# DA16600MOD Series

## Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module

## General Description

The DA16600 series is a highly integrated ultra-low-power Wi-Fi + Bluetooth® Low Energy Combo Module solution. This module includes the DA16200 that has an 802.11b/g/n radio (PHY), a baseband processor, a media access controller (MAC), on-chip memory, and a host networking application processor. DA16600 also has a DA14531 that has a 2.4 GHz transceiver and an Arm® Cortex-M0+® microcontroller with a RAM of 48 kB and a One-Time Programmable (OTP) memory of 32 kB. The radio transceiver, the baseband processor, and the qualified Bluetooth® low energy stack is fully compliant with the Bluetooth Low Energy 5.1 standard.

The DA16600 is a synthesis of breakthrough ultra-low-power technologies, which enables an extremely low power operation in the module. The DA16200 and DA14531 shut down every micro element of the chip that is not in use, which creates 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. The DA16600 also enables ultra-low power transmission and reception modes when the SoC 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

- Module Variants
  - DA16600MOD-AAC4WA32 (Chip Antenna)
  - DA16600MOD-AAE4WA32 (u.FL Connector)
- Dimensions
  - 14.3 mm × 24.3 mm × 3.0 mm, 51-Pins
- Operating temperature range
  - -40 °C to 85 °C
- Regulatory certifications:
  - FCC
  - IC
  - CE
  - TELEC

## Wi-Fi Features

- Highly integrated ultra-low power Wi-Fi® system on a chip
- RF Performance
  - Tx Power: +18 dBm, 1 Mbps DSSS
  - Rx Sensitivity: -97.5 dBm, 1 Mbps DSSS
- Full offload: SoC runs full networking OS and TCP/IP stack
- Hardware accelerators
  - General HW CRC engine
  - HW zeroing function for fast booting
  - Pseudo random number generator (PRNG)
- SPI flash Memory
  - 32 M-bit / 4 M-byte

- Wi-Fi processor
  - IEEE 802.11b/g/n, 1x1, 20 MHz channel bandwidth, 2.4 GHz
  - 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, Soft AP
  - WPS-PIN/PBC for easy Wi-Fi provisioning
  - Fast Wi-Fi connections

## Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module

- Complete software stack
  - Comprehensive networking software stack
  - Provides TCP/IP stack in the form of network socket APIs
- CPU core subsystem
  - Arm® Cortex®-M4F core with clock frequency of 30~160 MHz
  - ROM: 256 KB, SRAM: 512 KB, OTP: 8 KB, Retention Memory: 48 KB
- Advanced security
  - Secure booting
  - Secure debugging using JTAG/SWD and UART ports
  - Secure asset storage
- Built-in hardware crypto engines for advanced security
  - TLS/DTLS security protocol functions
  - Crypto engine for key deliberate generic security functions: AES (128,192,256), DES/3DES, SHA1/224/256, RSA, DH, ECC, CHACHA, and TRNG

- Supports various interfaces
  - Two UARTs
  - SPI Master/Slave interface
  - I2C Master/Slave interface
  - I2S for digital audio streaming
  - 4-channel PWM
  - Individually programmable, multiplexed GPIO pins
  - JTAG and SWD
- Built-in 2-channel auxiliary ADC for sensor interfaces
  - 12-bit SAR ADC: single-ended two channels
- Supply
  - Operating voltage: 2.1 V to 3.6 V (typical: 3.3 V)
  - 2 Digital I/O Supply Voltage: 1.8 V / 3.3 V
  - Black-out and brown-out detector
- Power management unit
  - On-Chip RTC
  - Wake-up control of fast booting or full booting with minimal initialization time
  - Supports three ultra-low power sleep modes

## Bluetooth Features

- Bluetooth
  - Compatible with Bluetooth® v5.1, ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T66 (Japan) core
  - Supports up to 3 connections
- Processing and memories
  - 16 MHz 32-bit Arm®Cortex-M0+ with SWD interface
  - 48 Kbytes RAM
  - 144 Kbytes ROM
  - 32 Kbytes OTP
- Current Consumption
  - 2 mA RX at VBAT = 3V
  - 4 mA TX at VBAT = 3 V and 0 dBm
  - 1.8 uA at sleep with all RAM retained

- Radio
  - Programmable RF transmit power
  - -93 dBm receiver sensitivity
- Interfaces
  - 2 channel 11-bit ENOB ADC
  - 2 general purpose timers with PWM
  - 5 GPIOs
  - SPI
  - 2x UART, 1-wire UART support
  - I2C
- Power management
  - Operating range (1.8 V - 3.3 V)
  - Inrush current control
- Other
  - Real Time Clock
  - Trimmed 32 MHz Crystal

## Contents

# Figures

# Tables

# 1 References

DA16600MOD consist of a DA16200 and a DA14531 chipset. Please see the respective chipset and module datasheets for details.

[1]  DA16200 Datasheet, Renesas Electronics

[2]  DA16200MOD Datasheet, Renesas Electronics

[3]  DA14531, Datasheet, Renesas Electronics

[4]  DA14531MOD Datasheet, Renesas Electronics

## 2    Block Diagram

The DA16600 provides a high level of integration for a battery used wireless system, with integrated IEEE 802.11 b/g/n and Bluetooth V5.1. The DA16600 is designed to address the needs of battery used devices that require minimal power consumption and reliable operation.

Figure 1 shows the interconnection of all the physical blocks in DA16600MOD.
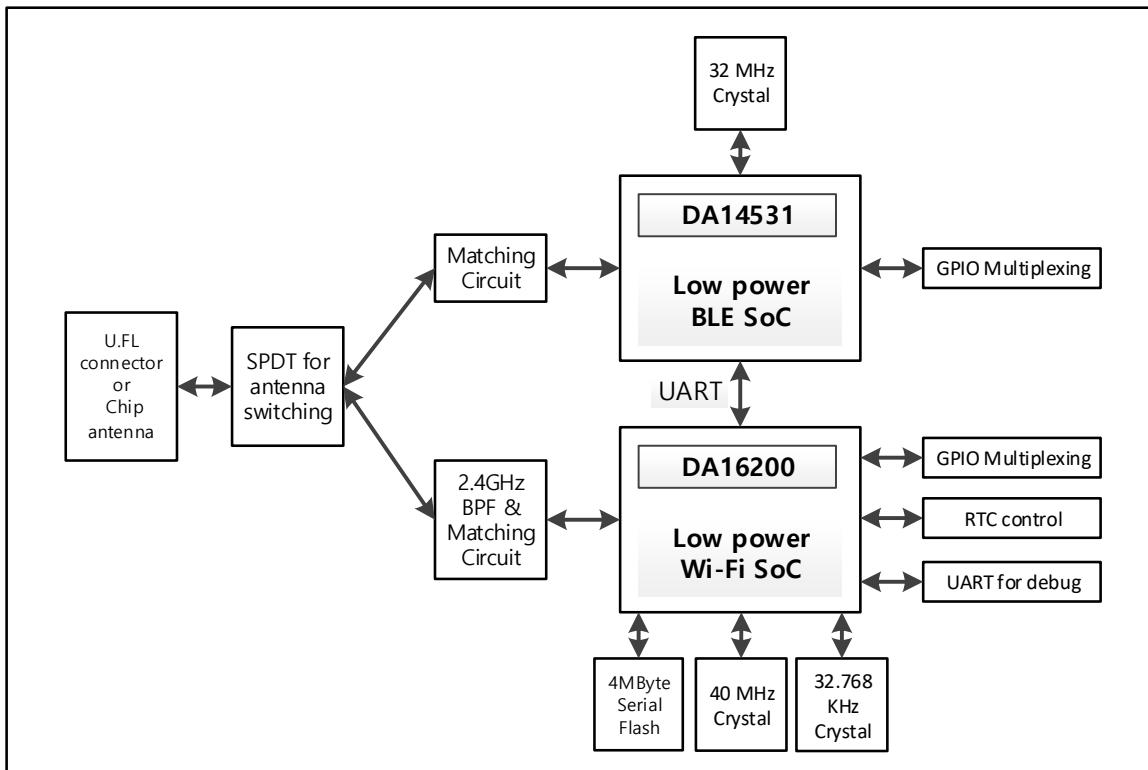


**Figure 1: DA16600 Block Diagram**

**Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module**

# 3 Pinout

## 3.1 Pinout Description (51-pins)
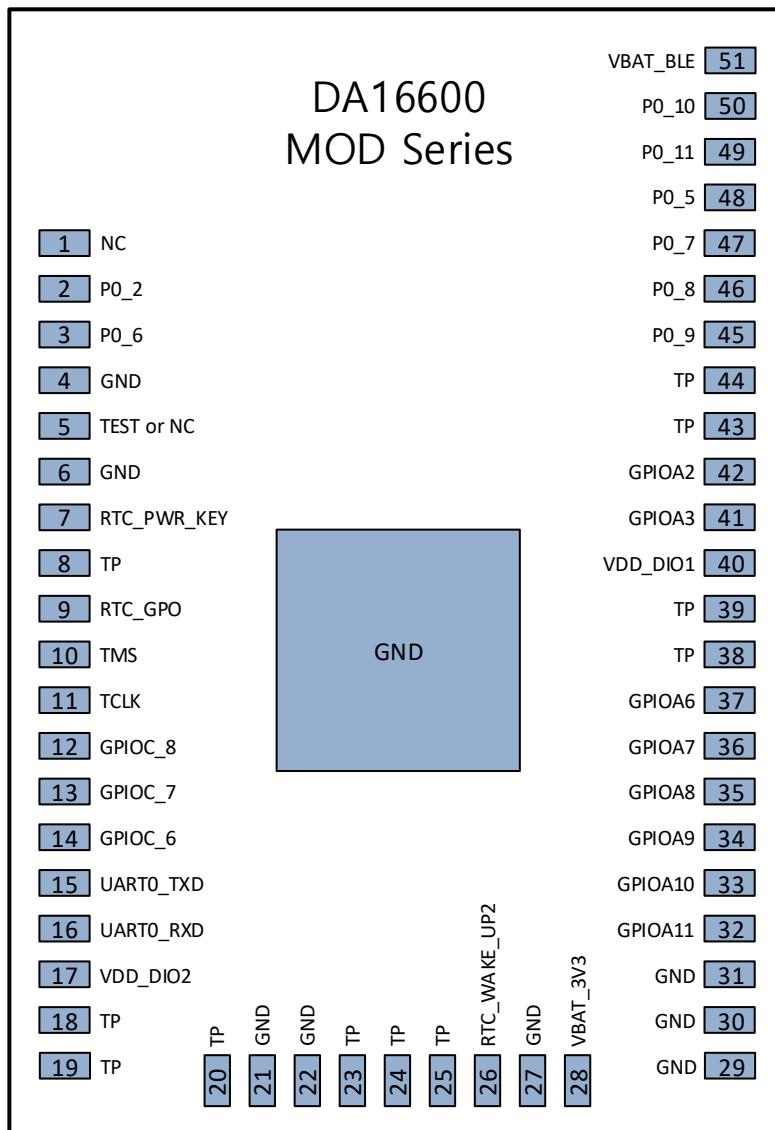


**Figure 2: DA16600MOD 51-Pins Pinout Diagram (Top View)**

# Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module

**Table 1: Pin Description**

| #Pin | Pin Name | Type | Drive(mA) | Reset State | Related Device | Description |
|------|----------|------|-----------|-------------|----------------|-------------|
| 1 | NC | AI | | | DA14531 | Not Connect |
| 2 | P0_2 | DIO | | | DA14531 | General Purpose I/O, JTAG I/F, SWCLK |
| 3 | P0_6 | DIO | | | DA14531 | Internally connected to RF switch<br>Note 1 |
| 4 | GND | GND | | | Common | Ground |
| 5 | TEST or NC | AI | | | Common | Chip antenna type: RF_Test<br>u.FL connector type: NC |
| 6 | GND | GND | | | Common | Ground |
| 7 | RTC_PWR_KEY | DI | | | DA16200 | RTC block enable signal |
| 8 | TP | DNC | | | DA16200 | RTC block wake up signal is internally connected<br>Note 1 |
| 9 | RTC_GPO | DO | | | DA16200 | Sensor control signal |
| 10 | TMS | DIO | 2/4/8/12 | I-PU | DA16200 | JTAG I/F, SWDIO |
| 11 | TCLK | DIO | 2/4/8/12 | I-PD | DA16200 | JTAG I/F, SWCLK, General Purpose I/O |
| 12 | GPIOC_8 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 13 | GPIOC_7 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 14 | GPIOC_6 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 15 | UART0_TXD | DO | 2/4/8/12 | O | DA16200 | UART transmit data |
| 16 | UART0_RXD | DI | 2/4/8/12 | I | DA16200 | UART receive data |
| 17 | VDD_DIO2 | VDD | | | DA16200 | Supply power for digital I/O<br>GPIOC6~GPIOC8, TMS/TCLK, TXD/RXD |
| 18 | TP | DNC | | | DA16200 | F_IO0 is internally connected to Flash Memory |
| 19 | TP | DNC | | | DA16200 | F_CLK is internally connected to Flash Memory |
| 20 | TP | DNC | | | DA16200 | F_IO3 is internally connected to Flash Memory |
| 21 | GND | GND | | | Common | Ground |
| 22 | GND | GND | | | Common | Ground |
| 23 | TP | DNC | | | DA16200 | F_IO1 is internally connected to Flash Memory |

| #Pin | Pin Name | Type | Drive(mA) | Reset State | Related Device | Description |
|------|----------|------|-----------|-------------|----------------|-------------|
| 24 | TP | DNC | | | DA16200 | F_CSN is internally connected to Flash Memory |
| 25 | TP | DNC | | | DA16200 | F_IO2 is internally connected to Flash Memory |
| 26 | RTC_WAKE_UP2 | DI | | | DA16200 | RTC block wake-up signal |
| 27 | GND | GND | | | Common | Ground |
| 28 | VBAT_3V3 | VDD | | | DA16200 | Supply power for internal DC-DC, DIO_LDO, and Analog IP of DA16200 |
| 29 | GND | GND | | | Common | Ground |
| 30 | GND | GND | | | Common | Ground |
| 31 | GND | GND | | | Common | Ground |
| 32 | GPIOA11 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 33 | GPIOA10 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 34 | GPIOA9 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 35 | GPIOA8 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 36 | GPIOA7 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 37 | GPIOA6 | DIO | 2/4/8/12 | I-PD | DA16200 | General Purpose I/O |
| 38 | TP | DNC | 2/4/8/12 | I-PD | Common | GPIOA5 of DA16200 is internally connected to P0_3 of DA14531 Note 1 |
| 39 | TP | DNC | 2/4/8/12 | I-PD | Common | GPIOA4 of DA16200 is internally connected to P0_4 of DA14531 Note 1 |
| 40 | VDD_DIO1 | VDD | | | DA16200 | Supply power for digital I/O GPIOA0~GPIOA11 |
| 41 | GPIOA3 | AI/DIO | 2/4/8/12 | I-PD | DA16200 | Aux. ADC input/General Purpose I/O |
| 42 | GPIOA2 | AI/DIO | 2/4/8/12 | I-PD | DA16200 | Aux. ADC input/General Purpose I/O |
| 43 | TP | DNC | 2/4/8/12 | I-PD | Common | GPIOA1 of DA16200 is internally connected to P0_0 of DA14531 Note 1, Note 2 |
| 44 | TP | DNC | 2/4/8/12 | I-PD | Common | GPIOA0 of DA16200 is internally connected to P0_1 of DA14531 Note 1 |
| 45 | P0_9 | DIO | 3.5 / 0.3 | I-PD | DA14531 | General Purpose I/O, UART Debug TXD |
| 46 | P0_8 | DIO | 3.5 / 0.3 | I-PD | DA14531 | General Purpose I/O, UART Debug RXD |
| 47 | P0_7 | DIO | 3.5 / 0.3 | I-PD | DA14531 | General Purpose I/O |
| 48 | P0_5 | DIO | 3.5 / 0.3 | I-PD | DA14531 | General Purpose I/O |

## Ultra-Low Power Wi-Fi + Bluetooth® LE
## Combo Module

| #Pin | Pin Name | Type | Drive(mA) | Reset State | Related Device | Description |
|------|----------|------|-----------|-------------|----------------|-------------|
| 49 | P0_11 | DIO | 3.5 / 0.3 | I-PD | DA14531 | General Purpose I/O |
| 50 | P0_10 | DIO | 3.5 / 0.3 | I-PD | DA14531 | General Purpose I/O |
| 51 | VBAT_BLE | VDD | | | DA14531 | Supply power for DA14531 |

**Note 1**   Pin3, Pin8, Pin 38, Pin 39, Pin 43, and Pin 44 are connected internally so these pins can`t be used as GPIO or as wake up input in application system.

**Note 2**   P0_0 has a reset function, but it is shared with GTL. It is recommended to connect the remaining GPIO as an additional reset function when P0_0 is not available for reset in abnormal situations.

This device provides various interfaces to support many kinds of applications.

In DA16200, it is possible to control each pin according to the required application in reference to the pin multiplexing illustrated in Table 2. Pin control can be realized through register setting.

In DA14531, I/O pin assignment can be configured by the SW and is organized into the Port 0.

Please refer the datasheet and user manual of DA16200 and DA14531 respectively for detail information.

### Table 2: DA16200 Pin Multiplexing

| Pin | JTAG | Analog | SPI master | SPI slave | I2C master | I2C slave | BT coex | I2S | I2S_Clock | UART2 | Muxed w/Analog | Pin State (nRESET=0) | Driving Strength (Default : 8mA) |
|-----|------|--------|------------|-----------|------------|-----------|---------|-----|-----------|-------|----------------|----------------------|----------------------------------|
| TP | | | | | | | | | | | Yes | I-PD | 2/4/8/12mA |
| TP | | | | | | | | | | | Yes | I-PD | 2/4/8/12mA |
| GPIOA2 | | CH2 | | SPI_CSB | | I2C_SDA | | SDO | | | Yes | I-PD | 2/4/8/12mA |
| GPIOA3 | | CH3 | | SPI_CLK | | I2C_CLK | | LRCK | CLK_IN | | Yes | I-PD | 2/4/8/12mA |
| TP | | | | | | | | | | | No | I-PD | 2/4/8/12mA |
| TP | | | | | | | | | | | No | I-PD | 2/4/8/12mA |
| GPIOA6 | | | SPI_CSB | SPI_CSB | | I2C_SDA | | SDO | | | No | I-PD | 2/4/8/12mA |
| GPIOA7 | | | SPI_CLK | SPI_CLK | | I2C_CLK | | LRCK | | | No | I-PD | 2/4/8/12mA |
| GPIOA8 | | | SPI_DIO0 /SPI_MOSI | SPI_MISO | I2C_SDA | | BT_SIG0 | BCLK | | | No | I-PD | 2/4/8/12mA |
| GPIOA9 | | | SPI_DIO1/SPI_MISO | SPI_MOSI | I2C_CLK | | BT_SIG1 | MCLK | | | No | I-PD | 2/4/8/12mA |
| GPIOA10 | | | SPI_DIO2 | SPI_MISO | | | BT_SIG2 | | CLK_IN | TXD | No | I-PD | 2/4/8/12mA |
| GPIOA11 | | | SPI_DIO3 | SPI_MOSI | | | | | | RXD | No | I-PD | 2/4/8/12mA |
| TCLK/GPIOA15 | TCLK | | | | | | | | | | No | I-PD | 2/4/8/12mA |
| TMS | TMS | | | | | | | | | | No | I-PU | 2/4/8/12mA |
| UART_TXD | | | | | | | | | | | No | O | 2/4/8/12mA |
| UART_RXD | | | | | | | | | | | No | I | 2/4/8/12mA |
| GPIOC8 | TDI | | | | | | | | | | No | I-PD | 2/4/8/12mA |
| GPIOC7 | TDO | | | | | | | | | RXD | No | I-PD | 2/4/8/12mA |
| GPIOC6 | NTRST | | | | | | | | | TXD | No | I-PD | 2/4/8/12mA |

Within the DA16600 module, various pins of the DA16200 and the DA14531 are internally connected and therefore cannot be used as GPIOs and are marked as TP (test points) on the DA16600MOD package. The GPIOs which are not available are:

- DA16200: GPIOA0, GPIOA1, GPIOA4, GPIOA5
- DA14531: P0_0, P0_1, P0_3, P0_4, P0_6

Due to these internal connections, the SDIO, SDeMMC and UART1 interfaces of the DA16200 are not available.

To support Bluetooth Coexistence, P06 of the DA14531 (which is internally connected to the RF switch) must be connected to a DA16200 GPIO pin as follows:

- For 1 pin Bluetooth Coexistence, connect P0_6 to GPIOA10
- For 3 pin Bluetooth Coexistence, connect P0_6 to GPIOA9

If GPIOA9 or GPIOA10 is used for Bluetooth Coexistence, then it cannot be used as a GPIO.

**Ultra-Low Power Wi-Fi + Bluetooth® LE
Combo Module**

# 4    Electrical Specification

## 4.1    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.

**Table 3: Absolute Maximum Ratings**

| Parameter | #Pins | Min | Max | Units |
|---|---|---|---|---|
| VBAT_3V3 | 28 | -0.2 | 3.7 | V |
| VDD_DIO1 | 40 | -0.2 | 3.7 | V |
| VDD_DIO2 | 17 | -0.2 | 3.7 | V |
| VBAT_BLE | 51 | -0.1 | 3.6 | V |
| Storage temperature range | | -40 | +125 | °C |

## 4.2    Recommended Operating Conditions

**Table 4: Recommended Operating Conditions**

| Parameter | #Pins | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| VBAT_3V3 | 28 | 2.1 | | 3.6 | V |
| VDD_DIO1 | 40 | 1.62 | | 3.6 | V |
| VDD_DIO2 | 17 | 1.62 | | 3.6 | V |
| VBAT_BLE | 51 | 1.8 | | 3.3 | V |
| Operating temperature range ($T_A$) | | -40 | | +85 | °C |

## 4.3    Electrical Characteristics

### 4.3.1    DC Parameters, 1.8 V IO

**Table 5: DC Parameters, 1.8 V IO**

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Voltage | Guaranteed logic Low level Note 1 | VSS | | 0.3 × DVDD | V |
| $V_{IH}$ | Input High Voltage | Guaranteed logic High level | 0.7 × DVDD | | DVDD | V |
| $V_{OL}$ | Output Low Voltage | DVDD=Min. | VSS | | 0.2 × DVDD | V |
| $V_{OH}$ | Output High Voltage | DVDD=Min. | 0.8 × DVDD | | DVDD | V |
| $R_{PU}$ | Pull-up Resistor | $V_{PAD}=V_{IH}$, DIO=Min. | | | 32.4 | kΩ |
| $R_{PD}$ | Pull-down Resistor | $V_{PAD}=V_{IL}$, DIO=Min. | | | 32.4 | |

**Note 1**    DVDD = 1.8V, VDD_DIO1, VDD_DIO2 Logic Level.

## Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module

### 4.3.2    DC Parameters, 3.3 V IO

**Table 6: DC Parameters, 3.3 V IO**

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Voltage | Guaranteed logic Low level<br>Note 2 | VSS | | 0.8 | V |
| $V_{IH}$ | Input High Voltage | Guaranteed logic High level | 2.0 | | DVDD | V |
| $V_{OL}$ | Output Low Voltage | DVDD=Min. | VSS | | 0.4 | V |
| $V_{OH}$ | Output High Voltage | DVDD=Min. | 2.4 | | DVDD | V |
| $R_{PU}$ | Pull-up Resistor | VPAD=VIH, DIO=Min. | | | 19.4 | kΩ |
| $R_{PD}$ | Pull-down Resistor | $V_{PAD}=V_{IL}$, DIO=Min. | | | 16.0 | |

**Note 2**    DVDD= 3.3 V, VDD_DIO1, VDD_DIO2 Logic Level.

### 4.3.3    DC Parameters for RTC Block

There are several control pins in RTC block.

**Table 7: DC Parameters for RTC block, 3.3 V VBAT**

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Voltage | Guaranteed logic Low level | VSS | | 0.6 | V |
| $V_{IH}$ | Input High Voltage | Guaranteed logic High level | 2.2 | | VBAT | V |

(RTC block: RTC_PWR_KEY, RTC_WAKE_UP2)

**Table 8: DC Parameters for RTC block, 2.1 V VBAT**

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Voltage | Guaranteed logic Low level | VSS | | 0.3 | V |
| $V_{IH}$ | Input High Voltage | Guaranteed logic High level | 1.6 | | VBAT | V |

(RTC block: RTC_PWR_KEY, RTC_WAKE_UP2)

**Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module**

## 4.4 Radio Characteristics

### 4.4.1 Wi-Fi Characteristics

- TA = +25 °C, VBAT = 3.3 V, CH1 (2412 MHz)

**Table 9: Wi-Fi Receiver Characteristics**

| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Sensitivity (8% PER for 11b rates, 10% PER for 11g/11n rates) | 1 Mbps DSSS | -98.5 | -97.5 | -95.5 | dBm |
| | 2 Mbps DSSS | -94 | -93 | -91 | |
| | 11 Mbps CCK | -89 | -88 | -86 | |
| | 6 Mbps OFDM | -90 | -89 | -87 | |
| | 9 Mbps OFDM | -90 | -89 | -87 | |
| | 18 Mbps OFDM | -88 | -87 | -85 | |
| | 36 Mbps OFDM | -81 | -80 | -78 | |
| | 54 Mbps OFDM | -75 | -74 | -72 | |
| | MCS0(GF) | -90 | -89 | -87 | |
| | MCS7(GF) | -72 | -71 | -69 | |
| Maximum input level (8% PER for 11b rates, 10% PER for 11g/11n rates) | 802.11b | -4 | 0 | 0 | |
| | 802.11g | -10 | -4 | -3 | |

**Table 10: Wi-Fi Transmitter Characteristics**

| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Maximum Output Power measured form IEEE spectral mask and EVM | 1 Mbps DSSS | 15 | 18 | 19 | dBm |
| | 2 Mbps DSSS | 15 | 18 | 19 | |
| | 5.5 Mbps CCK | 15 | 18 | 19 | |
| | 11 Mbps CCK | 15 | 18 | 19 | |
| | 6 Mbps OFDM | 14 | 17 | 18 | |
| | 9 Mbps OFDM | 14 | 17 | 18 | |
| | 12 Mbps OFDM | 14 | 17 | 18 | |
| | 18 Mbps OFDM | 14 | 17 | 18 | |
| | 24 Mbps OFDM | 13 | 16 | 17 | |
| | 36 Mbps OFDM | 13 | 16 | 17 | |
| | 48 Mbps OFDM | 11.5 | 14.5 | 15.5 | |
| | 54 Mbps OFDM | 10.5 | 13.5 | 14.5 | |
| | MCS0 OFDM | 14 | 17 | 18 | |
| | MCS7 OFDM | 10.5 | 13.5 | 14.5 | |
| Transmit center frequency accuracy | | -25 | | +25 | ppm |

### 4.4.2    Bluetooth® LE Characteristics

**Table 11: Radio 1 Mb/s – AC Characteristics**

| Parameter | Description | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| P$_{SENS\_CLEAN}$ | sensitivity level | Dirty Transmitter disabled; DC-DC converter disabled; PER = 30.8 %; Note 1 | | -93 | | dBm |
| P$_{SENS\_EPKT}$ | sensitivity level | Extended packet size (255 octets) Note 1 | | -90 | | dBm |

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

## 4.5    Current Consumption

### 4.5.1    Wi-Fi Characteristics

TA = +25 °C, VBAT = 3.3 V, w/ CPU clock is 80 MHz.

**Table 12: Current Consumption in Active State**

| Parameter | Condition | | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| ACTIVE | TX | 1 Mbps DSSS | @ 18.0 dBm | 260 | 280 | 320 | mA |
| | | 6 Mbps OFDM | @ 17.0 dBm | 240 | 260 | 300 | |
| | | 54 Mbps OFDM | @ 13.5 dBm | 180 | 200 | 240 | |
| | | MCS7 | @ 13.5 dBm | 180 | 200 | 240 | |
| | RX | No signal Note 1 | | 25 | 29 | 51 | |
| | | 1 Mbps DSSS Note 1 | | 26.5 | 30.5 | 53 | |
| | | 1 Mbps DSSS | | 27 | 37.5 | 54 | |
| | | 54 Mbps OFDM | | 29 | 38.5 | 54 | |
| | | MCS7 | | 29 | 38.5 | 54 | |

**Note 1**    Low Power Mode & CPU clock 30 MHz.

TA = +25 °C, VBAT = 3.3 V

**Table 13: Current Consumption in Low Power Operation**

| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Low Power Operation | Sleep 1 | | 5.2 Note 1 | | µA |
| | Sleep 2 | | 6.8 Note 1 | | |
| | Sleep 3 | | 8.5 Note 1 | | |

**Note 1**    RF switch current consumption is included. VDD of RF switch is connected to VBAT_3V3 for DA16200 and typical current consumption of RF switch is 5 µA.

### 4.5.2    Bluetooth® LE Characteristics

**Table 14: DC Characteristics**

| Parameter | Description | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $I_{BAT\_ACTIVE}$ | Battery supply current | | | 0.4 | | mA |
| $I_{BAT\_BLE\_ADV\_100ms}$ | Average battery supply current with system in Advertising state (3 channels) every 100ms and extended sleep with all RAM retained. | | | 80 | | µA |
| $I_{BAT\_BLE\_CONN\_30ms}$ | Average battery supply current with system in a connection state with 30ms connection interval and extended sleep with all RAM retained. | | | 92 | | µA |
| $I_{BAT\_HIBERN}$ | Battery supply current with system shut down | | | 0.6 | | µA |
| $I_{BAT\_RF\_RX}$ | Battery supply current | Continuous Rx | | 2.3 | | mA |
| $I_{BAT\_RF\_TX\_+2}$ | Battery supply current | Continuous Tx; Output power at 2dBm Note 1 | | 4.3 | | mA |
| $I_{BAT\_RF\_TX\_-1}$ | Battery supply current | Continuous Tx; Output power at -1dBm Note 2 | | 3.6 | | mA |
| $I_{BAT\_RF\_TX\_-4}$ | Battery supply current | Continuous Tx; Output power at -4dBm | | 2.8 | | mA |

**Note 1**    All Bluetooth applications run on DA16200, so DA16200 should be active to handle Bluetooth data (e.g. Bluetooth Connection Request coming from a Bluetooth peer), in which case, Rx active current of DA16200 is added to the total current consumption.

**Note 2**    The actual Tx output power is slightly different than the one indicated in the parameter name.

## 4.6 Radiation Performance
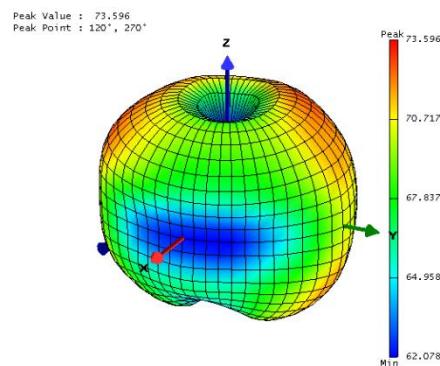


**Figure 3: TIS 3D**
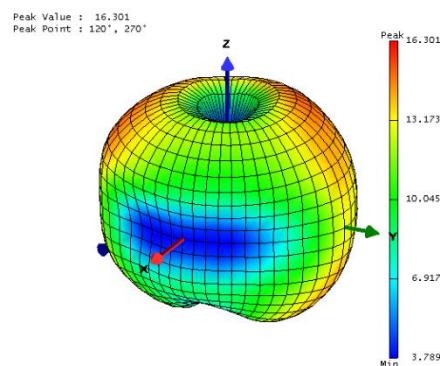


**Figure 4: TRP 3D**

## 4.7 ESD Ratings

**Table 15: 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 |

# 5    Power-on Sequence

The sequence after the initial switching from power-off to power-on of DA16200 is shown in Figure 5.

The RTC_PWR_KEY is a pin that enables the RTC block of DA16200. Once RTC_PWR_KEY is enabled after VBAT power is supplied, all the internal regulators are switched on automatically in the sequence pre-defined by the RTC block.

Once RTC_PWR_KEY is switched on, LDOs for both XTAL and digital I/O are switched on shortly and then the DC-DC regulator is switched on according to the pre-defined interval. The enabling intervals can also be modified in the register settings after initial power-up.
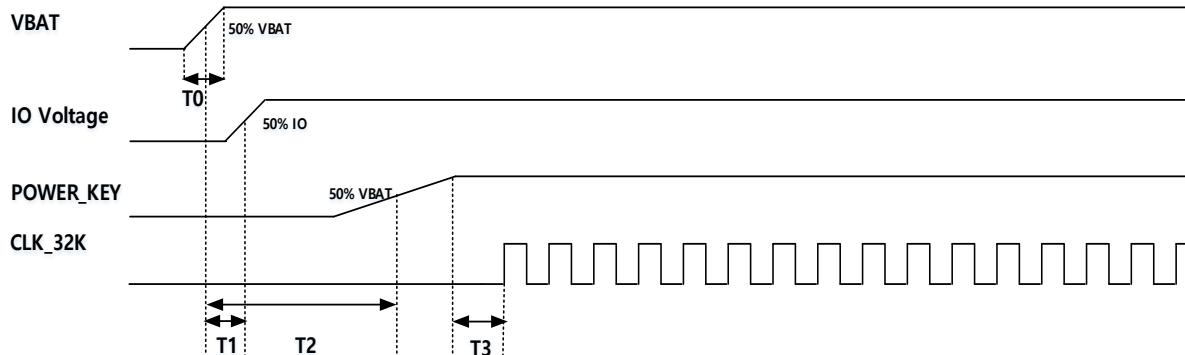


**Figure 5: Power On Sequence**

**Table 16: Power On Sequence Timing Requirements**

| Name | Description | Min | Typ | Max | Unit |
|------|-------------|-----|-----|-----|------|
| T0 | VBAT power-on time from 10 % to 90 % of VBAT | | | | ms |
| T1 | IO voltage and VCC supply | | 0 | | ms |
| T2 | RTC_PWR_KEY turn-on time from 50 % VBAT to 50 % POWER_KEY * Note 3 | | 5*T0 | | ms |
| T3 | Internal RC oscillator wake-up time | | 217 | | µs |

**Note 3**    If the T0 = 10 ms to switch on VBAT, the recommended T2 is 50 ms for the safe booting operation. It would be externally controlled by MCU or it would be implemented using RC filter at the input of RTC_PWR_KEY. The recommended C is 470 nF or 1 uF (not to exceed 1 uF) and R value is chosen to have T2 delay. For example, R and C values will be 82 kΩ and 1uF when T0 = 10 ms.

# 6 Applications Schematic

## 6.1 Typical Application
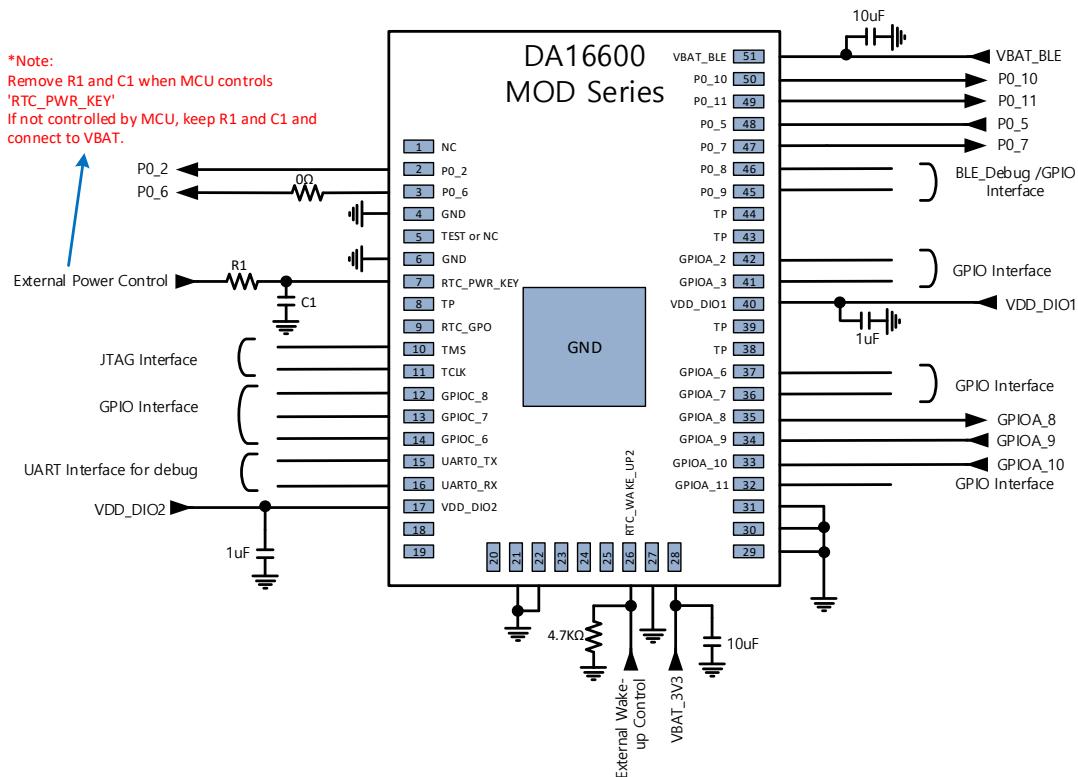


**Figure 6: Typical Application**

**Table 17: Coexistence Connection**

| DA14531 part | DA16200 part | Function |
|---|---|---|
| P0_5 | GPIOA_8 | Wi-Fi_ACT |
| P0_6 | GPIOA_9 | BT_ACT |
| P0_7 | GPIOA_10 | BT_PRIO |

**Table 18: Component Value**

| Part Reference | Value | Description |
|---|---|---|
| R1 | 470 kΩ | Remove R1 when MCU control 'RTC_PWR_KEY'. This value should be chosen by customer application to achieve the enough delay time depending on the power-on time of VBAT. For detail information, see Section 5. |
| C1 | 1 uF | Remove C1 when MCU control 'RTC_PWR_KEY'. This value should be chosen by customer application to achieve the enough delay time depending on the power-on time of VBAT. Not to exceed 1uF. For detail information, see Section 5. |

# 7 Package Information

## 7.1 Dimension: DA16600MOD-AAC

Unit: millimeters (mm)

Tolerance : 14.3 (±0.2) x 24.3 (±0.2) x 3.0 (±0.1)
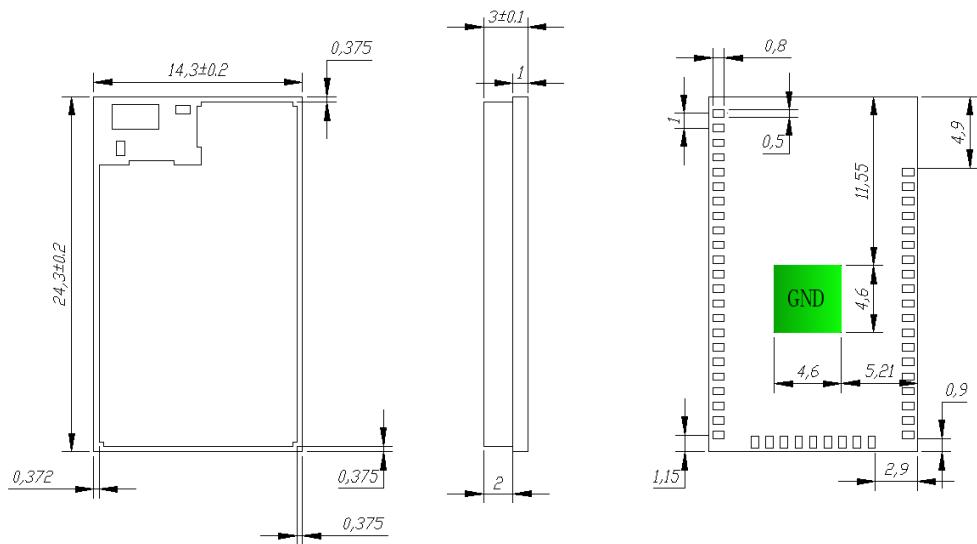


**Figure 7: AAC Module Dimension**

## 7.2 Dimension: DA16600MOD-AAE

Unit: millimeters (mm)

Tolerance : 14.3 (±0.2) x 24.3 (±0.2) x 3.0 (±0.1)
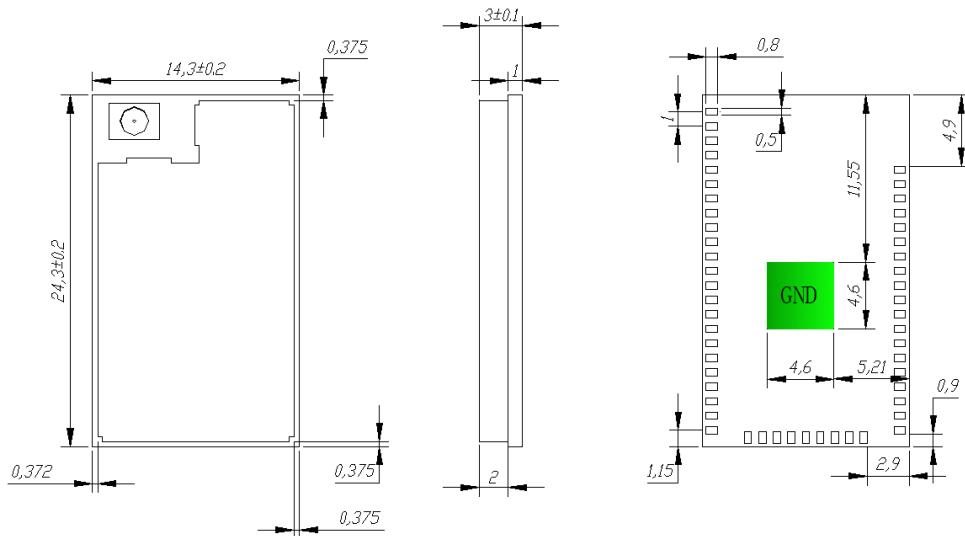
**Figure 8: AAE Module Dimension**

## 7.3    PCB Land Pattern

Unit: millimeters (mm)
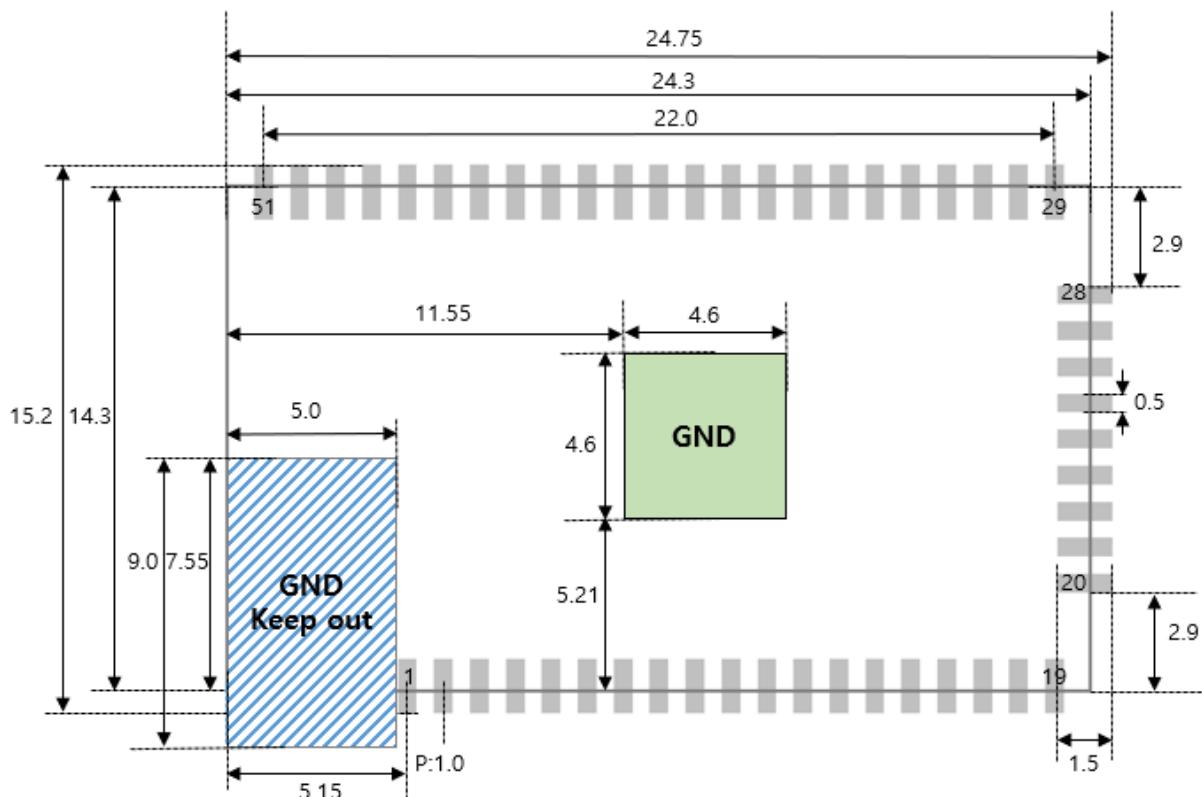


**Figure 9: PCB Land Pattern (Top View)**
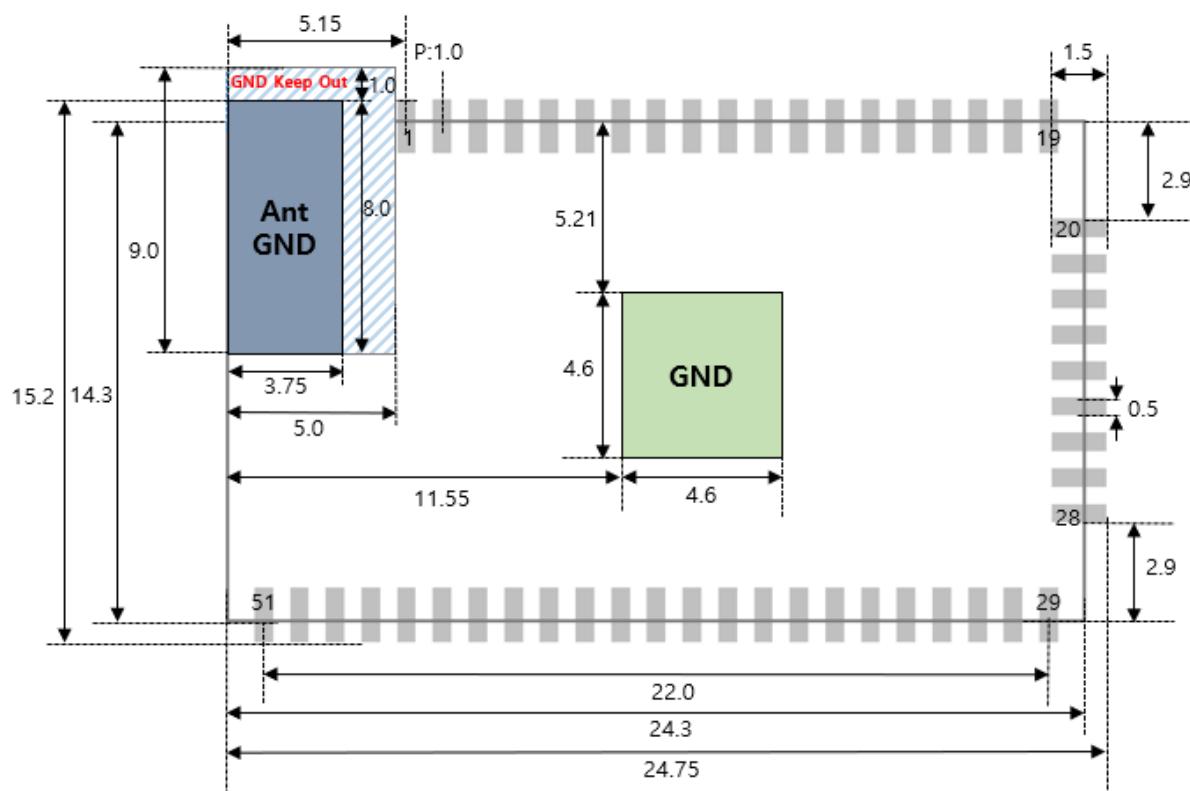
**Figure 10: PCB Land Pattern (Bottom View)**

Ant GND is only needed on the bottom of the PCB. GND must be removed for all layers including the inner layer except the bottom. See Figure 11 for details.

## 7.4    4-layer PCB Example

| Top Layer | layer 2 |
|---|---|
| | |
| layer 3 | Bottom layer |
| | |
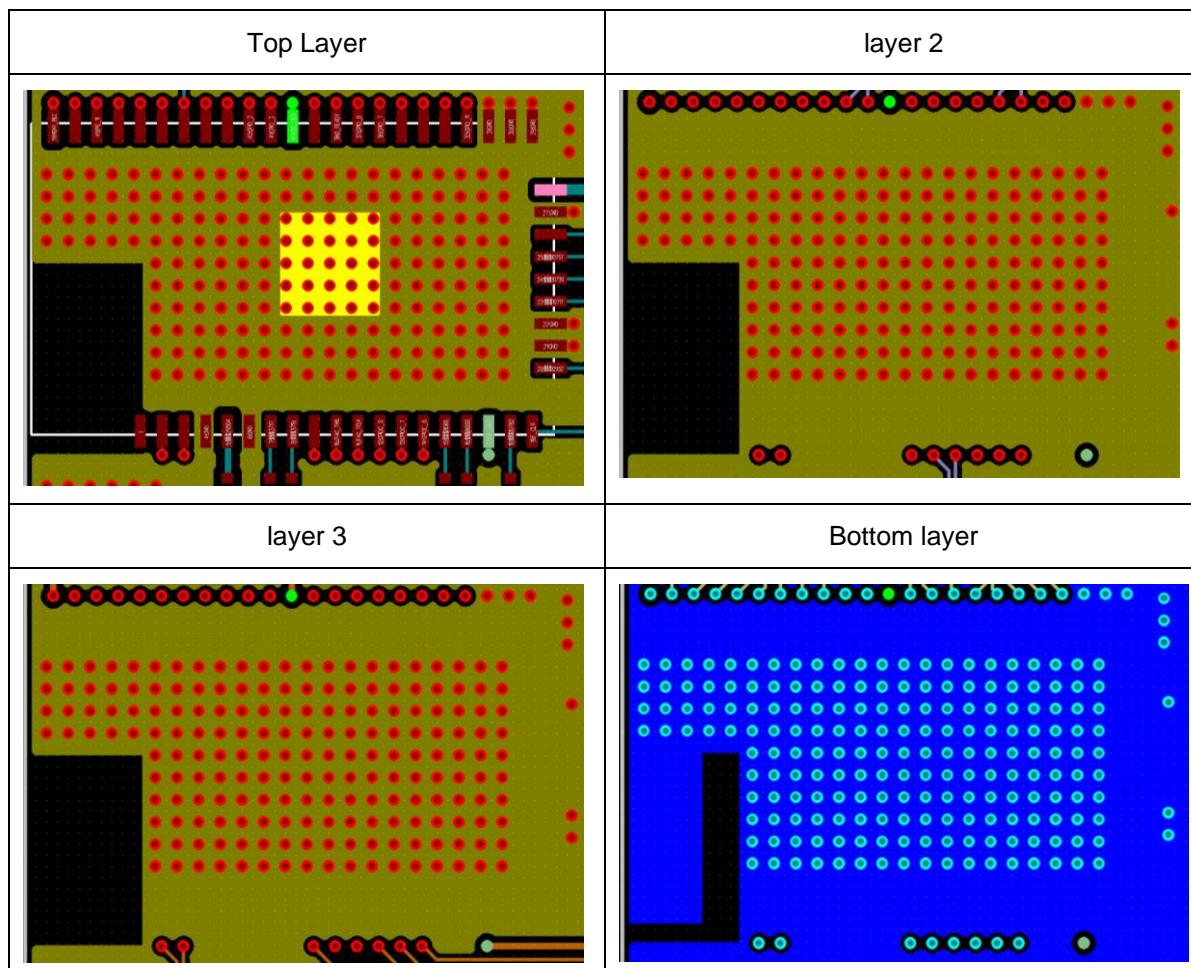
**Figure 11: 4-Layer PCB Example**

## 7.5 Soldering Information

### 7.5.1 Recommended Condition for Reflow Soldering

The reflow profile depends on the solder paste being used and the recommendations from the paste manufacturer should be followed to determine the proper reflow profile.

**Table 19: Typical Reflow Profile (Lead Free): J-STD-020C**

| Profile Feature | Lead Free SMD |
|---|---|
| Average ramp up rate ($Ts_{max}$ to $T_p$) | 3 °C/s Max. |
| Preheat | |
| • Temperature Min ($Ts_{min}$)<br>• Temperature Max ($Ts_{max}$)<br>• Time ($Ts_{max}$ to $Ts_{min}$) | • 150 °C<br>• 200 °C<br>• 60 to 180 seconds |
| Time maintained above | |
| • Temperature ($T_L$)<br>• Time ($t_L$) | • 217 °C<br>• 60 to 150 seconds |
| Peak/Classification temperature ($T_p$) | 260 °C |
| Time within 5 °C of peak temperature (tp) | 20 to 40 seconds |
| Ramp down rate | 6 °C/s Max. |
| Time from 25 °C to peak temperature | 8 minutes Max. |
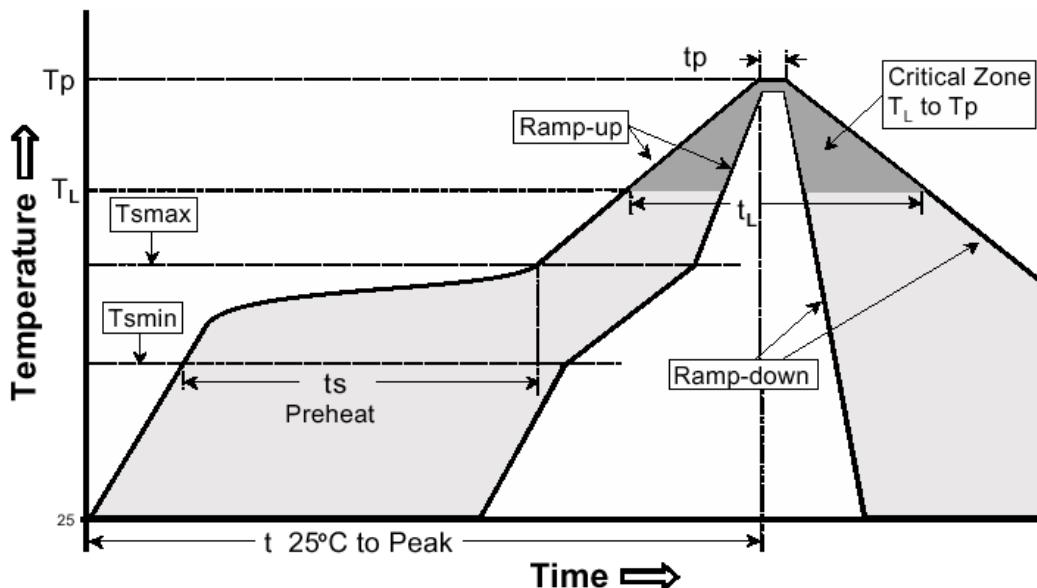


**Figure 12: Reflow Condition**

# 8   Ordering Information

The order number consists of the part number followed by a suffix that indicates the packing method. For details and availability, please visit the Low Power Wi-Fi | Renesas website or contact your local sales representative.

**Table 20: Ordering Information (Samples)**

| Part Number | Pins | Size (mm) | Shipment Form | Pack Quantity |
|---|---|---|---|---|
| DA16600MOD-AAC4WA32 | 51 | 14.3 x 24.3 x 3.0 | Reel | |
| DA16600MOD-AAE4WA32 | 51 | 14.3 x 24.3 x 3.0 | Reel | |

**Table 21: Ordering Information (Production)**

| Part Number | Pins | Size (mm) | Shipment Form | Pack Quantity |
|---|---|---|---|---|
| DA16600MOD-AAC4WA32 | 51 | 14.3 x 24.3 x 3.0 | Reel | 500 |
| DA16600MOD-AAE4WA32 | 51 | 14.3 x 24.3 x 3.0 | Reel | 500 |

**Part Number Legend:**

DA16600MOD-AAC4WA32

AA: Module revision number

C: Select module type

[C] Chip antenna, [E] u.FL connector

4: Flash memory

[4] 4Mbyte, [2] 2 Mbyte

W: Voltage range

[W] 3.3 V, [L] 1.8 V

A3: Package No.

2: T&R packing

## Revision History

| Revision | Date | Description |
|---|---|---|
| 3.2 | 04-Jan-2023 | Section 3.1 Updated coexistence description.<br>Updated Table 3 to add storage temperature range and adjusted min max voltages |
| 3.1 | 14-June-2022 | ● Update logo, disclaimer, copyright.<br>● Section 3.1 Updated Pin Multiplexing Table 2<br>● Section 6 Updated application Schematic Figure 6<br>● Updated Pin description Table 1 |
| 3.0 | 23-Feb-2021 | Official release |
| 1.4 | 26-Oct-2020 | Modified application schematic |
| 1.3 | 15-July-2020 | Modified application schematic |
| 1.2 | 22-May-2020 | Added ESD performance, Table 15 |
| 1.1 | 29-April-2020 | Preliminary datasheet |

## Ultra-Low Power Wi-Fi + Bluetooth® LE Combo Module

### Status Definitions

| Revision | Datasheet Status | Product Status | Definition |
|---|---|---|---|
| 1.<n> | Target | Development | This datasheet contains the design specifications for product development. Specifications may be changed in any manner without notice. |
| 2.<n> | Preliminary | Qualification | This datasheet contains the specifications and preliminary characterization data for products in pre-production. Specifications may be changed at any time without notice in order to improve the design. |
| 3.<n> | Final | Production | This datasheet contains the final specifications for products in volume production. The specifications may be changed at any time in order to improve the design, manufacturing and supply. Major specification changes are communicated via Customer Product Notifications. Datasheet changes are communicated via www.renesas.com. |
| 4.<n> | Obsolete | Archived | This datasheet contains the specifications for discontinued products. The information is provided for reference only. |

### Reach and RoHS Compliance

Renesas Electronics's suppliers certify that its products are in compliance with the requirements of REACH and Directive 2015/863/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.