RRQ61051 Module

Renesas Wi-Fi plus Bluetooth® LE Combo Module

Renesas RRQ61051 modules offer highly integrated Combo Dual-band Wi-Fi6 plus Bluetooth® Low Energy (LE) 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 Also, the RRQ61051 integrates Bluetooth® Low Energy (LE) 5.1 including the radio transceiver, the baseband processor, and a fully qualified Bluetooth LE stack compliant with the Bluetooth LE 5.1 standard.

RA6W1 MCU is a synthesis of breakthrough ultra-low-power technologies, which enables an extremely low power operation in the module. RA6W1 MCU and DA14531 shut down every micro element of the chip that is not in use, which results in a 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. RRQ61051 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 802.11b/g/n/ax, 1×1, 20 MHz channel bandwidth, 2.4 GHz
  - IEEE 802.11a/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
  - Bluetooth® LE coexistence
  - 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)

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- China (SRRC)
- Singapore (IMDA)

- **Clock Source**
  - 40 MHz crystal (± 20 ppm) for master clock
  - Integrated 32 kHz RC oscillator
- **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 × 28
  - 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
- **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
  - Blackout and brownout detector

Bluetooth Features

- **Bluetooth**
  - Compatible with Bluetooth® 5.1
  - Support up to three Bluetooth® connections
- **Standards Compatible**
  - Europe (CE/RED)
  - UK (UKCA)
  - US (FCC)
  - Canada (IC)
  - Japan (TELEC)
  - South Korea (KCC)
  - Taiwan (NCC)
  - Brazil (ANATEL)
  - China (SRRC)
  - Singapore (IMDA)
- **Processing and Memories**
  - 16 MHz 32-bit Arm®Cortex-M0+ with SWD interface
  - 48 kB RAM
  - 144 kB ROM
  - 32 kB OTP
- **Radio**
  - Programmable RF transmit power
  - -92 dBm receiver sensitivity
- **Power Management**
  - Operating range (1.8 V - 3.3 V)
- **Others**
  - Real Time Clock
  - Trimmed 32 MHz Crystal

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Tables

1. Terms and Definitions

API	Application Programming Interface
Bluetooth LE	Bluetooth® Low Energy
EVB	Evaluation Board
EVM	Error Vector Magnitude
GPIO	General Purpose Input/Output
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
IoT	Internet of Things
LDO	Low-dropout Regulator
MCU	Microcontroller Unit
MPU	Microprocessor Unit
OTP	One Time Programmable
PPA	Programmable Pin Assignment
PWM	Pulse Width Modulation
QSPI	Quad-lane SPI
RTC	Real-time Clock
SAR	ADC Successive Approximation Analog-to-Digital Converter
SEM	Spectral Emissions Mask
SOC	System on Chip
SPI	Serial Peripheral Interface
SWD	Serial Wire Debug
UART	Universal Asynchronous Receivers and Transmitter Etc.
VSWR	Voltage Standing Wave Ratio
XiP	eXecute In Place

2. Block Diagrams

The RRQ61051 modules provide a high level of integration for a range of IoT applications with integrated IEEE 802.11 a/b/g/n/ac/ax and Bluetooth V5.1. The RRQ61051 is designed to address the needs of battery-used devices that require minimal power consumption and reliable operation.

The RRQ61051 modules consist of five variants, based on the RF interface, the frequency band, and the Wi-Fi wireless standard they support, see Table 1.

Table 1: RRQ61051 modules

Part Number	Description	MCU Product number	MCU marking
RRQ61051-008	Wi-Fi/Bluetooth LE combo module, Wi-Fi 6 Dual Band 2.4/5 GHz 802.11 a/b/g/n/ac/ax, Bluetooth LE 5.1, 8 MB Flash, PCB trace antenna.	**R**7S**A6W1C**EDZDD (Wi-Fi) **DA14531**-00000FX2 (Bluetooth LE)	RA6W1C
RRQ61051-009	Wi-Fi/Bluetooth LE combo module, Wi-Fi 6 Dual Band 2.4/5 GHz 802.11a/b/g/n/ac/ax, BLE 5.1, 8 MB Flash, External Antenna connector, u.FL for mounting an antenna 50Ω.	**R**7S**A6W1C**EDZDD (Wi-Fi) **DA14531**-00000FX2 (Bluetooth LE)	RA6W1C
RRQ61051-010	Wi-Fi/Bluetooth LE combo module, Wi-Fi 6 Dual Band 2.4/5 GHz 802.11 a/b/g/n/ac/ax, Bluetooth LE 5.1, 8 MB Flash, RF antenna pin.	**R**7S**A6W1C**EDZDD (Wi-Fi) **DA14531**-00000FX2 (Bluetooth LE)	RA6W1C
RRQ61051-408	Wi-Fi/Bluetooth LE combo Module, Wi-Fi 6 Single Band 2.4 GHz, 802.11b/g/n/ax, Bluetooth LE 5.1, 8 MB Flash, PCB trace antenna.	**R**7S**A6W1B**EDZDD (Wi-Fi) **DA14531**-00000FX2 (Bluetooth LE)	RA6W1B
RRQ61051-208	Wi-Fi/Bluetooth LE combo Module, Wi-Fi 4 Single Band 2.4 GHz, 802.11b/g/n, Bluetooth LE 5.1, 8MB Flash, PCB trace antenna.	**R**7S**A6W1A**EDZDD (Wi-Fi) **DA14531**-00000FX2 (Bluetooth LE)	RA6W1A

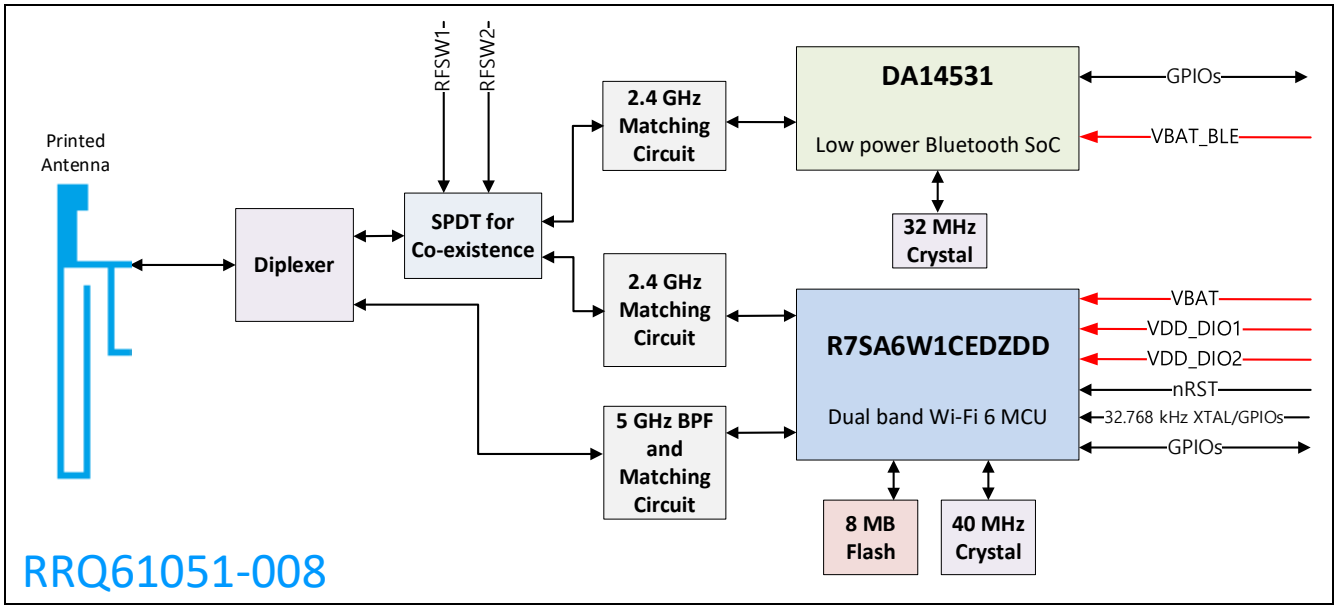


Figure 1. The interconnection of all the physical blocks in RRQ61051-008 module

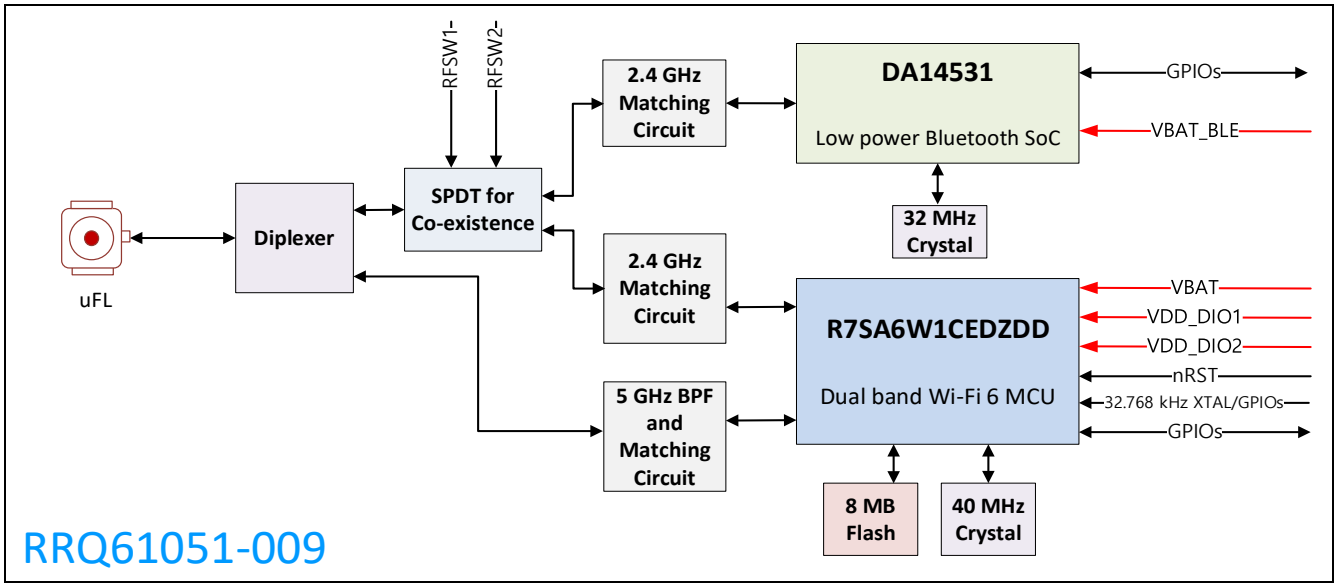


Figure 2. The interconnection of all the physical blocks in RRQ61051-009 module

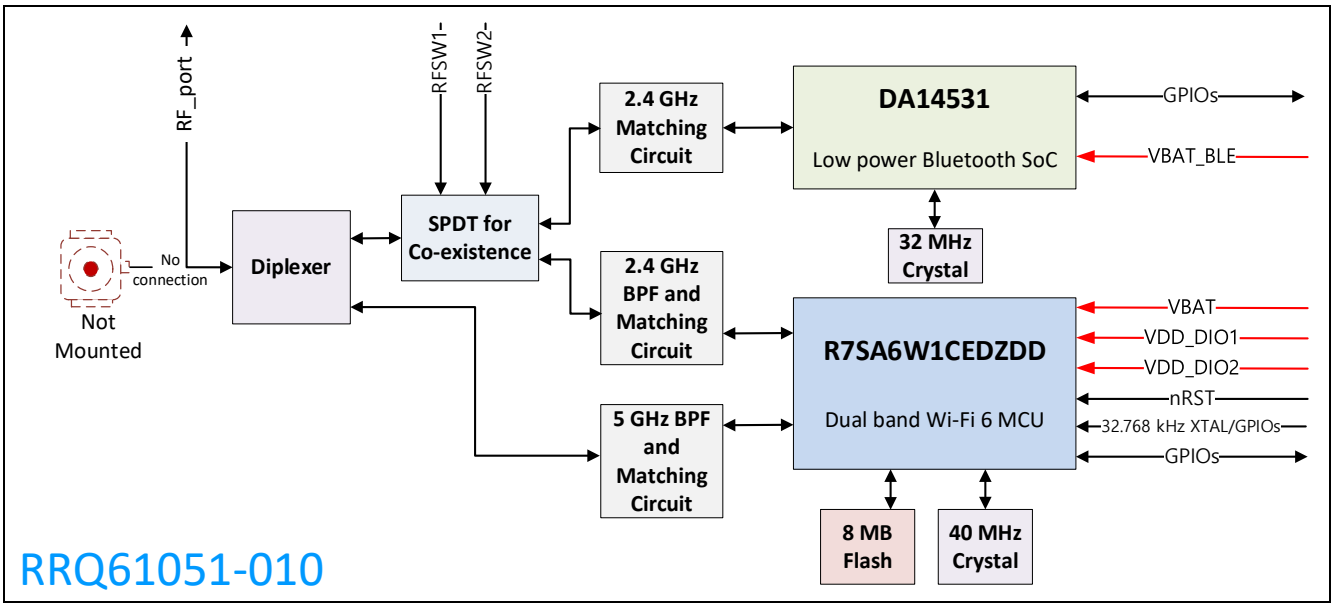


Figure 3. The interconnection of all the physical blocks in RRQ61051-010 module

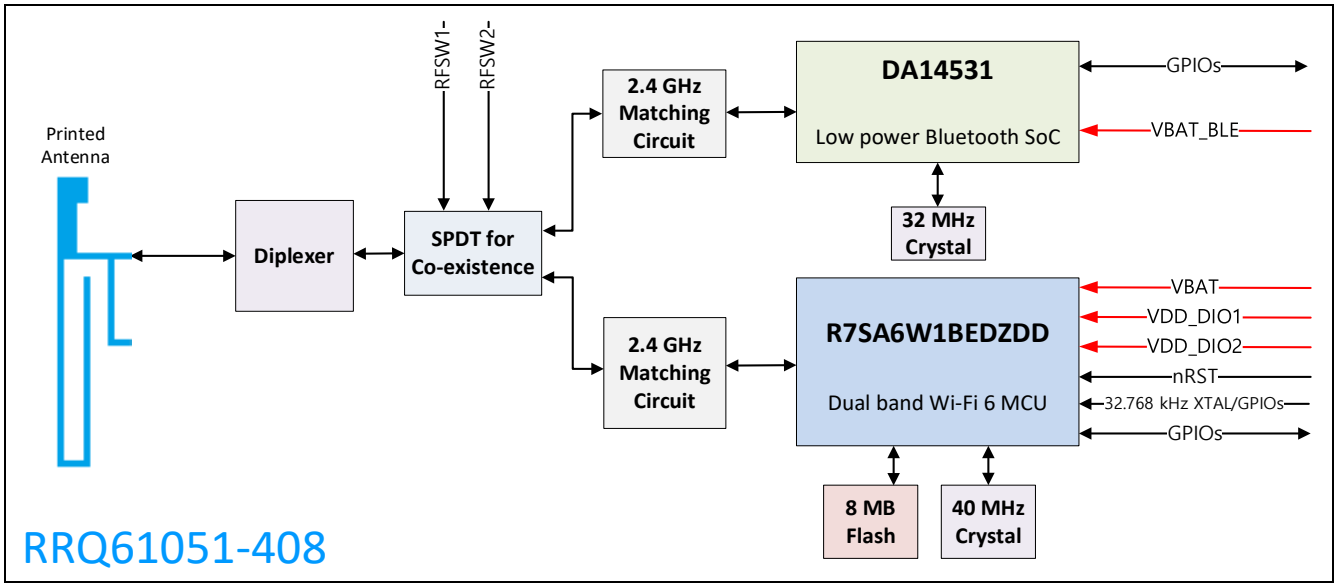


Figure 4. The interconnection of all the physical blocks in RRQ61051-408 module

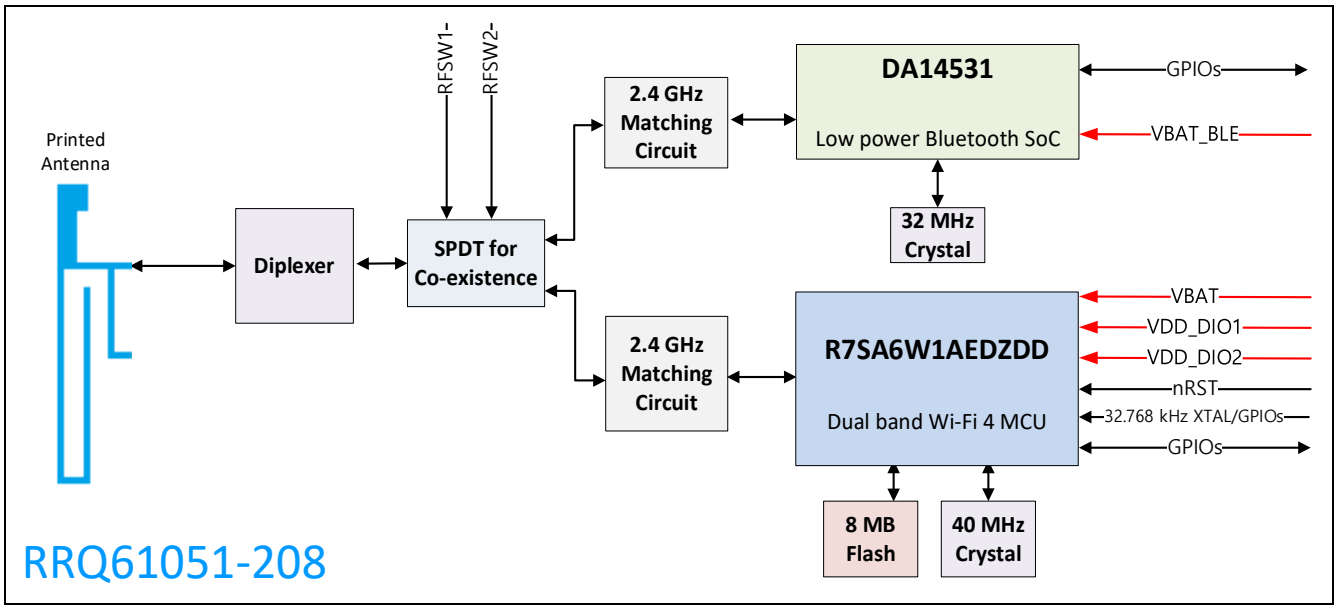


Figure 5. The interconnection of all the physical blocks in RRQ61051-208 module

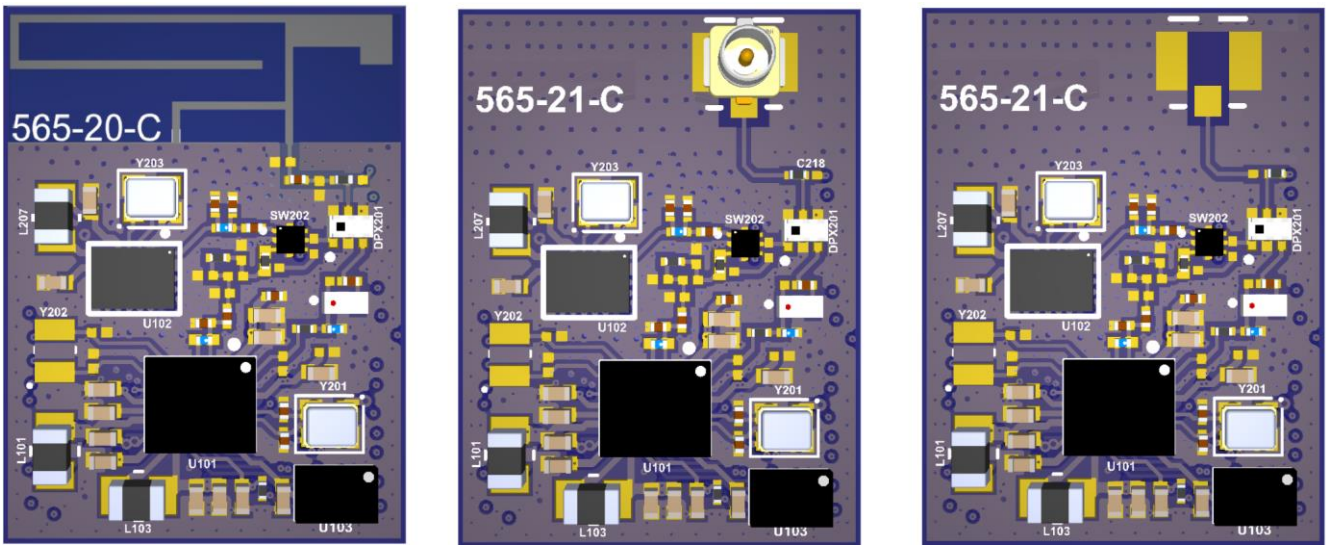


Figure 6. Renesas RRQ61051 modules: RRQ61051-x08 (left), RRQ61051-009 (center), and RRQ61051-010 (right)

3. Pinout

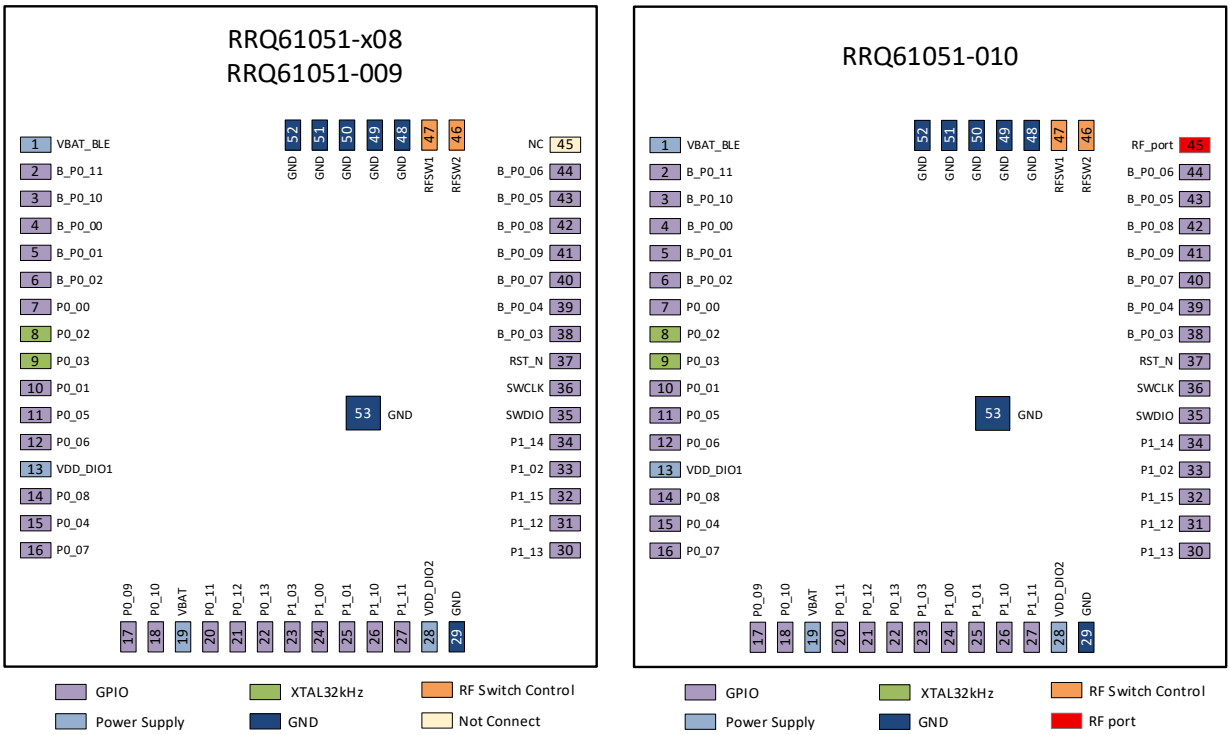


Figure 7. RRQ61051 module pinout (top view)

3.1 Pin Description

Table 2: Pin description

#Pin	Pin name	Type	Related device	Description
1	VBAT_BLE	VDD	DA14531	Supply power for DA14531.
2	B_P0_11	DIO	DA14531	General Purpose I/O.
3	B_P0_10	DIO	DA14531	General Purpose I/O.
4	B_P0_00	DIO	DA14531	General Purpose I/O.
5	B_P0_01	DIO	DA14531	General Purpose I/O.
6	B_P0_02	DIO	DA14531	General Purpose I/O, JTAG I/F, SWCLK.
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 IO power: 1.8~3.3 V (typ).
14	P0_08	DIO	RA6W1	INPUT/OUTPUT with pull-up/down resistor.

#Pin	Pin name	Type	Related device	Description
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	B_P0_03	DIO	DA14531	General Purpose I/O.
39	B_P0_04	DIO	DA14531	General Purpose I/O.
40	B_P0_07	DIO	DA14531	General Purpose I/O.
41	B_P0_09	DIO	DA14531	General Purpose I/O.
42	B_P0_08	DIO	DA14531	General Purpose I/O.
43	B_P0_05	DIO	DA14531	General Purpose I/O.
44	B_P0_06	DIO	DA14531	General Purpose I/O.
45	NC or RF_port	-	-	RRQ61051-008: No Connect. RRQ61051-009: No Connect. RRQ61051-010: RF_port. RRQ61051-208: No Connect. RRQ61051-408: No Connect.
46	RFSW2	DI	COMMON	RF SWITCH CONTROL.
47	RFSW1	DI	COMMON	RF SWITCH CONTROL.
48	GND	GND	COMMON	Ground.

#Pin	Pin name	Type	Related device	Description
49	GND	GND	COMMON	Ground.
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 and Bluetooth® LE subsystems are defined as GPIOs to give a total of 26 and 12 respectively configurable I/Os. These can be configured by software to be mapped to any of the supported digital peripherals. For Wi-Fi subsystem, 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 controller interfaces of Wi-Fi subsystem, 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 to be only accessible internally to the device. The OQSPI interface is assigned to 64 Mbit NOR QSPI Flash and it is not available externally to the module.

Quad SPI Controller (QSPIC)

The QSPI controller of Wi-Fi subsystem, 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 up to 64 MB.

UART, UART2, UART3

The UART interfaces of Wi-Fi subsystem 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 of Wi-Fi subsystem are serial peripheral interfaces with master and slave capability for connection to SPI devices in master mode or being connected to 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 of Wi-Fi subsystem 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) of Wi-Fi subsystem is provided to allow debugging of user applications during the development phase of a product. Once 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 of Wi-Fi subsystem 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 of Wi-Fi subsystem 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.

Bluetooth® Coexistence

The Bluetooth® coexistence interface allows for sharing of the 2.4 GHz band between Wi-Fi and a companion Bluetooth device such that these devices minimize interference with each other.

To support smart home systems which may also require coexistence with Zigbee or Thread devices, the coexistence interface provides enhanced features to coordinate the sharing of the 2.4 GHz band between Wi-Fi and two companion devices such as Bluetooth® LE and Thread.

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, for Wi-Fi Subsystem		-0.2	3.7	V
VDD_DIO1	Digital I/O power on Pin 13, for Wi-Fi Subsystem		-0.2	3.7	V
VDD_DIO2	Digital I/O power on Pin 28, for Wi-Fi Subsystem		-0.2	3.7	V
VBAT_BLE	Battery supply voltage on Pin 1, for Bluetooth LE Subsystem		-0.1	3.6	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, for Wi-Fi Subsystem		1.9	3.3	3.6	V
VDD_DIO1	Digital I/O power on Pin 13, for Wi-Fi Subsystem		1.62		3.6	V
VDD_DIO2	Digital I/O power on Pin 28, for Wi-Fi Subsystem		1.62		3.6	V
VBAT_BLE	Battery supply voltage on Pin 1, for Bluetooth LE Subsystem		1.8		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 Wi-Fi Subsection Characteristics

5.4.1 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

5.4.2 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
$V_{IH\_1RST\_N\_VBAT\_3V3}$	High-level input voltage		2.2			V
$V_{IL\_RST\_N\_VBAT\_3V3}$	Low-level input voltage				1.8	V

5.4.3 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

5.4.4 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

5.4.5 Radio

5.4.5.1 Wi-Fi Receiver Characteristics

Table 10: Radio - 802.11ax 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 - 802.11ax 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

5.4.5.2 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 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 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 country_code setting in software.

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 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 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

5.4.5.3 Current Consumption

CPU clock = 160 MHz unless otherwise stated, 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
		6 Mbps 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.

5.5 Bluetooth® LE Subsystem Characteristics

Table 16: DC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
I_{BAT_ACTIVE}	Battery supply current with CPU running CoreMark from RAM at 16 MHz.			0.385		mA
$I_{BAT\_BLE\_ADV\_100ms}$	Average battery supply current with system in Advertising state (3 channels) every 100 ms and extended sleep with all RAM retained.	Tx output power for power setting 12.		84		µA
$I_{BAT\_BLE\_CONN\_30ms}$	Average battery supply current with system in a connection state with 30 ms connection interval and extended sleep with all RAM retained.	Tx output power for power setting 12		88.5		µA
I_{BAT_HIBERN}	Battery supply current with system shut down (Hibernation or shipping mode).			0.39		µA

Parameter	Description	Conditions	Min	Typ	Max	Unit
I_{BAT_IDLE}	Battery supply current with CPU in Wait for Interrupt Mode.			0.223		mA
$I_{BAT\_SLP\_20KB}$	Battery supply current with system in extended sleep mode and 20 kB RAM retained.			1.15		µA
$I_{BAT\_SLP\_48KB}$	Battery supply current with system in extended sleep mode and all RAM retained.			1.46		µA
$I_{BAT\_RF\_RX}$	Battery supply current	Continuous RX; DCDC converter is on.		1.94		mA
$I_{BAT\_RF\_TX\_12U}$	Battery supply current	Continuous TX; DCDC converter is on; Output power for power setting 12. Note 1		4.24		mA
$I_{BAT\_RF\_TX\_9U}$	Battery supply current	Continuous TX; DCDC converter is on; Output power for power setting 9.		3.4		mA
$I_{BAT\_RF\_TX\_6U}$	Battery supply current	Continuous TX; DCDC converter is on; Output power for power setting 6		2.58		mA
$I_{BAT\_RF\_TX\_4U}$	Battery supply current	Continuous TX; DCDC converter is on; Output power for power setting 4.		2.07		mA
$I_{BAT\_RF\_TX\_1U}$	Battery supply current	Continuous TX; DCDC converter is on; Output power for power setting 1.		1.3		mA

Note 1 Power setting 12 is defined through RF_ATTR_REG[PA_POWER _SETTING]= 12.

Table 17: XTAL32MHz - Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
Frequency	Crystal Oscillation frequency			32.000		MHz
$\Delta f_{XTAL\_XTAL40M}$	Crystal frequency tolerance	After optional trimming including aging and temperature drift	-20		+20	ppm

Table 18: Digital IO - Recommended operating conditions

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{IH}	High-level input voltage		0.52			V
V_{IL}	Low-level input voltage				0.27	V

Table 19: Digital IO - DC characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
I_{IH}	High-level input current	$V_I=V_{BAT\_HIGH}$ = 3.0 V	-10		10	µA
I_{IL}	Low-level input current	$V_I=V_{SS}$ = 0 V	-10		10	µA
I_{IH_PD}	High-level input current	$V_I=V_{BAT}$ = 3.0 V	60		180	µA
I_{IL_PU}	Low-level input current	$V_I=V_{SS}$ = 0 V, V_{BAT} = 3.0 V	-180		-60	µA

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{OH}	High-level output voltage	I_O = 3.5 mA, V_{BAT} = 1.8 V	0.8*VBAT			V
V_{OL}	Low-level output voltage	I_O = 3.5 mA, V_{BAT} = 1.8 V			0.2*VBAT	V
V_{OH_LOWDRV}	High-level output voltage	I_O = 0.3 mA, V_{BAT} = 1.8 V	0.8*VBAT			V
V_{OL_LOWDRV}	Low-level output voltage	I_O = 0.3 mA, V_{BAT} = 1.8 V			0.2*VBAT	V

Table 20: Radio Bluetooth 1 Mb/s - AC characteristics

Parameter	Description	Condition	Min	Typ	Max	Unit
P_{SENS_CLEAN}	Sensitivity level	Dirty Transmitter disabled; PER = 30.8%. Note 1		-92		dBm
P_{SENS_EPKT}	Sensitivity level	Extended packet size (255 octets). Note 1		-89.2		dBm
P_{O_12}	Output power level	Power setting 12		0.84		dBm

Note 1 Measured according to Bluetooth® Low Energy Test Specification RF-PHY.TS/5.1.0.

5.6 ESD Ratings

Table 21: 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, RRQ61051 requires minimum resources to operate, power supply lines, an optional 32.768 kHz crystal and an external antenna for the RRQ61051-009 variant.

In addition, there are specific, critical external connections which must be present, for implementing the communication and co-existence between Wi-Fi and Bluetooth LE parts of the module. There are three hardware configurations (use cases) for system setup which are supported by the software.

- **Standalone Use Case:** the RRQ61051 is stand-alone, without requiring communication to an external MCU.
- **External MCU Supervised Use Case:** the RRQ61051 communicates with an external MCU through a Wi-Fi digital interface, such as UART, SPI or SDIO whereas Bluetooth LE communicates with RA6W1 only.

  On both cases, the RRQ61051 configuration is shown in Figure 8.

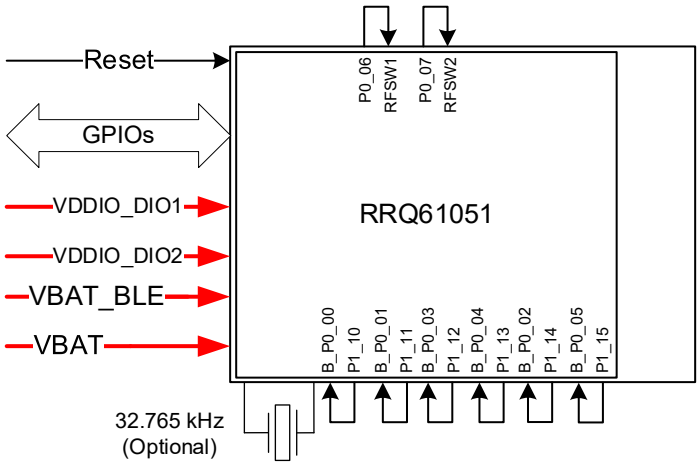


Figure 8. Connectivity between RA6W1 (Wi-Fi) and DA14531 (Bluetooth LE), standalone and external MCU use cases

The interconnection between Wi-Fi and Bluetooth LE consists of 4-wire UART, BLE_RST (Bluetooth LE reset), 1-wire coexistence signal, and the control signals of RF Switch (located internally to RRQ61051). All connections are external to RRQ61051.

Table 22: RRQ61051 required connections for Wi-Fi – Bluetooth LE communication and co-existence for standalone and external MCU use cases

RRQ61051 GPIO	Wi-Fi Function	RRQ61051 GPIO	Bluetooth LE Function
P1_10 (pin 26)	UART0_RX	B_P0_00 (pin 4)	UART TX
P1_11 (pin 27)	UART0_TX	B_P0_01 (pin 5)	UART_RX
P1_12 (pin 31)	UART0__CTS	B_P0_03 (pin 38)	UART_RTS
P1_13 (pin 30)	UART0__RTS	B_P0_04 (pin 39)	UART_CTS
P1_14 (pin 34)	BLE_ HW_RST	B_P0_02 (pin 6)	BLE HW_RST
P1_15 (pin 32)	COEX	B_P0_05 (pin 43)	iBtAct
P0_06 (pin 12)		RFSW1 (pin 47)	RF Switch control
P0_07 (pin 16)		RFSW2 (pin 46)	RF Switch control

- **Linux Hosted Use Case:** the RRQ61051 is connected to an MPU (Microprocessor Unit) which runs Linux OS. Wi-Fi subsystem communicates with MPU through SDIO or SPI interface, whereas Bluetooth LE subsystem downloads software and communicates with an MPU through a 4-wire UART (with flow control).

Wi-Fi and Bluetooth LE are connected only with one co-existence signal whereas the RF Switch is driven from Wi-Fi. All connections are external to RRQ61051. The RRQ61051 configuration for this use case is presented in Figure 9.

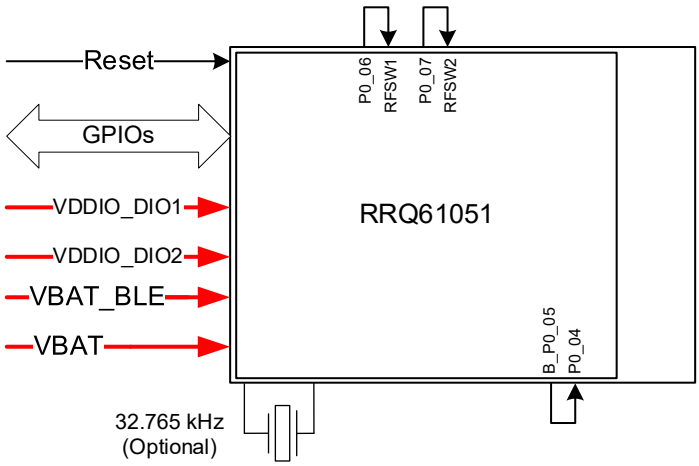


Figure 9. Connectivity between RA6W1 (Wi-Fi) and DA14531 (Bluetooth LE), Linux hosted use case

Table 23: RRQ61051 required connections for Wi-Fi – Bluetooth LE co-existence - Linux hosted use case

RRQ61051 GPIO	Wi-Fi function	RRQ61051 GPIO	Bluetooth LE function
P0_04 (pin 15)	COEX	B_P0_05 (pin 43)	iBtAct
P0_06 (pin 12)		RFSW1 (pin 47)	RF Switch control
P0_07 (pin 16)		RFSW2 (pin 46)	RF Switch control

6.1 Power Supply

The RRQ61051 has four power pins, VBAT_BLE, VBAT, VDDIO_DIO1, and VDDIO_DIO2.

- VBAT_BLE is the power source for the Bluetooth LE subsystem. VBAT_BLE supplies the DCDC converter of DA14531 which is configured in Buck mode. It also supplies B_P0_00 to B_P0_11.
- 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 RRQ61051, VDDIO_FDIO (1.8 V) is generated. This voltage rail is used for supplying the Flash memory (also placed internally to the module). VDDIO_FDIO is not available externally, but it supplies P1_00 to P1_03.

6.2 XTAL 32 kHz

For the RRQ61051 to support ultra-low power operation like DPM and TWT, an external 32 kHz XTAL must be connected to the RRQ61051 module pins P0_02 and P0_03. The 32 kHz XTAL must be placed at a distance not greater than 4 mm from the RRQ61051 Body. Recommended crystal specification is shown Table 24.

Table 24: 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.

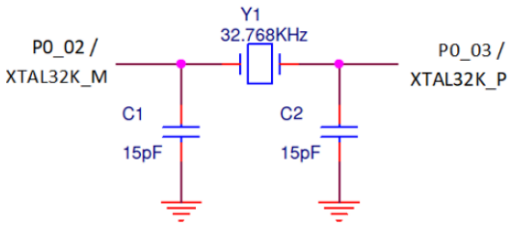


Figure 10. 32.768 kHz crystal configuration

An external clock can also be connected to the RRQ61051 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 then be used as a GPIO.

6.3 GPIOs and Programmable Pin Assignment

RRQ61051 provides 26 GPIOs for Wi-Fi subsystem. 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
- Selectable 25 kΩ pull-up/pull-down resistors per pin up to selected voltage rail
- Drive strength (2 mA, 4 mA, 8 mA, 14 mA)
- Slew rate (Fast/Slow)
- Input selection (CMOS/Schmitt Trigger)
- Pin state is maintained when the system enters low-power sleep 4 and 5 modes

RRQ61051 also provides 12 GPIOs for Bluetooth LE subsystem. In a similar way, the GPIOs functionality and characteristics are controlled from PPA. Configurable features for GPIOs are:

- Direction (input/output)
- Push pull/Open drain
- Pull-up/Pull-down
- Selectable 25 kΩ pull-up and pull-down resistors per pin
- Programmable driving strength outputs (0.35 mA and 3.5 mA)
- Pins can retain their last state when system enters a Sleep mode.

After a power on reset (POR), the default state of the pins of RRQ61051 Module, is shown in Table 25.

Table 25: Pin configuration

Pin	Subsystem	Support wake-up	Power domain	Alternate function 0	Alternate function 1	Alternate function 2	POR default
B_P0_00	Bluetooth LE		VBAT_B				RST
B_P0_01	Bluetooth LE		VBAT_B				GPIO
B_P0_02	Bluetooth LE		VBAT_B				SWCLK
B_P0_03	Bluetooth LE		VBAT_B				GPIO
B_P0_04	Bluetooth LE		VBAT_B				GPIO
B_P0_05	Bluetooth LE		VBAT_B				GPIO
B_P0_06	Bluetooth LE		VBAT_B				GPIO
B_P0_07	Bluetooth LE		VBAT_B				GPIO

Pin	Subsystem	Support wake-up	Power domain	Alternate function 0	Alternate function 1	Alternate function 2	POR default
B_P0_08	Bluetooth LE		VBAT_B				GPIO
B_P0_09	Bluetooth LE		VBAT_B				GPIO
B_P0_10	Bluetooth LE		VBAT_B				SWDIO
B_P0_11	Bluetooth LE		VBAT_B				GPIO
RST_N	Wi-Fi		VBAT	RST_N			RST_N
P0_00	Wi-Fi	Yes	VBAT	RTC_WAKE_UP			GPIO
P0_01	Wi-Fi		VBAT	sen_out			sen_out
P0_02	Wi-Fi		VBAT	xtal32k_m			xtal32k_m
P0_03	Wi-Fi		VBAT	xtal32k_p			xtal32k_p
P0_04	Wi-Fi	ana wake	VDDIO_DIO1	ADC0		eMMC_DIO4	GPIO
P0_05	Wi-Fi	ana wake	VDDIO_DIO1	ADC1		eMMC_DIO5	GPIO
P0_06	Wi-Fi	ana wake	VDDIO_DIO1	ADC2		eMMC_DIO6	GPIO
P0_07	Wi-Fi	ana wake	VDDIO_DIO1	ADC3	MCLK	eMMC_DIO7	GPIO
P0_08	Wi-Fi	Yes	VDDIO_DIO1	QSPIR_CLK	SDIO0_CLK	eMMC_CLK	GPIO
P0_09	Wi-Fi	Yes	VDDIO_DIO1	QSPIR_CS	SDIO0_CMD	eMMC_CMD	GPIO
P0_10	Wi-Fi	Yes	VDDIO_DIO1	QSPIR_D0	SDIO0_D0	eMMC_DIO0	GPIO
P0_11	Wi-Fi	Yes	VDDIO_DIO1	QSPIR_D1	SDIO0_D1	eMMC_DIO1	GPIO
P0_12	Wi-Fi	Yes	VDDIO_DIO1	QSPIR_D2	SDIO0_D2	eMMC_DIO2	GPIO
P0_13	Wi-Fi	Yes	VDDIO_DIO1	QSPIR_D3	SDIO0_D3	eMMC_DIO3	GPIO
P1_00	Wi-Fi		1.8V		eMMC_DIO4		GPIO
P1_01	Wi-Fi		1.8V		eMMC_DIO5		GPIO
P1_02	Wi-Fi		1.8V		eMMC_DIO6		GPIO
P1_03	Wi-Fi		1.8V		eMMC_DIO7		GPIO
P1_10	Wi-Fi	Yes	VDDIO_DIO2	eMMC_CMD	SDIO1_CMD		GPIO
P1_11	Wi-Fi	Yes	VDDIO_DIO2	eMMC_CLK	SDIO1_CLK		GPIO
P1_12	Wi-Fi	Yes	VDDIO_DIO2	eMMC_DIO0	SDIO1_D0		GPIO
P1_13	Wi-Fi	Yes	VDDIO_DIO2	eMMC_DIO1	SDIO1_D1		GPIO
P1_14	Wi-Fi		VDDIO_DIO2	eMMC_DIO2	SDIO1_D2		GPIO
P1_15	Wi-Fi		VDDIO_DIO2	eMMC_DIO3	SDIO1_D3		GPIO
P1_16	Wi-Fi			SWCLK			SWCLK
P1_17	Wi-Fi			SWDIO			SWDIO

6.4 Debugging Interfaces

Either UART or SWD interfaces can be used both for Wi-Fi and Bluetooth LE debugging.

These interfaces provide access to the Wi-Fi section of the module (RA6W1), with the following connectivity:

- Reset: RST_n (pin37), 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.

Module Bluetooth LE subsystem connectivity:

- Reset: B_P0_00 (pin 4), active high. When B_P0_00 is assigned to Reset function, an internal pull-down of 25 kΩ is connected.
- SWD: B_P0_2 (pin 6) as SWCLK and B_P0_10 (pin 3) as SWDIO.
- UART: B_P0_01(pin 5) and B_P0_00 (pin 4) assigned as two wires booting UART (URX and UTX respectively) for Bluetooth LE subsystem.

SWDIO/SWCLK accompany components for RRQ61051 modules:

- RRQ61051 modules require passive components to be assigned on SWDIO and SWCLK lines, pins 36 and 35 respectively.
- The components must be placed on the carrier board, closest possible to the pads of the module.

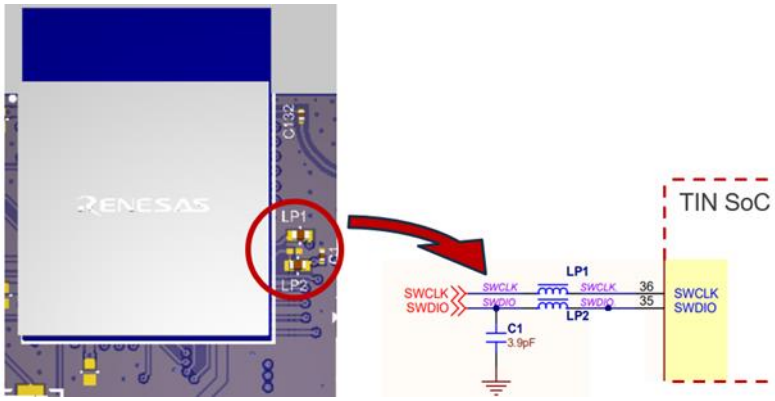


Figure 11. Components on carrier board for SWDIO (pin 35) and SWCLK (pin 36)

Table 26. 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 the radio circuit is incorporated into the module, there are very few considerations for Radio connectivity and operation that must be adhered to from the customer's side:

- RRQ61051-010 module provides an RF pin (pin45, RF_port). Connections from RF_port to RF connector or antenna must be done through a capacitor 100pF.
- For RRQ61051-009, RRQ61051-008, RRQ61051-208, RRQ61051-408, there is no RF pin available.
- RFSW1 and RFSW2 must be controlled externally (host PCB) through P0_06 and P0_07 respectively.
- For RRQ61051-009, ensure that when connecting to external equipment, a dc block is always applied. This is necessary for correct operation.
- For RRQ61051-009, ensure that for connecting with external attenuator, a dc block must be applied between module and attenuator.

For the RRQ61051-x08 (printed antenna version of the modules), the module must be placed on a host PCB following the design guidelines in Section 7.

7. Design Guidelines

7.1 RRQ61051-008

The RRQ61051-008, RRQ61051-208, and RRQ61051-408 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 12.

Metals close to the antenna degrade the antenna’s performance. The amount of degradation depends on the proximity and area of those features.

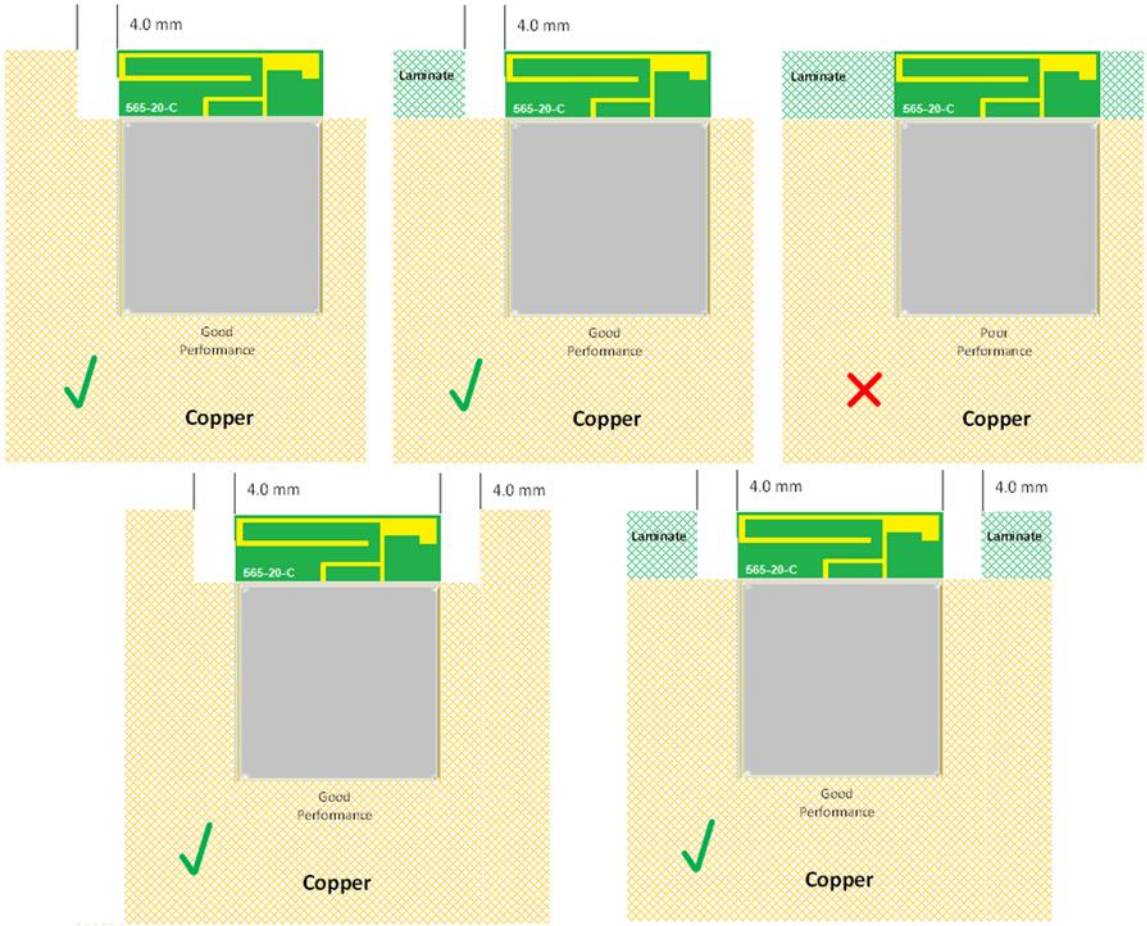


Figure 12. Antenna performance in proximity of Copper and Laminate

7.1.2 Placement of RRQ61051-x08 Module on Metallic Ground Plane

Placing RRQ61051-x08 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 13.

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 13, 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 14.

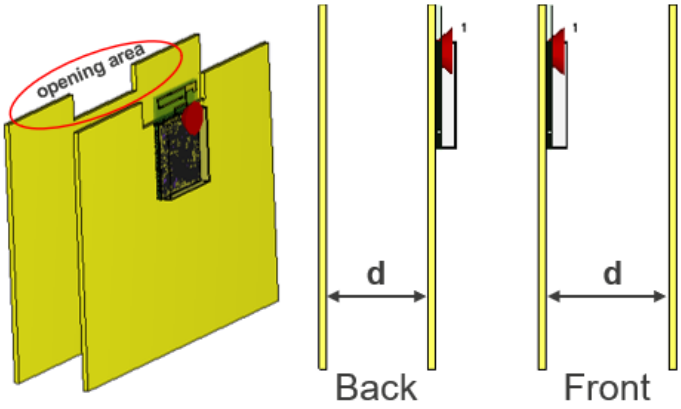


Figure 13. RRQ61051-008 placed above a GND metallic plane above or below, in a distance (d)

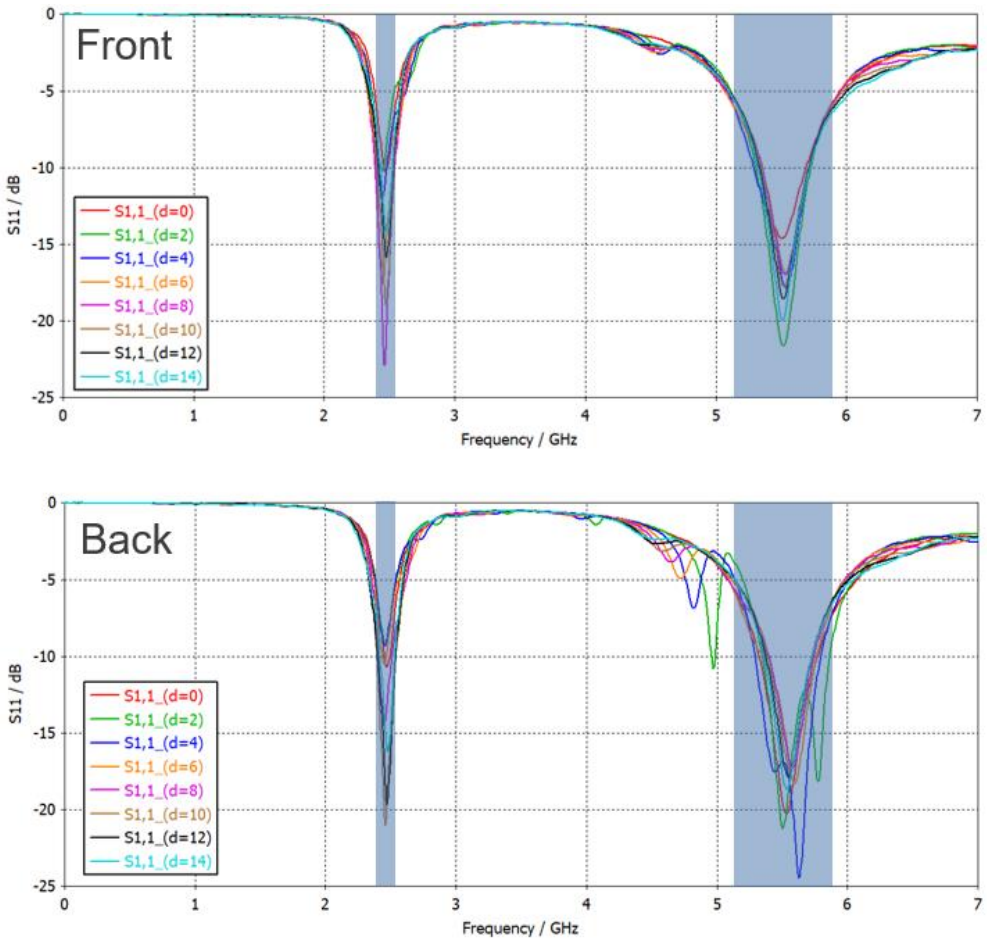


Figure 14. Antenna resonance for distances (d) 0 to 14 mm between RRQ61051-x08 module and GND plane

7.2 RRQ61051-009

7.2.1 Installation Location

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

7.2.2 Layout Considerations for RRQ61051-009 Module

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

7.3 RRQ61051-010

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 RRQ61051-010 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 ceoplanar waveguide with ground (CPW-G) structure. CPW-G structure offers 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.

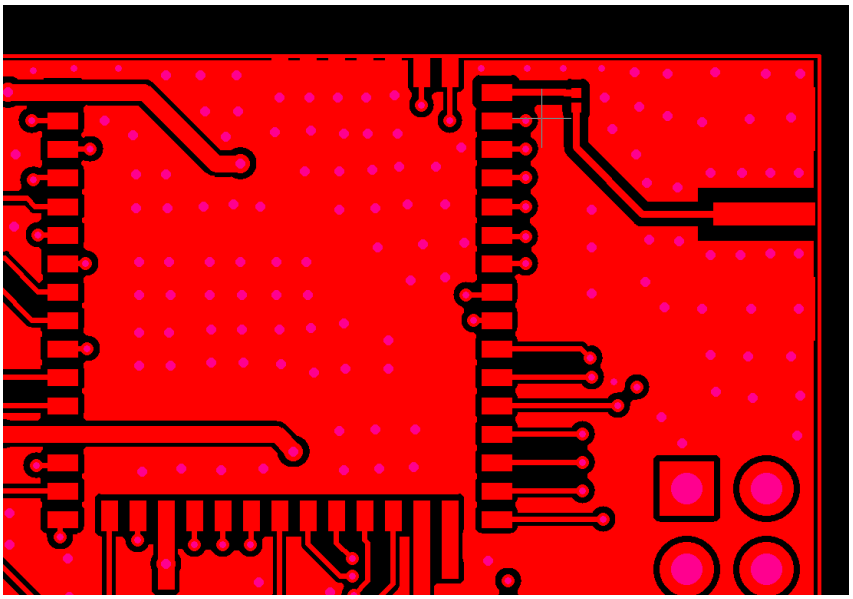


Figure 15. RF trace of coplanar waveguide with GND and via stitching (top view)

Figure 16 shows a cross section of the coplanar waveguide with the critical dimensions.

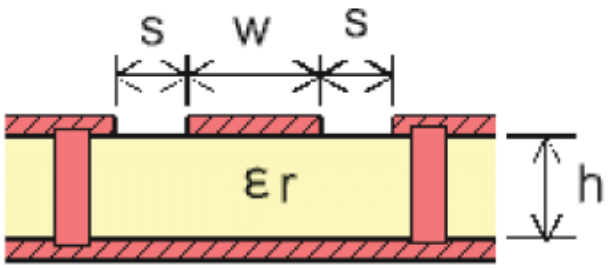


Figure 16. Coplanar waveguide (cross section)

8. RRQ61051-008 Printed Antenna Performance

The RRQ61051-x08 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 17.

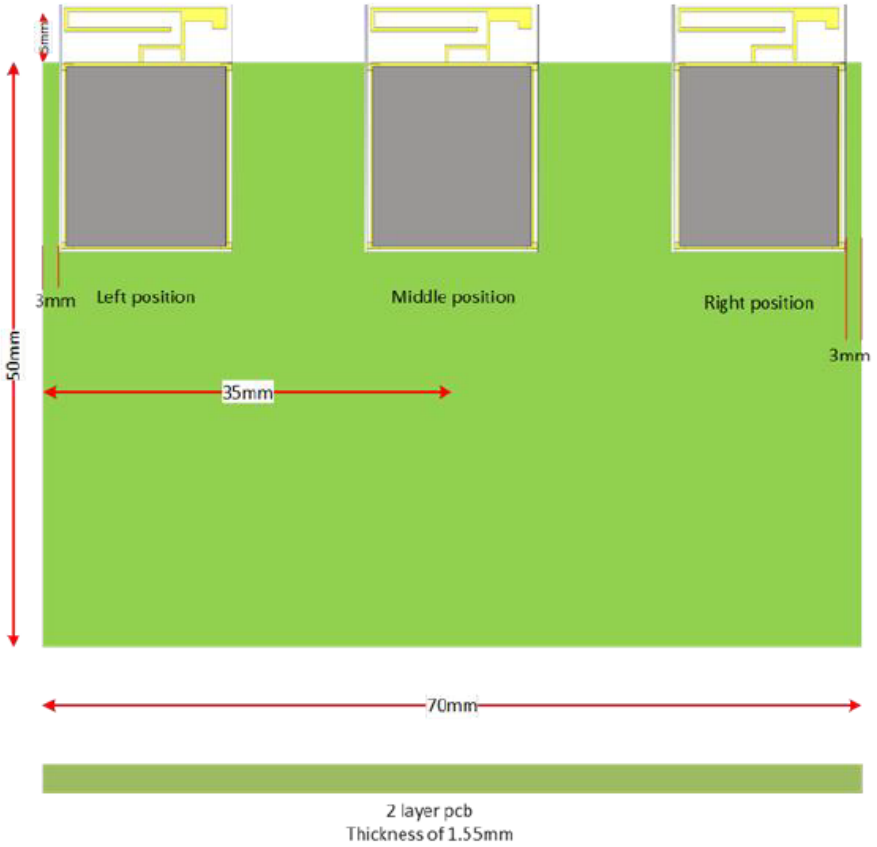


Figure 17. Module is positioned at right, middle, and left position on a reference board with dimension 70x50 mm

8.1 VSWR Measurements

The antenna VSWR measurements for the three installation positions are shown in the following figures.

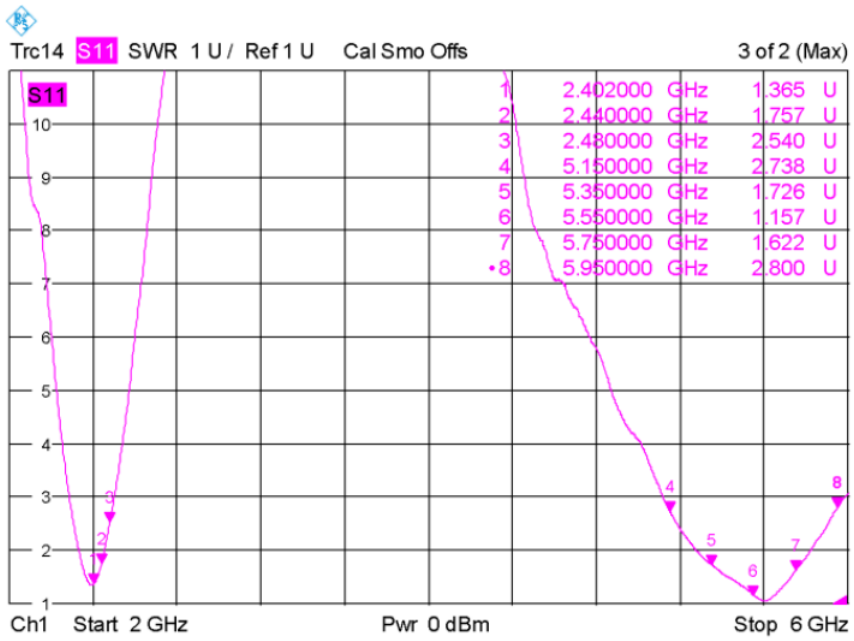


Figure 18. VSWR Renesas RRQ61051-008 Wi-Fi module antenna. Module in right position

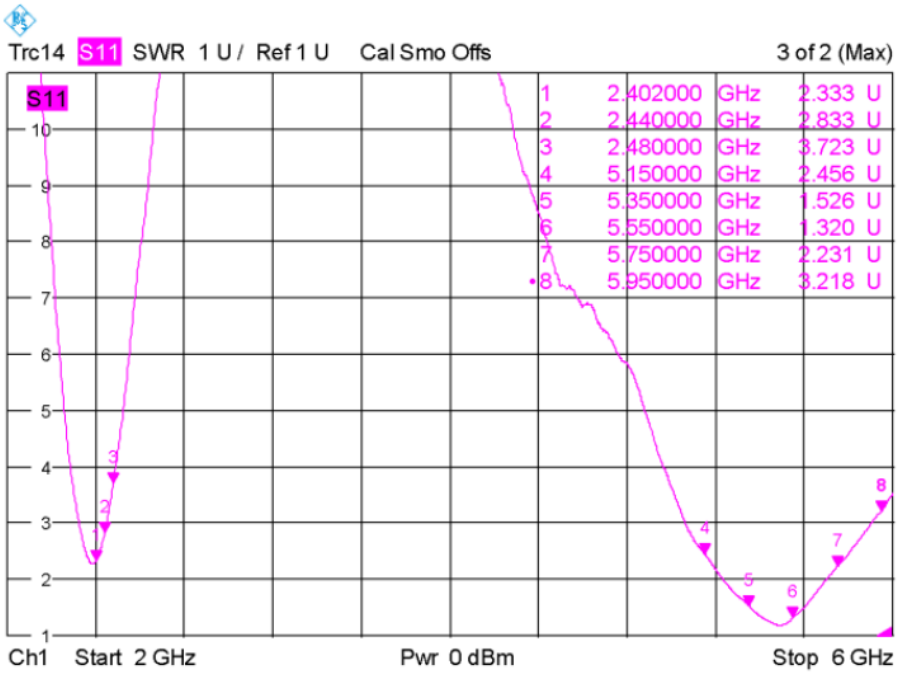


Figure 19. VSWR Renesas RRQ61051-008 Wi-Fi module antenna. Module in middle position

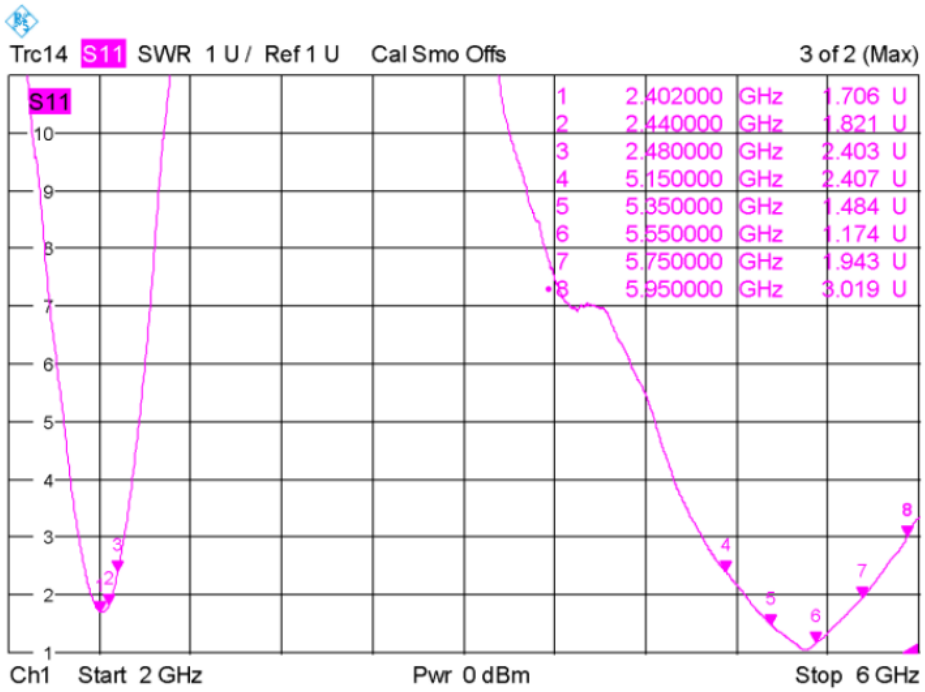


Figure 20. VSWR Renesas RRQ61051-008 Wi-Fi module antenna. Module in left position

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 27 summarizes the antenna efficiency at different installation locations on a host PCB as shown in Figure 17.

Table 27: Antenna efficiency vs RRQ61051-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 21. 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.

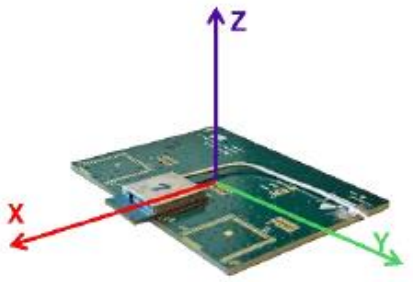


Figure 22. Measurements plane definitions

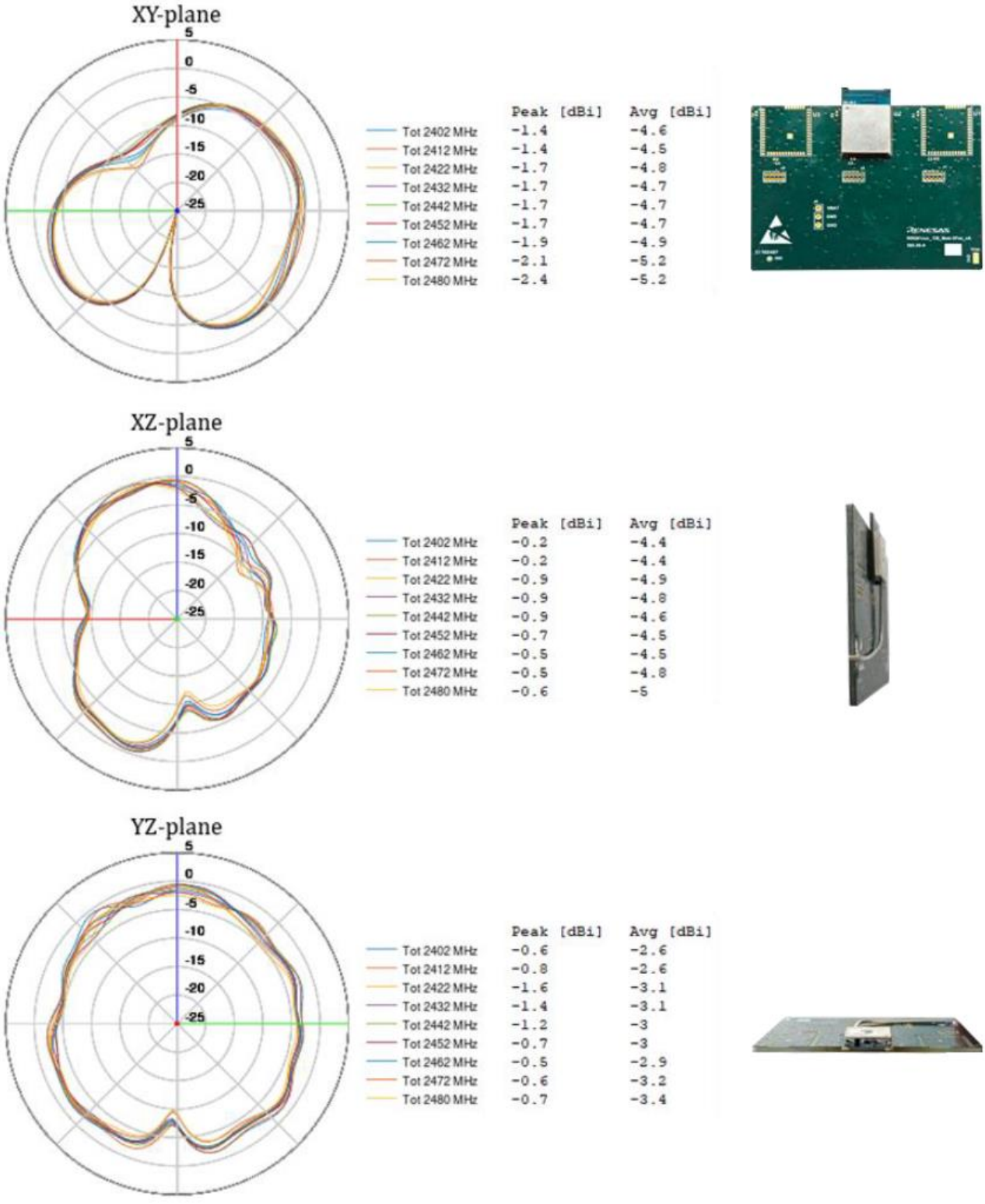
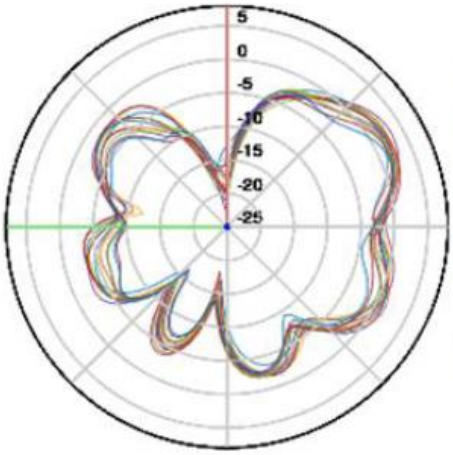
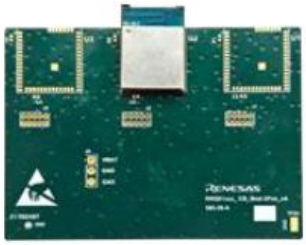


Figure 23. 2D radiation patterns for 2.4 GHz band for RRQ61051-008 module

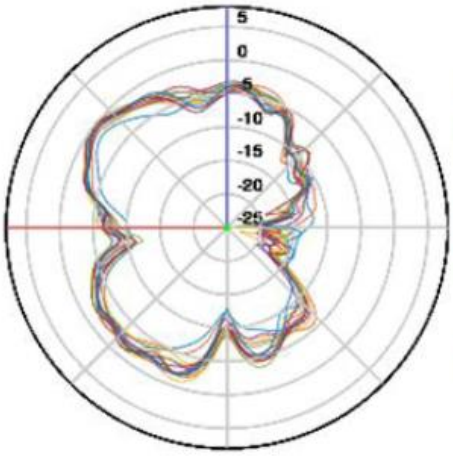
XY-plane



	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

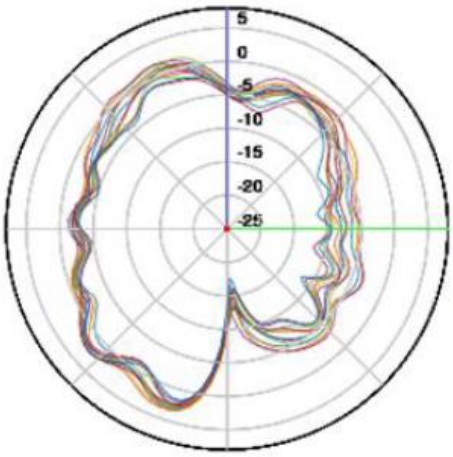


XZ-plane



	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 24. 2D radiation patterns for 5 GHz band for RRQ61051-008 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

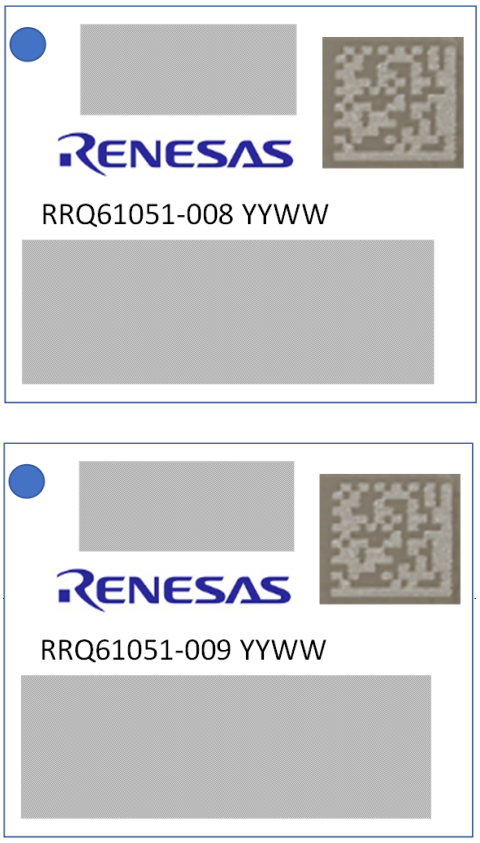


Figure 25. RRQ61051 modules shield marking

The shield marking consists of:

- Brand name: Renesas
- Model name: for example, RRQ61051-008, RRQ61051-009, and so on.
- 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 and SRRC IDs, and so on are engraved on the grayed-out area according to regulatory requirements.

10. Packaging Information

10.1 Tape and Reel

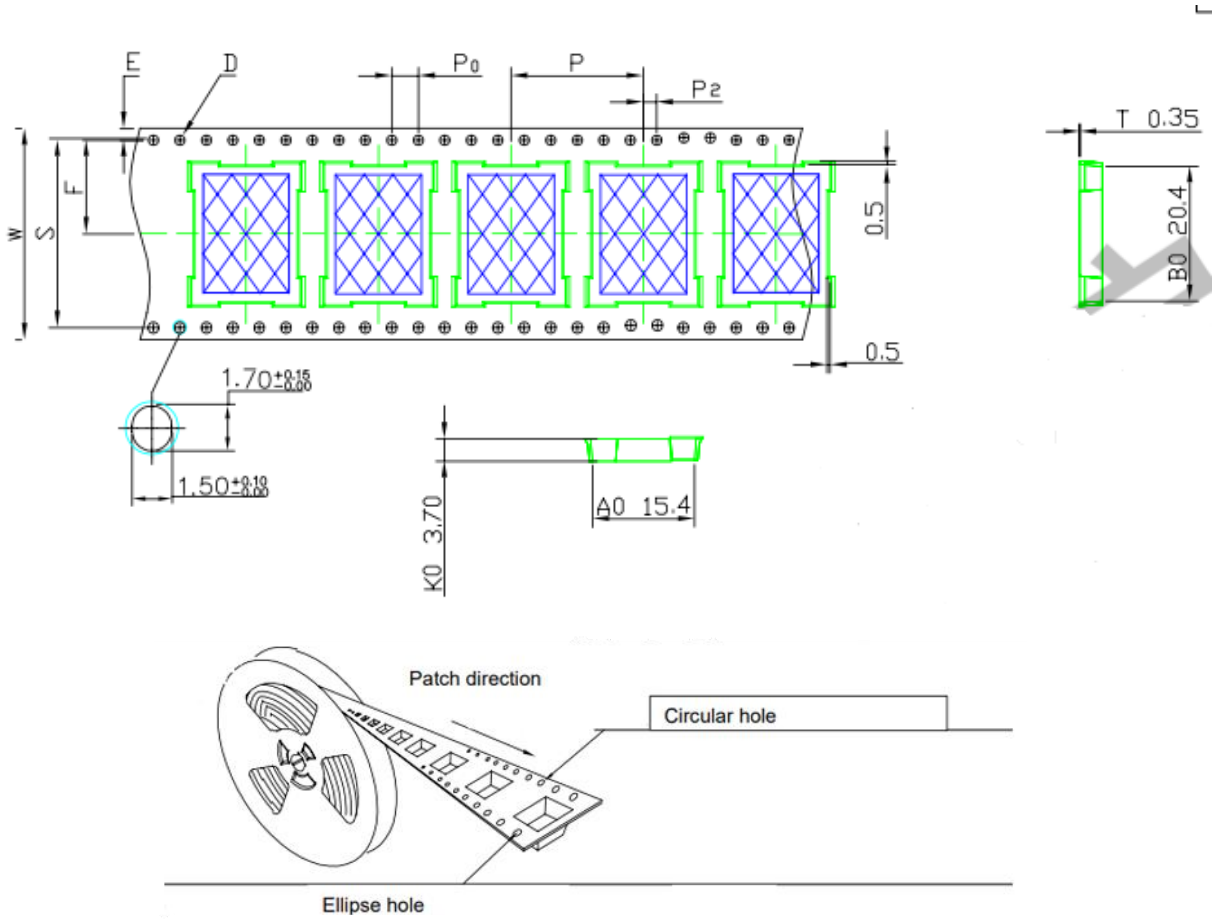


Figure 26. Tape and reel

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 (QTY 500), and part number as in Figure 27.

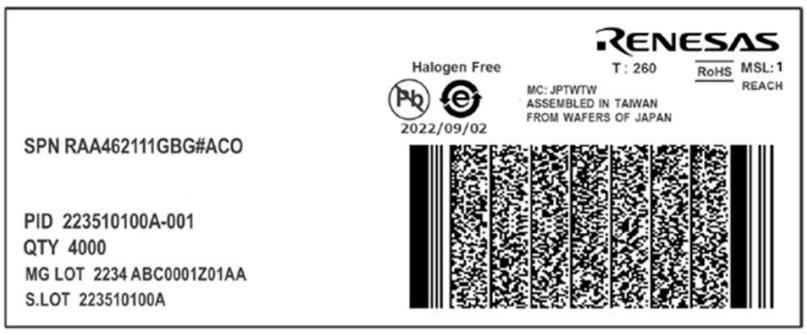


Figure 27. Reel part information label

11. Soldering

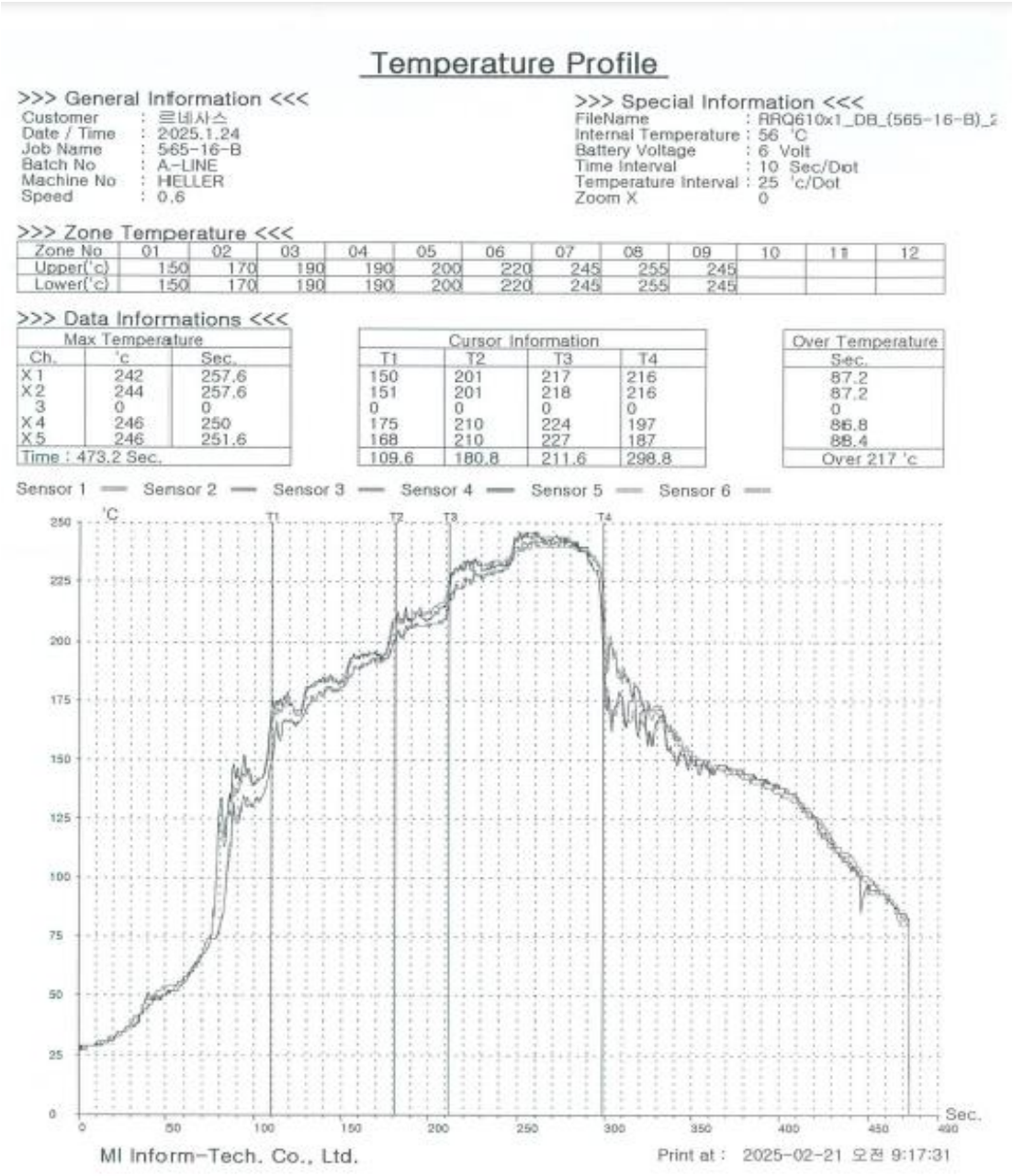


Figure 28. Reflow profile for lead free solder, applied on RRQ61051 daughterboard

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 RRQ61051 Module is qualified for MSL 3.

Table 28: 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 29: RRQ61051 modules

Part Number	Description	Flash	Antenna type
RRQ61051-008	Wi-Fi 6/Bluetooth LE combo	8 MB	PCB trace Antenna
RRQ61051-009	Wi-Fi 6/Bluetooth LE combo	8 MB	External Antenna connector, u.FL
RRQ61051-010	Wi-Fi 6/Bluetooth LE combo	8 MB	RF antenna pin
RRQ61051-208	Wi-Fi 4 Single band 2.4 GHz/Bluetooth LE combo	8 MB	PCB trace Antenna
RRQ61051-408	Wi-Fi 6 Single Band 2.4 GHz/Bluetooth LE combo	8 MB	PCB trace Antenna

14. Regulatory Information

This section outlines the regulatory information for the RRQ61051 Modules. The modules are certified for the global market which 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 30, 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 and/or certification, such as Korea EMC certification. Other markets, such as Japan, Taiwan, Brazil have the requirement to put a modular approval ID on the end product label or mark directly on host label that consists of an approved modular ID.

Table 30 shows the list of the Conformance Standards that RRQ61051 Modules meets.

Table 30: Standards conformance

Area	Item	Service	Standard	Certification IDs/Certificate numbers	
				RRQ61051-008 RRQ61051-208 RRQ61051-408 Note 1	**RRQ61051-009/ RRQ61051-010 Note 1**
Global	Safety	CB	IEC 62368-1	US-BACL-00811	US-BACL-00813
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	B2602025-IMDA B26020210-IMDA Note 2	B2602023-IMDA
US/CA	Wireless	FCC ID	47 CFR PART 15 Subpart C: 2021 section 15.247	2AU49- RRQ61051008 2AU49- RRQ61051408 Note 3	2AU49-RRQ61051009
		IC ID	RSS-247, ISSUE 4, July 2025 RSS-Gen Issue 5: April 2018 +A1: March 2019+A2: February 2021	34654- RRQ61051008 34654- RRQ61051408 Note 3	34654- RRQ61051009
Japan	Wireless	MIC	JRL	211-251009	211-251010

Area	Item	Service	Standard	Certification IDs/Certificate numbers	
				RRQ61051-008 RRQ61051-208 RRQ61051-408 Note 1	RRQ61051-009/ RRQ61051-010 Note 1
Taiwan	Wireless	NCC	LP0002	CCAP26Y10050T8 CCAP26Y10091T9 CCAP26Y10090T7	CCAP26Y10060T1 CCAP26Y10080T4
South Korea	Wireless	KC	방송통신표준 KS X 3123 "무선 설비 적합성 평가 시험 방법" KN 301 489	R-C-fci-RRQ61051008	R-C-fci-RRQ61051009
Brazil	Wireless	Anatel	ATO No.14448/2017 Resolution No.680	06846-25-15614	06843-25-15614
China	Wireless	SRRC	信部无【2002】353	25J99G3YQ229 25J99G3YX299 26J99G3YB424	25J99G3YW863(M) 26J99G3YP411(M)

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

Note 2 For IMDA, RRQ61051-208 and RRQ61051-408 share the same certificate number.

Note 3 RRQ61051-208 shares same FCC and IC ID with RRQ61051-408 due to series family certification.

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

Model no. RRQ61051-008

Model no. RRQ61051-208

Model no. RRQ61051-408

Model no. RRQ61051-009

Model no. RRQ61051-010

RRQ61051 Modules are Radio Equipment Directive (RED) assessed radio that are CE marked. The modules have been manufactured and tested with the intention of being a subassembly to a final product. The modules have 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.

Simplified Declaration of Conformity
Hereby, Renesas Design Korea Inc. declares that radio type equipment RRQ61051 Module and model no: RRQ61051-008, RRQ61051-208, RRQ61051-408, RRQ61051-009, RRQ61051-010 are 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. RRQ61051-008

Model no. RRQ61051-208

Model no. RRQ61051-408

Model no. RRQ61051-009

Model no. RRQ61051-010

RRQ61051 modules 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**

End product must undergo the radio EMC tests according to EN 301 489.

Simplified Declaration of Conformity
Hereby, Renesas Design Korea Inc declares that radio type equipment RRQ61051 Module and model no: RRQ61051-008, RRQ61051-208, RRQ61051-408, RRQ61051-009, RRQ61051-010 are 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. RRQ61051-008, FCC ID: 2AU49- RRQ61051008

Model no. RRQ61051-009, FCC ID: 2AU49- RRQ61051009

Model no. RRQ61051-010, FCC ID: 2AU49- RRQ61051009

Model no. RRQ61051-208, FCC ID: 2AU49- RRQ61051408

Model no. RRQ61051-408, FCC ID: 2AU49- RRQ61051408

14.3.1 List of Applicable FCC Rules

The module complies with FCC Part 15.247, 15.407.

14.3.2 Summary of Specific Operational Use Conditions

This module is 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 must 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 Antennas

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	50 Ω	Fixed

Type	Brand	Model name	Gain	Impedance	Application
			5 GHz: +4.4 dBi		

If of 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 RRQ61051 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: **RRQ61051-008** Contains FCC ID: **2AU49-RRQ61051008**
Model: **RRQ61051-009** Contains FCC ID: **2AU49-RRQ61051009**
Model: **RRQ61051-208** Contains FCC ID: **2AU49- RRQ61051408**
Model: **RRQ61051-408** Contains FCC ID: **2AU49- RRQ61051408**
Model: **RRQ61051-010** Contains FCC ID: **2AU49-RRQ61051009**

14.3.8 Information on Test Modes and Additional Testing Requirements

When testing 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 contains digital circuity.

14.4 ISED (Canada)

Model no. RRQ61051-008, IC: 34654- RRQ61051008

Model no. RRQ61051-009, IC: 34654- RRQ61051009

Model no. RRQ61051-010, IC: 34654- RRQ61051009

Model no. RRQ61051-208, IC: 34654- RRQ61051408

Model no. RRQ61051-408, IC: 34654- RRQ61051408

The RRQ61051 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:

- 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 has to 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 RRQ61051 Module is labeled with its own IC ID.

Model no. RRQ61051-008, IC: 34654- RRQ61051008

Model no. RRQ61051-009, IC: 34654- RRQ61051009

Model no. RRQ61051-010, IC: 34654- RRQ61051009

Model no. RRQ61051-208, IC: 34654- RRQ61051408

Model no. RRQ61051-408, IC: 34654- RRQ61051408.

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- RRQ610510xx” where x 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 RRQ61051 est étiqueté avec son propre identifiant IC.

Modèle no. RRQ61051-008, IC: 34654-RRQ61051008

Modèle no. RRQ61051-009, IC: 34654-RRQ61051009

Modèle no. RRQ61051-010, IC: 34654-RRQ61051009

Modèle no. RRQ61051-208, IC: 34654-RRQ61051408

Modèle no. RRQ61051-408, IC: 34654-RRQ61051408

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-RRQ610510xx »

14.5 SRRC (China)

Model no. RRQ61051-008, SRRC ID: 25J99G3YQ229

Model no. RRQ61051-009, SRRC ID: 25J99G3YW863(M)

Model no. RRQ61051-010, SRRC ID: 26J99G3YP411(M)

Model no. RRQ61051-208, SRRC ID: 25J99G3YX299

Model no. RRQ61051-408, SRRC ID: 26J99G3YB424

The modules have been tested and found to be compliant according to the following standards:

信部无【2002】353 号

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

14.6 MIC (Japan)

The modules have been tested and 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. RRQ61051-008, MIC ID: 211-251009

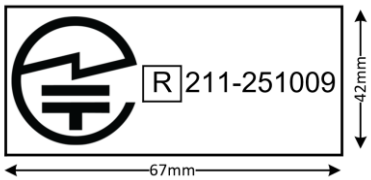
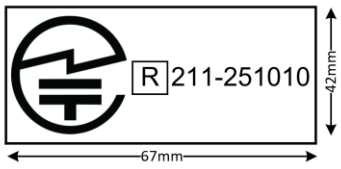
Model no. RRQ61051-208, MIC ID: 211-251009

Model no. RRQ61051-408, MIC ID: 211-251009

Model no. RRQ61051-009, MIC ID: 211-251010

Model no. RRQ61051-010, MIC ID: 211-251010

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
RRQ61051-008 **RRQ61051-208** **RRQ61051-408**	
RRQ61051-009 **RRQ61051-010**	

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.

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. RRQ61051-008, NCC ID: CCAP26Y10050T8

Model no. RRQ61051-009, NCC ID: CCAP26Y10060T1

Model no. RRQ61051-010, NCC ID: CCAP26Y10080T4

Model no. RRQ61051-208, NCC ID: CCAP26Y10091T9

Model no. RRQ61051-408, NCC ID: CCAP26Y10090T7

Model	NCC label
RRQ61051-008	CCAP26Y10050T8
RRQ61051-009	CCAP26Y10060T1
RRQ61051-010	CCAP26Y10080T4
RRQ61051-208	CCAP26Y10091T9
RRQ61051-408	CCAP26Y10090T7

RRQ61051 Modules have received compliance approval in accordance with the Telecommunications Act. The modules have been tested according to the following standard:

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

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

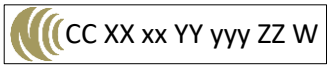
取得審驗證明之低功率射頻器材，非經核准，公司、商號或使 用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。低功率射頻器材之使用不得影響飛航安

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: 

14.8 KCC (S.Korea)

Model no. RRQ61051-008, Certification No: R-C-fci-RRQ61051008

Model no. RRQ61051-009, Certification No: R-C-fci-RRQ61051009

Model no. RRQ61051-010, Certification No: R-C-fci-RRQ61051009

Model no. RRQ61051-208, Certification No: R-C-fci-RRQ61051008

Model no. RRQ61051-408, Certification No: R-C-fci-RRQ61051008

The RRQ61051 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)** shall be displayed on the final product in accordance with **RRA labeling requirements**.

14.9 ANATEL (Brazil)

Model no. RRQ61051-008, ANATEL ID: 06846-25-15614

Model no. RRQ61051-009, ANATEL ID: 06843-25-15614

Model no. RRQ61051-010, ANATEL ID: 06843-25-15614

Model no. RRQ61051-208, ANATEL ID: 06846-25-15614

Model no. RRQ61051-408, ANATEL ID: 06846-25-15614

RRQ61051 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. RRQ61051-008

Model no. RRQ61051-009

Model no. RRQ61051-010

Model no. RRQ61051-208

Model no. RRQ61051-408

RRQ61051 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
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- 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
1.02	Apr 28, 2026	Updated mechanical specifications, printed antenna information, regulatory Information.
1.01	Jan 21, 2026	Added Regulatory Information. Added installation details.
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.