RRQ61001 Module

Renesas Wi-Fi Module

Renesas RRQ61001 modules offer highly integrated Wi-Fi® solutions for customers developing their IoT applications. These modules include the RA6W1 microcontroller unit (MCU) that has an 802.11 a/b/g/n/ac/ax radio (PHY), a baseband processor, a media access controller (MAC), on-chip memory, and an Arm® Cortex®-M33 core processor running at 160 MHz.

The RA6W1 MCU is a synthesis of breakthrough ultra-low-power technologies, which enables an extremely low power operation in the module. The RA6W1 MCU shuts down every micro element of the chip that is not in use, which creates power consumption that is near zero when not actively transmitting or receiving data. Such low power operation can extend the battery life up to a year or more depending on the application. The RRQ61001 also enables ultra-low power transmission and reception modes when the MCU needs to be awake to exchange information with other devices. Advanced algorithms enable sleep mode until the exact moment when wake-up is required to transmit or receive data.

Module Features

- Dimensions
  - 15 mm × 20 mm × 3.0 mm, 53 pins
- Operating temperature range
  - -40 °C to 85 °C

Wi-Fi Features

- **Arm® Cortex®-M33 Core**
  - Armv8-M architecture
  - Maximum operating frequency: 160 MHz
  - Arm Memory Protection Unit (Arm MPU)
    - Protected Memory System Architecture (PMSAv8)
    - MPU: 8 regions
  - SysTick timer
- **Full Networking OS and TCP/IP Stack**
  - Comprehensive networking software stack
  - Provide TCP/IP stack: in the form of network socket APIs
- **Wi-Fi Processor**
  - IEEE 802.11 b/g/n/ax, 1×1, 20 MHz channel bandwidth, 2.4 GHz
  - IEEE 802.11 a/n/ac/ax, 1×1, 20 MHz channel bandwidth, 5 GHz
  - IEEE 802.11s Wi-Fi mesh
  - On-chip PA, LNA, and RF switch
  - Wi-Fi security: WPA/WPA2-Enterprise/Personal, WPA2 SI, WPA3 SAE, and OWE
  - Vendor EAP types: EAP-TTLS/MSCHAPv2, PEAPv0/EAP-MSCHAPv2, PEAPv1, EAP-FAST, and EAP-TLS
  - Operating modes: Station and Soft AP Modes (GO, GC, GO fixed)
  - WPS-PIN/PBC for easy Wi-Fi provisioning
  - Connection manager for autonomous and fast Wi-Fi connections
  - Antenna switching diversity
- **Wi-Fi Alliance Certifications**
  - Wi-Fi CERTIFIED™ b, g, n
  - WPA™ - Enterprise, Personal
  - WPA2™ - Enterprise, Personal
  - WPA3™ - Enterprise, Personal
  - Wi-Fi Enhanced Open™
  - WMM
  - WMM - Power Save
  - Wi-Fi Protected Setup™
- **Standards Compatible**
  - Europe (CE/RED)/ UK (UKCA)
  - US (FCC)
  - Canada (IC)
  - Japan (TELEC)
  - South Korea (KCC)
  - Taiwan (NCC)
  - Brazil (ANATEL)
  - China (SRRC)
  - Singapore (IMDA)
- **Interfaces**
  - eMMC/SD expanded memory
  - SDIO Host/Slave function
  - OQSPI with encrypted XIP for external
  - Code/data flash
  - QSPI for additional PSRAM storage
  - UART × 3
  - SPI Master/Slave interface

- I2C Master/Slave interface
- I2S for digital audio streaming
- PDM/Digital Mic for digital audio streaming
- General PWM Timer 32-bit × 8
- Multiplexed GPIO × 26
- ADC (12-bit SAR) for sensor interfaces × 4

- **Advanced Security and Encryption**
  - Secure Crypto Engine
    - Symmetric algorithms: AES, DES/3DES, CHACHA
    - Hash/HMAC: SHA1/224/256
    - Asymmetric algorithms: RSA, DH, ECC
    - TRNG
  - Secure boot
  - Secure debug (SWD)
  - Secure asset storage
  - Device lifecycle management
  - TLS/DTLS protocol acceleration

- **Memory**
  - SRAM: 704 kB
  - Retention memory: 64 kB
  - ROM: 256 kB
  - OTP: 2 kB
  - Flash memory: 64-Mbit
- **Power Management Unit**
  - On-Chip RTC
  - Wake-up control of fast booting or full booting with minimal initialization time
  - Integrated DC-DC and LDOs
  - Support for ultra-low power Sleep modes
- **Clock Source**
  - 40 MHz crystal (± 20 ppm) for master clock
  - Integrated 32 kHz RC oscillator
- **Supply**
  - Single operating voltage: 1.8 V to 3.6 V (typical: 3.3 V)
  - Digital I/O Supply Voltage: 1.8 V/3.3 V
  - Black-out and brown-out detector

Contents

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Tables

1. Terms and Definitions

API	Application Programming Interface
GPIO	General Purpose Input/Output
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
IoT	Internet of Things
LE	Low Energy
LDO	Low-dropout Regulator
MCU	Microcontroller Unit
OTP	One Time Programmable
PPA	Programmable Pin Assignment
PWM	Pulse Width Modulation
QSPI	Quad-lane SPI
RTC	Real-time Clock
RX	Receive
SAR	ADC Successive Approximation Analog-to-Digital Converter
SoC	System on Chip
SPI	Serial Peripheral Interface
SWD	Serial Wire Debug
TX	Transmit
UART	Universal Asynchronous Receivers and Transmitter
VSWR	Voltage Standing Wave Ratio
XiP	eXecute In Place

2. Block Diagrams

The RRQ61001 modules provide a high level of integration for a range of IoT applications with integrated IEEE 802.11 a/b/g/n/ac/ax. The RRQ61001 is designed to address the needs of battery used devices that require minimal power consumption and reliable operation.

The RRQ61001 modules consist of three variants, based on the RF interface, the frequency band and the Wi-Fi wireless standard they support.

Table 1: RRQ61001 modules

Part Number	Description	MCU	MCU marking
RRQ61001-008	Wi-Fi Module, Wi-Fi 6 Dual Band 2.4/5 GHz 802.11a/b/g/n/ac/ax, 8 MB Flash, PCB trace antenna	**R**7S**A6W1C**EDZDD	RA6W1C
RRQ61001-009	Wi-Fi Module, Wi-Fi 6 Dual Band 2.4/5 GHz 802.11a/b/g/n/ac/ax, 8 MB Flash, External Antenna connector, u.FL	**R**7S**A6W1C**EDZDD	RA6W1C
RRQ61001-010	Wi-Fi module, Wi-Fi 6 Dual Band 2.4/5 GHz 802.11a/b/g/n/ac/ax, 8 MB Flash, RF antenna pin	**R**7S**A6W1C**EDZDD	RA6W1C

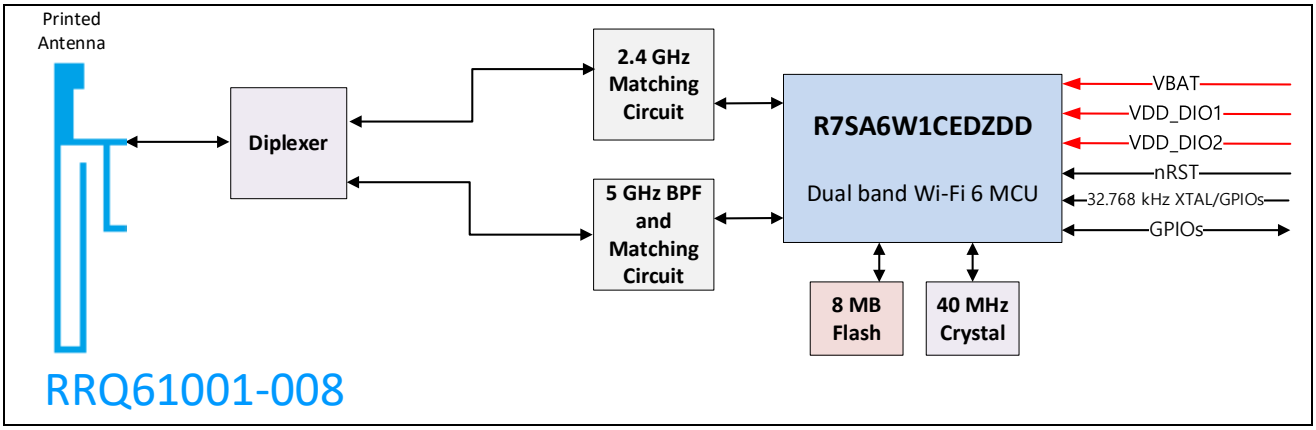


Figure 1. Interconnection of all the physical blocks in RRQ61001-008 module

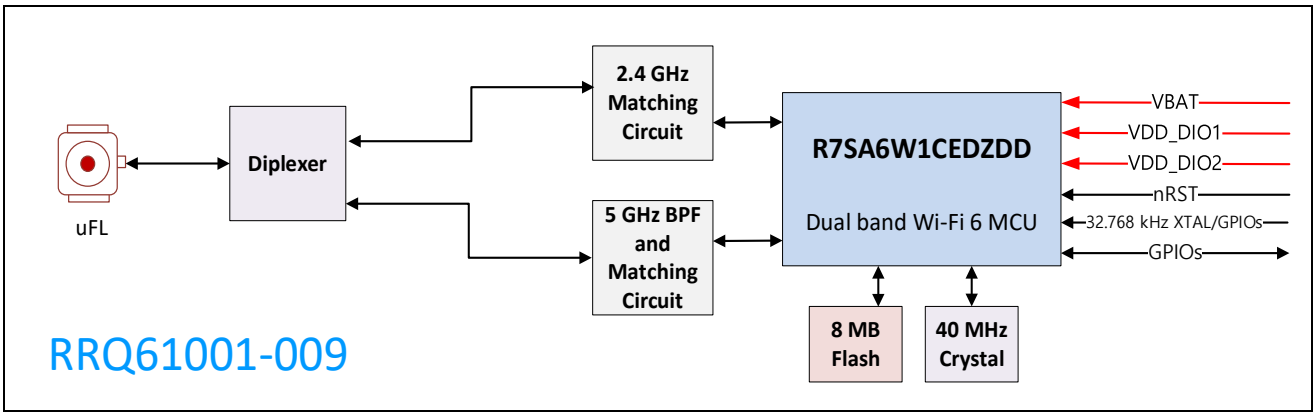


Figure 2. Interconnection of all the physical blocks in RRQ61001-009 module

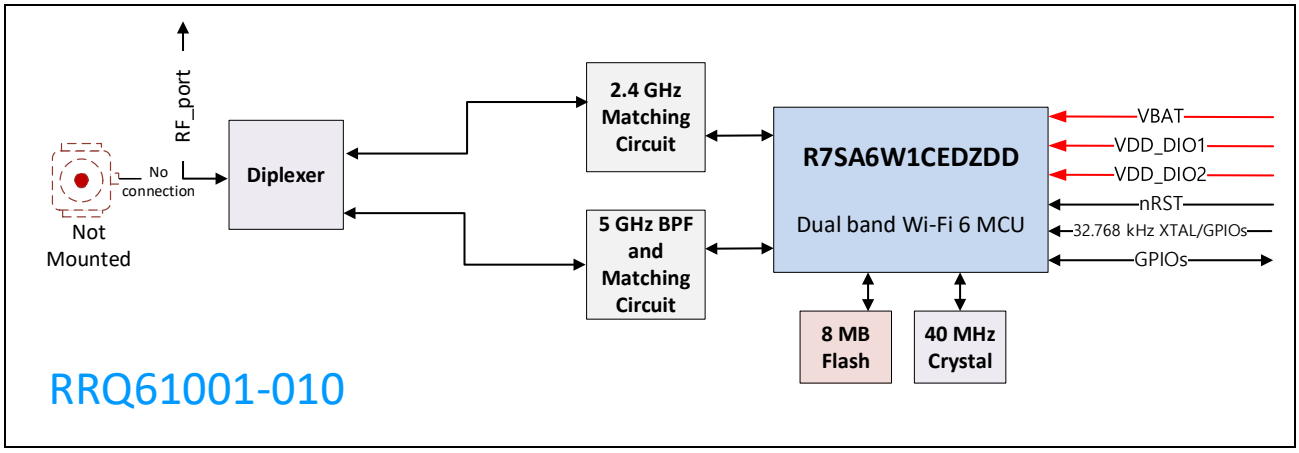


Figure 3. Interconnection of all the physical blocks in RRQ61001-010 module

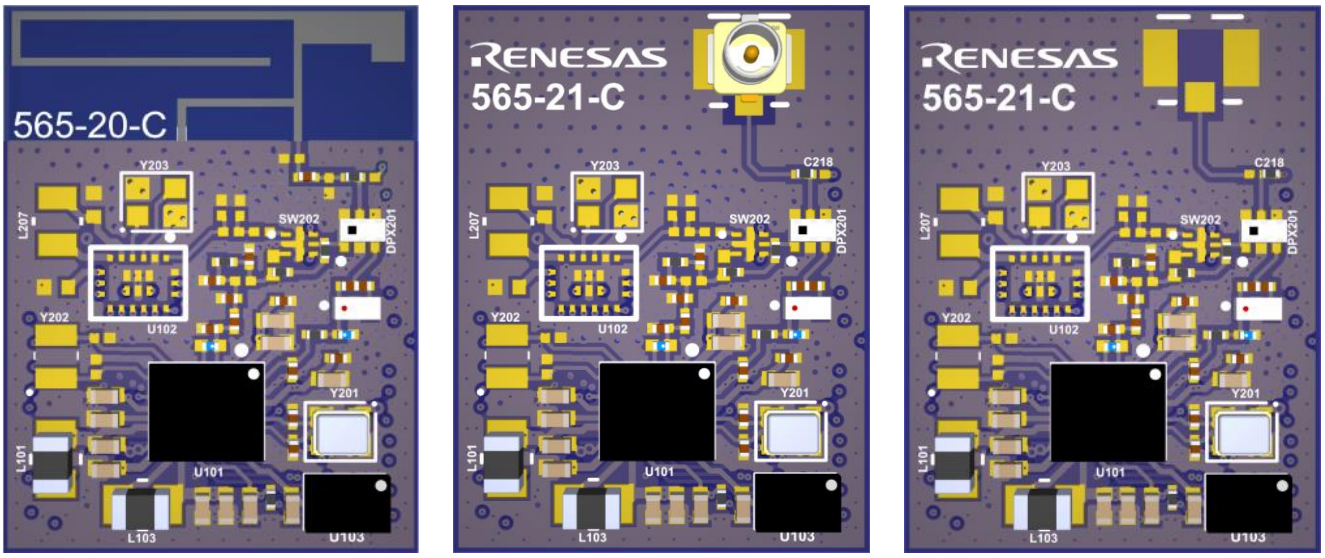


Figure 4. Renesas RRQ61001 modules: RRQ61001-008 (left), RRQ61001-009 (center), and RRQ61001-010 (right)

3. Pinout

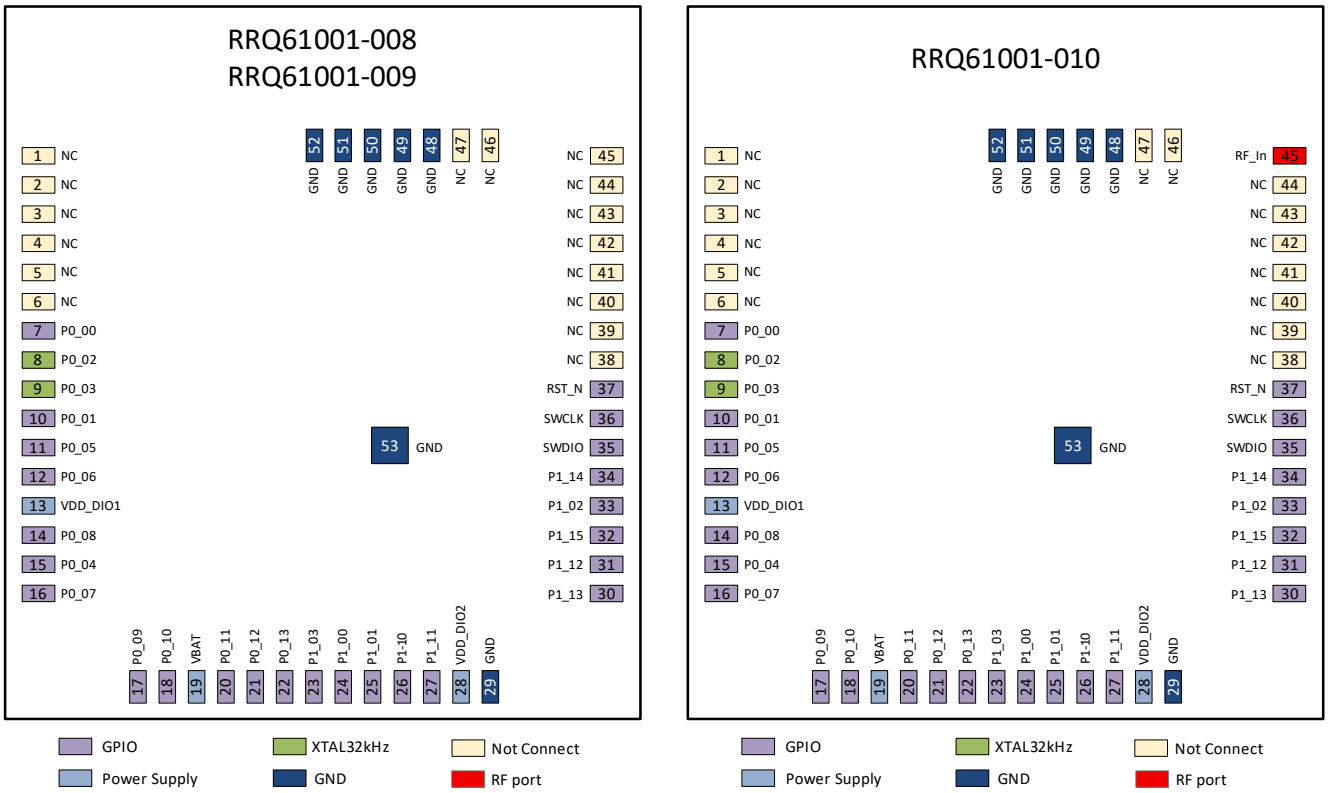


Figure 5. RRQ61001 pinout

3.1 Pin Description

Table 2: Pin description

#Pin	Pin name	Type	Related device	Description
1	NC			Leave unconnected.
2	NC			Leave unconnected.
3	NC			Leave unconnected.
4	NC			Leave unconnected.
5	NC			Leave unconnected.
6	NC			Leave unconnected.
7	P0_00	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: wake-up1 (VBAT power domain).
8	P0_02/XTAL32K_M	AIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: XTAL32K_M (VBAT power domain).
9	P0_03/XTAL32K_P	AIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: XTAL32K_P (VBAT power domain).
10	P0_01	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: wake-up2 (VBAT power domain).
11	P0_05	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: GPADC input channel 2, ATB for IQ signal test.
12	P0_06	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: GPADC input channel 3, ATB for IQ signal test.
13	VDD_DIO1	AI	RA6W1	Digital I/O power: 1.8~3.3 V (typ).

#Pin	Pin name	Type	Related device	Description
14	P0_08	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
15	P0_04	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: GPADC input channel 1, ATB for IQ signal test.
16	P0_07	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. Analog sharing: GPADC input channel 4, ATB for IQ signal test.
17	P0_09	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
18	P0_10	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
19	VBAT	AI	RA6W1	Battery input: 1.8~3.6 V.
20	P0_11	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
21	P0_12	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
22	P0_13	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
23	P1_03	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
24	P1_00	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
25	P1_01	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
26	P1_10	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
27	P1_11	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
28	VDD_DIO2	AI	RA6W1	Digital IO power: 1.8~3.3 V (typ).
29	GND	GND	COMMON	Ground.
30	P1_13	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
31	P1_12	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
32	P1_15	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. ATB for analog test.
33	P1_02	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.
34	P1_14	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor. ATB for analog test.
35	SWDIO	DIO	RA6W1	INPUT. Serial Wire Debug clock.
36	SWCLK	DIO	RA6W1	INPUT/OUTPUT. Serial Wire Debug data I/O.
37	RST_N	DIO	RA6W1	INPUT. Device reset (active LOW). (VBAT power domain).
38	NC			Leave unconnected.
39	NC			Leave unconnected.
40	NC			Leave unconnected.
41	NC			Leave unconnected.
42	NC			Leave unconnected.
43	NC			Leave unconnected.
44	NC			Leave unconnected.
45	NC or RF_in	-	-	RRQ61001-008: No Connect. RRQ61001-009: No Connect. RRQ61001-010: RF_in
46	NC			Leave unconnected.
47	NC			Leave unconnected.
48	GND	GND	COMMON	Ground.
49	GND	GND	COMMON	Ground.

#Pin	Pin name	Type	Related device	Description
50	GND	GND	COMMON	Ground.
51	GND	GND	COMMON	Ground.
52	GND	GND	COMMON	Ground.
53	GND	GND	COMMON	Ground.

4. System Overview

GPIO and Programmable Pin Assignment

By default, all digital I/O pins for the Wi-Fi Subsystem are defined as GPIOs to give a total of 26 configurable I/Os. These can be configured by software to be mapped to any of the supported digital peripherals. High performance interfaces such as OQSPI, QSPI, SDIO, and eMMC have fixed mapping whereas all other interfaces can be mapped to any pin through the programmable pin assignment (PPA) block.

Octa/Quad SPI Controller (OQSPI)

The OQSPI interfaces to external Quad or Octa Flash devices which store the applications code and data. The controller provides a zero-overhead secure eXecute In Place (XiP) interface which decrypts the code/data on the fly at up to 80 MHz. This allows for the code/data to be stored securely in Flash and is only accessible internally to the device. The OQSPI interface supports Flash devices of up to 64 MB.

Quad SPI Controller (QSPIC)

The QSPI controller can interface with an external non secure Flash or PSRAM. For increased read/write performance of the PSRAM, an 8 kB data cache with write-back capabilities can be enabled. The QSPI interface supports Flash or PSRAM devices of up to 64 MB.

UART, UART2, UART3

The UART interfaces are asynchronous serial interfaces with hardware flow control. The UART interfaces support both RS-232 and RS-485 physical protocols at data rates up to 5 Mbaud.

SPI, SPI2

The SPI interfaces are serial peripheral interfaces with master and slave capability for connection to SPI devices in master mode or being connected to by a host MCU in slave mode. They have separate RX/TX FIFOs (32 B) and support SPI clock rates up to 60 MHz.

I2C, I2C2

The I2C interfaces support master and slave capability with clock stretching and are used for communicating to sensors and/or a host MCU. Each controller includes a 32-location deep FIFO (8-bit RX, 9-bit TX). They support slow, fast, and high-speed modes up to 3.4 Mbps.

Debug Interface

A standard Serial Wire Debug (SWD) is provided to allow debugging of user applications during the development phase of a product. When development is complete, the device is set to secure mode and the SWD interface is disabled to protect the device from being tampered with.

SD/eMMC Host Controller

The SD/MMC Host Controller supports up to 80 MHz clock output in 1-bit, 4-bit or 8-bit data bus mode. In 4-bit mode, two SD/SDIO/MMC 4.41 cards can be supported and one SD card operating at 1.8 V. The SD/MMC Host Controller is compliant with the following features:

- Secure Digital (SD) memory version 3.0 and version 3.01
- Secure Digital I/O (SDIO) version 3.0
- Multimedia Cards (MMC version 4.41, eMMC version 4.5, and version 4.51).

SDIO Device Controller

The SDIO device controller is compliant with version 3.00 of the SD specification. It supports up to 80 MHz operation in 1-bit, 4-bit SD bus mode, and SPI bus mode. This is used to provide a high bandwidth interface to a host MCU or AP for high-speed communications of commands and Wi-Fi data.

5. Electrical Specification

5.1 Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, so functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification are not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

⚠	CAUTION
Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by the warranty.	

Table 3: Absolute maximum ratings

Parameter	Description	Conditions	Min	Max	Units
VBAT	Battery supply voltage on Pin 19		-0.2	3.7	V
VDD_DIO1	Digital I/O power on Pin 13		-0.2	3.7	V
VDD_DIO2	Digital I/O power on Pin 28		-0.2	3.7	V

5.2 Recommended Operating Conditions

Table 4: Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Units
VBAT	Battery supply voltage on Pin 19		1.9	3.3	3.6	V
VDD_DIO1	Digital I/O power on Pin 13		1.62		3.6	V
VDD_DIO2	Digital I/O power on Pin 28		1.62		3.6	V
T_A	Operating temperature range		-40		+85	°C

5.3 XTAL32kHz Oscillator

Table 5: XTAL32K - Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
$f_{CLK\_EXT\_XTAL32K}$	External clock frequency		10		100	kHz
$\Delta f_{XTAL\_XTAL32K}$	Crystal frequency tolerance (including aging)		-250		250	ppm
$ESR_{\_XTAL32K}$	Equivalent series resistance			100		kΩ
$C_{L\_XTAL32K}$	Load capacitance			10		pF
$C_{0\_XTAL32K}$ Note 2	Shunt capacitance			15		pF

Note 1 32.768 kHz crystal is optional, and it needs to be connected outside of the module.

Note 2 There are no-tunable capacitors inside. So, oscillation frequency must be adjusted using external capacitors.

5.4 XTAL 40MHz

Table 6: XTAL40MHz - Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
Frequency	Crystal Oscillation frequency			40.000		MHz
$\Delta f_{XTAL\_XTAL40M}$	Crystal frequency tolerance	After optional trimming including aging and temperature drift	-20		+20	ppm

5.5 RST_N Digital I/O - Recommended Operating Conditions

Table 7: RST_N digital I/O - Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
$V_{BAT\_RST\_N}$	Battery supply voltage		1.62		3.6	V
$V_{IH\_RST\_N\_VBAT\_1V8}$	High-level input voltage		1.13			V
$V_{IL\_RST\_N\_VBAT\_1V8}$	Low-level input voltage				0.92	V
$V_{IH\_RST\_N\_VBAT\_3V3}$	High-level input voltage		2.2			V
$V_{IL\_RST\_N\_VBAT\_3V3}$	Low-level input voltage				1.8	V

5.6 GPIO - Recommended Operating Conditions

Table 8: GPIO - Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{BAT_GPIO}	Battery supply voltage		1.62		3.6	V
$V_{IH\_GPIO\_1V8}$	High-level input voltage		1.26		1.8	V
$V_{IL\_GPIO\_1V8}$	Low-level input voltage		0		0.54	V
$V_{IH\_GPIO\_3V3}$	High-level input voltage		2		3.3	V
$V_{IL\_GPIO\_3V3}$	Low-level input voltage		0		0.8	V

5.7 GPIO - DC Characteristics

Table 9: GPIO - DC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
$V_{OH\_GPIO\_1V8}$	High-level output voltage		1.2		1.8	V
$V_{OL\_GPIO\_1V8}$	Low-level output voltage		0		0.4	V
$R_{PU\_GPIO\_1V8}$	Pull-up resistance		10		60	kΩ
$R_{PD\_GPIO\_1V8}$	Pull-down resistance		10		60	kΩ
$V_{OH\_GPIO\_3V3}$	High-level output voltage		2.4		3.3	V
$V_{OL\_GPIO\_3V3}$	Low-level output voltage		0		0.4	V

Parameter	Description	Conditions	Min	Typ	Max	Unit
$R_{PU\_GPIO\_3V3}$	Pull-up resistance		10		30	kΩ
$R_{PD\_GPIO\_3V3}$	Pull-down resistance		10		30	kΩ
$I_{IH\_GPIO\_3V3}$	High-level input current		-10	0.1	10	nA
$I_{IL\_GPIO\_3V3}$	Low-level input current		-10	-0.1	10	nA
$I_{IH\_GPIO\_1V8}$	High-level input current		-10	0.1	10	nA
$I_{IL\_GPIO\_1V8}$	Low-level input current		-10	-0.1	10	nA

5.8 Radio

5.8.1 Wi-Fi Receiver Characteristics

Table 10: Radio - 802.11.ax RX (2.4 GHz) - AC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
$P_{SENS\_RX2G\_11b\_1M}$	Sensitivity (8% PER for 11b rates, 10% PER for 11g/n/ax rates)	802.11b, 1 Mbps DSSS		-94.5		dBm
$P_{SENS\_RX2G\_11b\_2M}$		802.11b, 2 Mbps DSSS		-91.5		dBm
$P_{SENS\_RX2G\_11b\_11M}$		802.11b, 11 Mbps CKK		-84		dBm
$P_{SENS\_RX2G\_11g\_6M}$		802.11g, 6 Mbps OFDM		-87		dBm
$P_{SENS\_RX2G\_11g\_9M}$		802.11g, 9 Mbps OFDM		-86.5		dBm
$P_{SENS\_RX2G\_11g\_18M}$		802.11g, 18 Mbps OFDM		-83		dBm
$P_{SENS\_RX2G\_11g\_36M}$		802.11g, 36 Mbps OFDM		-77		dBm
$P_{SENS\_RX2G\_11g\_54M}$		802.11g, 54 Mbps OFDM		-70.5		dBm
$P_{SENS\_RX2G\_11n\_MCS0}$		802.11n, MCS0		-87		dBm
$P_{SENS\_RX2G\_11n\_MCS7}$		802.11n, MCS7		-67.5		dBm
$P_{SENS\_RX2G\_11ax\_MCS9}$		802.11ax, MCS9		-61		dBm

Table 11: Radio - 802.11.ax RX (5 GHz) - AC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
$P_{SENS\_RX5G\_11a\_6M}$	Sensitivity (10% PER for 11a/n/ac/ax rates)	802.11a, 6 Mbps OFDM		-86.5		dBm
$P_{SENS\_RX5G\_11a\_9M}$		802.11a, 9 Mbps OFDM		-86		dBm
$P_{SENS\_RX5G\_11a\_18M}$		802.11a, 18 Mbps OFDM		-83.5		dBm
$P_{SENS\_RX5G\_11a\_36M}$		802.11a, 36 Mbps OFDM		-77.5		dBm
$P_{SENS\_RX5G\_11a\_54M}$		802.11a, 54 Mbps OFDM		-71		dBm
$P_{SENS\_RX5G\_11n\_MCS0}$		802.11n, MCS0		-86.5		dBm
$P_{SENS\_RX5G\_11n\_MCS7}$		802.11n, MCS7		-67		dBm
$P_{SENS\_RX5G\_11ac\_MCS7}$		802.11ac, MCS7		-66.5		dBm

Parameter	Description	Conditions	Min	Typ	Max	Unit
$P_{SENS\_RX5G\_11ax\_MCS7}$		802.11ax, MCS7		-67		dBm

5.8.2 Wi-Fi Transmitter Characteristics

Table 12: Radio - 802.11ax TX (2.4 GHz) - AC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
$P_{O(MAX)\_11b\_1M}$	Maximum output power measured for EVM and SEM compliance Note 1	802.11b, 1 Mbps DSSS		15.5		dBm
$P_{O(MAX)\_11b\_2M}$		802.11b, 2 Mbps DSSS		15.5		dBm
$P_{O(MAX)\_11b\_5M5}$		802.11b, 5.5 Mbps CCK		16.5		dBm
$P_{O(MAX)\_11b\_11M}$		802.11b,11 Mbps CCK		16.5		dBm
$P_{O(MAX)\_11g\_6M}$		802.11g, 6 Mbps OFDM		16.5		dBm
$P_{O(MAX)\_11g\_54M}$		802.11g, 54 Mbps OFDM		13.5		dBm
$P_{O(MAX)\_11n\_MCS0}$		802.11n, MCS0		14		dBm
$P_{O(MAX)\_11n\_MCS7}$		802.11n, MCS7		12.5		dBm
$P_{O(MAX)\_11ax\_MCS9}$		802.11ax, MCS9		9		dBm
$P_{O(MAX)\_11b\_1M}$	Maximum output power measured for EVM compliance Note 1	802.11b, 1 Mbps DSSS		18.5		dBm
$P_{O(MAX)\_11b\_2M}$		802.11b, 2 Mbps DSSS		18		dBm
$P_{O(MAX)\_11b\_5M5}$		802.11b, 5.5 Mbps CCK		18.5		dBm
$P_{O(MAX)\_11b\_11M}$		802.11b,11 Mbps CCK		18		dBm
$P_{O(MAX)\_11g\_6M}$		802.11g, 6 Mbps OFDM		18		dBm
$P_{O(MAX)\_11n\_MCS0}$		802.11n, MCS0		18.5		dBm
Δf_{C_2G4}	Transmit center frequency accuracy		-20		20	ppm

Note 1 For each variant, the supported transmit power levels for regulatory radio compliance are determined by the country_code setting in SW.

Table 13: Radio - 802.11ax TX (5 GHz) - AC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
$P_{O(MAX)\_11a\_6M}$	Maximum output power measured for EVM and SEM compliance Note 1	802.11a, 6 Mbps OFDM		14.5		dBm
$P_{O(MAX)\_11a\_54M}$		802.11a, 54 Mbps OFDM		12.5		dBm
$P_{O(MAX)\_11n\_MCS0}$		802.11n, MCS0		14		dBm
$P_{O(MAX)\_11n\_MCS7}$		802.11n, MCS7		10.5		dBm
$P_{O(MAX)\_11ac\_MCS7}$		802.11ac, MCS7		10.5		dBm
$P_{O(MAX)\_11ax\_MCS7}$		802.11ax, MCS7		10.5		dBm
$P_{O(MAX)\_11a\_6M}$	Maximum output power measured for EVM compliance Note 1	802.11a, 6 Mbps OFDM		18		dBm
$P_{O(MAX)\_11n\_MCS0}$		802.11n, MCS0		18		dBm
Δf_{C_5G0}	Transmit center frequency accuracy		-20		20	ppm

5.9 Current Consumption

CPU clock = 160 MHz, VBAT = 3.3 V, at 25 °C

Table 14: Current Consumption in Active State - 2.4 GHz, Ch1

Parameter	Condition			Min	Typ.	Max	Unit
Active	TX Per SEM	1 Mbps DSSS	At 16.5 dBm	-	370	-	mA
		6Mbps OFDM	At 15 dBm	-	285	-	
	TX Per EVM	1 Mbps DSSS	At 18 dBm	-	492	-	
		6 Mbps OFDM	At 18 dBm	-	492	-	
		N MCS7	At 13.5 dBm	-	226	-	
		AX MCS9	At 9.5 dBm	-	150	-	
	RX	No signal Note 1		-	47	-	
		1 Mbps DSSS Note 1		-	50	-	
		1 Mbps DSSS		-	61	-	
		N MCS7		-	60	-	
		AX MCS9		-	60	-	

Note 1 CPU clock = 40 MHz, Low Current Mode for DTIM.

Table 15: Current Consumption in Active State - 5 GHz, Ch36

Parameter	Condition			Min	Typ.	Max	Unit
Active	TX Per SEM	6 Mbps OFDM	At 14 dBm	-	340	-	mA
	TX Per EVM	6 Mbps OFDM	At 17.5 dBm	-	613	-	
		AX MCS7	At 10 dBm	-	224	-	
	RX	No signal Note 1		-	55	-	
		6 Mbps OFDM Note 1		-	59	-	
		6 Mbps OFDM		-	67	-	
		AX MCS7		-	67	-	

Note 1 CPU clock = 40 MHz, Low Current Mode for DTIM.

5.10 ESD Ratings

Table 16: ESD performance

Reliability test	Standards	Test conditions	Result
Human Body Model (HBM)	ANSI/ESDA/JEDEC JS-001-2017	± 2,000 V	Pass
Charge Device Mode (CDM)	ANSI/ESDA/JEDEC JS-002-2018	± 500 V	Pass

6. Application Information

Due to high scale integration, the RRQ61001 requires minimum resources to operate. Power supply lines, an optional 32.768 kHz crystal and an antenna for the RRQ61001-009 variant.

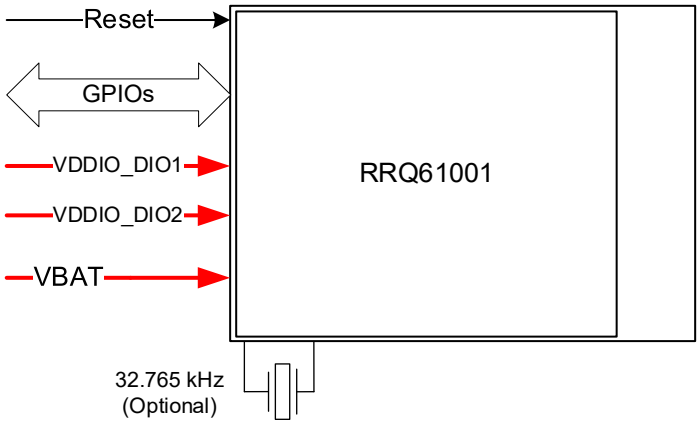


Figure 6. Hardware setup of RRQ61001

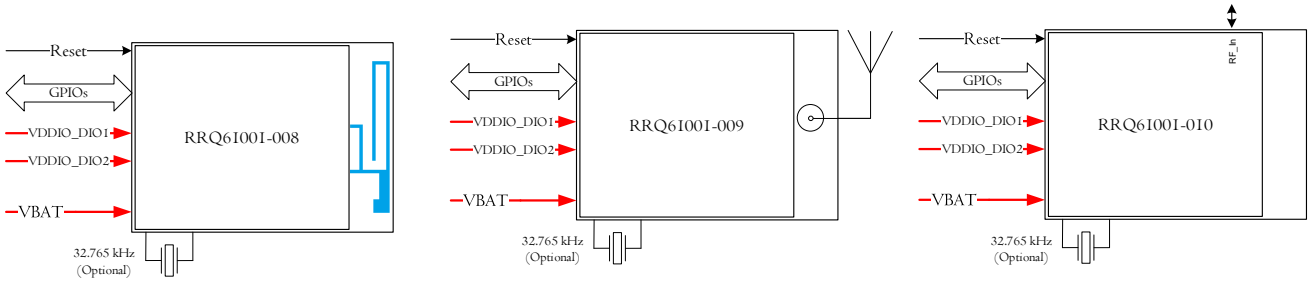


Figure 7. Hardware setup of RRQ61001-008 (left), RRQ61001-009 (center), and RRQ61001-010 (right)

For flexibility, all available GPIOs of the RA6W1 MCU are provided externally, to the peripheric pins of the RRQ61001. There are 26 pins available, including Reset, SWD interface, XTAL32 kHz crystal, and GPIOs.

6.1 Power Supply

The RRQ61001 provides three power pins, VBAT, VDDIO_DIO1, and VDDIO_DIO2.

- VBAT is the power source of two DCDC converters. It supplies RST_n and P0_00 to P0_03.
- VDDIO_DIO1 supplies P0_04 to P0_13.
- VDDIO_DIO2 supplies P1_10 to P1_15, SWCLK, SWDIO of Wi-Fi subsystem.

No external decoupling capacitors are required.

Internally to the RRQ61001, VDDIO_FDIO (1.8 V) is generated. This voltage rail is used for supplying the Flash memory (also placed internally the module). VDDIO_FDIO is not available externally, but it supplies P1_00 to P1_03.

6.2 XTAL 32 kHz

For the RRQ61001 to support ultra-low power operation like DPM and TWT, an external 32 kHz XTAL must be connected to the RRQ61001 module to pins P0_02 and P0_03. The 32 kHz XTAL must be placed from the RRQ61001 at a distance, not higher than 4 mm. Recommended crystal specification is shown in Table 17.

Table 17: XTAL32K - Recommended specification

Parameter	Description	Value
Frequency	Crystal frequency	32.768 kHz
Frequency tolerance	Crystal frequency tolerance	±20 ppm
ESR	Equivalent series resistance	100 kΩ
CL	Load capacitor	10 pF

Two shunt capacitors to GND, 15 pF each, are required for ensuring proper operation of the crystal.

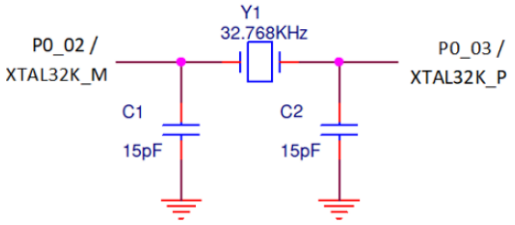


Figure 8. 32.768 kHz crystal configuration

External clock can also be connected to the RRQ61001 module. P0_02 must be used for the input of the external clock. In this case, for utilizing the clock direct input mode, the internal XTAL circuit must be disabled by setting CLK_XTAL32K_REG register to 0x18. P0_03 can be used as GPIO.

6.3 GPIOs and Programmable Pin Assignment

RRQ61001 provides 26 GPIOs. The functions assigned to the GPIO pins are fully configurable and are controlled by the Programmable Pin Assignment (PPA). PPA provides a multiplexing function for the I/O pins of the on-chip peripherals. Any of the peripheral input or output signals can be freely mapped to any available GPIO port, except ADC, QSPI, SDIO, eMMC and SWD which have fixed assignment. Information for the peripherals can be found in the *RA6W1 Datasheet*.

When a pin is configured to function as a GPIO, it has the following configurable features:

- Direction (input/output)
- Push pull/Open drain
- Pull-up/Pull-down
- Drive strength (2 mA, 4 mA, 8 mA, 14 mA)
- Slew rate (Fast/Slow)
- Input selection (CMOS/Schmitt Trigger).

After a power on reset (POR), the default state of the pins is shown in Table 18.

Table 18: Pin configuration

Pin	Support wake-up	Power domain	Alternate function 0	Alternate function 1	Alternate function 2	POR default
RST_N		VBAT	RST_N			RST_N
P0_00	Yes	VBAT	RTC_WAKE_UP			GPIO
P0_01		VBAT	sen_out			sen_out
P0_02		VBAT	xtal32k_m			xtal32k_m
P0_03		VBAT	xtal32k_p			xtal32k_p
P0_04	ana wake	VDDIO_DIO1	ADC0		eMMC_DIO4	GPIO
P0_05	ana wake	VDDIO_DIO1	ADC1		eMMC_DIO5	GPIO
P0_06	ana wake	VDDIO_DIO1	ADC2		eMMC_DIO6	GPIO
P0_07	ana wake	VDDIO_DIO1	ADC3	MCLK	eMMC_DIO7	GPIO
P0_08	Yes	VDDIO_DIO1	QSPIR_CLK	SDIO0_CLK	eMMC_CLK	GPIO

Pin	Support wake-up	Power domain	Alternate function 0	Alternate function 1	Alternate function 2	POR default
P0_09	Yes	VDDIO_DIO1	QSPIR_CS	SDIO0_CMD	eMMC_CMD	GPIO
P0_10	Yes	VDDIO_DIO1	QSPIR_D0	SDIO0_D0	eMMC_DIO0	GPIO
P0_11	Yes	VDDIO_DIO1	QSPIR_D1	SDIO0_D1	eMMC_DIO1	GPIO
P0_12	Yes	VDDIO_DIO1	QSPIR_D2	SDIO0_D2	eMMC_DIO2	GPIO
P0_13	Yes	VDDIO_DIO1	QSPIR_D3	SDIO0_D3	eMMC_DIO3	GPIO
P1_00		1.8V		eMMC_DIO4		GPIO
P1_01		1.8V		eMMC_DIO5		GPIO
P1_02		1.8V		eMMC_DIO6		GPIO
P1_03		1.8V		eMMC_DIO7		GPIO
P1_10	Yes	VDDIO_DIO2	eMMC_CMD	SDIO1_CMD		GPIO
P1_11	Yes	VDDIO_DIO2	eMMC_CLK	SDIO1_CLK		GPIO
P1_12	Yes	VDDIO_DIO2	eMMC_DIO0	SDIO1_D0		GPIO
P1_13	Yes	VDDIO_DIO2	eMMC_DIO1	SDIO1_D1		GPIO
P1_14		VDDIO_DIO2	eMMC_DIO2	SDIO1_D2		GPIO
P1_15		VDDIO_DIO2	eMMC_DIO3	SDIO1_D3		GPIO
P1_16			SWCLK			SWCLK
P1_17			SWDIO			SWDIO

6.4 Debugging Interface

Either UART or SWD interfaces can be used:

- Reset: RST_n (pin 37), active low. If not controlled externally a 10K pull-up to VBAT must be applied.
- SWD: SWCLK (pin 36) and SWDIO (pin 35).
- UART: P0_00 (pin 7) and P0_01 (pin 10) assigned to URX and UTX as booting UART for the Wi-Fi.

SWDIO/SWCLK accompany components for RRQ61001 modules:

- RRQ61001 modules require passive components to be assigned on SWDIO and SWCLK lines, pins 36 and 35 respectively.
- The components must be placed to the carrier board, closest possible to the pads of the module.

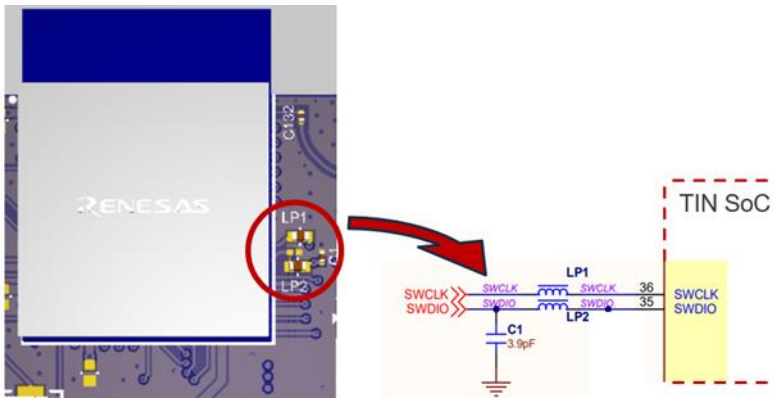


Figure 9. Components on carrier board for SWDIO (pin 35) and SWCLK (pin 36)

Table 19. Suggested components for SWDIO and SWCLK

Description	Component	Part number
SWDIO Capacitor	C1	GJM1555C1H3R9CB01
SWDIO Ferrite bead	LP2	BLM15AG601SN1D
SWCLK Ferrite bead	LP1	BLM15AG601SN1D

6.5 RF Considerations

As Radio circuit is incorporated into the module, there are very few considerations for Radio implementation:

- RRQ61001-010 module provides an RF pin (pin45, RF_port). Connections from RF port to RF connector or antenna must be done through a capacitor 100 pF.
- There is no RF pin available for RRQ61001-009, RRQ61001-008.
- For RRQ61001-008 (antenna version of the module), you must place the module on a host PCB following the design guidelines, see Section 7.

7. Design Guidelines

7.1 RRQ61001-008

The RRQ61001-008 modules come with an integrated PCB trace antenna. The antenna area is 15 mm x 5 mm. The antenna's Voltage Standing Wave Ratio (VSWR) and efficiency depend on the installation location.

The RF front end is optimized to achieve the maximum possible efficiency for various installation positions of the module on a host PCB. For optimum performance, follow the guidelines described in Section 7.1.1.

7.1.1 Installation Location

For optimum performance, install the module at the edge of a host PCB with the antenna edge facing out. The module can be located on either of the outer corners or in the middle of the host PCB with equivalent performance.

The antenna should have 4.0 mm free space in all directions. Copper or laminate in the proximity of the PCB trace antenna affects the efficiency of the antenna. Laminate or copper under the antenna should be avoided as it severely affects the performance of the antenna. The antenna keep-out area is shown in Figure 10.

Metals close to the antenna degrade the antenna's performance. The amount of degradation depends on the host system's characteristics.

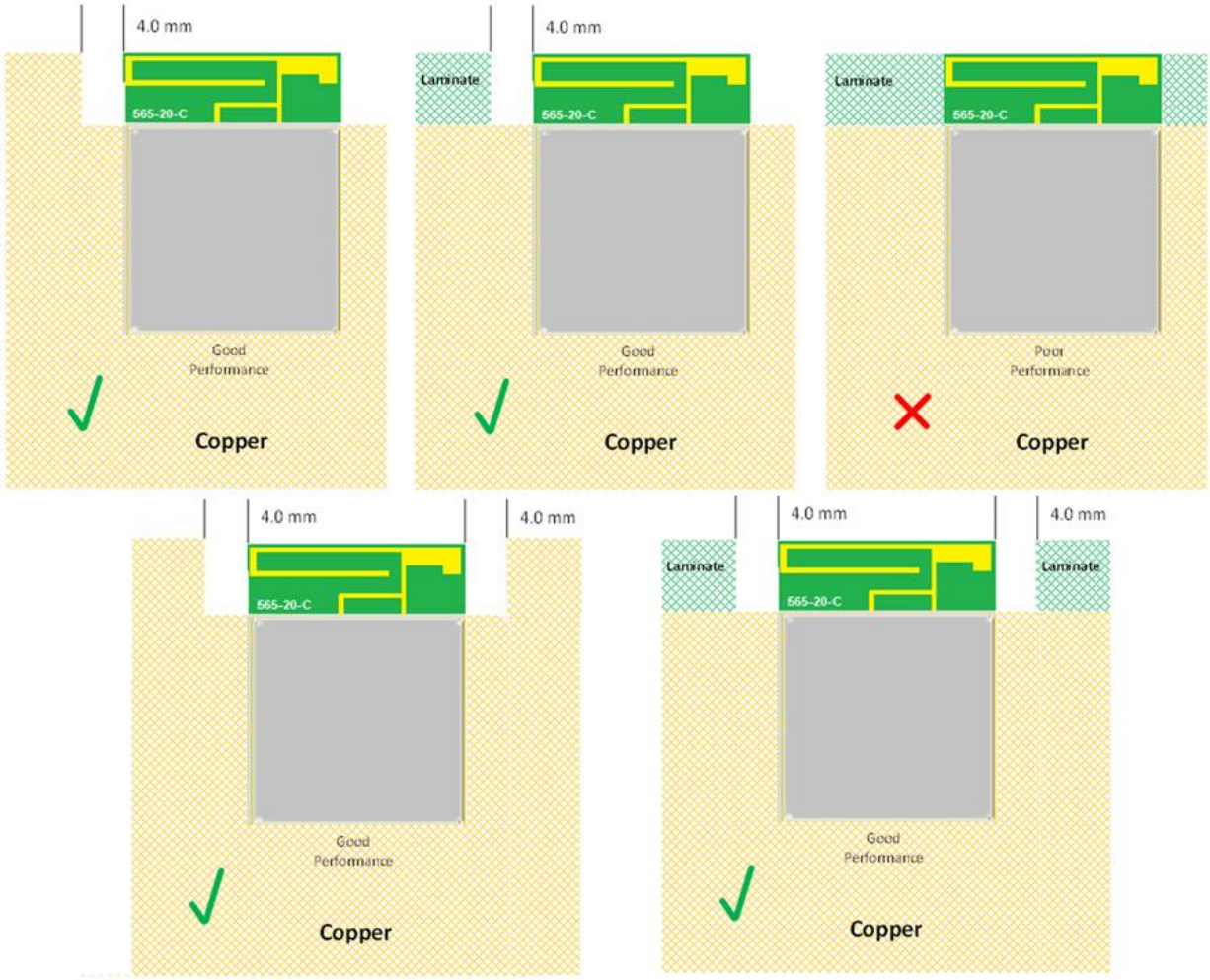


Figure 10. Antenna performance in proximity of copper and laminate

7.1.2 Placement of RRQ61001-008 Module on Metallic Ground Plane

Placing RRQ61001-008 above or below of a Ground plane presents negligible impact on antenna resonance, if a cutout of the size of the antenna keep out is applied on the GND plane, under the antenna, see Figure 11.

Simulations of a metallic plane (with the same size of the carrier board) with the same opening of the area of the antenna module, placed in the Front and in the Back side of the Carrier Board, see Figure 11, for different separation distance between them, shown that both resonances (2.45 and 5.5 GHz) are not tuning and preserve the good matching, see Figure 12.

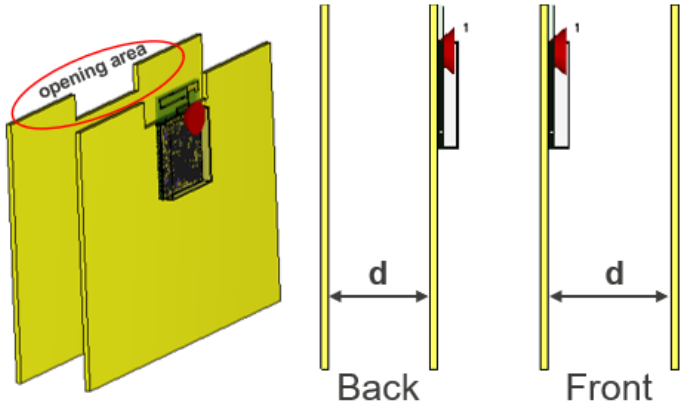


Figure 11. RRQ61001-008 placed above a GND metallic plane above or below, in a distance (d)

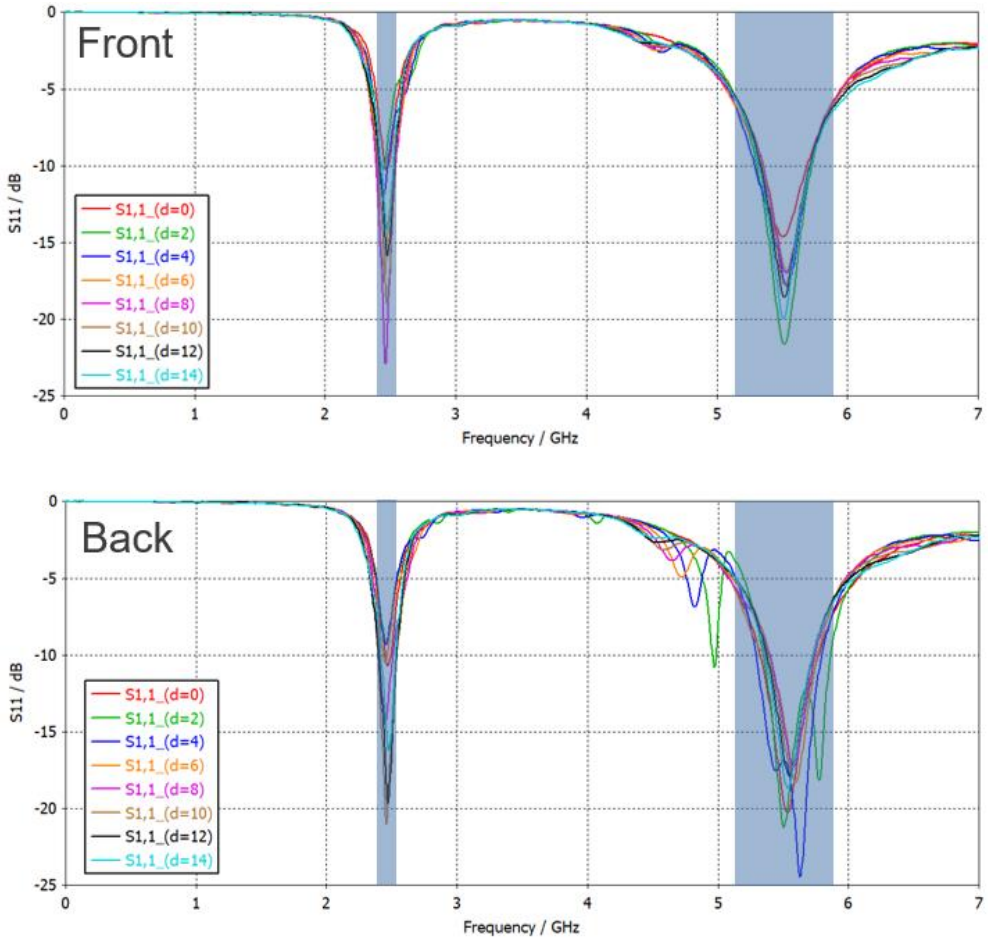


Figure 12. Antenna resonance for distances (d) 0 to 14 mm between RRQ61001-008 module and GND plane

7.2 RRQ61001-009

7.2.1 Installation Location

Because the module has a u.FL connector, it has no placement restriction for optimum antenna performance.

7.2.2 Layout considerations for RRQ61001-009 Module

Ensure that the module is properly grounded. No special layout considerations.

7.3 RRQ61001-010

7.3.1 Installation Location

The module must be placed close to the edge of the PCB to minimize the distance of the RF pad to the external SMA connector.

7.3.2 Layout Considerations for RRQ61001-010 Module

A 50-Ω RF trace should be designed from module's RF pad to SMA connector. The RF signal from the RF pad is routed to the SMA connector and external antenna using a coplanar waveguide with ground (CPW-G) structure. CPW-G structures offer the maximum amount of isolation and the best possible shielding to the RF lines. In addition to the ground on the L1 layer, placing GND vias along the line also provides additional shielding.

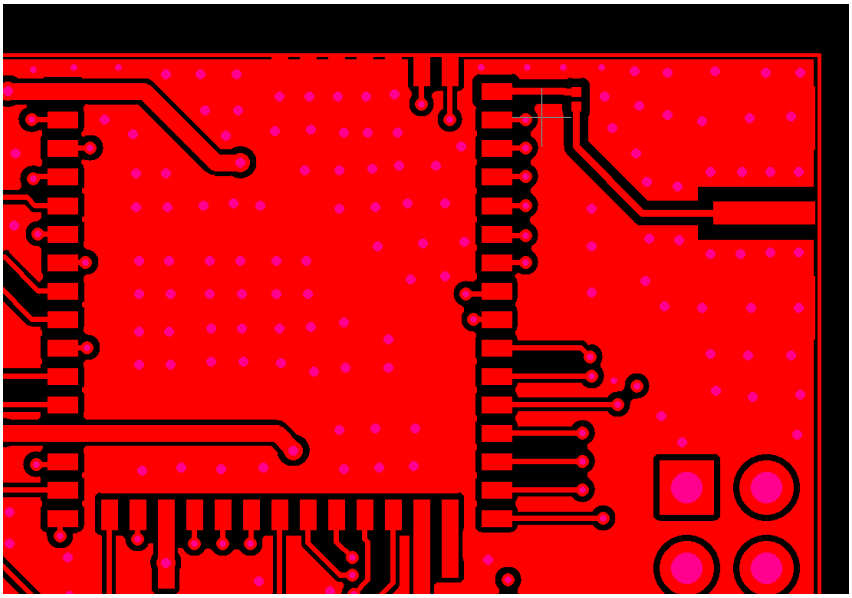


Figure 13: RF trace of coplanar waveguide with GND and via stitching (top view)

Figure 14 shows a cross section of the coplanar waveguide with the critical dimensions.

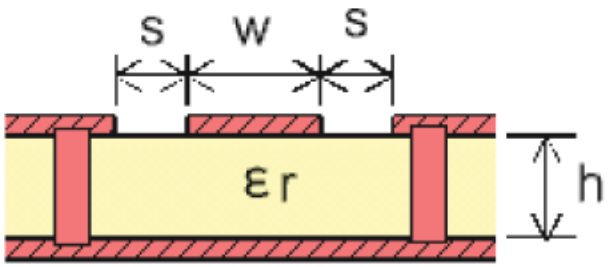


Figure 14: Coplanar waveguide (cross section)

8. RRQ61001-008 Printed Antenna Performance

The RRQ61001-008 printed antenna performance is characterized in terms of Voltage Standing Wave Ratio (VSWR), antenna efficiency and radiation patterns, when the module is positioned at three locations; left, middle, and right on a reference test board with dimensions 70 x 50 mm, Figure 15.

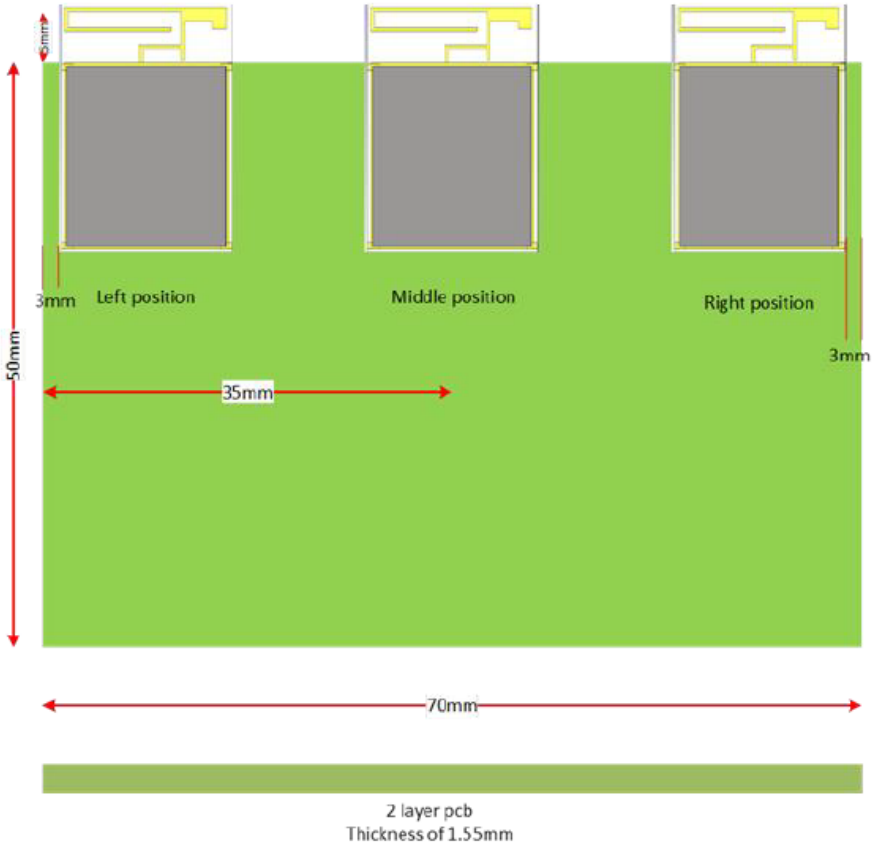


Figure 15. Module is positioned at right, middle, and left position on a reference board with dimension 70 x 50 mm

8.1 VSWR Measurements

The antenna VSWR measurements for the three installation positions are shown in Figure 16, Figure 17, and Figure 18.

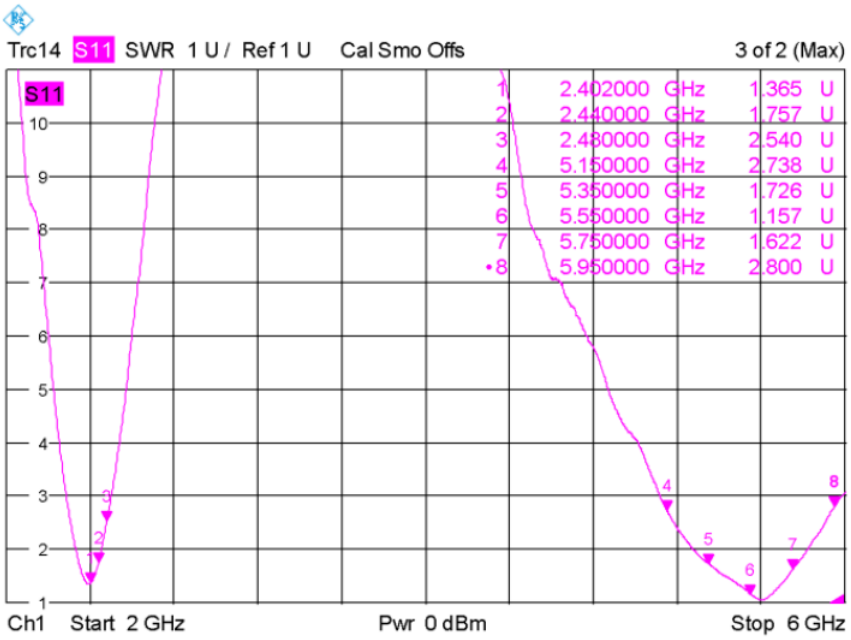


Figure 16. VSWR Renesas RRQ61001-008 Wi-Fi module antenna, module in right position

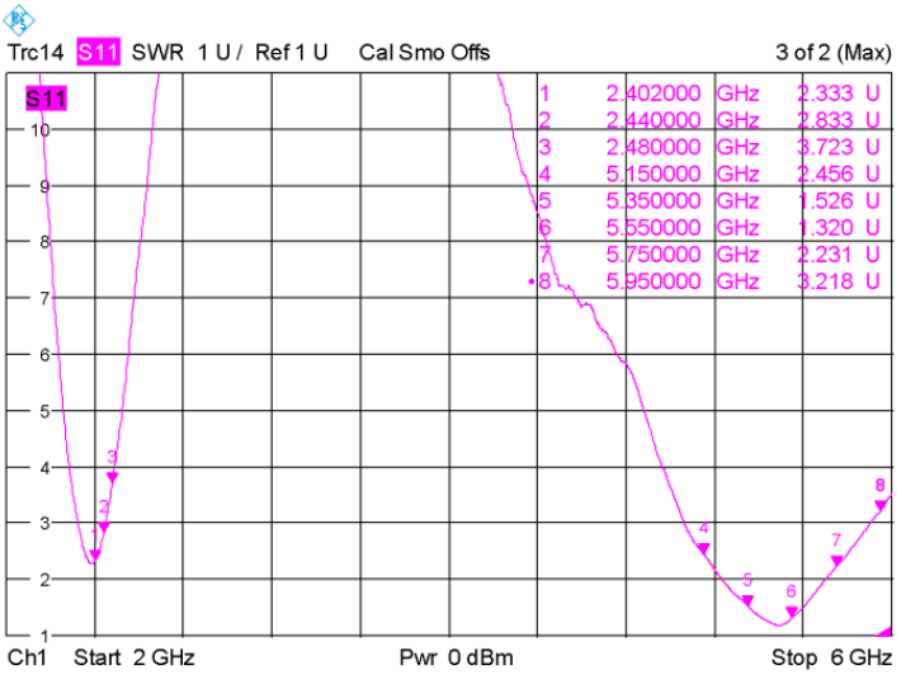


Figure 17. VSWR Renesas RRQ61001-008 Wi-Fi module antenna, module in middle position

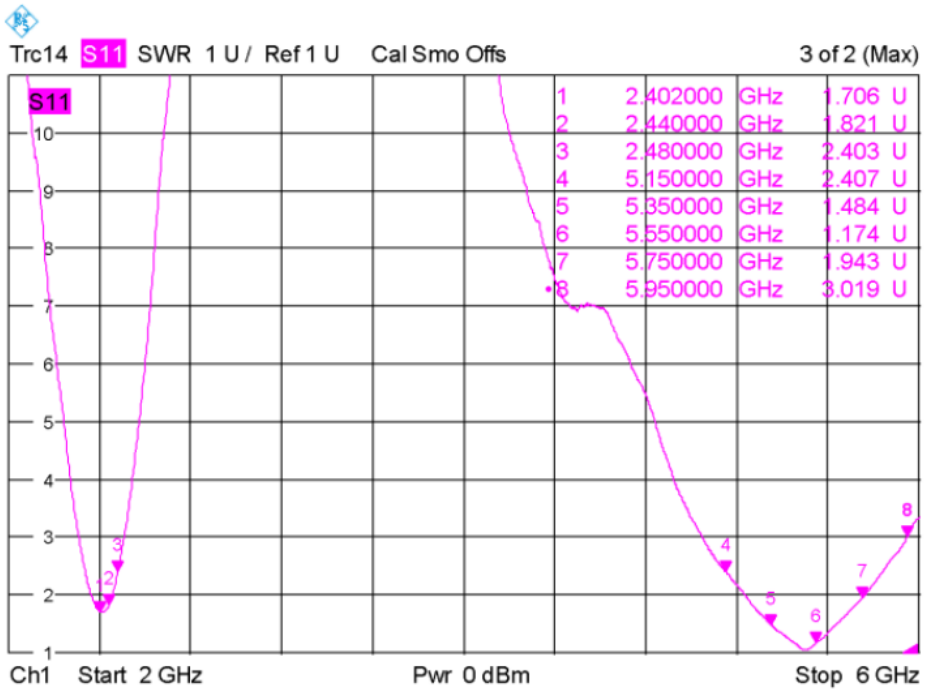


Figure 18. VSWR Renesas RRQ61001-008 Wi-Fi module antenna, module in left position

8.2 Antenna Efficiency

The antenna efficiency measurements are carried out in a Satimo SG-23 6 GHz Stargate Antenna Test Chamber. The antenna efficiency, ε_T, is the ratio of the power delivered at the 50Ω antenna interface, Pt, relative to the power radiated from the antenna, $Pradiated$. ($\varepsilon_T = Pradiated / Pt$).

Table 20 summarizes the antenna efficiency at different installation locations on a host PCB as shown in Figure 15.

Table 20: Antenna efficiency vs RRQ61001-x08 module positions

Freq	Position # 1 (Left)		Position # 2 (Middle)		Position # 3 (Right)	
	Antenna efficiency		Antenna efficiency		Antenna efficiency	
[MHz]	[%]	[dB]	[%]	[dB]	[%]	[dB]
2402	69.18	-1.6	44.67	-3.5	63.10	-2.0
2442	67.61	-1.7	42.66	-3.7	58.88	-2.3
2480	60.26	-2.2	38.02	-4.2	54.95	-2.6
5170	75.86	-1.2	77.62	-1.1	74.13	-1.3
5250	87.10	-0.6	89.13	-0.5	85.11	-0.7
5550	91.20	-0.4	87.10	-0.6	79.43	-1.0
5735	85.11	-0.7	79.43	-1.0	70.79	-1.5
5835	75.86	-1.2	74.13	-1.3	64.57	-1.9

Figure 19. Satimo SG-23 6 GHz Stargate Antenna Test Chamber

8.3 Radiation Pattern

The antenna radiation pattern measurements are carried out in an anechoic chamber. Radiation patterns are presented for three measurement planes: XY-, XZ-, and YZ- planes with horizontal and vertical polarization of the receiving antenna.

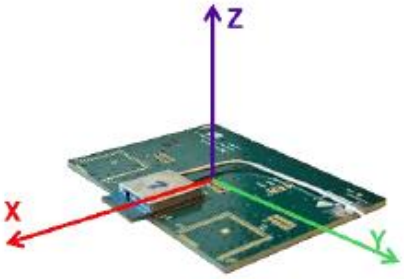


Figure 20. Measurements plane definitions

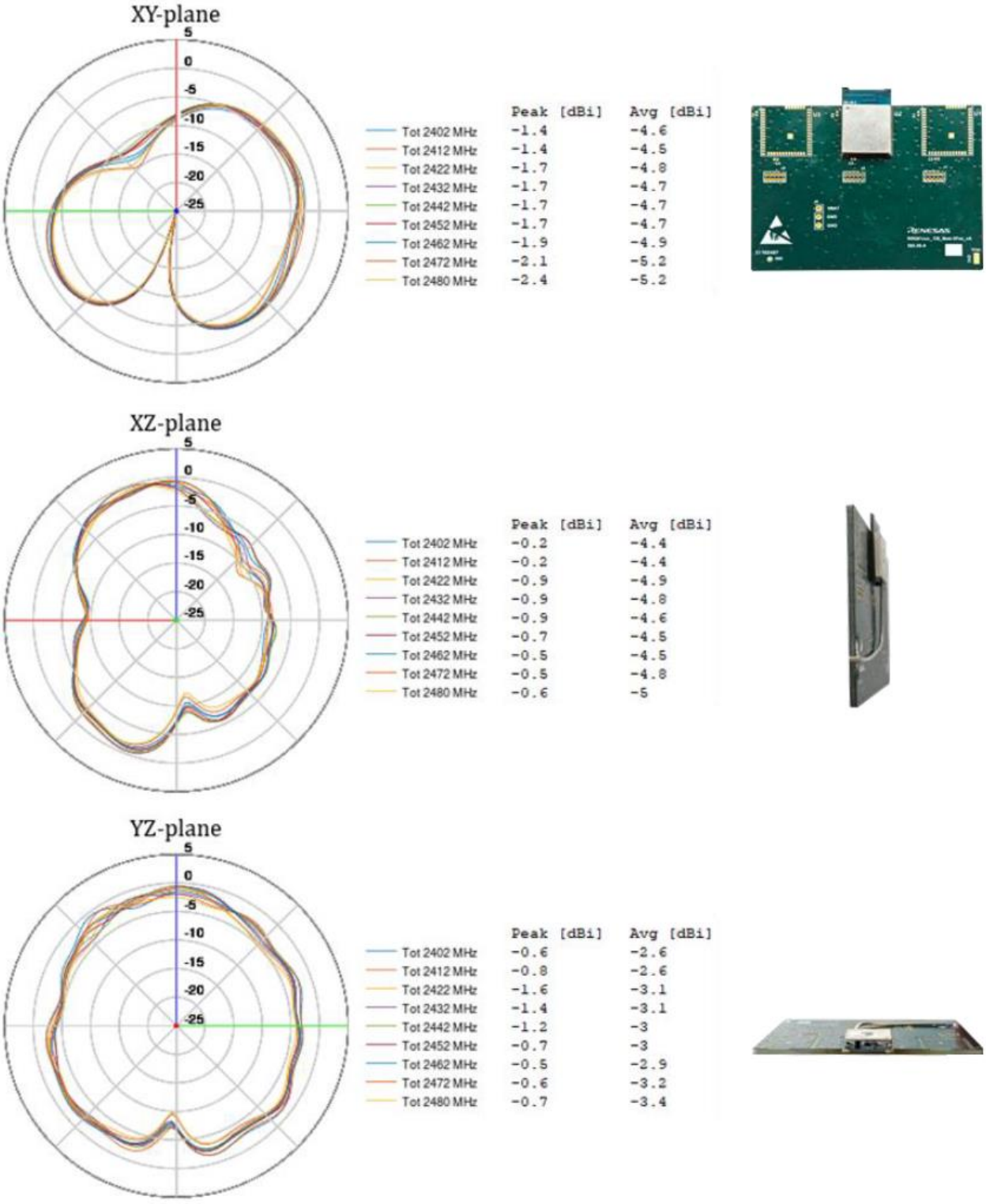
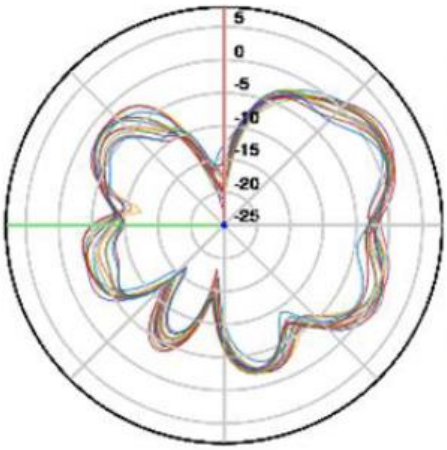
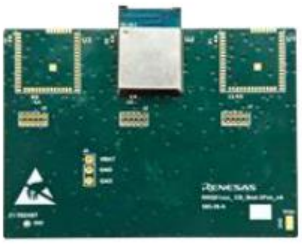


Figure 21. 2D radiation patterns for 2.4 GHz band for RRQ61001-008 module

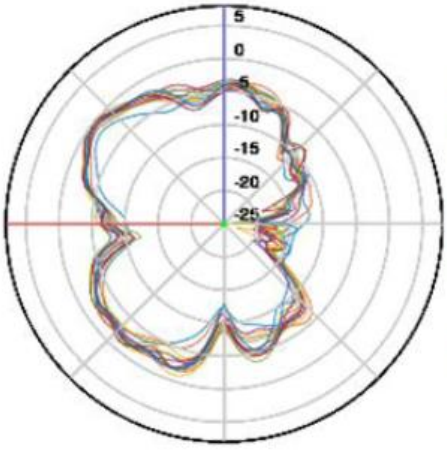
XY-plane



	Peak [dBi]	Avg [dBi]
Tot 5150 MHz	1.7	-3.4
Tot 5210 MHz	2.5	-3
Tot 5270 MHz	2.2	-2.9
Tot 5330 MHz	3.3	-2.4
Tot 5490 MHz	2.6	-3
Tot 5550 MHz	2.5	-2.8
Tot 5610 MHz	2.1	-3.1
Tot 5670 MHz	2.5	-3.1
Tot 5730 MHz	1.6	-3.7
Tot 5775 MHz	2.1	-3.6
Tot 5835 MHz	1.9	-3.8
Tot 5895 MHz	1.6	-4.4
Tot 5955 MHz	1.3	-4.6

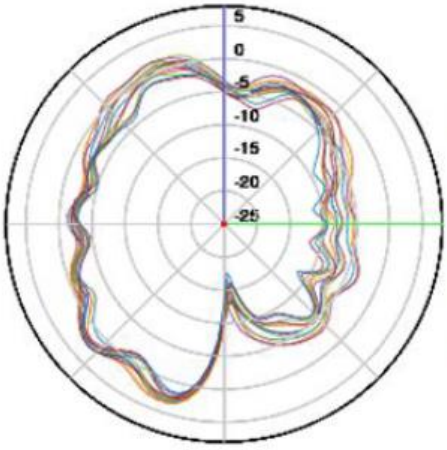


XZ-plane



	Peak [dBi]	Avg [dBi]
Tot 5150 MHz	-1.8	-6.5
Tot 5210 MHz	-1.1	-5.7
Tot 5270 MHz	-0.9	-5.8
Tot 5330 MHz	-0.1	-5.1
Tot 5490 MHz	0	-5.1
Tot 5550 MHz	0.1	-5.1
Tot 5610 MHz	-0.5	-5.4
Tot 5670 MHz	-0.4	-5.1
Tot 5730 MHz	-0.4	-4.9
Tot 5775 MHz	-0.7	-5.2
Tot 5835 MHz	-0.2	-5
Tot 5895 MHz	-0.3	-5.2
Tot 5955 MHz	-0.6	-5.3

YZ-plane



	Peak [dBi]	Avg [dBi]
Tot 5150 MHz	2.4	-2.4
Tot 5210 MHz	3.4	-1.6
Tot 5270 MHz	3.4	-1.6
Tot 5330 MHz	3.4	-1.4
Tot 5490 MHz	2.8	-2.1
Tot 5550 MHz	2.6	-2.1
Tot 5610 MHz	3.1	-2.3
Tot 5670 MHz	3.4	-2.6
Tot 5730 MHz	3.4	-2.6
Tot 5775 MHz	1.8	-3.1
Tot 5835 MHz	2.5	-3.1
Tot 5895 MHz	2.4	-3.4
Tot 5955 MHz	2.7	-3.5

Figure 22. 2D radiation patterns for 5 GHz band for RRQ61001-008 module

9. Mechanical Specifications

9.1 Mechanical Dimensions and Land Pattern

The module's dimensions are accessible from the Renesas website, 53-Module.

9.2 Marking

Figure 23. RRQ61001 modules shield marking

The shield marking consists of:

- Brand name: Renesas
- Model name: for example, RRQ61001-008, RRQ61001-009
- QR code
- Date code: YYWW, where:
  - YY – the assembly year.
  - WW – the workweek when the device was assembled.
- Certification marks such as CE, UKCA logo, FCC, IC, ANATEL, SRRC IDs, and so on are engraved on the grayed-out area according to regulatory requirements.

10. Packaging Information

10.1 Tape and Reel

Reel Modules: QTY-500 Modules.

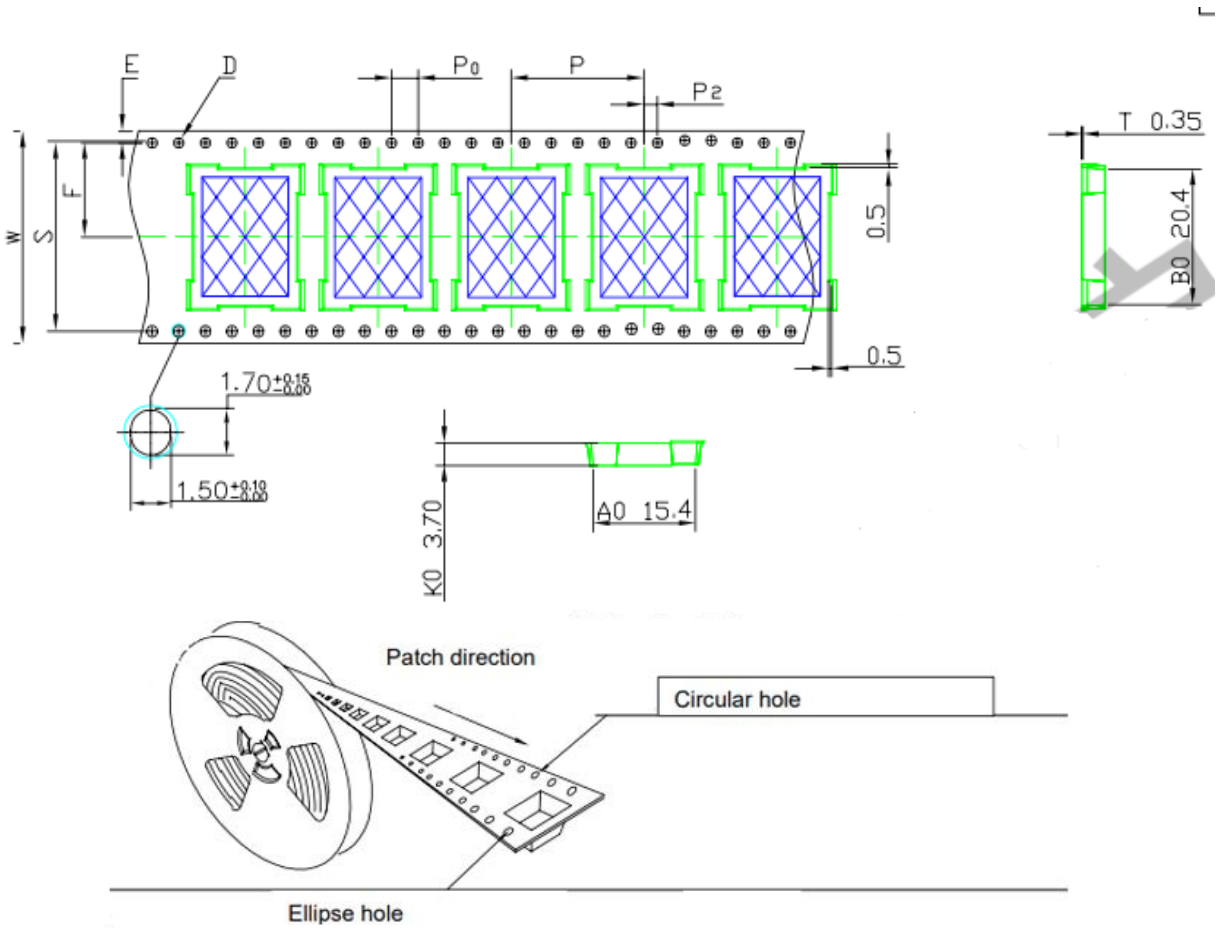


Figure 24. Tape and reel

10.2 Labeling

On each reel, a set of labels are placed. The information label shows information regarding the batch number, date code, reel date and number, quantity (MOQ 500), and part number as shown in Figure 25.

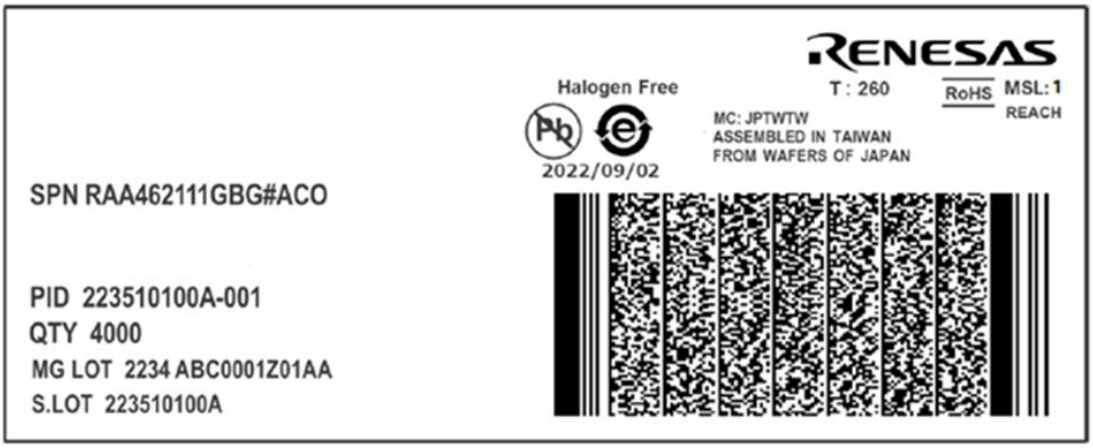


Figure 25. Reel part information label

11. Soldering

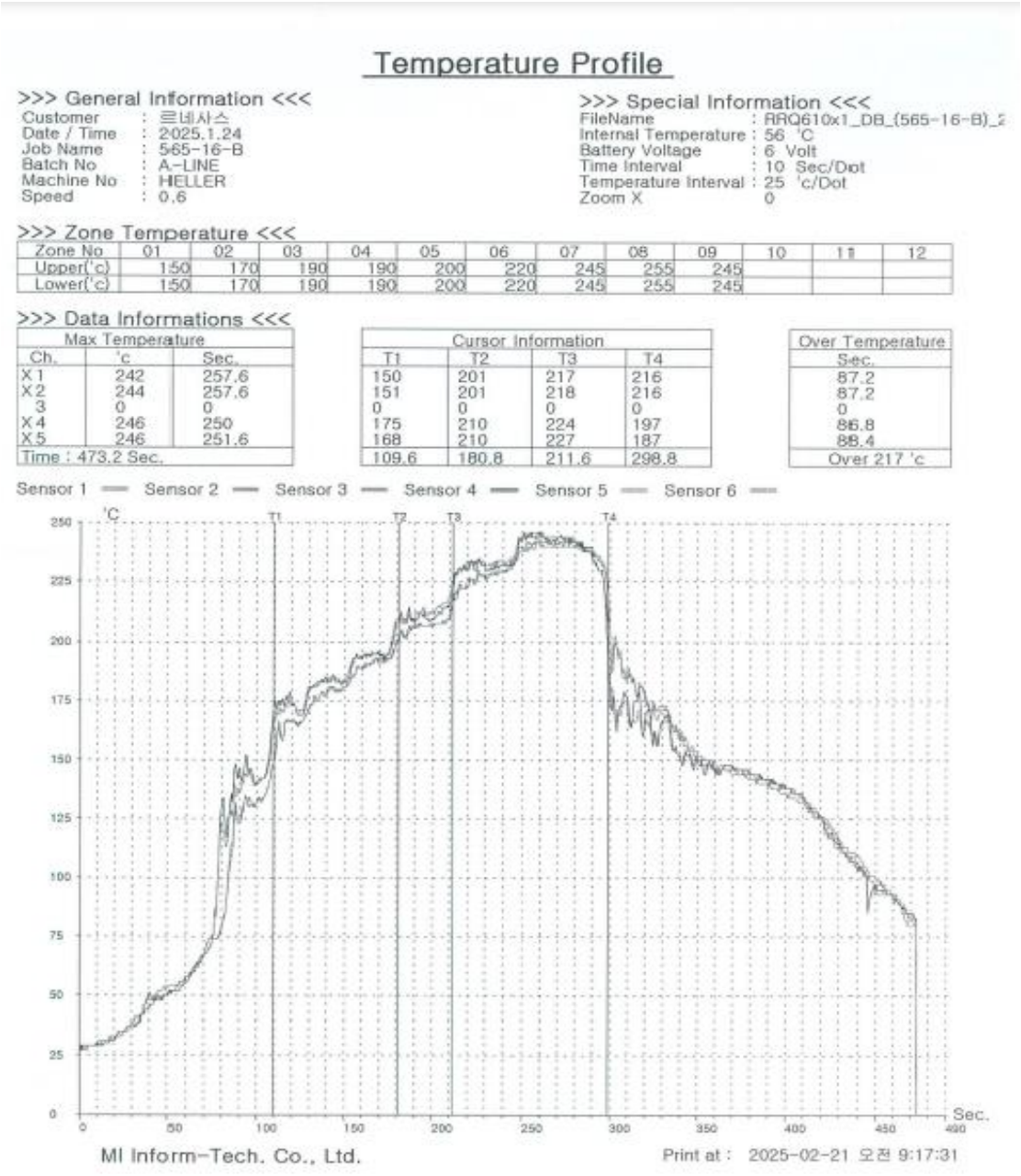


Figure 26. Reflow profile for lead free solder, applied on RRQ61001 daughterboard

12. Moisture Sensitivity Label

MSL is an indicator for the maximum allowable time period (floor lifetime) in which a moisture-sensitive plastic device, when removed from the dry bag, can be exposed to an environment with a maximum temperature of 30 °C and a maximum relative humidity of 60% RH before the solder reflow process.

The RRQ61001 Module is qualified for MSL 3.

Table 21: MSL level vs floor lifetime

MSL Level	Floor Lifetime
MSL 4	72 hours
MSL 3	168 hours
MSL 2	4 weeks
MSL 2A	1 year
MSL 1	Unlimited at 30 °C/85%RH

13. Ordering Information

For sample availability and ordering information, contact your local sales representative.

Table 22: RRQ61001 modules

Part number	Description	Flash	Antenna type
RRQ61001-008	Wi-Fi 6	8 MB	PCB trace Antenna
RRQ61001-009	Wi-Fi 6	8 MB	External Antenna connector, u.FL
RRQ61001-010	Wi-Fi 6	8 MB	RF antenna pin

14. Regulatory Information

This section outlines the regulatory information for the RRQ61001 Modules. The modules are certified for the global market. This facilitates the market entry of the end product. The end product would need to apply for the end product certification; however, the module certification listed in Table 23 facilitates that procedure.

When the user sends the end product to those markets, the end product may need to follow additional requirements according to the specific market regulation.

For example, some markets have additional testing or certification, such as South Korea's EMC certification. Other markets, such as Japan, Taiwan, and Brazil have the requirement to put modular approval ID on the end product label or mark directly on host label that it contains an approved modular ID.

Table 23 shows the list of the Conformance Standards that RRQ61001 Modules meets.

Table 23: Standards conformance

Area	Item	Service	Standard	Certification IDs/Certificate Numbers	
				RRQ61001-008	RRQ61001-009/ RRQ61001-010 Note 1
Global	Safety	CB	IEC 62368-1	US-BACL-00812	US-BACL-00814
Europe	Wireless	RED	EN 300 328 v2.2.2 (2019-07), EN 300 440 v2.2.1 (2018-07), EN 301 893 v2.2.1 (2024-11) EN 50665:2017, EN IEC 62311:2020	Not Applicable	Not Applicable
	Safety	CE	EN IEC 62368-1:2020+A11:2020		
	EMC	RED	EN 301 489-1 v2.2.3, EN 301 489-3 v2.3.2, EN 301 489-17 v3.3.1		
UK	Wireless	UKCA-RED	EN 300 328 v2.2.2 (2019-07), EN 300 440 v2.2.1 (2018-07), EN 301 893 v2.2.1 (2024-11) BS EN 50665:2017, BS EN IEC 62311:2020	Not Applicable	Not Applicable
	Safety	UKCA-LVD	BS EN IEC 62368-1:2020+A11:2020		
	EMC	UKCA-RED	EN 301 489-1 v2.2.3, EN 301 489-3 v2.3.2, EN 301 489-17 v3.3.1		
Singapore	Wireless	IMDA	Based on RED	B2602026-IMDA	B2602024-IMDA
US/CA	Wireless	FCC ID	47 CFR PART 15 Subpart C: 2021 section 15.247	2AU49-RRQ61001008	2AU49-RRQ61001009
		IC ID	RSS-247, ISSUE 4, July 2025 RSS-Gen Issue 5: April 2018 +A1: March 2019+A2: February 2021	34654-RRQ61001008	34654- RRQ61001009
Japan	Wireless	MIC	JRL	211-251007	211-251008
Taiwan	Wireless	NCC	LP0002	CCAP26Y10030T2	CCAP26Y10040T5 CCAP26Y10080T4
South Korea	Wireless	KC	방송통신표준 KS X 3123 "무선 설비 적합성 평가 시험 방법" KN 301 489	R-C-fci-RRQ61001008	R-C-fci-RRQ61001009
Brazil	Wireless	Anatel	ATO No.14448/2017 Resolution No.680	06844-25-15614	06842-25-15614
China	Wireless	SRRC	信部无【2002】353	25J99G3YU696	25J99G3YK869(M) 25J99G3Y3263(M)

Note 1 Series approval for listed modules is applied wherever applicable.

14.1 CE (Radio Equipment Directive 2014/53/EU (RED)) - (Europe)

Model no. RRQ61001-008

Model no. RRQ61001-009

Model no. RRQ61001-010

The RRQ61001 Module is a Radio Equipment Directive (RED) assessed radio that is CE marked. The module has been manufactured and tested with the intention of being a subassembly to a final product. The module has been tested to RED 2014/53/EU Essential Requirements for Health, Safety, and Radio. The applicable standards are:

- **Radio: EN 300 328 v2.2.2 (2019-07), EN 300 440 v2.2.1, EN 301 893 v2.2.1**
- **EMC: EN 301 489-1 v2.2.3, EN 301 489-3 v2.3.2, EN 301 489-17 v3.3.1**
- **Health: EN 50665:2017, EN IEC 62311:2020**
- **Safety: EN IEC 62368-1:2020+A11:2020**

The end product must undergo the radio EMC tests according to EN 301 489. The conducted tests can be inherited from the module test report. It is recommended to repeat the EN 300 328 radiated testing with the end product assembly.

Simplified Declaration of Conformity
Hereby, Renesas Design Korea Inc. declares that radio type equipment RRQ61001 Module is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address: www.renesas.com

14.2 UKCA (UK)

Model no. RRQ61001-008

Model no. RRQ61001-009

Model no. RRQ61001-010

The module has been tested and found to comply with the standards harmonized with the regulations according to UKCA-Radio Equipment Regulations 2017-CHAPTER 1 6(1)(a) Health, 6(1)(b) & 6(2).

The applicable standards are:

- **Radio: EN 300 328 v2.2.2 (2019-07), EN 300 440 v2.2.1, EN 301 893 v2.2.1**
- **EMC: EN 301 489-1 v2.2.3, EN 301 489-3 v2.3.2, EN 301 489-17 v3.3.1**
- **Health: BS EN 50665:2017, BS EN IEC 62311:2020**
- **Safety: BS EN IEC 62368-1:2020+A11:2020**

The end product must undergo the radio EMC tests according to EN 301 489. The conducted tests can be inherited from the module test report. It is recommended to repeat the EN 300 328 radiated testing with the end product assembly.

Simplified Declaration of Conformity
Hereby, Renesas Design Korea Inc. declares that radio type equipment RRQ61001 Module is in compliance with Radio Equipment Regulations 2017. The full text of the UK declaration of conformity is available at the following internet address: www.renesas.com

14.3 FCC (USA)

Model no. RRQ61001-008, FCC ID: 2AU49-RRQ61001008

Model no. RRQ61001-009, FCC ID: 2AU49-RRQ61001009

Model no. RRQ61001-010, FCC ID: 2AU49-RRQ61001009

14.3.1 List of Applicable FCC Rules

The module complies with FCC Part 15.247, 15.407.

14.3.2 Summary of the Specific Operational Use Conditions

This module is a stand-alone modular transmitter. If the end product involves the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

14.3.3 Limited Module Procedures

Not applicable.

14.3.4 Trace Antenna Designs

Not applicable.

14.3.5 RF Exposure Considerations

This equipment complies with FCC's RF radiation exposure limits set forth for an uncontrolled environment. The module integrator must place the device at a minimum distance of 20 cm from the human body, otherwise the module integrator has to do SAR testing and certification. The antenna(s) used for this transmitter must not be collocated or operating in conjunction with any other antenna or transmitter.

14.3.6 Antenna Information

Type	Brand	Model name	Gain	Impedance	Application
PCB Antenna	Renesas	RRQ610X1-008	2.4 GHz: -0.2 dBi 5 GHz: +3.4 dBi	50 Ω	Fixed
Dipole External Antenna – RP SMA Plug	Aristotle Enterprises Inc.	RFA-27-H60-U-GB70	2.4 GHz: +3.3 dBi 5 GHz: +4.4 dBi	50 Ω	Fixed

If PCB antenna is permanently attached, it cannot be replaced.

In the case of external dipole antenna, to maintain compliance with FCC RF exposure and emissions regulations, **only antennas that are identical to the originally supplied antenna or antennas with equal or lower gain may be used**.

Using an antenna with higher gain than specified **is strictly prohibited**, as it may result in:

- Non-compliance with FCC Part 15 transmission limits
- Increased RF exposure levels
- Voiding of the user's authority to operate the equipment

Any replacement antenna must:

- Have the **same antenna type** (for example, dipole) as approved for this device.
- Have an antenna gain that is **equal to or lower than the maximum gain** listed in the device's FCC certification.
- Be installed according to the manufacturer's instructions without modification.

Modifications to the antenna or use of non-approved antenna types or gains may invalidate the FCC certification and void the user's authority to operate this equipment.

14.3.7 Label and Compliance Information

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

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Note
The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications or changes to this equipment. Such modifications or changes could void the user's authority to operate the equipment.

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

Note
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: ▪ Reorient or relocate the receiving antenna. ▪ Increase the separation between the equipment and receiver. ▪ Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. ▪ Consult the dealer or an experienced radio/TV technician for help.

The system integrator must place an exterior label on the outside of the final product housing the RRQ61001 Module. Below are the contents that must be included on this label.

OEM Labeling Requirements:

Notice
The OEM must make sure that FCC labeling requirements are met. This includes a clearly visible exterior label on the outside of the final product housing that displays the contents shown below.

Model: **RRQ61001-008** Contains FCC ID: **2AU49-RRQ61001008**
Model: **RRQ61001-009** Contains FCC ID: **2AU49-RRQ61001009**
Model: **RRQ61001-010** Contains FCC ID: **2AU49-RRQ61001009**

14.3.8 Information on Test Modes and Additional Testing Requirements

When testing a host product, the host manufacture should follow FCC KDB Publication 996369 D04 Module Integration Guide for testing the host products. The host manufacturer may operate their product during the measurements. In setting up the configurations, if the pairing and call box options for testing do not work, then the host product manufacturer should coordinate with the module manufacturer for access to test mode software.

14.3.9 Additional Testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (FCC Part 15.247 and 15.407) listed on the grant. The host product manufacturer is responsible for compliance with any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed when containing digital circuity.

14.4 ISED (Canada)

Model no. RRQ61001-008, IC: 34654- RRQ61001008

Model no. RRQ61001-009, IC: 34654- RRQ61001009

Model no. RRQ61001-010, IC: 34654- RRQ61001009

The RRQ61001 Module is certified for the IC as a single-modular transmitter. The module meets IC modular approval and labeling requirements. The IC follows the same testing and rules as the FCC regarding certified modules in authorized equipment.

The module has been tested according to the following standards:

- Radio: RSS-247, ISSUE 4, July 2025, RSS-Gen Issue 5: April 2018 +A1: March 2019+A2: February 2021
- Health: RSS-102 Issue 6:2023

This device contains license exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

(1) this device may not cause interference

(2) this device must accept any interference, including interference that may cause undesired operation of the device.

L'emitteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Inovvation, Sciences et Développement economic Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) L'appareil ne doit pas produire de brouillage

(2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

RF Exposure Statement

This device complies with IC radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the IC radio frequency (RF) Exposure rules. The module integrator must place the device at a minimum distance of 20 cm from the human body, otherwise the module integrator has to do SAR testing and certification. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Le présent appareil est conforme à l'exposition aux radiations IC définies pour un environnement non contrôlé et répond aux RSS-102 de la fréquence radio (RF) IC règles d'exposition. L'intégrateur de module doit intégrer l'appareil à une distance minimale de 20 cm du corps humain, sinon l'intégrateur de module doit effectuer des tests et une certification SAR. L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur.

OEM Responsibilities to Comply with IC Regulations

OEM integrator is responsible for testing their end product for any additional compliance requirements needed for the module installation like IC ES003 (EMC). This can be combined with the FCC Part 15B test.

End Product Labeling

The RRQ61001 Module is labeled with its own IC ID.

Model no. RRQ61001-008, IC: 34654- RRQ61001008

Model no. RRQ61001-009, IC: 34654- RRQ61001009

Model no. RRQ61001-010, IC: 34654- RRQ61001009

If the IC ID is not visible when the module is installed inside another device, the host product must be labelled to display the ISED certification number for the module, preceded by the word "contains" or similar wording expressing the same meaning, as follows: “Contains IC: 34654- RRQ610010xx” where xxx the appropriate model suffix.

Responsabilités des OEM en matière de conformité aux réglementation IC

L’intégrateur OEM est responsable de tester son produit final afin de vérifier toute exigence de conformité supplémentaire requise pour l’installation du module, telle que la norme IC ES003 (CEM). Ces essais peuvent être combinés avec les tests FCC Part 15B.

Étiquetage du produit final

Le module RRQ61001 est étiqueté avec son propre identifiant IC.

Modèle no. RRQ61001-008, IC: 34654- RRQ61001008

Modèle no. RRQ61001-009, IC: 34654- RRQ61001009

Modèle no. RRQ61001-010, IC: 34654- RRQ61001009

Si l’identifiant IC n’est pas visible lorsque le module est installé à l’intérieur d’un autre appareil, le produit hôte doit porter une étiquette indiquant le numéro de certification ISED du module, précédé du mot « Contient » ou d’une mention équivalente exprimant la même signification, comme suit : « Contient IC : 34654-RRQ610010xx »

14.5 SRRC (China)

Model no. RRQ61001-008, SRRC ID: 25J99G3YU696

Model no. RRQ61001-009, SRRC ID: 25J99G3YK869(M)

Model no. RRQ61001-010, SRRC ID: 25J99G3Y3263(M)

The module has been tested and found to be compliant according to the following standards:

信部无【2002】353 号

The end product may need to follow additional requirements according to the regulation EMC.

14.6 MIC (Japan)

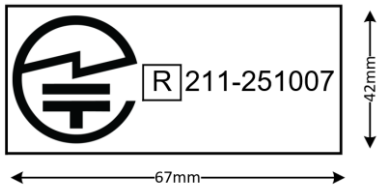
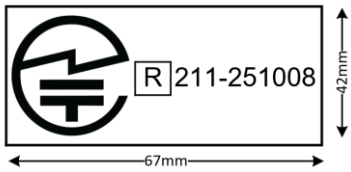
The RRQ61001 Modules have received type certification as required to conform to the technical standards regulated by the Ministry of Internal Affairs and Communications (MIC) of Japan pursuant to the Radio Act of Japan.

Model no. RRQ61001-008, MIC ID: 211-251007

Model no. RRQ61001-009, MIC ID: 211-251008

Model no. RRQ61001-010, MIC ID: 211-251008

Indoor Use Warning
W52/W53 屋内使用限定 ただし登録局に接続される場合は除く W52/W53 indoor use only (except when connected to a registered station)

Model	GITEKI mark label
RRQ61001-008	
RRQ61001-009, RRQ61001-010	

The modules have been tested according to the following standards:

Radio: JRL "Article 49-20 and the relevant articles of the Ordinance Regulating Radio" Equipment

The end product may need to follow additional requirements according to the regulation EMC.

End Product labeling

The MIC ID can be applied directly to the end product's label. **The end product may bear the GITEKI mark and certification number so that is clear that the end product contains a certified radio module. The following note may be shown next to, below, or above the GITEKI mark and certification number to indicate the presence of a certified radio module:**

当該機器には電波法に基づく、技術基準適合証明等を受けた特定無線設備を装着している。

Translation of the text:

"This equipment contains specified radio equipment that has been certified to the Technical Regulation Conformity Certification under the Radio Law."

14.7 NCC (Taiwan)

Model no. RRQ61001-008, NCC ID: CCAP26Y10030T2

Model no. RRQ61001-009, NCC ID: CCAP26Y10040T5

Model no. RRQ61001-010, NCC ID: CCAP26Y10070T1

Model	NCC label
RRQ61001-008	CCAP26Y10030T2
RRQ61001-009	CCAP26Y10040T5
RRQ61001-010	CCAP26Y10070T1

The RRQ61001 Modules have received compliance approval in accordance with the Telecommunications Act. The modules have been tested according to the following standards:

- Radio: Low Power Radio Frequency Devices Technical Regulations (LP0002)

The end product may need to follow additional requirements according to the regulation EMC.

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使 用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。低功率射頻器材之使用不得影響飛航安

及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前述合法通信，指依電信管理法規定作業之無線電通信。低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

應避免影響附近雷達系統之操作。
高增益指向性天線只得應用於固定式點對點系統。

End Product labeling

The NCC ID can be applied directly to the end product's label.

NCC Warning
本模組於取得認證後將依規定於模組本體標示審驗合格標籤，並要求最終產品平台廠商 (OEM Integrator)於最終產品平台(End Product)上標示" 本產品內含射頻模組， 其 NCC 型式認證號碼為: CC XX xx YY yyy ZZ W

14.8 KCC (S.Korea)

Model no. RRQ61001-008, Certification No: R-C-fci-RRQ61001008

Model no. RRQ61001-009, Certification No: R-C-fci-RRQ61001009

Model no. RRQ61001-010, Certification No: R-C-fci-RRQ61001009

The RRQ61001 Modules have received **Certification of Conformity** in accordance with the **Radio Waves Act of the Republic of Korea**. The certification was issued by the **Radio Research Agency (RRA)**.

Radio (RF) Compliance

Radio testing was performed in accordance with the applicable Korean radio technical requirements specified in **Ministry of Science and ICT Notice No. 2025-15** and **Radio Research Agency Notice No. 2025-14**.
Test methods followed **KS X 3123:2025 – Test methods for conformity assessment of radio equipment**.

EMC Compliance

Electromagnetic compatibility (EMC) testing was conducted in accordance with the **RRA EMC regulations**. The applied test standards were:

- **KS X 3124:2020** – common EMC test methods for radio equipment.
- **KS X 3126:2020** – EMC test methods for low-power wireless data communication equipment with immunity tests based on the applicable **KS C IEC 61000-4-x series**.

End Product Evaluation

For evaluation of an end product incorporating this module, the module's **RRA RF and EMC test reports** may be referenced to demonstrate prior compliance of the radio module. However, the **final host product remains subject to conformity assessment**, depending on its configuration, antenna, power supply, enclosure, and integration environment.

End Product Labeling

The **KC conformity mark** and the applicable **RRA certification number (R-C-xxx-xxxxx)** must be displayed on the final product in accordance with **RRA labeling requirements**.

14.9 ANATEL (Brazil)

Model no. RRQ61001-008, ANATEL ID: 06844-25-15614

Model no. RRQ61001-009, ANATEL ID: 06842-25-15614

Model no. RRQ61001-010, ANATEL ID: 06842-25-15614

The RRQ61001 Modules have been evaluated for conformity in accordance with ANATEL technical requirements for Restricted Radiation Radiocommunication Equipment, as defined by Resolução Nº 680/2017 and applicable ANATEL Acts, including Ato Nº 14.448/2017 and Ato Nº 4.776/2020.

⚠	**WARNING**
"Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados. Para mais informações consulte o site da ANATEL www.anatel.gov.br" Translation of the text: "This equipment is not entitled to protection against harmful interference and must not cause interference in duly authorized systems. For more information, consult the ANATEL website www.anatel.gov.br"	

14.10 IMDA (Singapore)

Model no. RRQ61001-008

Model no. RRQ61001-009

Model no. RRQ61001-010

The RRQ61001 Modules have been certified under the **IMDA Mutual Recognition Arrangement (MRA) Phase II scheme** and comply with the applicable IMDA technical requirements for short-range radio devices. The certification is recognized by the Infocomm Media Development Authority of Singapore.

End Product Labeling

When this module is integrated into a final product and marketed in Singapore, the **final product must be registered with IMDA** by a Singapore-licensed local supplier and **must display the IMDA compliance label**. The required label text is:

```
Complies with IMDA Standards
DAXXXXXX
```

- The final product must be registered separately with IMDA.

- The final product must display its own IMDA compliance label.
- The label must use the OEM’s (or local supplier’s) Dealer Registration Number.

14.11 WEEE Directive (2012/19/EU)

The Waste Electrical and Electronic Equipment Regulations 2013

For Customers in the UK and European Union

The WEEE (Waste Electrical and Electronic Equipment)
regulations put responsibilities on producers for the collection and recycling or disposal of electrical and electronic waste. Return of WEEE under these regulations is applicable in the UK and European Union.

This equipment (including all accessories) is not intended for household use. After use, the equipment cannot be disposed of as household waste, and the WEEE must be treated, recycled, and disposed of in an environmentally sound manner.
Renesas Electronics Europe GmbH can take back the end of life equipment. Register for this service at:
https://www.renesas.com/eu/en/support/regional-customer-support/weee

15. Revision History

Revision	Date	Description
1.01	Apr 28, 2026	Updated mechanical specifications, printed antenna information, regulatory information.
1.00	Nov 26, 2025	Initial release.

RoHS Compliance

Renesas Electronics' suppliers certify that its products are in compliance with the requirements of Directive 2011/65/EU of the European Parliament on the restriction of the use of certain hazardous substances in electrical and electronic equipment. RoHS certificates from our suppliers are available on request.