



## NJR4652JS1, NJR4652F2S1

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

### 60GHz Smart Sensor Micro-Module Turnkey solution: Presence Detection

Preliminary

#### Features

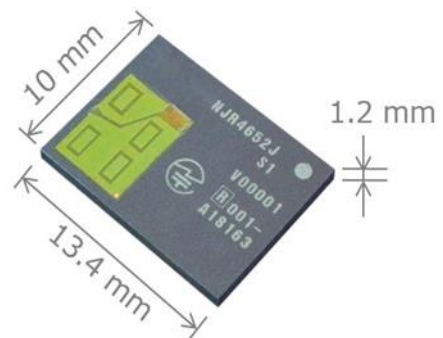
- Presence detection sensor by 60GHz millimeter wave
- All-in-one from antenna to signal processing
- IC-like package compatible with SMT
- Low power consumption for intermittent operation 30mA @3.6V
- Application software included (turnkey solution) Presence Detection
- Supports UART/USB/GPIO interfaces
- FOV  $\pm 45^\circ$  in V plane /  $\pm 45^\circ$  in H plane
- Maximum detection range
  - Macro motion: 10m
  - Micro motion: 5m

#### 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 Presence Detection (this product) and Smart Entrance Counter (another product model name: NJR4652JS2, NJR4652F2S2) are available as turnkey solutions to shorten customers' product development time.

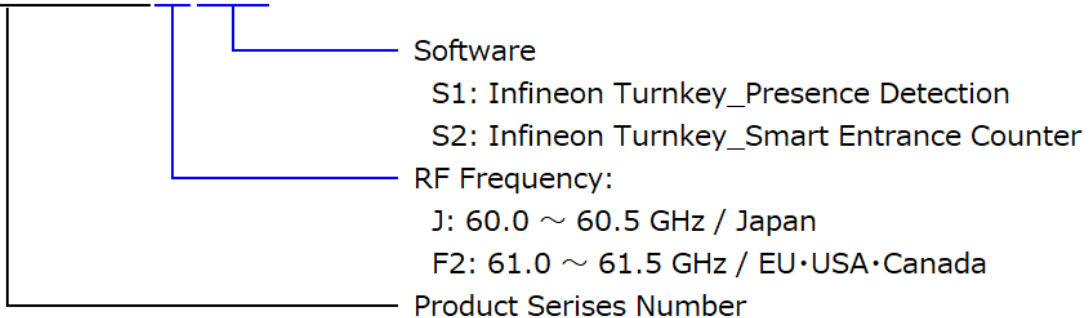
#### Applications

- Lighting
  - Security
  - Housing
  - Robot/Hobby
- Other applications which need motion sensors.



#### Product Line-up

N J R 4 6 5 2 J S 1



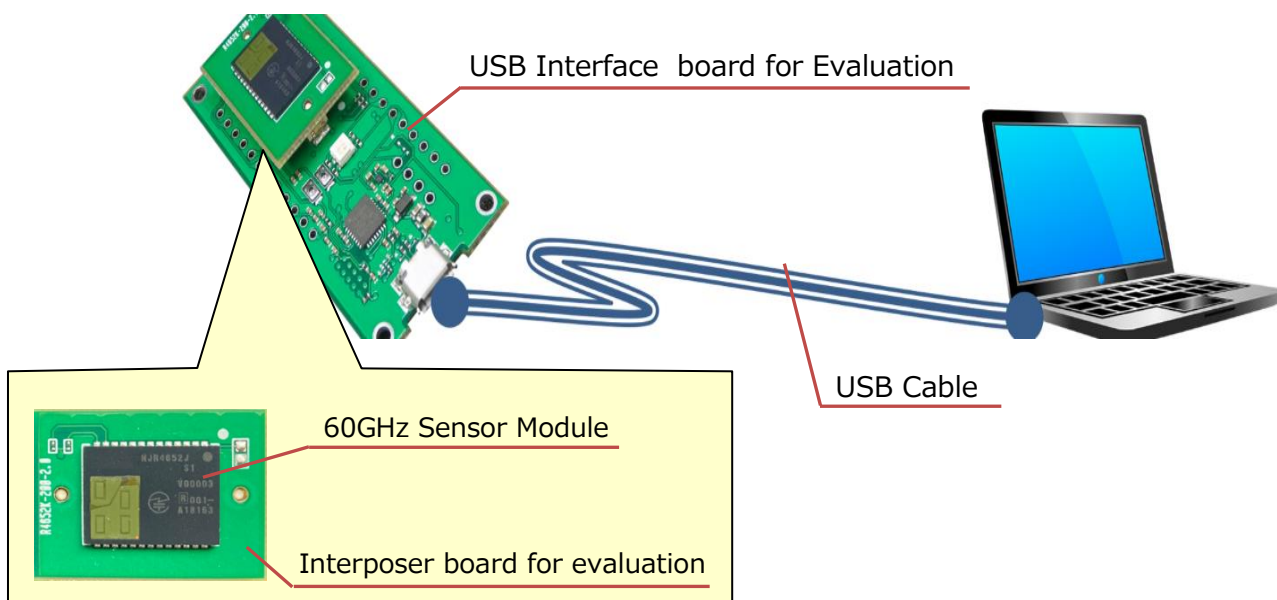
List of product models:

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

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

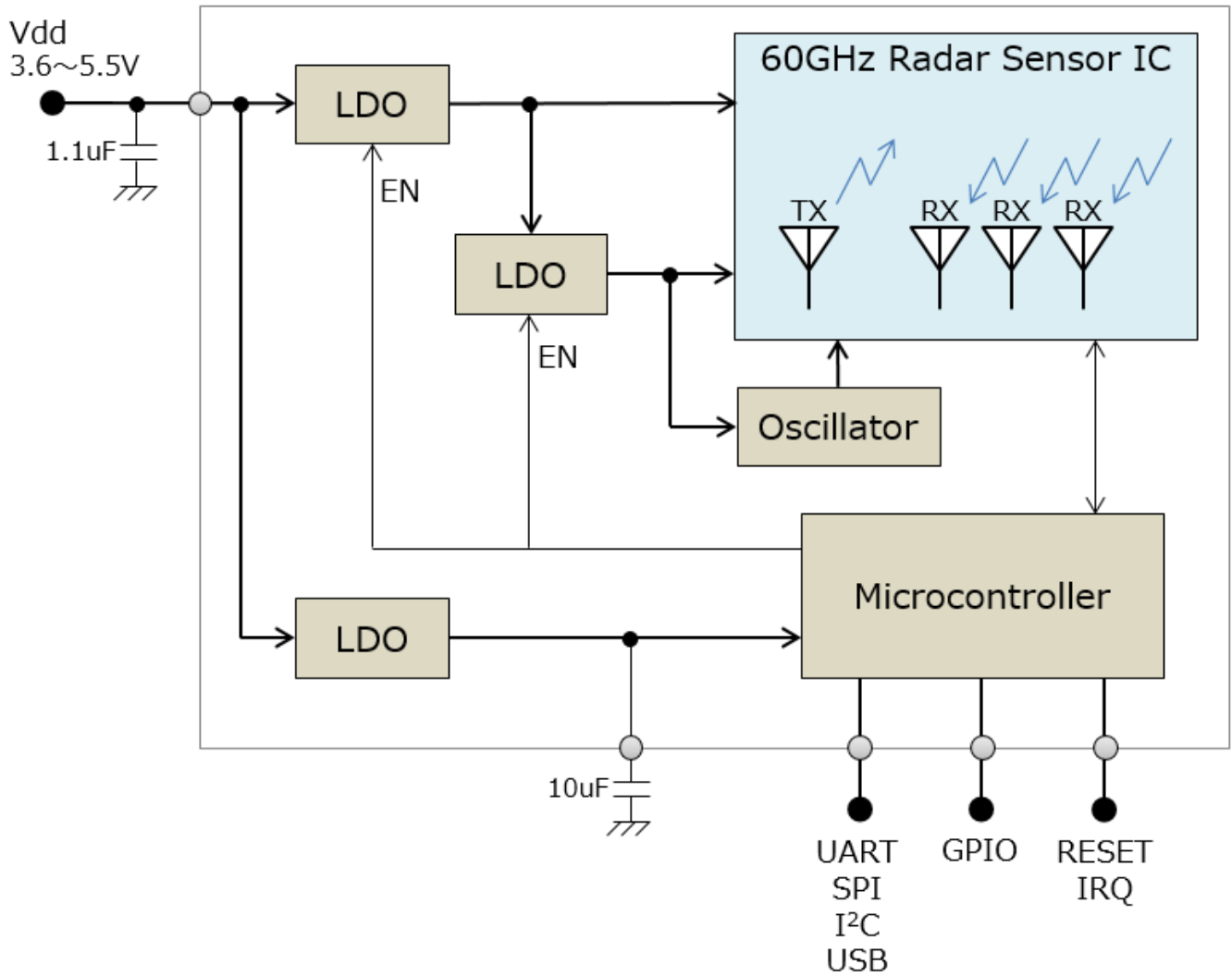
Evaluation Kit:

- Evaluation kits are available for the NJR4652 series. The evaluation kit consists of the following components
- Evaluation Kit Model Name: NJR4652F2S1EV
- Configuration
  1. Evaluation USB interface board (model name: NJR4652K)
  2. Evaluation interposer board (model name: NJR4652F2S1K)
  3. USB cable
  4. GUI application software (download from designated website) \*Note)



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	°C	Guaranteed performance temperature range
Storage temperature	-40	—	+85	°C	

## 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) In case presence detect ON					
Average current    Number of chirps per frame					
•1 time (Min. of times)	—	13	—	mA	
•6 times	—	24	—	mA	
•11 times	—	35	—	mA	
•16 times (Max. of times)	—	46	—	mA	
Peak current	—	155	185	mA	
2) In case presence 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.

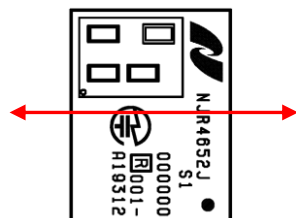
Item	Specs			Units	Remarks
	Min	Typ	Max		
2.2. Input / Output Pin Characteristics					
1) MCU_3V3 pin					
Output Voltage	-2%	3.3	2%	V	
2) Digital pin (GPIO, UART)					
High level output voltage range	MCU_3V3-0.5	—	—	V	Output current=8mA
Low level output voltage range	—	—	0.4	V	Output current=-8mA
High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

Item	Specs			Unit	Remarks
	Min	Typ	Max		
<b>2.3. RF Circuit Specifications</b>					
Conforming standards	<ul style="list-style-type: none"> <li>● Japan / Radio Law: Construction Design Certification</li> <li>● EU / Radio Equipment Directive (RED) * Note 1</li> <li>● United States / FCC , Canada / ISED *Note 1</li> </ul>				
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	
2 <sup>nd</sup> Harmonic level (E.I.R.P.)	—	—	-30	dBm	
<b>2.4. Antenna Characteristics</b>					
Half width (H-plane)	—	65	—	deg.	
Half width (V-plane)	—	60	—	deg.	

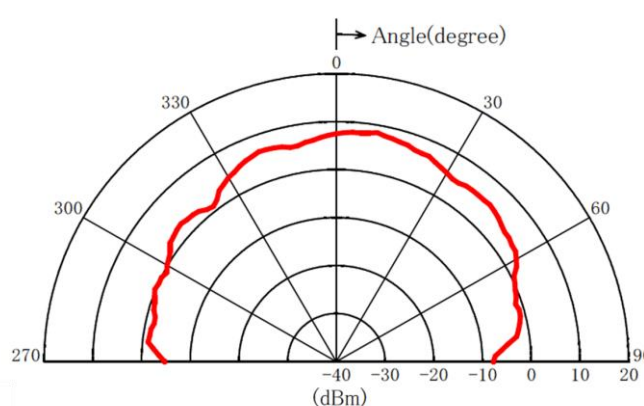
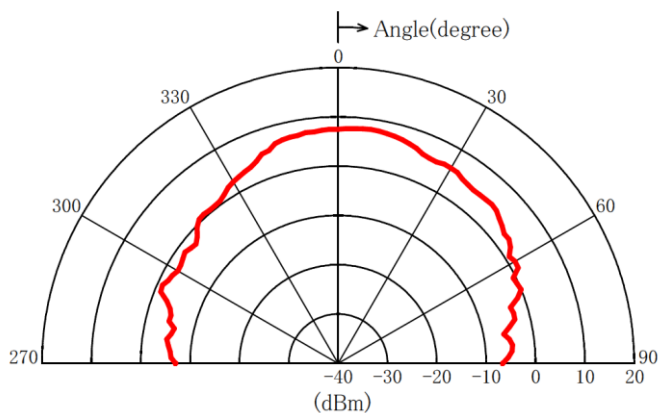
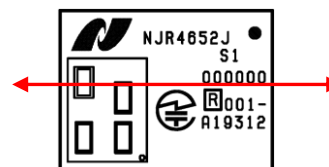
\* Note1: Please ask us about conformity to the other overseas standards.

Antenna Pattern

H-plane

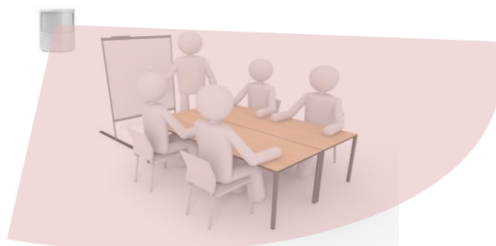


V-plane



### 3. Detection performance

The system can detect the presence of people in offices, conference rooms, etc. Even stationary people can be detected. Distance information to the target of detection can also be obtained. There are two ways to identify presence detection: macro motion detection and micro motion detection. Macro motion refers to large movements, while micro motion refers to small movements (microvibrations of a person).

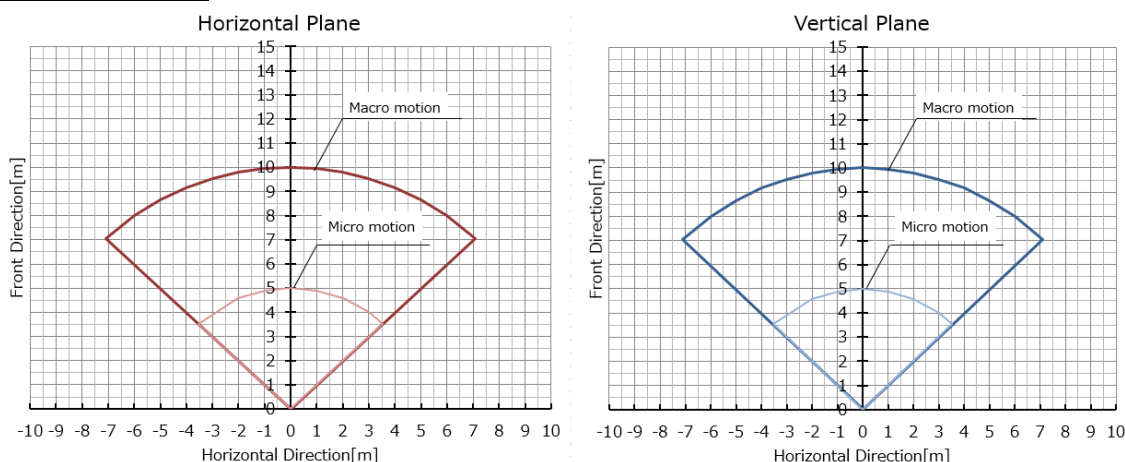


Reference Image

Item	Specs			Unit	Remarks
	Min	Typ	Max		
Maximum detection distance for macro motion	—	10	—	m	Sensor Front Direction
Maximum detection distance for micro motion	—	5	—	m	Sensor Front Direction
FOV X-Z plane Detection angle range	—	±45	—	deg.	
FOV Y-Z plane Detection angle range	—	±45	—	Deg.	

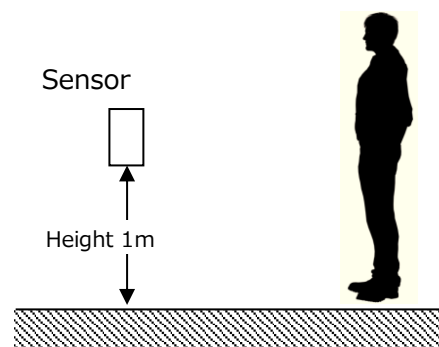
Note: The above values are for reference only. Differences may occur depending on the installation method and surrounding environment. Please check the actual environment carefully.

#### Detection Area



#### Measurement Conditions of Detection performance

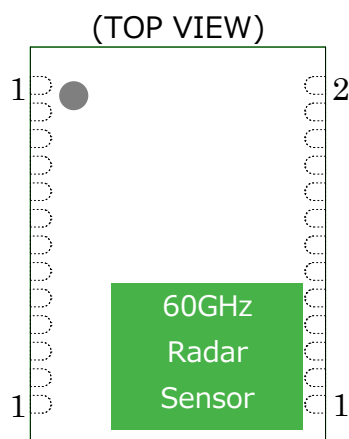
- \*Measured temperature:  $T_a = +25^{\circ}\text{C}$
- \*Subject of detection: 170 cm in height, 70 kg in weight
- \*Human condition: standing upright, facing the sensor
- \*Sensor installation: 1 m high, radiating horizontally





### 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	USBDM_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 not detected, High
20	GPIO_1	O	Default Low, when presence is 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

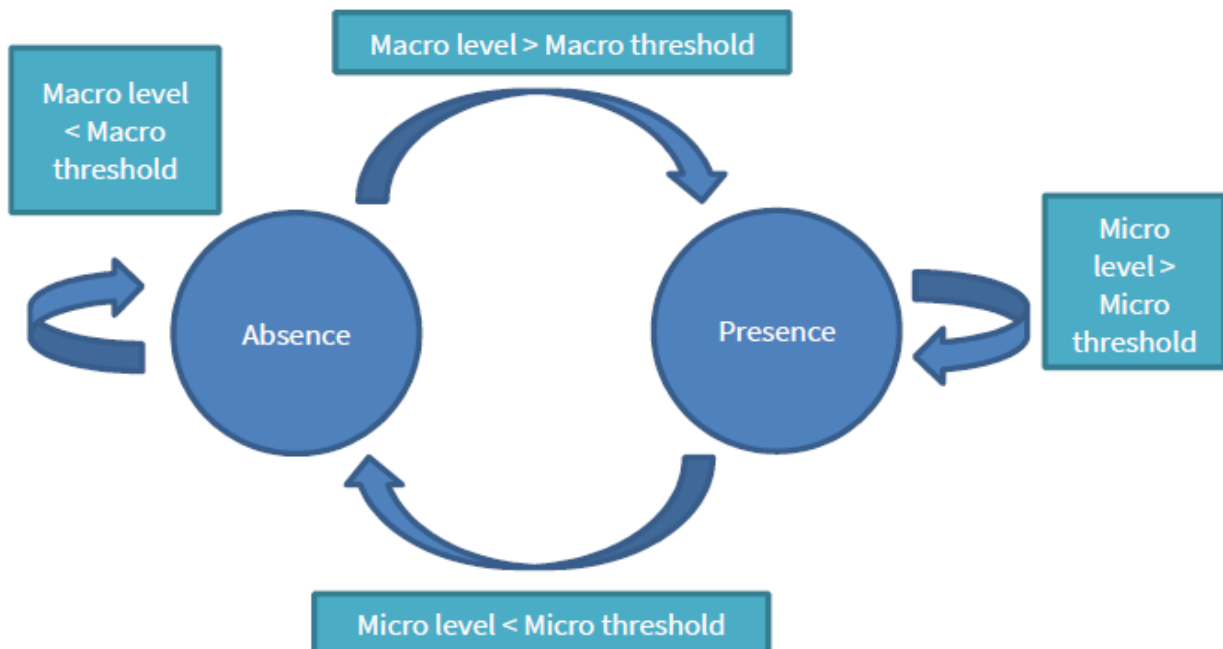
### 5.2 Detection Rise Time

- 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 480 to 980 ms.
- The time from sleep mode to the first output after detection ON is 480 to 980 ms.

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

### 5.3 Explanation of presence detection operation

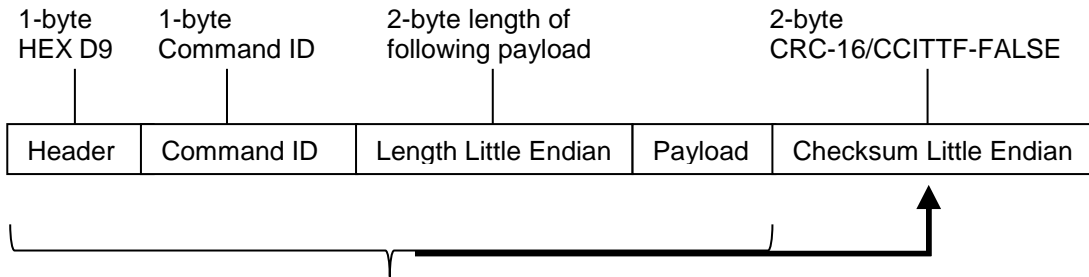
For a detailed description of macro motion and micro motion, please refer to the evaluation kit NJR4652JTK User's Manual, Presence Detection.



## 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);
}
```

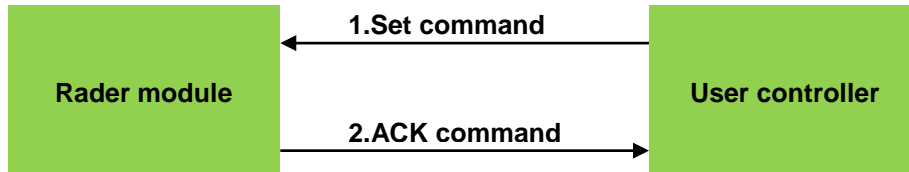
This function will return a 16-bit checksum (in little endian) for the input array.

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.



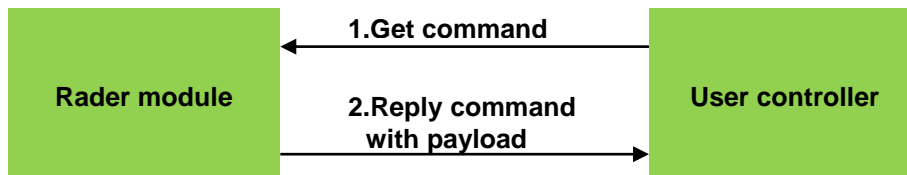
Example: Set maximum detection distance to 1.0 m

User transmission: D9 03 04 00 00 00 00 80 3F D5 5C

Module response: D9 02 02 00 02 01 EE 3D

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 maximum detection distance

User Transmission: D9 03 00 00 74 03

Module response (detection distance is 1.0 m): D9 03 04 00 00 00 80 3F D5 5C

Event Command

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



Example: Presence detection event

Time: 64611ms

Distance: 0.815m

Accuracy: 0.163 m

Module transmission: D9 06 10 00 63 FC 00 00 00 00 00 19 8D 50 3F 4D D7 26 3E 85 17

### 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 Maximum presence detection range (0x03)

Packet	Maximum detection range of presence detection				
Command type	Set / Get				
Comment	Valid range is 0.2-10.0. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x03	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	max_range	Maximum detection range		

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

6.3.4 Presence detection sensitivity (0x04)

Packet	Detection sensitivity of presence detection				
Command type	Set / Get				
Comment	Higher sensitivity means the presence detection is more sensitive to small motion. The change will be saved in flash. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x04	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	sensitivity	Detection sensitivity 0: low 1: medium 2: high 3: customize, only available at get, indicating macro/micro threshold value is manually changed by command		

6.3.5 Presence detection output (0x05)

Packet	Presence detection event command output status				
Command type	Set / Get				
Comment	This status controls whether an event command will send out for a change in presence event. The change will be saved in flash. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x05	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	output_status	Event command output status 0: disabled 1: enabled		

6.3.6 Presence detection IN event (0x06)

Packet	Presence detection IN event command				
Command type	Event				
Comment	This event command will send out once for a change in IN presence event				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x06	16	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint64_t	event_time	Event time, in ms		
8	float	distance	Detected object distance, in meter		
12	float	accuracy	Detected object distance accuracy, in meter		



6.3.7 Presence detection OUT event (0x07)

Packet	Presence detection OUT event command				
Command type	Event				
Comment	This event command will send out once for a change in OUT presence event				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x07	8	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint64_t	event_time	Event time, in ms		

6.3.8 Reset configuration (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

6.3.9 Get present detection status (0x09)

Packet	Poll presence detection result				
Command type	Get				
Comment	This command is used to get the current presence detection result. Reply will be IN (0x06) or OUT (0x07) event command.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x09	0	NA	CRC16

6.3.10 Presence detect enable (0x0A)

Packet	Enable/Disable presence detection				
Command type	Set				
Comment	This command is used to enable/disable presence detection. Make sure to disable RFCW mode before enabling presence 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	Presence detection enable status 0: disable 1: enable		

6.3.11 RFCW mode (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 60.02/61.02GHz 2: RFCW output at 60.25/61.25GHz 3: RFCW output at 60.48/61.48GHz 4: RFCW test at 60.02/61.02GHz with TX off 5: RFCW test at 60.25/61.25GHz with TX off 6: RFCW output at 60.48/61.48GHz with TX off		

6.3.12 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)		

6.3.13 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 °C		

6.3.14 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		

6.3.15 Calibration mode (0x0F)

Packet	Enable/disable calibration mode				
Command type	Set				
Comment	This command is used enable/disable calibration mode. Calibration message indicating the activity level will output periodically when enabled. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0F	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	status	0: disable 1: enable		

6.3.16 Calibration message (0x10)

Packet	Calibration message				
Command type	Event				
Comment	This command will output periodically when calibration mode enabled.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x10	N	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	string	calibrate_msg	Calibration message string		

6.3.17 Calibration message output rate (0x11)

Packet	Calibration message output rate				
Command type	Set				
Comment	This command is used to set the calibration message output rate. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x11	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	output_rate	1: message rate at 1 per second, 1s 2: message rate at 2 per second, 0.5s 3: message rate at 3 per second, 0.33s 4: message rate at 4 per second, 0.25s		

6.3.18 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		

6.3.19 Signal verification mode (0x1F)

Packet	Enable/disable signal verification mode				
Command type	Set				
Comment	This command is used enable/disable signal verification mode. Signal verification value command indicating the range bin result will output periodically (1 sec) when enabled. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x1F	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	status	0: disable 1: enable		

6.3.20 Signal verification value (0x20)

Packet	Signal verification value				
Command type	Event				
Comment	This command will output periodically (1 sec) when signal verification mode enabled. A range bin array of floating numbers is stored in the payload. Each bin value represent the signal level at different range (m).				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x20	4 + N * 4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	range_res	Range resolution, in meter		
4	float	range_bin 0	Signal level at 0m		
8	float	range_bin 1	Signal level at range_res m		
...	float	range_bin X	Signal level at range_res * Xm		

## 6.3.21 Minimum detection range (0x30)

Packet	Minimum detection range of presence detection				
Command type	Set/Get				
Comment	Valid range is 0.0-10.0. User needs to ensure this value is smaller than maximum detection range. The change will be saved in flash. Default is 0.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x30	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	min_range	Minimum detection range		

## 6.3.22 Macro threshold (0x31)

Packet	Macro movement threshold value of presence detection				
Command type	Set/Get				
Comment	Threshold value used for detecting macro movement. After changing this value, Sensitivity will become customize. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x31	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	macro_threshold	Macro movement threshold value		



6.3.23 Micro threshold (0x32)

Packet	Micro movement threshold value of presence detection				
Command type	Set/Get				
Comment	Threshold value used for detecting micro movement. After changing this value, Sensitivity will become customize. The change will be saved in flash. Default is 25.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x32	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	micro_threshold	Micro movement threshold value		

6.3.24 Macro valid (0x33)

Packet	Macro movement detection timeout value of presence detection				
Command type	Set/Get				
Comment	Timeout value (second) used for judging the motion is no longer macro movement. For example, if value is 1, it means detected value below macro threshold for continuous 1 second will be treated as no macro movement. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x33	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	macro_valid	Macro movement detection timeout value		

6.3.25 Micro valid (0x34)

Packet	Micro movement detection timeout value of presence detection				
Command type	Set/Get				
Comment	Timeout value (second) used for judging the motion is no longer macro movement. Judging criteria is same as in Macro valid value. The change will be saved in flash. Default is 4.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x34	4	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	micro_valid	Micro movement detection timeout value		

6.3.26 Presence detection mode (0x35)

Packet	Presence detection detect mode				
Command type	Set/Get				
Comment	This command is used to set or get the detect mode of presence detection. The change will be saved in flash. Default is Macro then micro.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x35	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	detect_mode	<p>0: Macro then micro mode. Radar will first detect macro motion for presence, and enter micro motion detect mode when the object movement becomes small</p> <p>1: Macro only mode. Radar will only detect macro movement</p> <p>2: Micro only mode. Radar will only detect micro movement</p> <p>3: Macro and micro mode. Radar will always detect both macro and micro movement, either one kind of motion exceeding the threshold will be treated as presence</p>		

6.3.27 Macro detection trigger range (0x36)

Packet	Macro detection trigger range of presence detection				
Command type	Set/Get				
Comment	This command is used to set or get the trigger range for macro movement detection. Setting a higher value, user need to enter the detection zone inner to trigger presence. Value is multiple of 0.33m. The change will be saved in flash. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x36	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	trigger_range	Macro detection trigger range		

6.3.28 Macro detection trigger delay (0x37)

Packet	Macro detection trigger delay of presence detection				
Command type	Set/Get				
Comment	This command is used to set or get the trigger delay for macro movement detection. Setting a higher value, radar will need a longer continuous macro movement to trigger presence. Value is multiple of 0.25s. This parameter can be used to filter false trigger such as sudden short vibration object in the detection zone. The change will be saved in flash. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x37	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	trigger_delay	Macro detection trigger delay		

6.3.29 Presence chirp per frame (0x38)

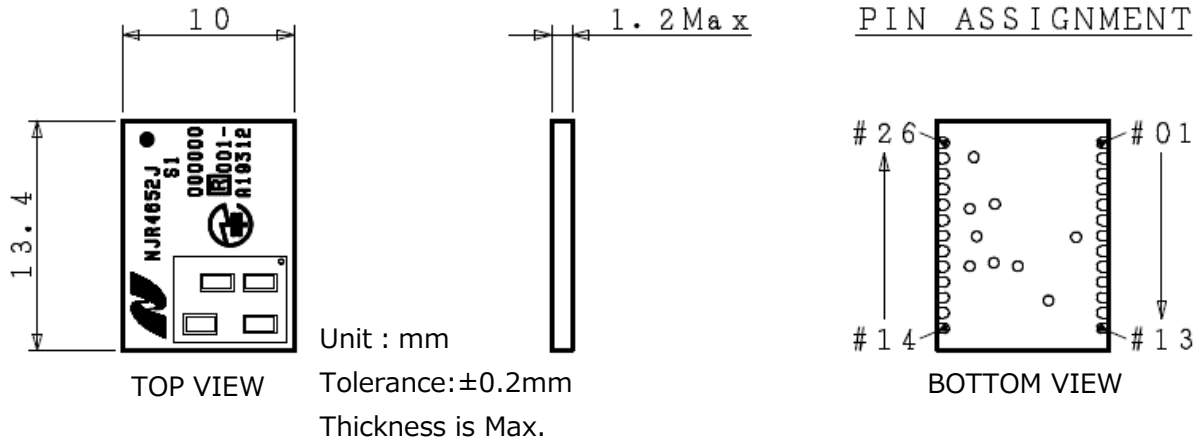
Packet	Chirp per frame of presence detection				
Command type	Set/Get				
Comment	This command is used to set or get the number of chirp per frame for coherent integration. Setting a higher value, radar will send out more chirps in a frame and use for coherent integration, resulting in a better signal to noise ratio. Valid range is 1-16. Notice that power consumption will also increase for setting higher value, as the RF active time will also increase. The change will be saved in flash. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x37	1	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	chirp_num	Number of chirp per frame (1-4)		

6.3.30 Unique ID (0xF7)

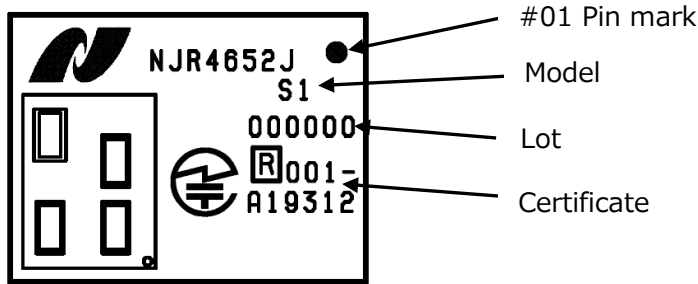
Packet	Get the unique ID of the module				
Command type	Get				
Comment	This command is used to get the unique ID of the module				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0xF7	8	see below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t x 8	unique_id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

7 Outline

7.1 Outline Drawing



7.2 Printed Drawing



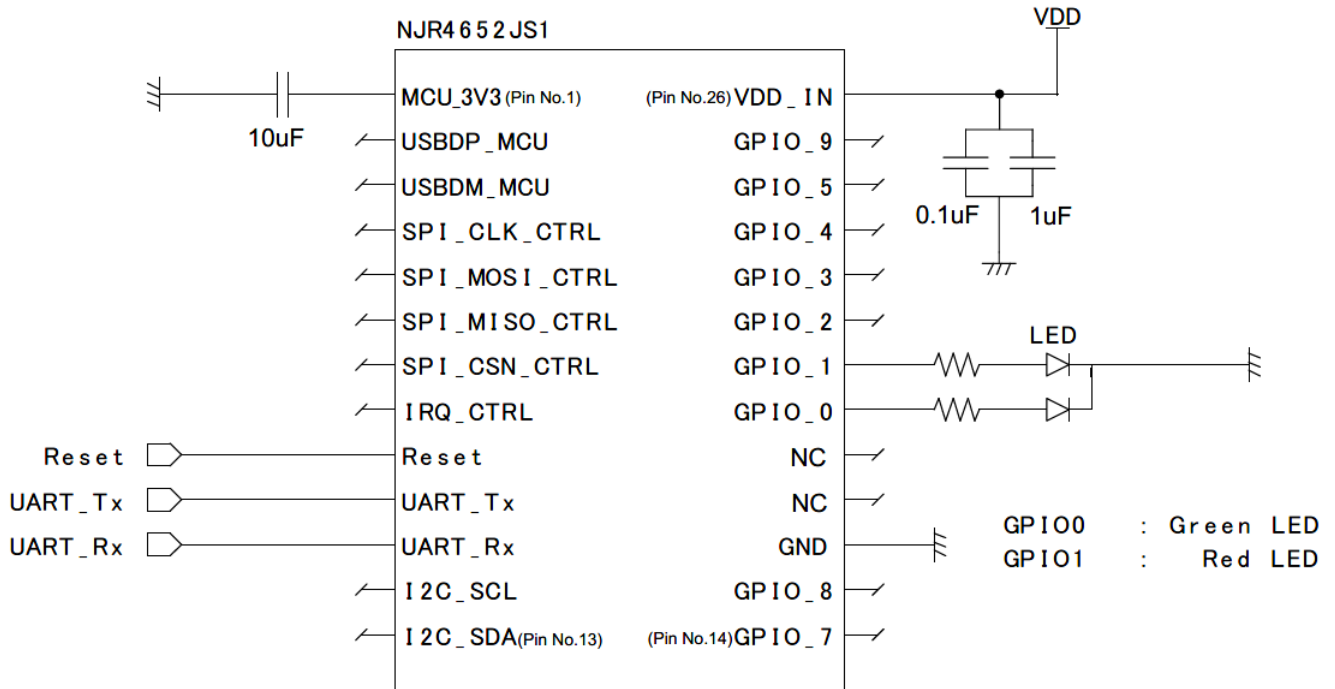
Note: NJR4652F2S1 for CE, FCC&ISED is under preparation

8 Environmental Performance

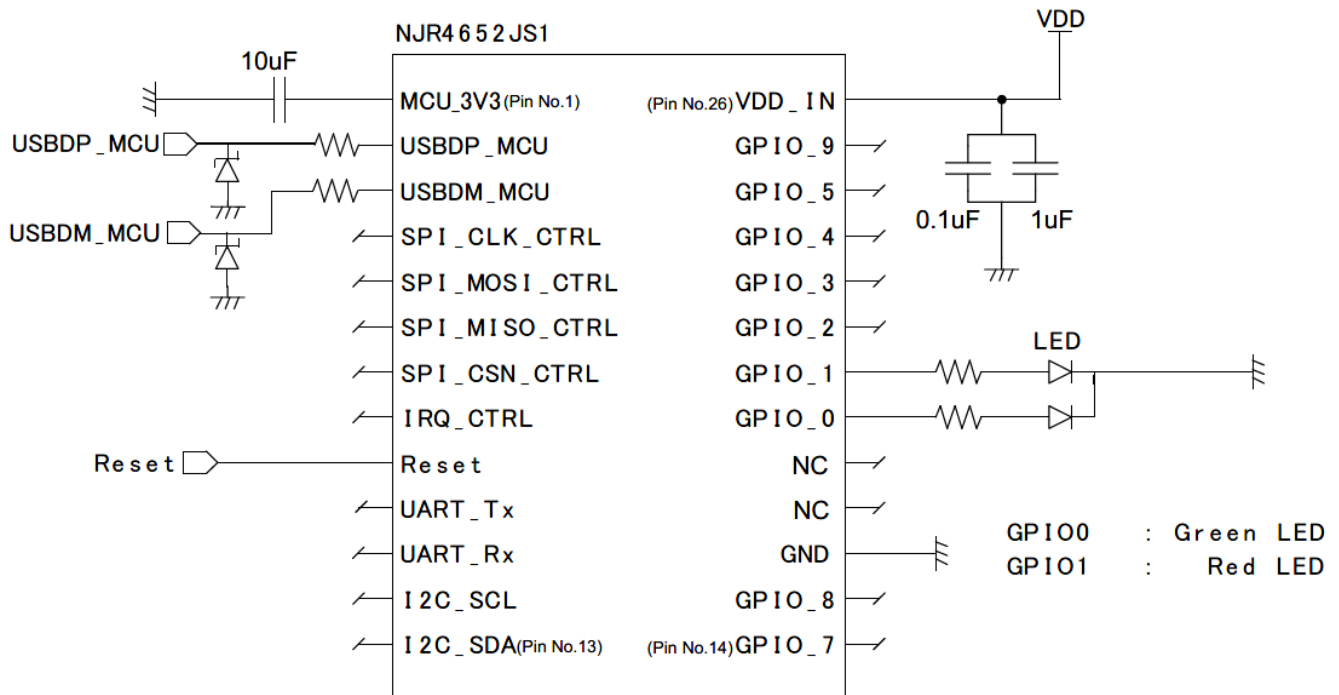
Item	Spec
Operating Temperature	-20 ~ +70°C
Storage Temperature	-40 ~ +85°C
Humidity	0 ~ 95%RH @+30°C
Moisture Sensitivity Level	MSL 3
Vibration	49.03m/s <sup>2</sup> (5G) Condition: 30~50Hz, 10 minutes, XYZ axes
Shock	196.13m/s <sup>2</sup> (20G) Condition: Half sine, 11msec, XYZ axes, 3 times

9 Reference Circuits

9.1 UART Connection Chart

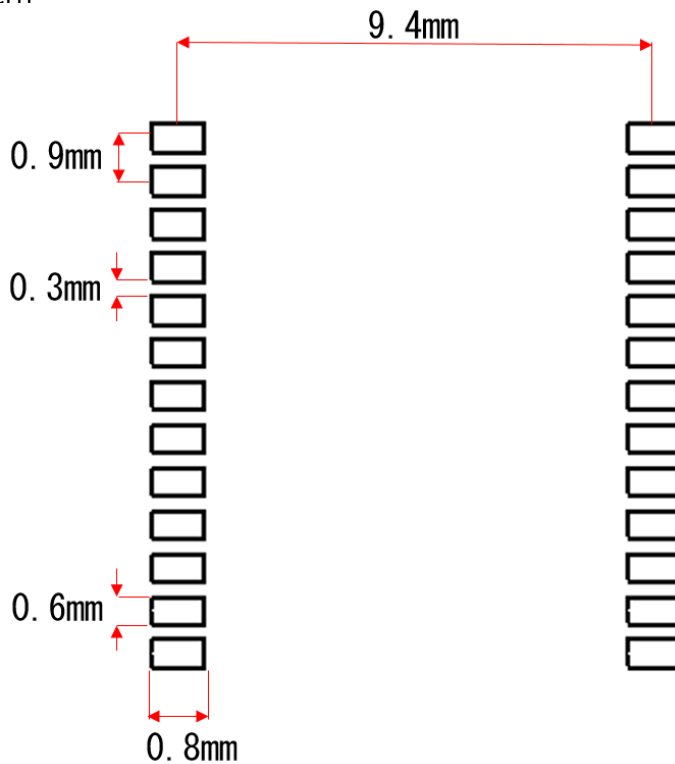


9.2 USB Connection Chart



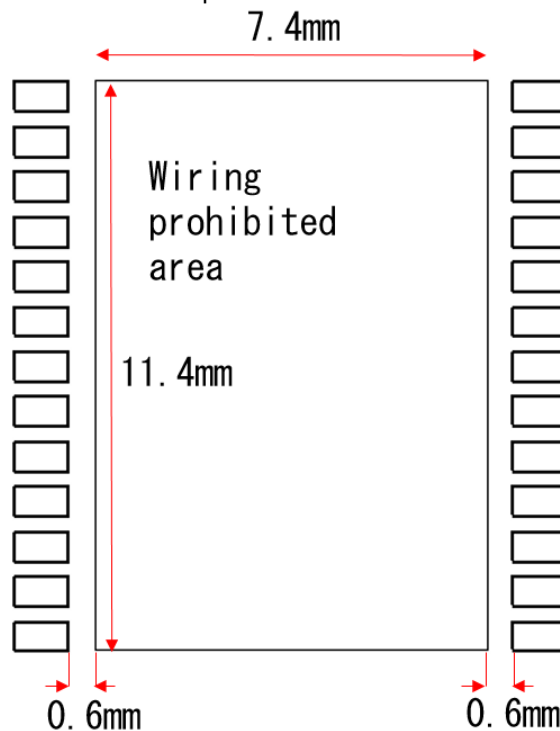
### 10 Recommended Footprint

#### 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)

A red rectangular box with a thin border containing the text "TBD" in a large, red, serif font.

## 12.2 Tray (Large)

A red rectangular box with a thin border containing the text "TBD" in a large, red, serif font.

## 12.3 Reel

A red rectangular box with a thin border containing the text "TBD" in a large, red, serif font.

## ■ Revision History

Date	Revision	Contents of Change
Month day, year	Ver.	-
May. 15th,2022	0.1e	Preliminary 0.1
Nov. 28th,2022	0.2e	Updated information about FCC certification
Jan. 12th,2023	0.3e	Corrected 19th and 20th terminals for "4.1Pin assignment"



## <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.