles, airplanes, trains, ships, etc.)
   - Various safety devices

3. The following acts are different from the conditions at the time of application for this product and are violations of radio laws and regulations, and are subject to severe penalties (fines, imprisonment, etc.) and must be absolutely avoided.
   1) Opening and modifying the housing of the product.
   2) Removing the labeling on the product.
   3) Use the product in a mode other than the power supply standard range and unmodulated mode of the product.
   4) To make any other modifications to the product in accordance with the Radio Law and related laws.

   If you intend to use this product under conditions different from those of our application, please obtain a technical standards conformity certificate or construction design certification for your system separately. In the event of such an act, the labeling on the product must be removed in accordance with the provisions of the Radio Law.

4. When handling this product, please be sure to take anti-static measures such as grounding the measurement system and human body. Also, when placing the product in a reflow oven, please handle it in compliance with the MSL level.

5. Please note that the local oscillation frequency will be affected if strong stresses are applied to the external form of the product. Also, do not apply shocks exceeding the rated value.

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

7. Do not use the product under conditions that deviate from the product specifications listed in this specification sheet, as this may cause deterioration or destruction of the product. We shall not be liable for any injury, accident, or social damage resulting from use of the product under conditions that deviate from the specifications.

8. The contents of this specification are subject to change without notice. The delivery specifications must be exchanged before use.