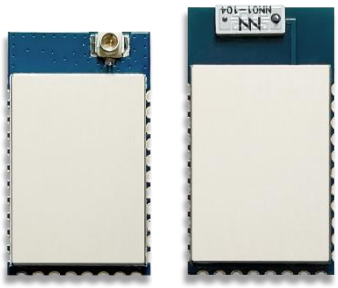
RM-BE1

Ultra-Low-Power Energy-Efficient Bluetooth® 5.0 Module with Harvesting

Datasheet



The RM-BE1 is a Bluetooth® 5.0 Low-Energy module fully compliant with 2Mbit High-Throughput (HT) and Long-Range extensions.

RM-BE1 is based on Renesas energy-efficient RE01 MCU, featuring an Arm® Cortex®-M0+ core. RE01 is implemented on Silicon on Thin Buried Oxide (SOTB) process technology enabling for ultra-low current consumption in both active and standby mode and high-speed CPU operation (64MHz) at low voltage (1.62V).

The module power supply circuitry supports energy harvesting and rechargeable batteries, allowing for building devices that do not require battery replacement.

KEY FEATURES

- 32-bit ARM® Cortex®-M0+ core
- High-speed operation 64MHz at low voltage 1.62V
- 1.5 MB code flash memory, 256 kB RAM
- Active current: 35µA/MHz, Standby current: 670nA
- Bluetooth 5.0 core specification compliant BLE supporting LE1M, 2M and Coded PHY.

1. Feature List

MCU

- 32-bit ARM® Cortex®-M0+ core with MPU
- Maximum operating frequency: 64 MHz (in boost mode)
- ULP-CP score 705 certified by EEBC
- 1.5-Mbyte code flash memory
- 156-kB RAM

POWER SAVING FUNCTIONS

- Back-bias control function based on silicon-on-thin-buried-oxide (SOTB™) process technology
- Operation at ultra-low power-supply voltages (from 1.62 V to 3.6 V)
- Four power control modes based on the operating frequency
- Four low power consumption modes
- Three power supply modes

ENERGY HARVESTING CONTROL

- A power generation element is directly connectable
- High-speed startup is possible without having to wait for a secondary battery to be charged
- Protection of a secondary battery against overcharging

DIMENSIONS

- RM-BE1-S1: 27.5 x 15.0 x 2.6 mm
- RM-BE1-U1: 26.0 x 15.0 x 2.6 mm

RADIO FEATURES

- RF transceiver and link layer compliant with the Bluetooth 5.0 Low Energy specification
- Support for LE1M, 2M and Coded PHY and Extended Advertising
- Programmable RF output power up to +4 dBm

ANALOG PERIPHERALS

- 14-bit successive approximation A/D
- Up to four analog input channels
- Ultra-low power operations, A/D conversion at about 4µA (1.68ksps with 32kHz low CL)

DIGITAL PERIPHERALS

- 9x Timers (2x GPT, 2x AGT, 2x TMR, RTC, WDT, LST)
- Up to 3x I2C
- Up to 2x UART
- Up to 2x SPI

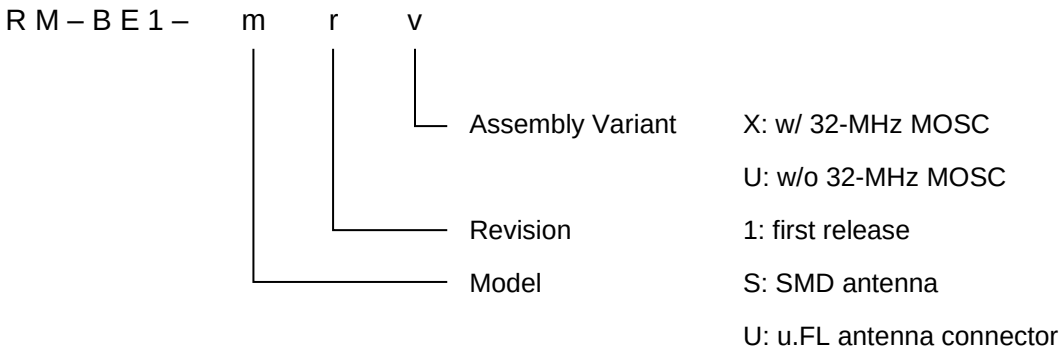
ENVIRONMENTAL & REGULATORY

- Operating temperature range: -40÷85 °C

2. Ordering Information

Table 1 – Ordering information.

Product Code	Antenna	Flash	RAM	Main OSC 32-MHz
RM-BE1-S1X	SMD antenna	1.5 MB	256 kB	XTAL Fitted
RM-BE1-U1X	u.FL connector	1.5 MB	256 kB	XTAL Fitted
RM-BE1-S1U	SMD antenna	1.5 MB	256 kB	XTAL Not fitted
RM-BE1-U1U	u.FL connector	1.5 MB	256 kB	XTAL Not fitted



Outline

3. System Overview

The RM-BE1 is a Bluetooth® 5.0 Low-Energy module fully compliant with 2Mbit High-Throughput (HT) and Long-Range extensions.

RM-BE1 is based on Renesas energy-efficient RE01 MCU, featuring an Arm® Cortex®-M0+ core. RE01 is implemented on Silicon on Thin Buried Oxide (SOTB) process technology enabling for ultra-low current consumption in both active and standby mode and high-speed CPU operation (64MHz) at low voltage (1.62V).

The module power supply circuitry supports energy harvesting and rechargeable batteries, allowing for building devices that do not require battery replacement.

3.1. Module versions

To provide designer with maximum integration flexibility, RM-BE1 module is available in two variants, featuring different antenna options. RM-BE1-S variant features an on-module SMD antenna whereas RM-SS2-U module option includes an u.FL RF connector.

RM-BE1-S

RM-BE1-U

3.2. Block diagram

Module basic block diagrams are depicted in the image below.

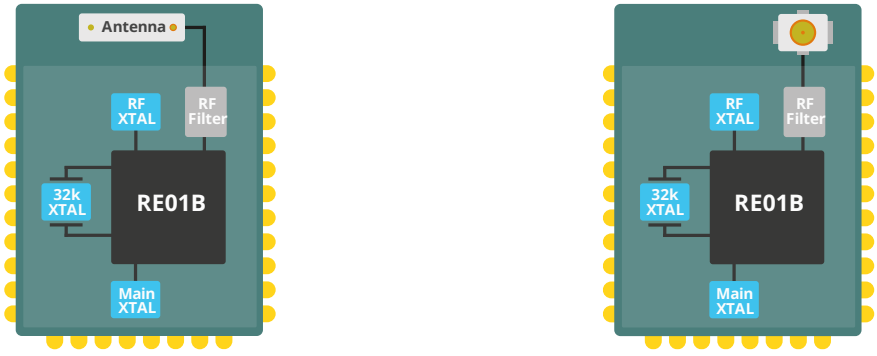


Figure 1 - Module block diagrams (RM-BE1-S – RM-BE1-U, respectively).

4. Module Specifications

4.1. General specifications

The following table describes the general specifications for the devices.

Table 2 – RM-SS2 module general specifications.

Specification	RM-BE1-S	RM-BE1-U
Operating frequency bands	2402 ÷ 2480 MHz	
Form factor	Surface mount	
Dimensions	27.5 x 15.0 x 2.6 mm	26.0 x 15.0 x 2.6 mm
Operating temperature range	-40 to +85 °C	-40 to +85 °C
Antenna	SMD antenna	u.FL connector

4.2. Electrical specifications

The following tables give detailed specifications for the RM-BE1 module series. T_{amb} = 25 °C for all specifications given, if not differently specified.

4.2.1 Nominal Operating Conditions

Table 3 – RM-SS2 module electrical specifications.

Parameter	Min	Typ	Max	Units	Condition/Notes
Operating Temperature	-40		+85	°C	
Supply Voltage (VDD_MCU, VDD_RF, VDD_UM)	1.62	3.3	3.6	V	

4.2.2 Absolute Maximum Ratings

Table 4 – RM-SS2 module absolute maximum ratings.

Parameter	Min	Max	Units
Power Supply Voltage (VDD_x, VBAT_EHC)	-0.3	4.0	V

Input Voltage	-0.3	VCC + 0.3 (max. 4.0 V)	V
Analog Power Supply Voltage	-0.3	4.0	V
Storage Temperature	-55	+125	°C
Operating Temperature	-40	+95	°C

Stresses beyond those listed in this table may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions beyond those indicated in the operating conditions of the specification is not implied. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.
MCU absolute maximum ratings are detailed in [1] .

5. Connection Diagrams

Connect RM-BE1 module according to the following guidelines.

5.1. Normal mode

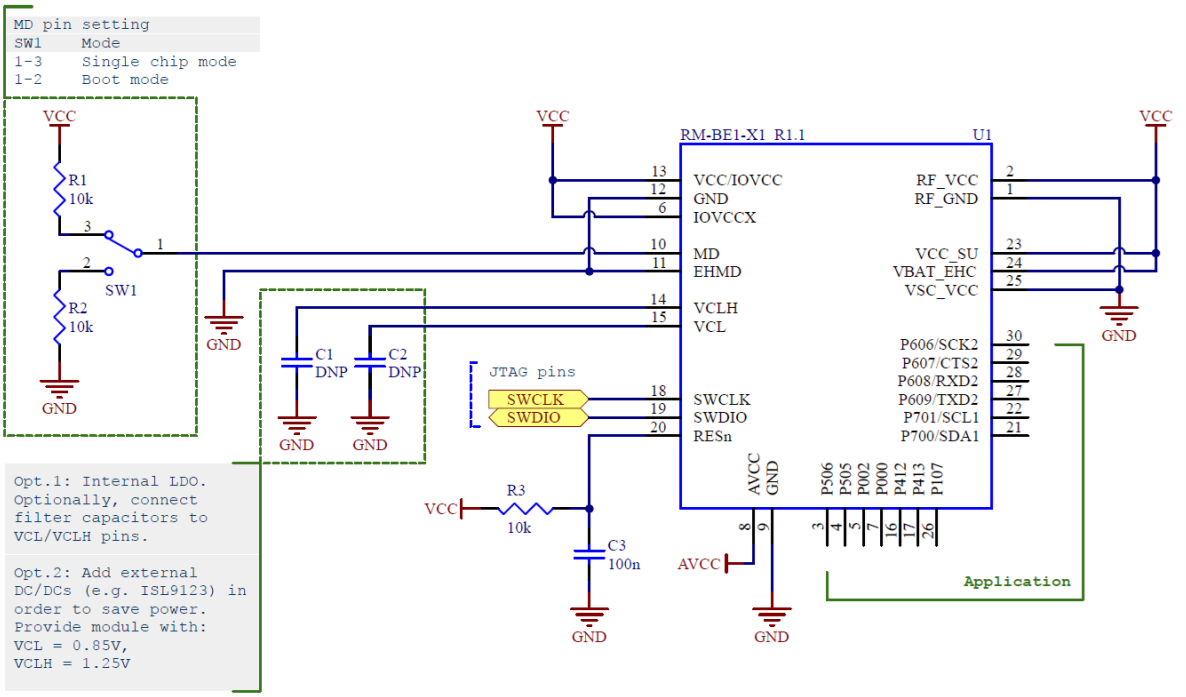


Figure 2 - Module connection diagram for Normal mode operations.

5.2. EHC mode

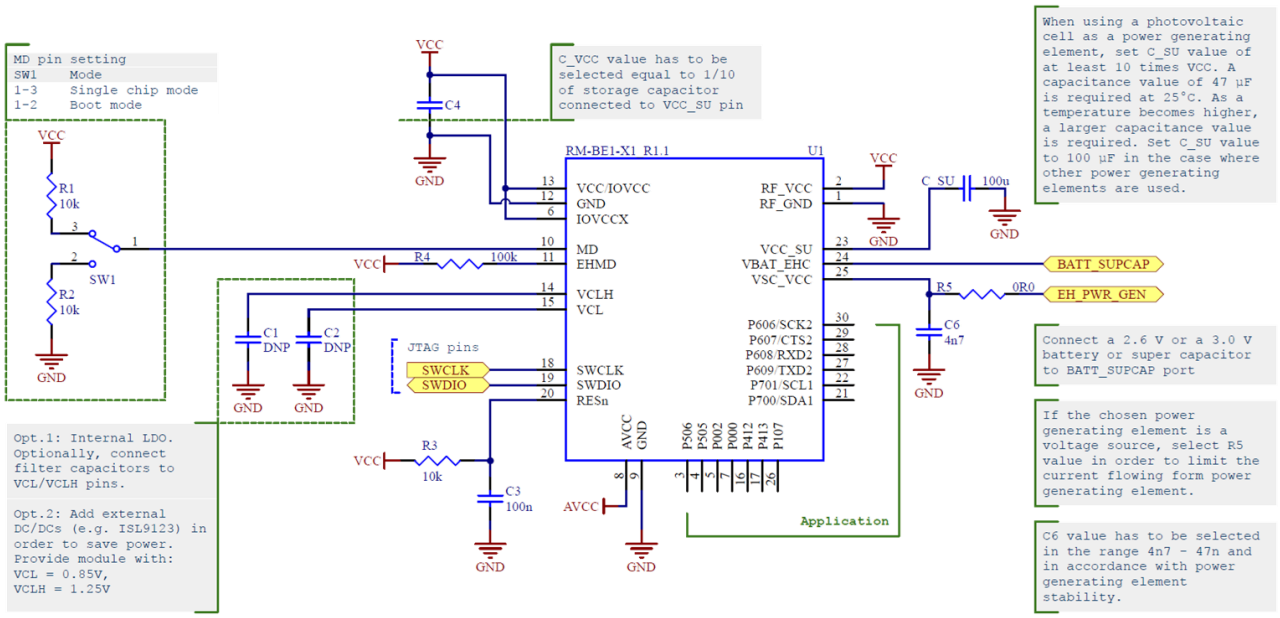


Figure 3 - Module connection diagram for Harvesting mode operations.

6. Layout Guidelines

6.1. Recommended placement on the application PCB

6.1.1 RM-BE1-S

For optimal performance of the RM-BE1-S module with on-board SMD antenna, please follow these guidelines:

- Place the module at the edge of the PCB, as shown in Figure 4.
- Do not place any metal (traces, components, battery, etc.) within the clearance area of the antenna.
- Connect all ground pads directly to a solid ground plane.
- Place the ground vias as close to the ground pads as possible.

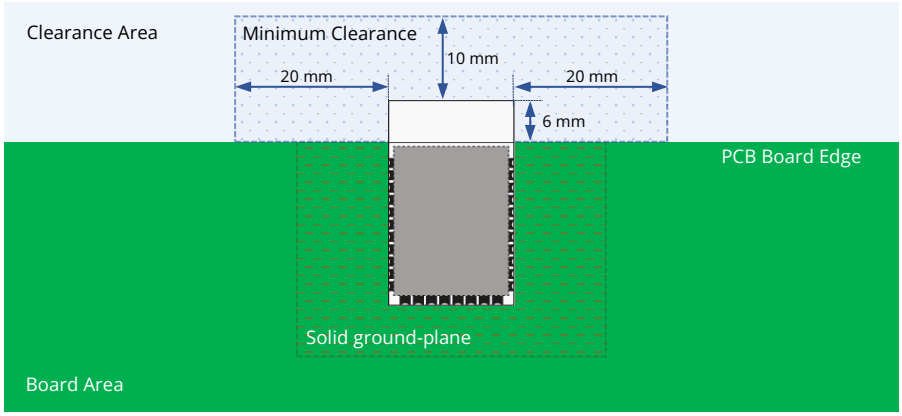


Figure 4 - Placement guidelines for RM-BE1-S device.

6.1.2 RM-BE1-U

For optimal performance of the RM-BE1-U module with u.FL antenna, please follow these guidelines:

- Place the module in the preferred position on the PCB. Module can be entirely placed on the PCB area, as depicted in Figure 5 below.
- Connect all ground pads directly to a solid ground plane.
- Place the ground vias as close to the ground pads as possible.

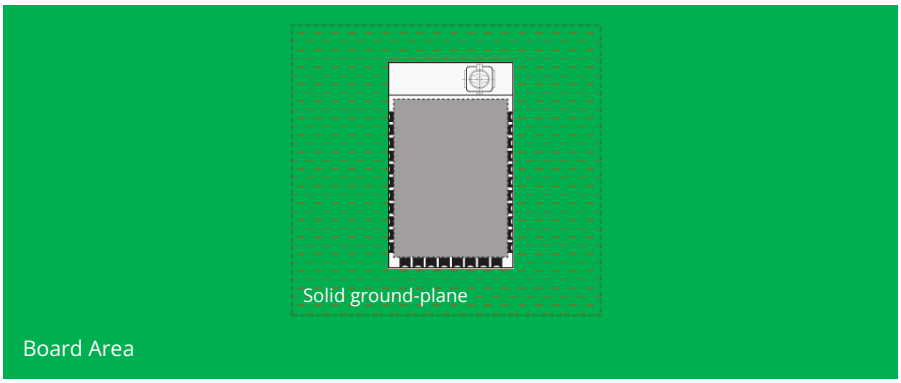


Figure 5 - Placement guidelines for RM-BE1-U device.

7. Pin Definitions

7.1. Pin Numbering

7.1.1 RM-BE1-S

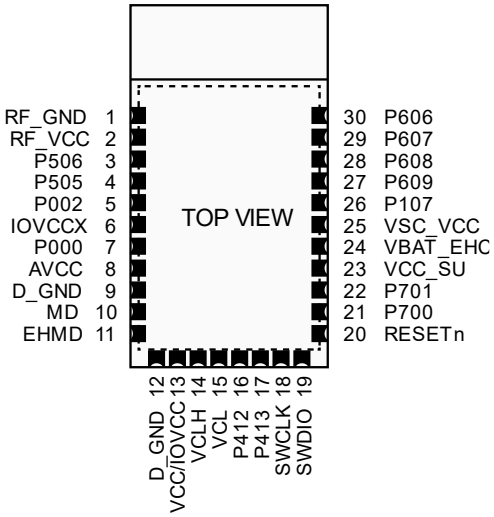


Figure 6 – RM-BE1-S pinout

7.1.2 RM-BE1-U

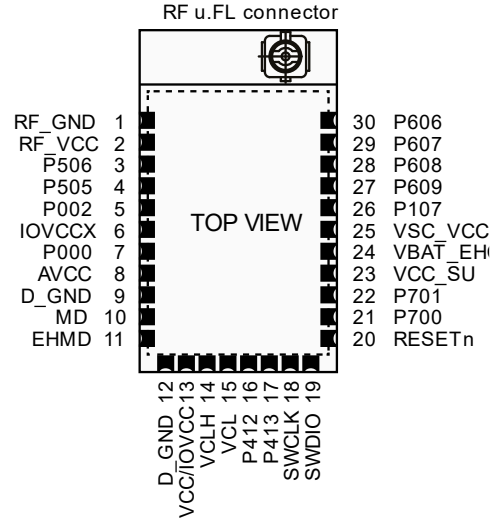


Figure 7 - RM-BE1-U pinout.

7.2. Pin Description

Device pinout is detailed in the table below. Several RE01B MCU ports and peripherals are routed to the module pins, providing designer with access to microcontroller main functionalities (see “MCU Pin #” column). Main module pin functionalities are detailed in the Description column. For a detailed description, please check MCU pin functions in [1] .

Table 5 – RM-BE1 module pin connections and descriptions.

Pin #	Pin Name	Type	Description	MCU Pin #
1	RF_GND	GND	Ground Connection – RF Section	32-65
2	RF_VCC	Power Supply	Power Supply – RF Section Input (1.62 V ÷ 3.6 V)	2-48
3	MCU_P506	Digital I/O – Analog	GPIO / IRQ0_C / AN028	51
4	MCU_P505	Digital I/O – Analog	GPIO / IRQ1_C / AN028	52
5	MCU_P002	Digital I/O – Analog	GPIO / AN002	58
6	IOVCCX	Power Supply	Power supply – Bank 1-2 (IOVCC1 / IOVCC2)	28-40
7	MCU_P000	Digital I/O – Analog	GPIO / AN000	61
8	AVCC	Power Supply	Power Supply – Analog Section Input (1.62 V ÷ 3.6 V)	62-63
9	D_GND	GND	Ground Connection – Digital Section	1-6-19-23-29-41-55
10	MD	Boot Config	Start-up Mode Selection (Boot Mode)	17
11	EHMD	Boot Config	Start-up Mode Selection (Power Mode)	12
12	D_GND	GND	Ground Connection – Digital Section	1-6-19-23-29-41-55
13	VCC/IOVCC	Power Supply	Power Supply Input (1.8 V ÷ 3.6 V)	9-54
14	VCLH	Power Supply	Internal Core Power Supply	3
15	VCL	Power Supply	Internal Core Power Supply	10
16	MCU_P412[1]	Digital I/O	GPIO / RXD3 / GTETRGB_A	8

[1] Do not use P412 pin with RM-BE1-□□X variants. Detailed pin functionality only applies to RM-BE1-□□U variants.

17	MCU_P413[2]	Digital I/O	GPIO / RXD3 / GTETRGA_A	7
18	SWCLK	SWD Interface	Serial wire clock input pin	11
19	SWDIO	SWD Interface	Serial wire data I/O pin	15
20	RESETn	System Control	Reset signal input pin – active low	16
21	MCU_P700	Digital I/O	SDA1 / TMO1	26
22	MCU_P701	Digital I/O	SCL1 / TMRI1 / RTCIC2_B	25
23	VCC_SU	Power Supply	Power supply from storage capacitor	20
24	VBAT_EHC	Power Supply	Power supply pin supplied from a secondary battery	21
25	VSC_VCC	Power Supply	Power supply pin supplied from a power generation element	22
26	MCU_P107	Digital I/O	AGTOB1_A / IRQ7_A / KRM07_A	42
27	MCU_P609	Digital I/O	TXD2_C / SSDA2_C / MOSI2_C / MOSIB_B	33
28	MCU_P608	Digital I/O	RXD2_C / SSCL2_C / MISO2_C / MISOB_B	34
29	MCU_P607	Digital I/O	CTS2_C / RTS2_C / SS2_C / RSPCKB_B	35
30	MCU_P606	Digital I/O	SCK2_C / SSLB2_B	36

[2] Do not use P413 pin with RM-BE1-□□X variants. Detailed pin functionality only applies to RM-BE1-□□U variants.

8. Package Specifications

8.1. Module dimensions

8.1.1 RM-BE1-S

The figure below shows the RM-BE1-S module dimensions.

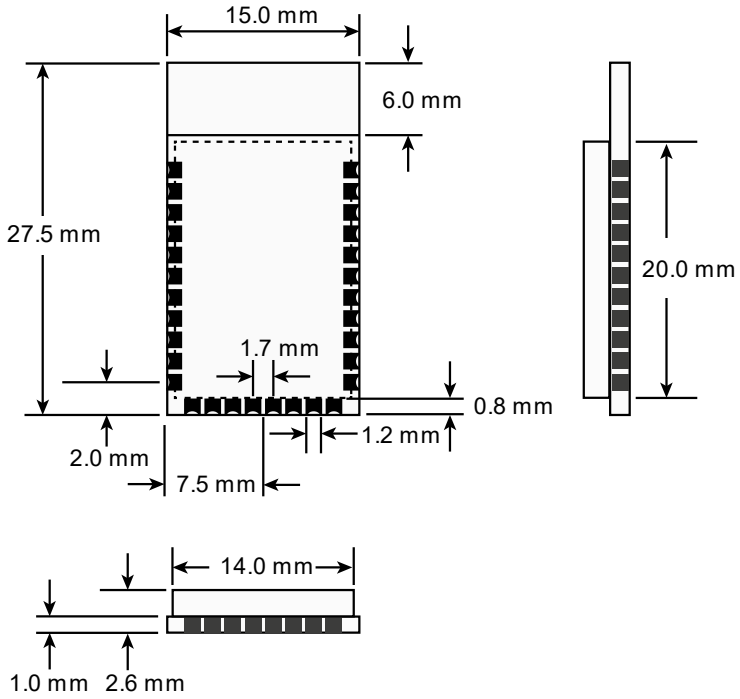


Figure 8 - RM-BE1-S module dimensions.

8.1.2 RM-BE1-U

The figure below shows the RM-BE1-U module dimensions.

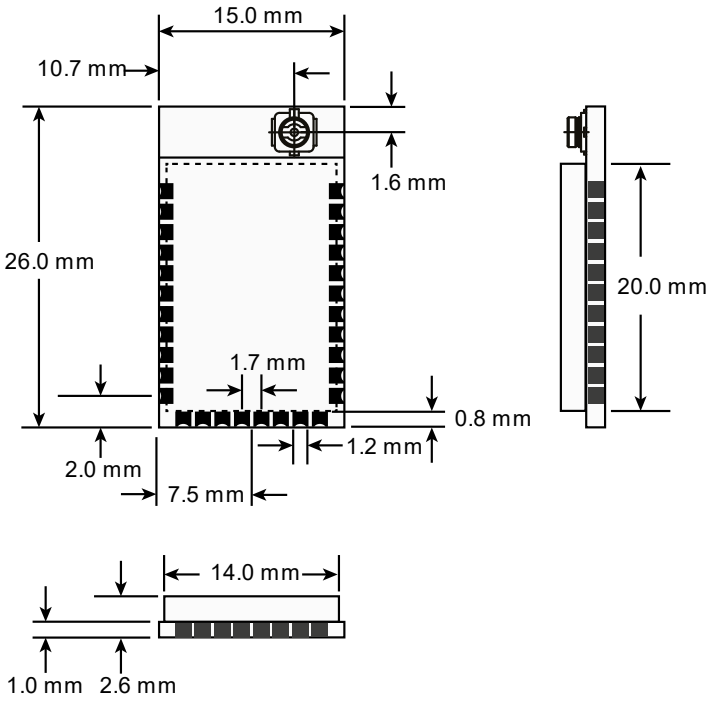


Figure 9 - RM-SS2-U module dimensions.

8.2. Module land pattern

8.2.1 RM-BE1-S

The figure below shows the RM-BE1-S module recommended land pattern.

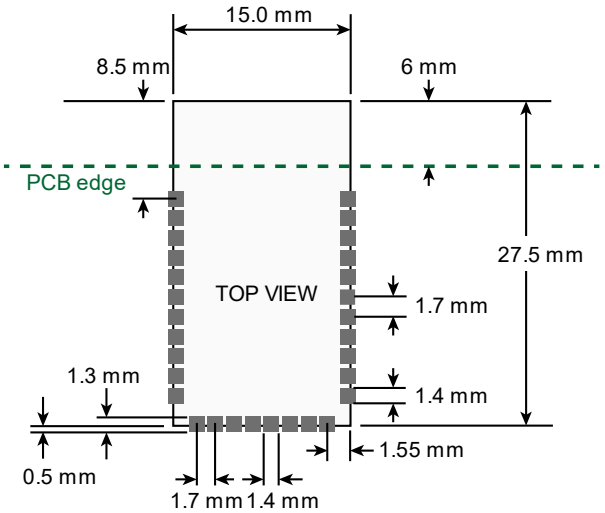


Figure 10 - RM-BE1-S suggested footprint.

8.2.2 RM-BE1-U

The figure below shows the RM-BE1-U module recommended land pattern.

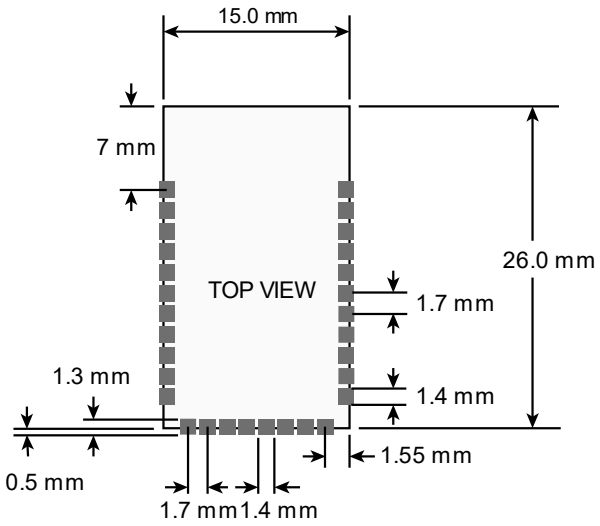


Figure 11 - RM-BE1-U suggested footprint.

References

[1] Renesas Electronics Corporation, “RE01B Group Product with 1.5-Mbyte Flash Memory - Datasheet”, R01DS0384EJ0100, Rev.1.00, Oct 07, 2020 [available online]

https://www.renesas.com/us/en/document/dst/re01b-group-product-15-mbyte-flash-memory-datasheet

Revision History

REVISION	DATE	STATUS / COMMENTS	AUTHOR
0.4	12/05/2021	Preliminary release	AR
1.0	27/10/2021	First issued edition	LDB

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