

## 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 are 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
  - KCC
  - IMDA
  - NCC
  - SRRC

### 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-Mbit/4-Mbyte
- Complete software stack
  - Comprehensive networking software stack
  - Provide TCP/IP stack in the form of network socket APIs
- CPU core subsystem
- 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
- Support various interfaces
  - Two UARTs
  - SPI Master/Slave interface
  - I2C Master/Slave interface
  - I2S for digital audio streaming
  - 4-channel PWM

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

- 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
- 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
  - Support 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
  - Support 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 = 3 V
  - 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
- Others
  - Real Time Clock
  - Trimmed 32 MHz Crystal

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

### Contents

General Description .....	1
Module Features .....	1
Wi-Fi Features .....	1
Bluetooth Features .....	2
Contents .....	3
Figures .....	4
Tables .....	4
<b>1 Terms and Definitions .....</b>	<b>5</b>
<b>2 References .....</b>	<b>5</b>
<b>3 Block Diagram .....</b>	<b>6</b>
<b>4 Pinout .....</b>	<b>7</b>
<b>5 Electrical Specification .....</b>	<b>11</b>
5.1 Absolute Maximum Ratings .....	11
5.2 Recommended Operating Conditions .....	11
5.3 Electrical Characteristics .....	11
5.3.1 DC Parameters, 1.8 V IO .....	11
5.3.2 DC Parameters, 3.3 V IO .....	12
5.3.3 DC Parameters for RTC Block .....	12
5.4 Radio Characteristics .....	13
5.4.1 Wi-Fi Characteristics .....	13
5.4.2 Bluetooth® LE Characteristics .....	14
5.5 Current Consumption .....	14
5.5.1 Wi-Fi Characteristics .....	14
5.5.2 Bluetooth® LE Characteristics .....	15
5.6 Radiation Performance .....	16
5.7 ESD Ratings .....	16
<b>6 Power-on Sequence .....</b>	<b>17</b>
<b>7 Application Schematic .....</b>	<b>18</b>
<b>8 Mechanical Specifications .....</b>	<b>19</b>
8.1 Dimension: DA16600MOD-AAC .....	19
8.2 Dimension: DA16600MOD-AAE .....	19
8.3 Marking .....	20
<b>9 Design Guidelines .....</b>	<b>21</b>
9.1 PCB Land Pattern .....	21
9.2 4-Layer PCB Example .....	22
<b>10 Soldering .....</b>	<b>23</b>
<b>11 Package Information .....</b>	<b>24</b>
11.1 Tape and Reel .....	24
11.2 Labeling .....	25
<b>12 Ordering Information .....</b>	<b>26</b>
<b>Appendix A Regulatory Approval .....</b>	<b>27</b>

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

Revision History ..... 28

Figures

Figure 1: DA16600MOD Block Diagram ..... 6  
 Figure 2: DA16600MOD 51 Pinout Diagram (Top View) ..... 7  
 Figure 3: TIS 3D ..... 16  
 Figure 4: TRP 3D..... 16  
 Figure 5: Power On Sequence ..... 17  
 Figure 6: Application Schematic..... 18  
 Figure 7: AAC Module Dimension ..... 19  
 Figure 8: AAE Module Dimension ..... 19  
 Figure 9: Module Shield Marking..... 20  
 Figure 10: PCB Land Pattern (Top View)..... 21  
 Figure 11: PCB Land Pattern (Bottom View) ..... 21  
 Figure 12: 4-Layer PCB Example..... 22  
 Figure 13: Reflow Condition ..... 23  
 Figure 14: Tape and Reel..... 24  
 Figure 15: Component Direction ..... 24  
 Figure 16: Reel Labeling ..... 25

Tables

Table 1: Pin Description ..... 8  
 Table 2: Absolute Maximum Ratings..... 11  
 Table 3: Recommended Operating Conditions ..... 11  
 Table 4: DC Parameters, 1.8 V IO ..... 11  
 Table 5: DC Parameters, 3.3 V IO ..... 12  
 Table 6: DC Parameters for RTC Block, 3.3 V VBAT ..... 12  
 Table 7: DC Parameters for RTC Block, 2.1 V VBAT ..... 12  
 Table 8: Wi-Fi Receiver Characteristics ..... 13  
 Table 9: Wi-Fi Transmitter Characteristics ..... 13  
 Table 10: Radio 1 Mb/s – AC Characteristics ..... 14  
 Table 11: Current Consumption in Active State ..... 14  
 Table 12: Current Consumption in Low Power Operation ..... 14  
 Table 13: DC Characteristics ..... 15  
 Table 14: ESD Performance ..... 16  
 Table 15: Power On Sequence Timing Requirements..... 17  
 Table 16: Coexistence Connection ..... 18  
 Table 17: Component Value..... 18  
 Table 18: Typical Reflow Profile (Lead Free): J-STD-020C..... 23  
 Table 19: Reel Specification..... 25  
 Table 20: Ordering Information (Samples) ..... 26  
 Table 21: Ordering Information (Production)..... 26

---

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

## 1 Terms and Definitions

API	Application Programming Interface
CRC	Cyclic Redundancy Check
DMA	Direct Memory Access
GPIO	General Purpose Input/Output
HW	Hardware
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
IoT	Internet of Things
JTAG	Joint Test Action Group
LDO	Low-dropout Regulator
PLL	Phase-locked Loop
PRNG	Pseudo Random Number Generator
PWM	Pulse Width Modulation
QSPI	Quad-lane SPI
RTC	Real-time Clock
SAR ADC	Successive Approximation Analog-to-Digital Converter
SPI	Serial Peripheral Interface
SW	Software
SWD	Serial Wire Debug
UART	Universal Asynchronous Receivers and Transmitter

## 2 References

DA16600MOD consists 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

### 3 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.

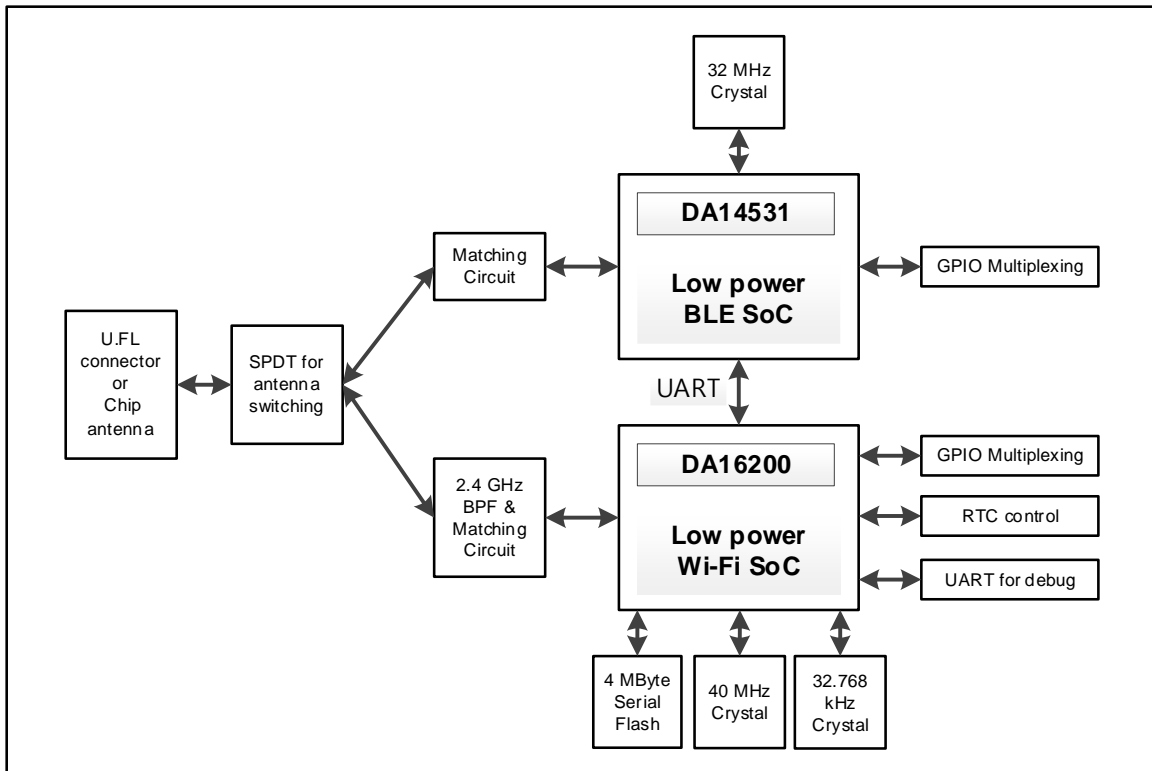


Figure 1: DA16600MOD Block Diagram

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

4 Pinout

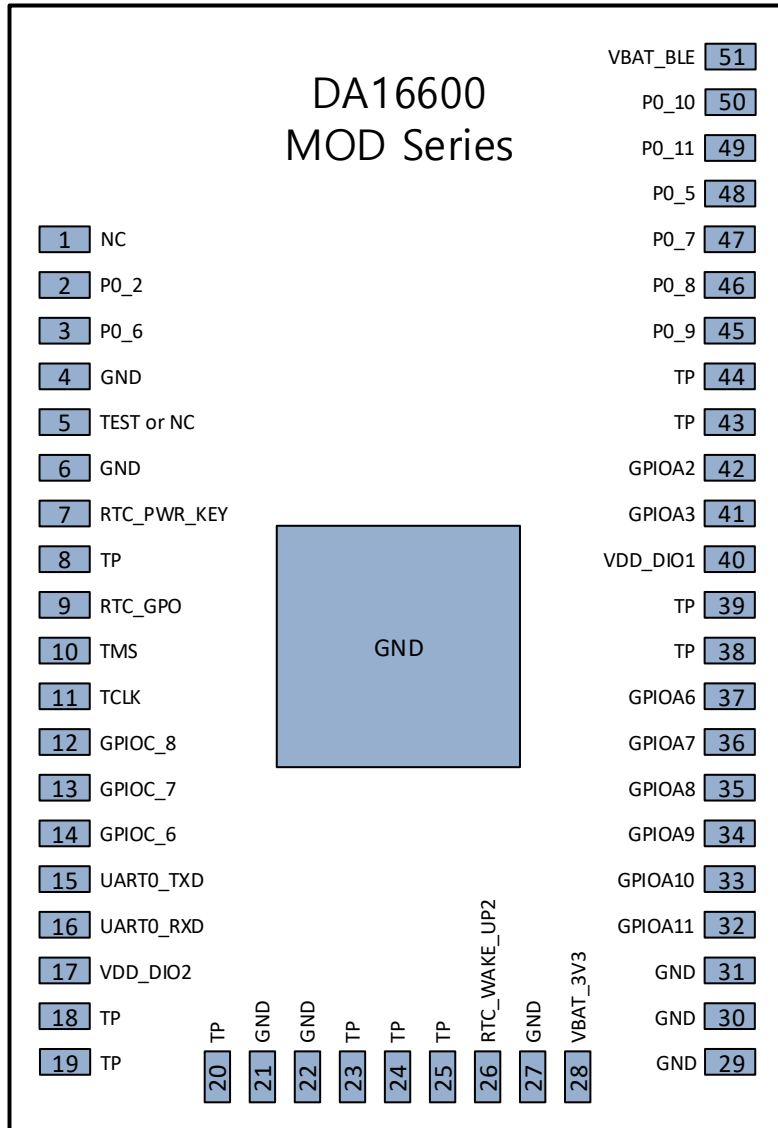


Figure 2: DA16600MOD 51 Pinout Diagram (Top View)

## 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 Connected
2	P0_2	DIO	-	-	DA14531	General Purpose I/O, JTAG I/F, SWCLK
3	P0_6	DIO	-	-	DA14531	Internally connected to RF switch (Note 1)
4	GND	GND	-	-	Common	Ground
5	TEST or NC	AI	-	-	Common	Chip antenna type: RF_Test 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 (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 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
24	TP	DNC	-	-	DA16200	F_CSN is internally connected to Flash Memory



**Ultra-Low Power Wi-Fi + Bluetooth<sup>®</sup> LE Combo Module**

#Pin	Pin Name	Type	Drive (mA)	Reset State	Related Device	Description
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 ( <a href="#">Note 1</a> )
39	TP	DNC	2/4/8/12	I-PD	Common	GPIOA4 of DA16200 is internally connected to P0_4 of DA14531 ( <a href="#">Note 1</a> )
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 ( <a href="#">Note 1</a> and <a href="#">Note 2</a> )
44	TP	DNC	2/4/8/12	I-PD	Common	GPIOA0 of DA16200 is internally connected to P0_1 of DA14531 ( <a href="#">Note 1</a> )
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
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

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

#Pin	Pin Name	Type	Drive (mA)	Reset State	Related Device	Description
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 cannot 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.

Within the DA16600 module, 4 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

### 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.

**Table 2: 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

#### 5.2 Recommended Operating Conditions

**Table 3: 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 <sub>A</sub> )	-	-40		+85	°C

#### 5.3 Electrical Characteristics

##### 5.3.1 DC Parameters, 1.8 V IO

**Table 4: DC Parameters, 1.8 V IO**

Symbol	Parameter	Condition	Min	Typ	Max	Units
V <sub>IL</sub>	Input Low Voltage	Guaranteed logic Low level (Note 1)	VSS	-	0.3 × DVDD	V
V <sub>IH</sub>	Input High Voltage	Guaranteed logic High level	0.7 × DVDD	-	DVDD	V
V <sub>OL</sub>	Output Low Voltage	DVDD=Min.	VSS	-	0.2 × DVDD	V
V <sub>OH</sub>	Output High Voltage	DVDD=Min.	0.8 × DVDD	-	DVDD	V
R <sub>PU</sub>	Pull-up Resistor	V <sub>PAD</sub> =V <sub>IH</sub> , DIO=Min.	-	-	32.4	kΩ
R <sub>PD</sub>	Pull-down Resistor	V <sub>PAD</sub> =V <sub>IL</sub> , DIO=Min.	-	-	32.4	

**Note 1** DVDD = 1.8 V, VDD\_DIO1, VDD\_DIO2 Logic Level.

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

### 5.3.2 DC Parameters, 3.3 V IO

**Table 5: DC Parameters, 3.3 V IO**

Symbol	Parameter	Condition	Min	Typ	Max	Units
V <sub>IL</sub>	Input Low Voltage	Guaranteed logic Low level (Note 1)	VSS	-	0.8	V
V <sub>IH</sub>	Input High Voltage	Guaranteed logic High level	2.0	-	DVDD	V
V <sub>OL</sub>	Output Low Voltage	DVDD=Min.	VSS	-	0.4	V
V <sub>OH</sub>	Output High Voltage	DVDD=Min.	2.4	-	DVDD	V
R <sub>PU</sub>	Pull-up Resistor	V <sub>PAD</sub> =V <sub>IH</sub> , DIO=Min.	-	-	19.4	kΩ
R <sub>PD</sub>	Pull-down Resistor	V <sub>PAD</sub> =V <sub>IL</sub> , DIO=Min.	-	-	16.0	

**Note 1** DVDD= 3.3 V, VDD\_DIO1, VDD\_DIO2 Logic Level.

### 5.3.3 DC Parameters for RTC Block

There are several control pins in RTC block.

**Table 6: DC Parameters for RTC Block, 3.3 V VBAT**

Symbol	Parameter	Condition	Min	Typ	Max	Units
V <sub>IL</sub>	Input Low Voltage	Guaranteed logic Low level	VSS	-	0.6	V
V <sub>IH</sub>	Input High Voltage	Guaranteed logic High level	2.2	-	VBAT	V

(RTC block: RTC\_PWR\_KEY, RTC\_WAKE\_UP2)

**Table 7: DC Parameters for RTC Block, 2.1 V VBAT**

Symbol	Parameter	Condition	Min	Typ	Max	Units
V <sub>IL</sub>	Input Low Voltage	Guaranteed logic Low level	VSS	-	0.3	V
V <sub>IH</sub>	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

5.4 Radio Characteristics

5.4.1 Wi-Fi Characteristics

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

Table 8: 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 9: 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

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

### 5.4.2 Bluetooth® LE Characteristics

**Table 10: Radio 1 Mb/s – AC Characteristics**

Parameter	Description	Condition	Min	Typ	Max	Unit
P <sub>SENS_CLEAN</sub>	sensitivity level	Dirty Transmitter disabled; DC-DC converter disabled; PER = 30.8%; (Note 1)	-	-93	-	dBm
P <sub>SENS_EPKT</sub>	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

## 5.5 Current Consumption

### 5.5.1 Wi-Fi Characteristics

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

**Table 11: 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 and CPU clock is 30 MHz.

TA = +25 °C, VBAT = 3.3 V

**Table 12: 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.

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

### 5.5.2 Bluetooth® LE Characteristics

**Table 13: DC Characteristics**

Parameter	Description	Conditions	Min	Typ	Max	Units
I <sub>BAT_ACTIVE</sub>	Battery supply current	-	-	0.4	-	mA
I <sub>BAT_BLE_ADV_100ms</sub>	Average battery supply current with system in Advertising state (3 channels) every 100ms and extended sleep with all RAM retained.	-	-	80	-	μA
I <sub>BAT_BLE_CONN_30ms</sub>	Average battery supply current with system in a connection state with 30ms connection interval and extended sleep with all RAM retained.	-	-	92	-	μA
I <sub>BAT_HIBERN</sub>	Battery supply current with system shut down	-	-	0.6	-	μA
I <sub>BAT_RF_RX</sub>	Battery supply current	Continuous Rx	-	2.3	-	mA
I <sub>BAT_RF_TX_+2</sub>	Battery supply current	Continuous Tx; Output power at 2 dBm (Note 1)	-	4.3	-	mA
I <sub>BAT_RF_TX_-1</sub>	Battery supply current	Continuous Tx; Output power at -1 dBm (Note 2)	-	3.6	-	mA
I <sub>BAT_RF_TX_-4</sub>	Battery supply current	Continuous Tx; Output power at -4 dBm	-	2.8	-	mA

**Note 1** All Bluetooth applications run on DA16200, so DA16200 should be active to handle Bluetooth data (for example, 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.

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

5.6 Radiation Performance

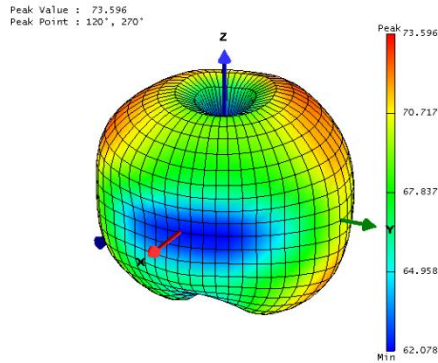


Figure 3: TIS 3D

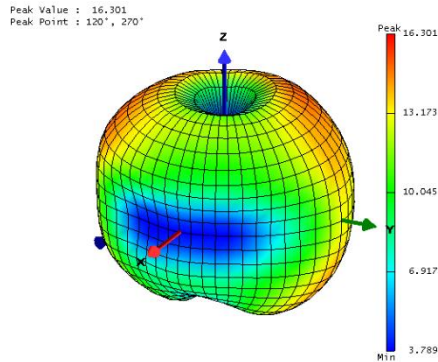


Figure 4: TRP 3D

5.7 ESD Ratings

Table 14: 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



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

## 6 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.

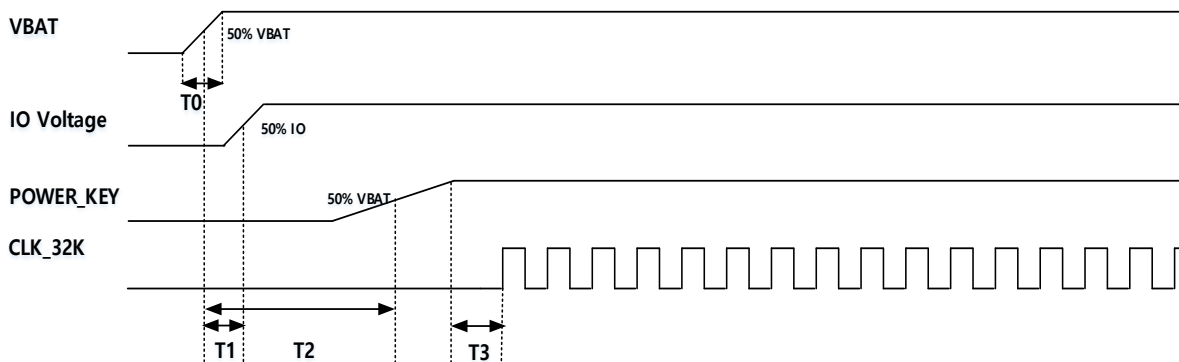


Figure 5: Power On Sequence

Table 15: 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 1)	-	5*T0	-	ms
T3	Internal RC oscillator wake-up time	-	217	-	µs

**Note 1** If the T0 = 10 ms to switch on VBAT, the recommended T2 is 50 ms for the safe booting operation. It can be externally controlled by MCU or it can 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.

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

7 Application Schematic

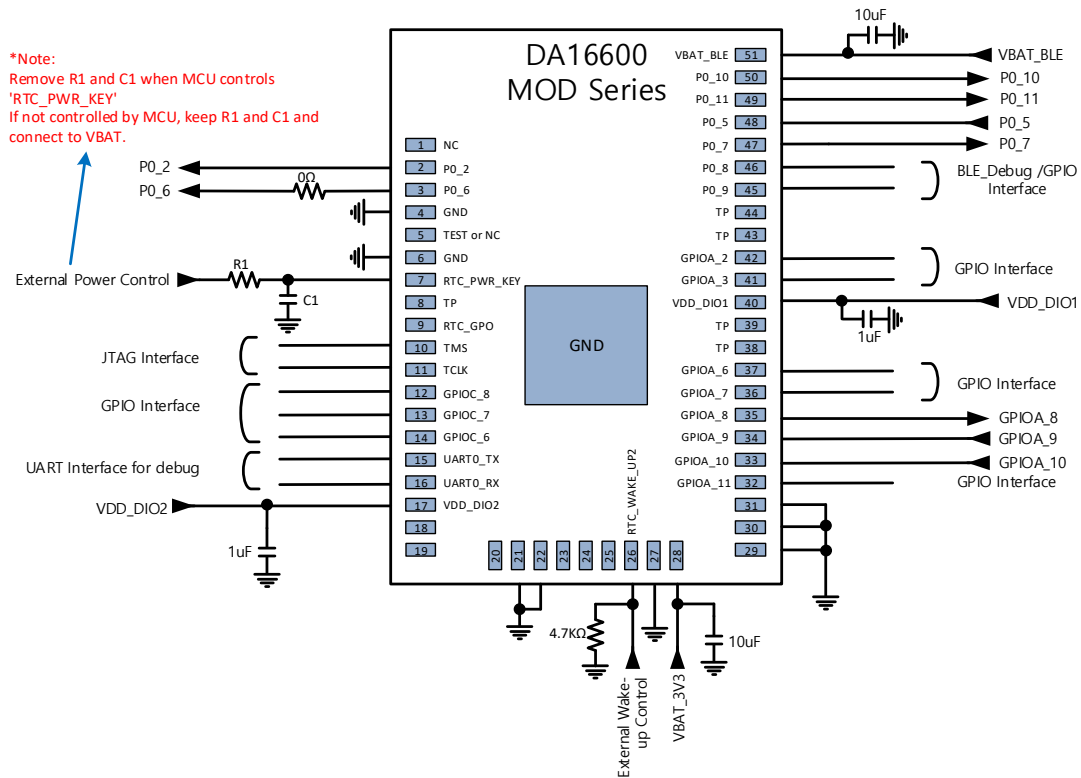


Figure 6: Application Schematic

Table 16: 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_PRI0

Table 17: 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.
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 1 uF.

# DA16600MOD Series

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

### 8 Mechanical Specifications

#### 8.1 Dimension: DA16600MOD-AAC

Unit: millimeter (mm)

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

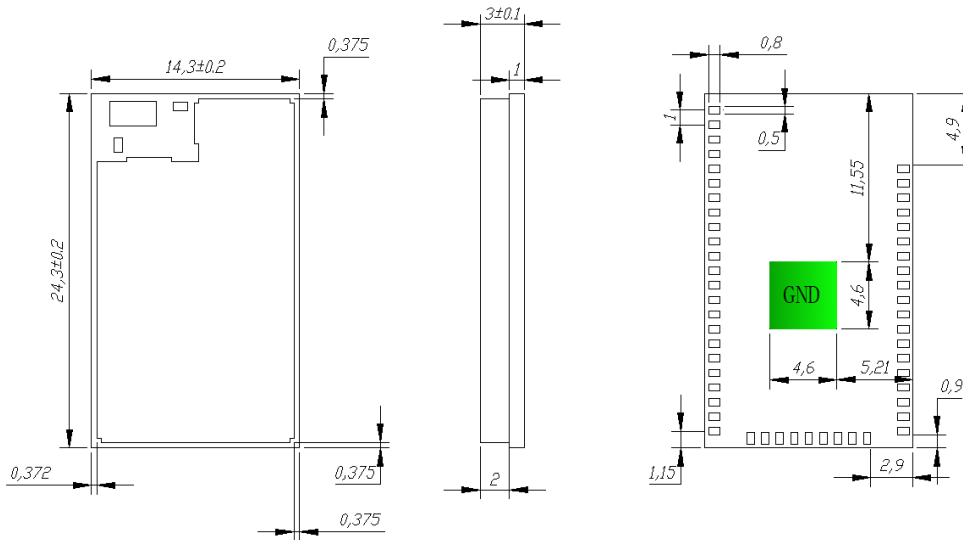


Figure 7: AAC Module Dimension

#### 8.2 Dimension: DA16600MOD-AAE

Unit: millimeter (mm)

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

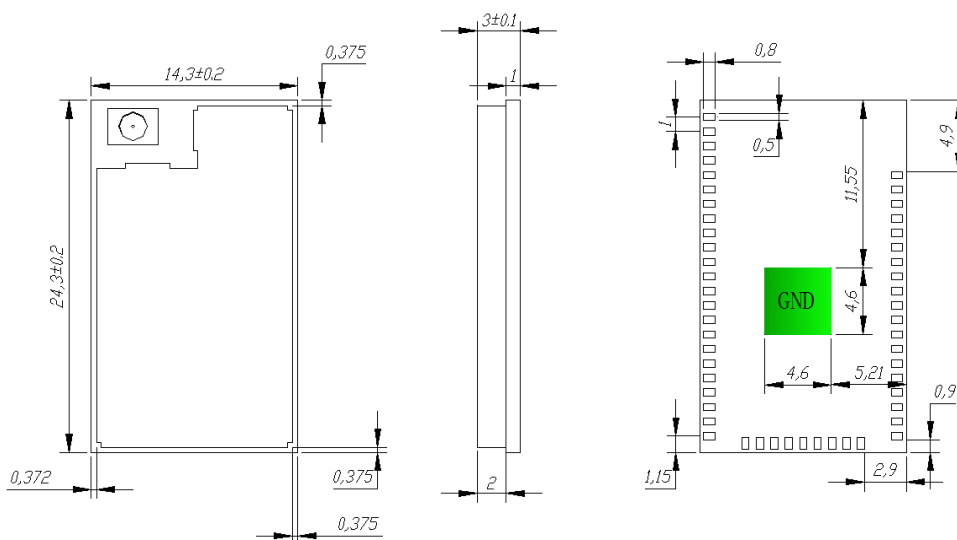
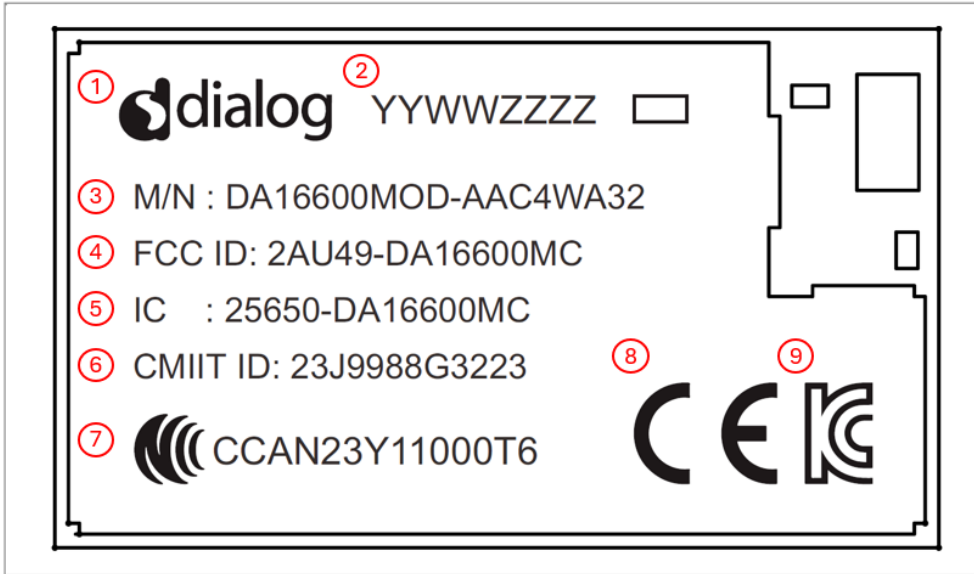


Figure 8: AAE Module Dimension

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

8.3 Marking



- ① Brand Name: Dialog
- ② Datecode: xxxxP4Ax
- ③ Model Name: DA16600MOD-AAx4WA32
- ④ FCC ID
- ⑤ IC ID
- ⑥ CMIIT ID
- ⑦ NCC logo
- ⑧ CE logo
- ⑨ KCC logo

Figure 9: Module Shield Marking

<b>NOTE</b>
DA16600MOD-AAC4WA32 only has the NCC logo.

## 9 Design Guidelines

### 9.1 PCB Land Pattern

Unit: millimeter (mm)

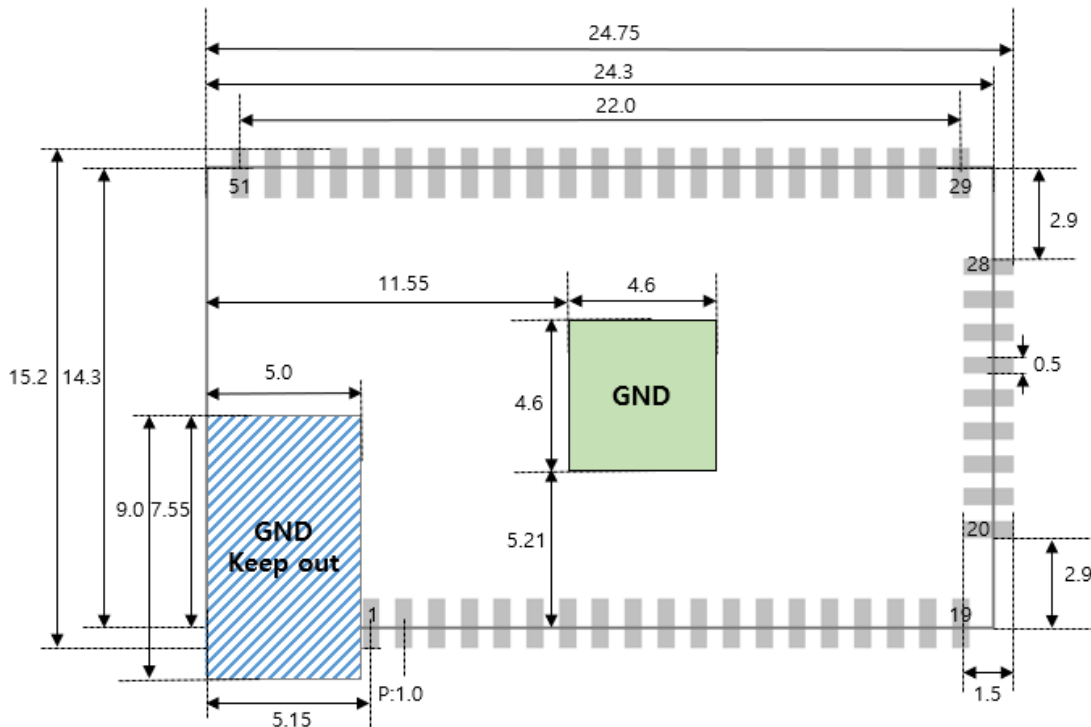


Figure 10: PCB Land Pattern (Top View)

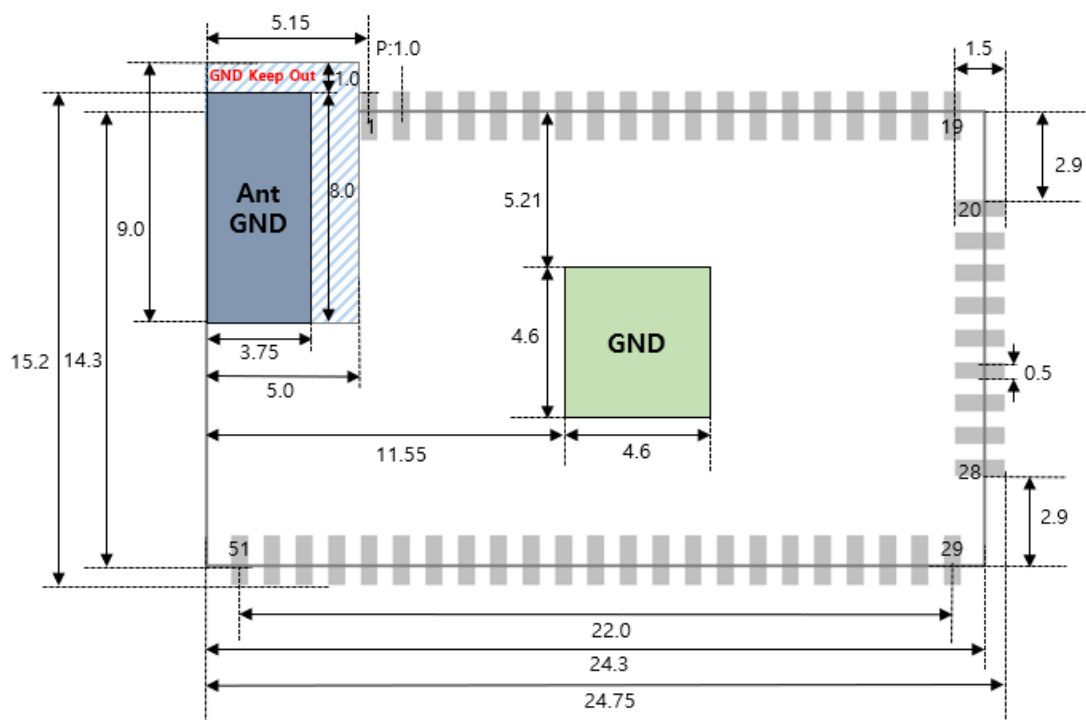


Figure 11: PCB Land Pattern (Bottom View)

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

9.2 4-Layer PCB Example

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.

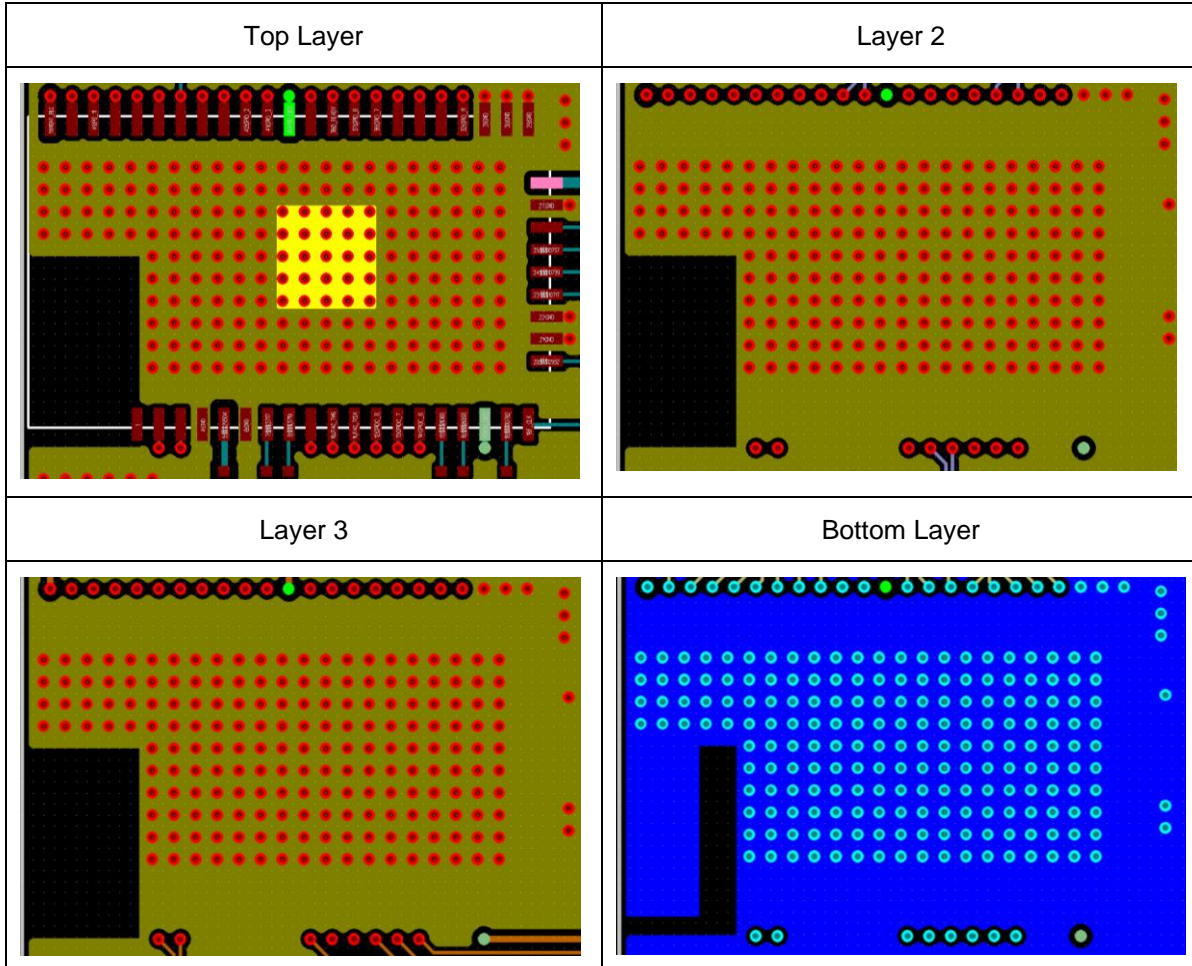


Figure 12: 4-Layer PCB Example

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

10 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.

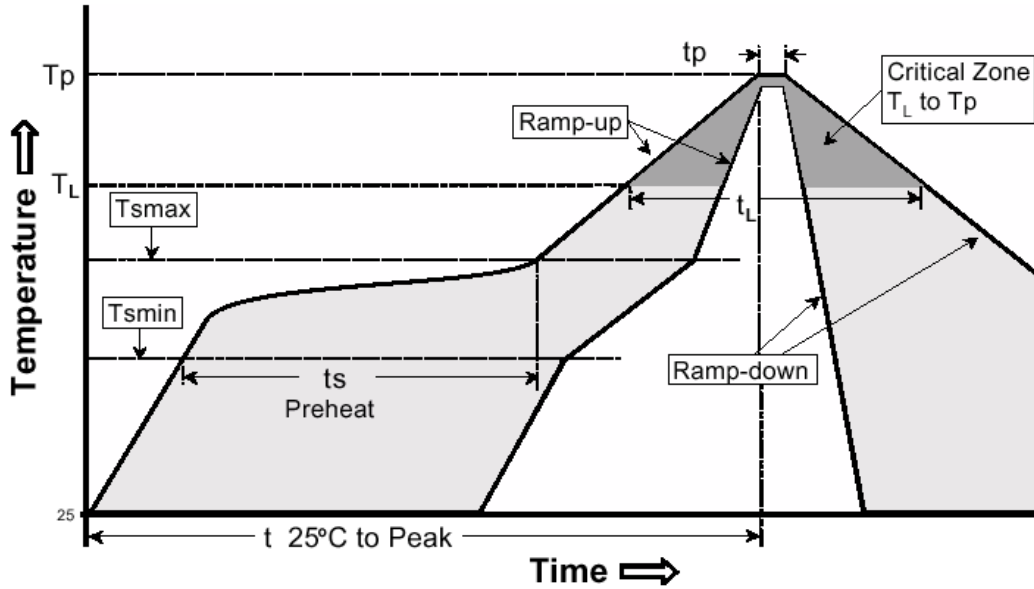


Figure 13: Reflow Condition

Table 18: Typical Reflow Profile (Lead Free): J-STD-020C

Profile Feature	Lead Free SMD
Average ramp up rate ( $T_{Smax}$ to $T_p$ )	3 °C/s Max.
Preheat	
<ul style="list-style-type: none"> <li>Temperature Min (<math>T_{Smin}</math>)</li> <li>Temperature Max (<math>T_{Smax}</math>)</li> <li>Time (<math>T_{Smax}</math> to <math>T_{Smin}</math>)</li> </ul>	<ul style="list-style-type: none"> <li>150 °C</li> <li>200 °C</li> <li>60 to 180 seconds</li> </ul>
Time maintained above	
<ul style="list-style-type: none"> <li>Temperature (<math>T_L</math>)</li> <li>Time (<math>t_L</math>)</li> </ul>	<ul style="list-style-type: none"> <li>217 °C</li> <li>60 to 150 seconds</li> </ul>
Peak/Classification temperature ( $T_p$ )	260 °C
Time within 5 °C of peak temperature ( $t_p$ )	20 to 40 seconds
Ramp down rate	6 °C/s Max.
Time from 25 °C to peak temperature	8 minutes Max.

## 11 Package Information

### 11.1 Tape and Reel

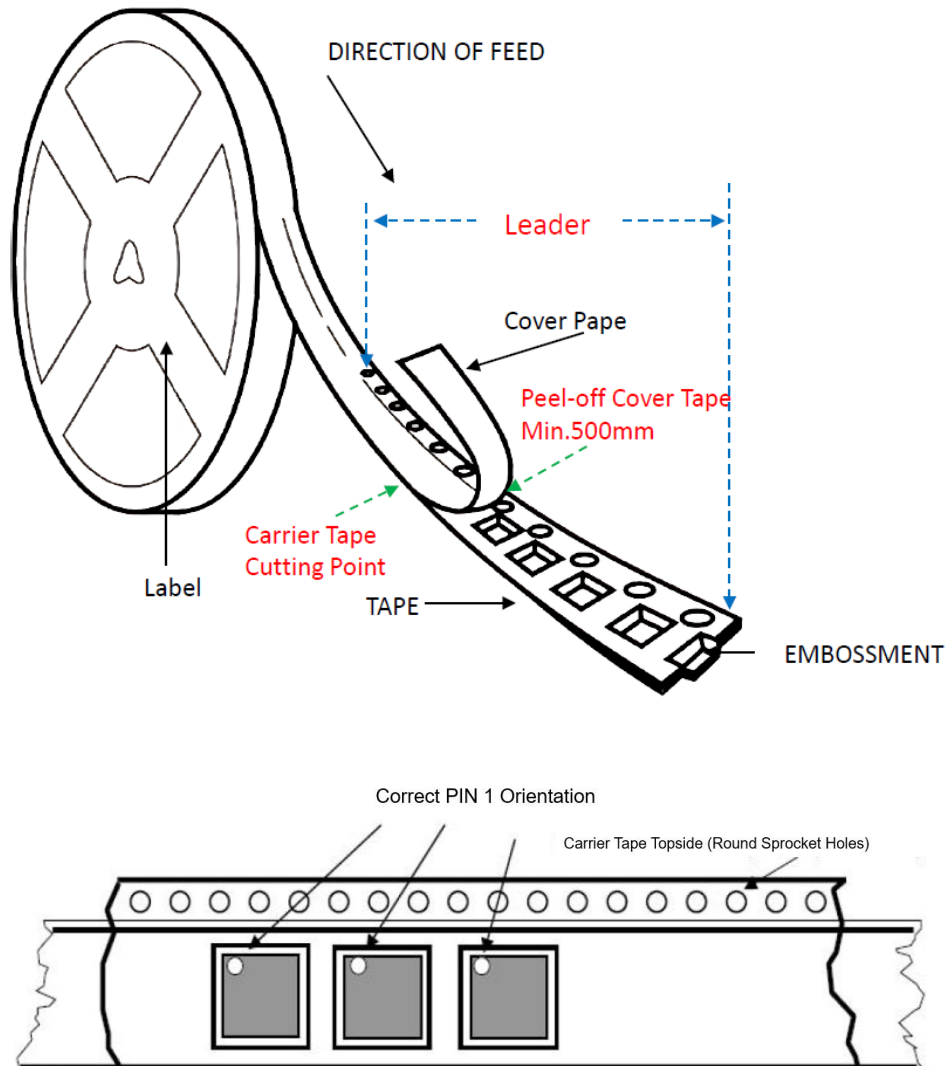


Figure 14: Tape and Reel

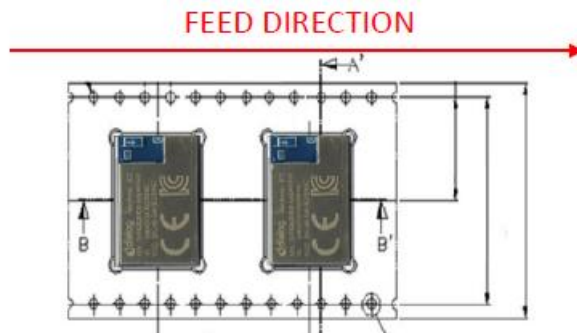


Figure 15: Component Direction



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

The actual reel specifications are presented in the following table:

Table 19: Reel Specification

Item	Description
Diameter	13 inches
Reel tape width	44 mm
Tape material	Antistatic
Qty/Reel	500
Leader	Min. 500 mm
Trailer	Min. 500 mm

11.2 Labeling

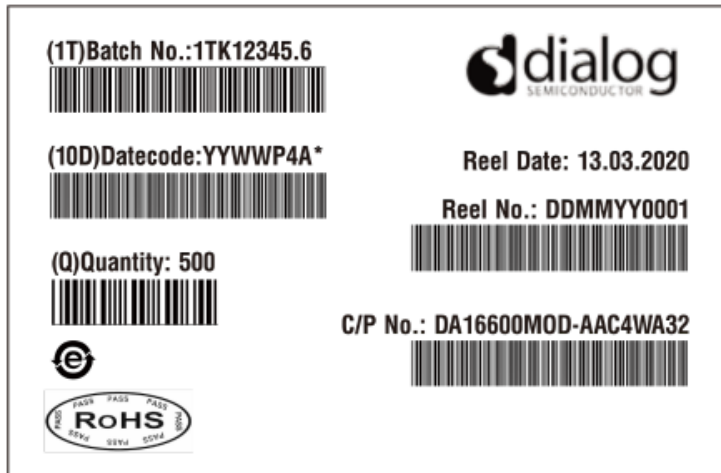


Figure 16: Reel Labeling

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

### 12 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 Renesas website (<https://www.renesas.com/kr/en/products/wireless-connectivity/wi-fi/low-power-wi-fi>) 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] 4-Mbyte, [2] 2-Mbyte

W: Voltage range

[W] 3.3 V, [L] 1.8 V



A3: Package No.

2: T&R packing

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


### Appendix A Regulatory Approval

DA16600MOD-AAC and DA16600MOD-AAE modules have received regulatory approval for the following countries:

- FCC / United States
  - DA16600MOD-AAC4WA32 FCC ID: 2AU49-DA16600MC
  - DA16600MOD-AAE4WA32 FCC ID: 2AU49-DA16600ME
- IC / Canada
  - DA16600MOD-AAC4WA32 IC ID: 25650-DA16600MC
  - DA16600MOD-AAE4WA32 IC ID: 25650-DA16600ME
- KCC / Korea
  - DA16600MOD-AAC4WA32 KCC ID: R-C-fci-DA16600AAC
  - DA16600MOD-AAE4WA32 KCC ID: R-C-fci-DA16600AAE
- TELEC / Japan
  - DA16600MOD-AAC4WA32 TELEC ID:
    -  R 210-155426
  - DA16600MOD-AAE4WA32 TELEC ID:
    -  R 210-216668
- CE / Europe
  - DA16600MOD-AAC4WA32 CE ID: LCS200907037AE
  - DA16600MOD-AAE4WA32 CE ID: LCS200907033AE
- SRRC / China
  - DA16600MOD-AAC4WA32 CMIIT ID: 23J9988G3223
  - DA16600MOD-AAE4WA32 CMIIT ID: 23J9988GT642(M)
- IMDA / Singapore
  - DA16600MOD-AAC4WA32 IMDA ID: N4512-23
- NCC / Taiwan
  - DA16600MOD-AAC4WA32

「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全及干擾合法通信；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。」

- 此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，並要求平台廠商於平台上標示本產品內含發射器模組

 CCAN23Y11000T6

NOTE
The NCC ID must be clearly displayed on the exterior of the finished product or mounted board.

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

### Revision History

Revision	Date	Description
3.4	Apr. 12, 2024	<ul style="list-style-type: none"> <li>Added regulatory certifications in Appendix A: NCC and SRRC</li> <li>Updated Section 8.3 Marking</li> </ul>
3.3	Oct. 05, 2023	<ul style="list-style-type: none"> <li>Removed redundant sections</li> <li>Added Appendix A</li> <li>Added Tape and Reel Information</li> </ul>
3.2	Jan. 04, 2023	<ul style="list-style-type: none"> <li>Section 3.1 updated coexistence description</li> <li>Updated Table 3 to add storage temperature range and adjusted min max voltages</li> </ul>
3.1	June 14, 2022	<ul style="list-style-type: none"> <li>Updated logo, disclaimer, and copyright</li> <li>Section 3.1 updated Pin Multiplexing Table 2</li> <li>Section 6 updated application Schematic Figure 6</li> <li>Updated Pin description Table 1</li> </ul>
3.0	Feb. 23, 2021	Official release
1.4	Oct. 26, 2020	Modified application schematic
1.3	July 15, 2020	Modified application schematic
1.2	May 22, 2020	Added ESD performance, Table 15
1.1	Apr. 29, 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 <a href="http://www.renesas.com">www.renesas.com</a> .
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' 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.

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

### Important Notice and Disclaimer

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers skilled in the art designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only for development of an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising out of your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

© 2024 Renesas Electronics Corporation

## Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu

Koto-ku, Tokyo 135-0061, Japan

[www.renesas.com](http://www.renesas.com)

### Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:

<https://www.renesas.com/contact/>

### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.