

## General Description

The DA16600 series is a highly integrated ultra-low power Wi-Fi +BLE Combo Module solution. This module includes the DA16200 which contains an 802.11b/g/n radio (PHY), a baseband processor, a media access controller (MAC), on-chip memory, and a host networking application processor. It also has a DA14531 which contains 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 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 allows a near zero level of power consumption 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

## Wi-Fi Features

- Highly integrated ultra-low power Wi-Fi® system on chip
  - Sleep current: 3.5 uA, VBAT=3.3 V
- Best 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)
- Complete software stack
  - Comprehensive networking software stack
  - Provides TCP/IP stack: in the form of network socket APIs
- Built-in 4-channel auxiliary ADC for sensor interfaces
  - 12-bit SAR ADC: single-ended four channels
  - Provides dynamic auto switching function
- Wi-Fi processor
  - IEEE 802.11b/g/n, 20 MHz channel bandwidth, 2.4 GHz
  - IEEE 802.11s Wi-Fi mesh
  - 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, SoftAP, and Wi-Fi Direct® Modes (GO, GC, GO fixed)
  - WPS-PIN/PBC for easy Wi-Fi provisioning
  - Connection manager for autonomous and fast Wi-Fi connections

- CPU core subsystem
  - Arm® Cortex®-M4F core w/ 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
- 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
- Supports various interfaces
  - QSPI for external flash control
  - Three 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
- SPI flash Memory
  - 32 M-bit / 4 M-byte
- Regulatory certifications: *(will be progress)*
  - FCC
  - IC
  - CE
- 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

## Bluetooth Features

- 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)
- Supports up to three BLE connections
- Typical cold boot to radio active 35 ms
- Processing power
  - 16 MHz 32-bit Cortex-M0+ with SWD interface
  - Dedicated Link Layer Processor
  - AES-128 encryption Processor
  - Software based certified True Random Number Generator (TRNG)
- Memories
  - 32 kB One-Time-Programmable (OTP)
  - 48 kB Retainable System RAM
  - 144 kB ROM
- Power management
  - Integrated Buck/Boost DCDC converter
  - Buck:  $1.8\text{ V} \leq V_{\text{BAT\_HIGH}} \leq 3.3\text{ V}$  if OTP read needed
  - Buck:  $1.1\text{ V} \leq V_{\text{BAT\_HIGH}} \leq 3.3\text{ V}$  if RAM retained
  - Clock-less Hibernation mode of 270 nA
  - 10-bit ADC for battery voltage monitoring
  - Built-in temperature sensor for die temperature monitoring
- Digital controlled oscillators
  - 32 MHz crystal and 32 MHz RC oscillator
  - 32 kHz crystal and 32/512 kHz RC oscillator
- 15 kHz RCX as 32 kHz crystal replacement
- Programmable Reset Circuitry
- 2 x General purpose Timers with capture and PWM capabilities

- Digital interfaces
  - UART
  - SPI Master/Slave up to 32 MHz (Master)
  - I2C bus at 100 kHz, 400 kHz
  - 3-axis capable Quadrature Decoder
  - Keyboard controller
- Analog interfaces
  - 4-channel 10-bit ADC
- Radio transceiver
  - Fully integrated 2.4 GHz CMOS transceiver
  - Single wire antenna
  - TX: 3.5 mA, RX: 2.2 mA (system currents with DC-Dc,  $V_{BAT\_HIGH} = 3V$  and 0 dBm)
  - Programmable transmit output power from -20 dBm to +2.0 dBm
  - -93.5 dBm receiver sensitivity

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## 1 References

DA16600MOD consist of DA16200 and DA14531 chipset, please refer to the chipset datasheet for details.

- [1] DA16200\_Datasheet
- [2] DA14531\_Datasheet

### 3 Pinout

#### 3.1 Pin-out Description (51-pins)

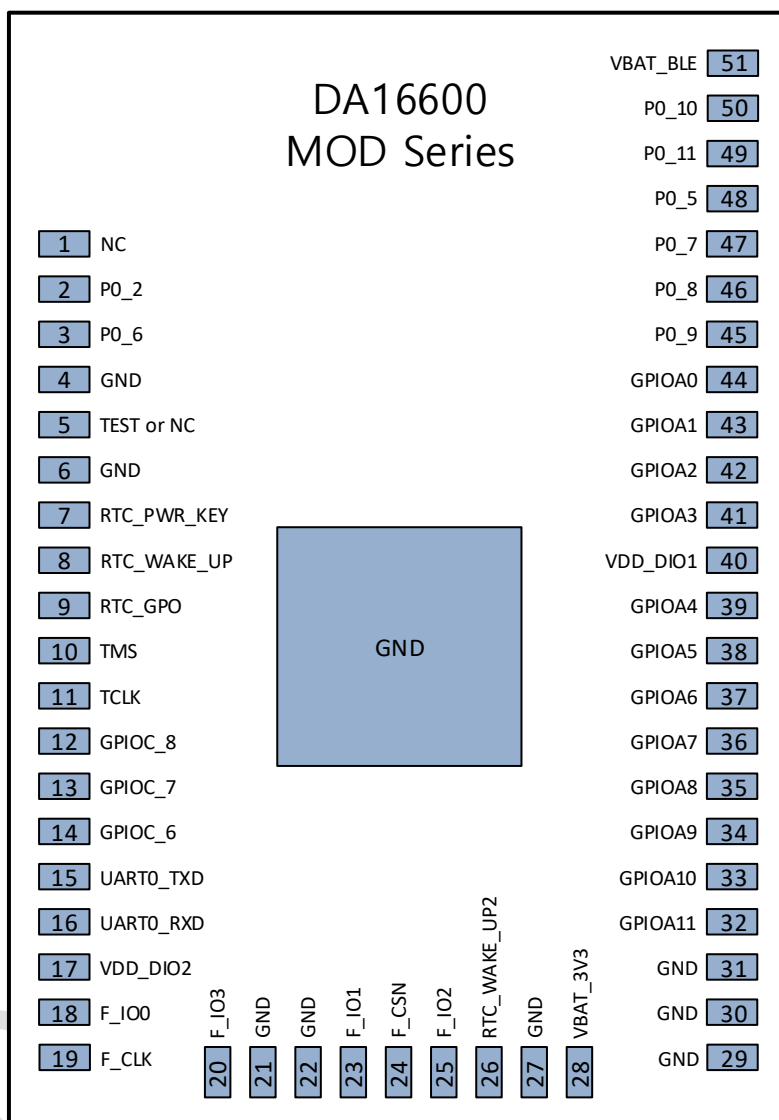


Figure 2: DA16600MOD 51-pins Pin-out Diagram (Top View)

Table 1: Pin Description

| #Pin | Pin Name     | Type | Drive(mA) | Reset State | Related chipset | Description                                                           |
|------|--------------|------|-----------|-------------|-----------------|-----------------------------------------------------------------------|
| 1    | NC           | AI   |           |             | DA14531         | Not Connect                                                           |
| 2    | P0_2         | DIO  |           |             | DA14531         |                                                                       |
| 3    | P0_6         | DIO  |           |             | DA14531         | Internally connected to RF switch                                     |
| 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    | RTC_WAKE_UP  | DI   |           |             | DA16200         | RTC block wake-up signal                                              |
| 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   | F_IO0        | DIO  |           |             | DA16200         | Internally connected to Flash Memory                                  |
| 19   | F_CLK        | DIO  |           |             | DA16200         | Internally connected to Flash Memory                                  |
| 20   | F_IO3        | DIO  |           |             | DA16200         | Internally connected to Flash Memory                                  |
| 21   | GND          | GND  |           |             | Common          |                                                                       |
| 22   | GND          | GND  |           |             | Common          |                                                                       |
| 23   | F_IO1        | DIO  |           |             | DA16200         | Internally connected to Flash Memory                                  |
| 24   | F_CSN        | DIO  |           |             | DA16200         | Internally connected to Flash Memory                                  |
| 25   | F_IO2        | DIO  |           |             | DA16200         | Internally connected to Flash Memory                                  |
| 26   | RTC_WAKE_UP2 | DI   |           |             | DA16200         | RTC block wake-up signal                                              |
| 27   | GND          | GND  |           |             | Common          |                                                                       |
| 28   | VBAT_3V3     | VDD  |           |             | DA16200         | Supply power for internal DC-DC,<br>DIO_LDO, and analog IP of DA16200 |
| 29   | GND          | GND  |           |             | Common          |                                                                       |
| 30   | GND          | GND  |           |             | Common          |                                                                       |
| 31   | GND          | GND  |           |             | Common          |                                                                       |
| 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                                                   |

| #Pin | Pin Name | Type   | Drive(mA) | Reset State | Related chipset | Description                                 |
|------|----------|--------|-----------|-------------|-----------------|---------------------------------------------|
| 37   | GPIOA6   | DIO    | 2/4/8/12  | I-PD        | DA16200         | General Purpose I/O                         |
| 38   | GPIOA5   | DIO    | 2/4/8/12  | I-PD        | DA16200         | Internally connected to P0_3 of DA14531     |
| 39   | GPIOA4   | DIO    | 2/4/8/12  | I-PD        | DA16200         | Internally connected to P0_4 of DA14531     |
| 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   | GPIOA1   | AI/DIO | 2/4/8/12  | I-PD        | DA16200         | Internally connected to P0_0 of DA14531     |
| 44   | GPIOA0   | AI/DIO | 2/4/8/12  | I-PD        | DA16200         | Internally connected to P0_1 of DA14531     |
| 45   | P0_9     | DIO    | 3.5 / 0.3 | I-PD        | DA14531         | General Purpose I/O                         |
| 46   | P0_8     | DIO    | 3.5 / 0.3 | I-PD        | DA14531         | General Purpose I/O                         |
| 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                         |
| 51   | VBAT_BLE | VDD    |           |             | DA14531         | Supply power for DA14531                    |

**Note 1** Pin 38, Pin 39, Pin 43, and Pin 44 are connected internally so it is not possible to use GPIO in application system

## 4 Electrical Specification

### 4.1 Absolute Maximum Ratings

Table 2: Absolute Maximum Ratings

| Parameter                        | #Pins | Min  | Max | Units |
|----------------------------------|-------|------|-----|-------|
| VBAT_3V3                         | 28    | VSS  | 3.9 | V     |
| VDD_DIO1                         | 40    | VSS  | 3.9 | V     |
| VDD_DIO2                         | 17    | VSS  | 3.9 | V     |
| VBAT_BLE                         | 51    | -0.2 | 3.6 | V     |
| Operating temperature range (TA) |       | -40  | +85 | °C    |



## 4.2 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    | 1.1  |     | 3.3 | V     |
| Operating temperature range (TA) |       | -40  |     | +85 | °C    |

## 4.3 Electrical Characteristics

### 4.3.1 DC Parameters, 1.8V IO

Table 4: DC Parameters, 1.8 V IO

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

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

### 4.3.2 DC Parameters, 3.3V IO

Table 5: DC Parameters, 3.3V IO

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

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

## 4.4 Radio Characteristics

### 4.4.1 WLAN Characteristics

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

**Table 6: WLAN Receiver Characteristics**

| Parameter                                                                | Condition    | Min   | Typ   | Max   | Units |
|--------------------------------------------------------------------------|--------------|-------|-------|-------|-------|
| Sensitivity<br>(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<br>(8% PER for 11b rates, 10% PER for 11g/11n rates) | 802.11b      | -4    | 0     | 0     |       |
|                                                                          | 802.11g      | -10   | -4    | -3    |       |

**Table 7: WLAN Transmitter Characteristics**

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

## 4.4.2 BLE Characteristics

Table 8: BLE 1Mb/s specifications – AC Characteristics

| Parameter                    | Description                                          | Condition                                                                                                                                                                                                                                                                                | Min | Typ   | Max | Unit |
|------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------|-----|------|
| P <sub>SENS_CLEAN</sub>      | sensitivity level                                    | Dirty Transmitter disabled;<br>DC-DC converter disabled;<br>PER = 30.8 %;<br><a href="#">Note 1</a>                                                                                                                                                                                      |     | -93   |     | dBm  |
| P <sub>SENS_EPKT</sub>       | sensitivity level                                    | Extended packet size<br>(255 octets)<br><a href="#">Note 1</a>                                                                                                                                                                                                                           |     | -89.5 |     | dBm  |
| P <sub>SENS</sub>            | sensitivity level                                    | Normal Operating<br>Conditions; DC-DC converter<br>disabled; PER = 30.8 %;<br><a href="#">Note 1</a>                                                                                                                                                                                     |     | -92   |     | dBm  |
| P <sub>SENS_EOC</sub>        | sensitivity level                                    | Extreme Operating<br>Conditions; DC-DC converter<br>enabled; PER = 30.8 %;<br>-40 °C ≤ T <sub>A</sub> ≤ +85 °C<br><a href="#">Note 1</a>                                                                                                                                                 |     |       | -89 | dBm  |
| P <sub>SENS_EPKT_CLEAN</sub> | sensitivity level                                    | Dirty Transmitter disabled;<br>DC-DC converter disabled;<br>Extended packet size (255<br>octets)<br><a href="#">Note 1</a>                                                                                                                                                               |     | -90.5 |     | dBm  |
| P <sub>I_MAX</sub>           | maximum input power level                            | DC-DC converter disabled;<br>PER = 30.8 %;<br><a href="#">Note 1</a>                                                                                                                                                                                                                     | 0   |       |     | dBm  |
| P <sub>INT_IMD</sub>         | intermodulation distortion<br>interferer power level | worst-case interferer level @<br>f <sub>1</sub> , f <sub>2</sub> with 2*f <sub>1</sub> - f <sub>2</sub> = f <sub>0</sub> ,  f <sub>1</sub> - f <sub>2</sub>  <br>= n MHz and n = 3, 4, 5;<br>P <sub>WANTED</sub> = -64 dBm @ f <sub>0</sub> ;<br>PER = 30.8 %;<br><a href="#">Note 1</a> | -35 | -20.5 |     | dBm  |
| CIR <sub>0</sub>             | carrier to interferer ratio                          | n = 0;<br>interferer @ f <sub>1</sub> = f <sub>0</sub> + n*1<br>MHz;<br><a href="#">Note 1</a>                                                                                                                                                                                           |     | 7.5   | 21  | dB   |
| CIR <sub>1</sub>             | carrier to interferer ratio                          | n = ±1;<br>interferer @ f <sub>1</sub> = f <sub>0</sub> + n*1<br>MHz;<br><a href="#">Note 1</a>                                                                                                                                                                                          |     | -1.5  | 15  | dB   |
| CIR <sub>P2</sub>            | carrier to interferer ratio                          | n = +2 (image frequency);<br>interferer @ f <sub>1</sub> = f <sub>0</sub> + n*1<br>MHz;<br><a href="#">Note 1</a>                                                                                                                                                                        |     | -27   | -9  | dB   |
| CIR <sub>M2</sub>            | carrier to interferer ratio                          | n = -2;<br>interferer @ f <sub>1</sub> = f <sub>0</sub> + n*1<br>MHz;<br><a href="#">Note 1</a>                                                                                                                                                                                          |     | -31   | -17 | dB   |

| Parameter             | Description                   | Condition                                                                                                                          | Min | Typ   | Max | Unit       |
|-----------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----|-------|-----|------------|
| CIR <sub>P3</sub>     | carrier to interferer ratio   | n = +3 (image frequency + 1 MHz); interferer @ $f_1 = f_0 + n \cdot 1$ MHz;<br>Note 1                                              |     | -37.5 | -15 | dB         |
| CIR <sub>M3</sub>     | carrier to interferer ratio   | n = -3;<br>interferer @ $f_1 = f_0 + n \cdot 1$ MHz;<br>Note 1                                                                     |     | -43   | -27 | dB         |
| CIR <sub>4</sub>      | carrier to interferer ratio   | n  ≥ 4 (any other B channel);<br>interferer @ $f_1 = f_0 + n \cdot 1$ MHz;<br>Note 1                                               |     | -41.5 | -27 | dB         |
| P <sub>BL_I</sub>     | blocker power level           | 30 MHz ≤ f <sub>BL</sub> ≤ 2000 MHz;<br>P <sub>WANTED</sub> = -67 dBm;<br>Note 1                                                   | -17 | 5     |     | dBm        |
| P <sub>BL_II</sub>    | blocker power level<br>Note 2 | 2003 MHz ≤ f <sub>BL</sub> ≤ 2399 MHz;<br>P <sub>WANTED</sub> = -67 dBm;<br>Note 1                                                 | -17 | 0     |     | dBm        |
| P <sub>BL_III</sub>   | blocker power level           | 2484 MHz ≤ f <sub>BL</sub> ≤ 2997 MHz;<br>P <sub>WANTED</sub> = -67 dBm;<br>Note 1                                                 | -17 | 0     |     | dBm        |
| P <sub>BL_IV</sub>    | blocker power level           | 3000 MHz ≤ f <sub>BL</sub> ≤ 12.75 GHz;<br>P <sub>WANTED</sub> = -67 dBm;<br>Note 1                                                | -17 | 5     |     | dBm        |
| L <sub>ACC_RSSI</sub> | level accuracy                | tolerance at 5 % to 95 % confidence interval of P <sub>RF</sub> :<br>when RXRSSI[7:0] = X, 50 < X < 175; burst mode, 1500 packets; |     | 0     | 3   | dB         |
| L <sub>RES_RSSI</sub> | level resolution              | gradient of monotonous range for RXRSSI[7:0] = X, 50 < X < 175; burst mode, 1500 packets;                                          |     | 0.5   |     | dB/L<br>SB |
| ACP <sub>2M</sub>     | adjacent channel power level  | f <sub>oFS</sub> = 2 MHz;<br>Note 1                                                                                                |     | -53   |     | dBm        |
| ACP <sub>2M_EOC</sub> | adjacent channel power level  | Extreme Operating Conditions;<br>f <sub>oFS</sub> = 2 MHz; -40 °C ≤ TA ≤ +85 °C<br>Note 1                                          |     | -53   | -47 | dBm        |
| ACP <sub>3M</sub>     | adjacent channel power level  | f <sub>oFS</sub> ≥ 3 M ;<br>Note 1                                                                                                 |     | -57   |     | dBm        |
| ACP <sub>3M_EOC</sub> | adjacent channel power level  | Extreme Operating Conditions; f <sub>oFS</sub> ≥ 3 M ; -40 °C ≤ TA ≤ +85 °C<br>Note 1                                              |     | -57   | -47 | dBm        |

| Parameter         | Description        | Condition                            | Min | Typ   | Max | Unit |
|-------------------|--------------------|--------------------------------------|-----|-------|-----|------|
| P <sub>O_12</sub> | output power level | RF_ATTR_REG<br>[PA_POWE_SETTING]= 12 |     | 2.5   |     | dBm  |
| P <sub>O_11</sub> | output power level | RF_ATTR_REG<br>[PA_POWE_SETTING]= 11 |     | 1.5   |     | dBm  |
| P <sub>O_10</sub> | output power level | RF_ATTR_REG<br>[PA_POWE_SETTING]= 10 |     | 1     |     | dBm  |
| P <sub>O_09</sub> | output power level | RF_ATTR_REG<br>[PA_POWE_SETTING]= 9  |     | 0     |     | dBm  |
| P <sub>O_08</sub> | output power level | RF_ATTR_REG<br>[PA_POWE_SETTING]= 8  |     | -1    |     | dBm  |
| P <sub>O_07</sub> | output power level | RF_ATTR_REG<br>[PA_POWE_SETTING]= 7  |     | -2    |     | dBm  |
| P <sub>O_06</sub> | output power level | RF_ATTR_REG<br>[PA_POWER_SETTING]= 6 |     | -3.5  |     | dBm  |
| P <sub>O_05</sub> | output power level | RF_ATTR_REG<br>[PA_POWER_SETTING]= 5 |     | -5    |     | dBm  |
| P <sub>O_04</sub> | output power level | RF_ATTR_REG<br>[PA_POWER_SETTING]= 4 |     | -7    |     | dBm  |
| P <sub>O_03</sub> | output power level | RF_ATTR_REG<br>[PA_POWER_SETTING]= 3 |     | -10   |     | dBm  |
| P <sub>O_02</sub> | output power level | RF_ATTR_REG<br>[PA_POWER_SETTING]= 2 |     | -13.5 |     | dBm  |
| P <sub>O_01</sub> | output power level | RF_ATTR_REG<br>[PA_POWER_SETTING]= 1 |     | -19.5 |     | dBm  |

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

Note 2 Frequencies close to the ISM band can show slightly worse performance

## 4.5 Current Consumption

### 4.5.1 WLNA Characteristics

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

**Table 9: 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 <a href="#">Note</a>     | 25   | 29   | 51  |       |
|           |           | 1 Mbps DSSS <a href="#">Note 1</a> | 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 10: Current Consumption in Low Power Operation**

| Parameter           | Condition | Min | Typ | Max | Units |
|---------------------|-----------|-----|-----|-----|-------|
| Low Power Operation | Sleep 1   |     | 0.2 |     | μA    |
|                     | Sleep 2   |     | 1.8 |     |       |
|                     | Sleep 3   |     | 3.5 |     |       |

### 4.5.2 BLE characteristics

**Table 11: BLE 1Mb/s specifications - DC Characteristics**

| Parameter     | Description                 | Conditions                                                                              | Min | Typ | Max | Units |
|---------------|-----------------------------|-----------------------------------------------------------------------------------------|-----|-----|-----|-------|
| IBAT_RF_RX    | Current at VBAT_LOW = 1.1 V | radio receiver and synthesizer active; TA = 25 °C                                       |     | 4.3 |     | mA    |
| IBAT_RF_TX_12 | Current at VBAT_LOW = 1.1 V | radio transmitter and synthesizer active; power setting = 12; POUT = 2.5dBm; TA = 25 °C |     | 7.9 |     | mA    |
| IBAT_RF_TX_9  | Current at VBAT_LOW = 1.1 V | radio transmitter and synthesizer active; power setting = 9; POUT = 0 dBm; TA = 25 °C   |     | 6.9 |     | mA    |
| IBAT_RF_TX_6  | Current at VBAT_LOW = 1.1 V | radio transmitter and synthesizer active; power setting = 6; POUT = -3.5dBm; TA = 25 °C |     | 5.7 |     | mA    |

## 4.6 Radiation Performance

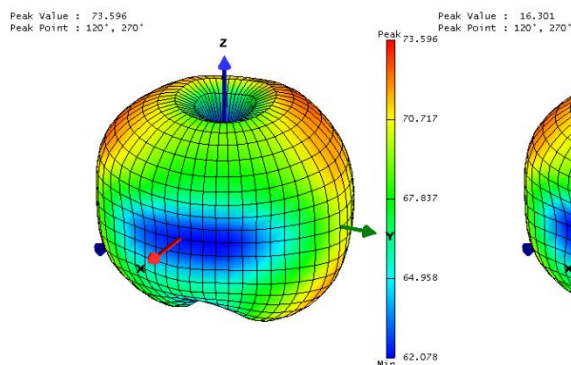


Figure 3: TIS 3D

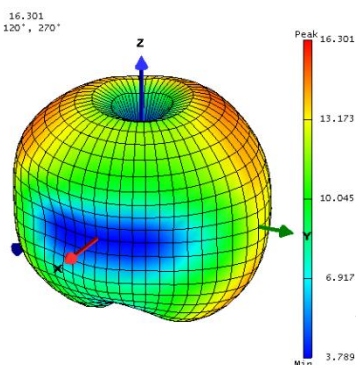


Figure 4: TRP 3D

## 4.7 ESD Ratings

Table 12: ESD performance

| Reliability Test         | Standards                   | Test Conditions | Result |
|--------------------------|-----------------------------|-----------------|--------|
| Human Body Model (HBM)   | ANSI/ESDA/JEDEC JS-001-2017 | $\pm 2,000$ V   | Pass   |
| Charge Device Mode (CDM) | ANSI/ESDA/JEDEC JS-002-2018 | $\pm 500$ V     | Pass   |

## 6 Package Information

### 6.1 Dimension: DA16600MOD-AAC

Unit: millimeters (mm)

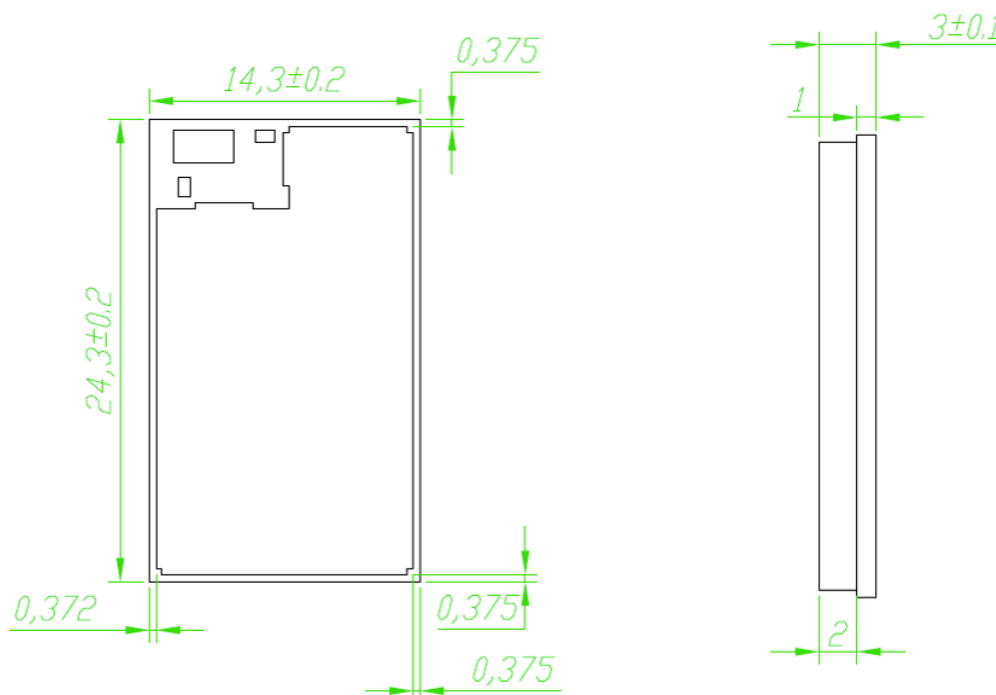


Figure 6: Module Top

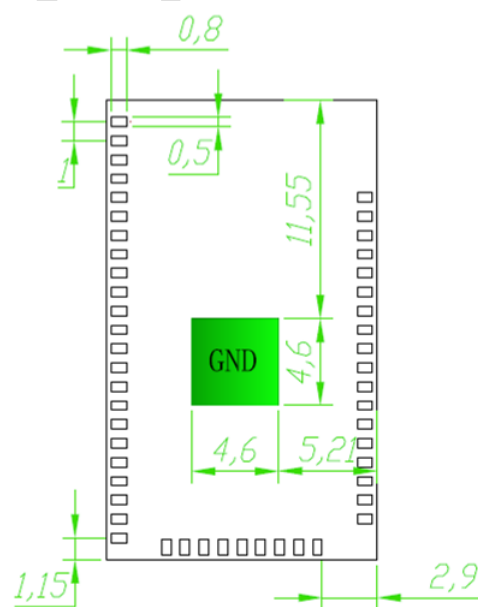


Figure 7: Module Bottom Top-View



## 6.2 Dimension: DA16600MOD-AAE

Unit: millimeters (mm)

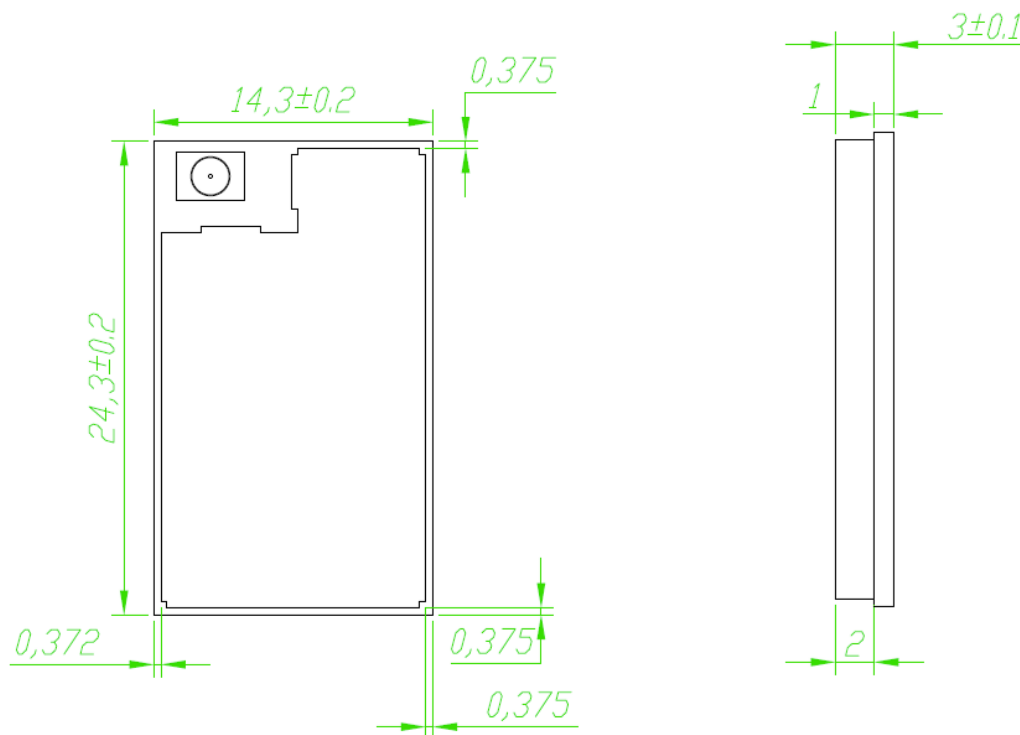


Figure 8: Module Top

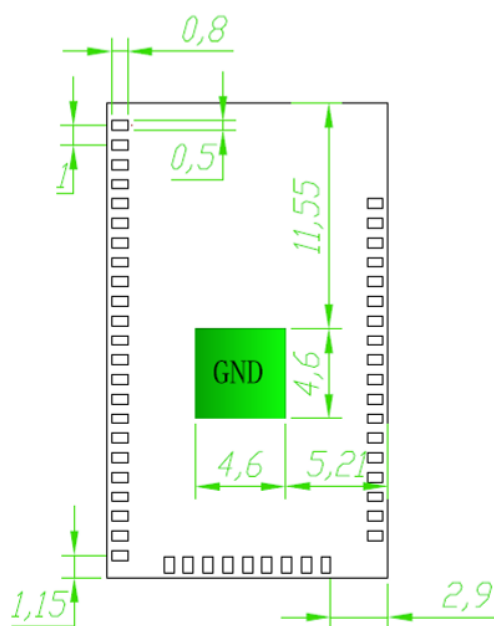
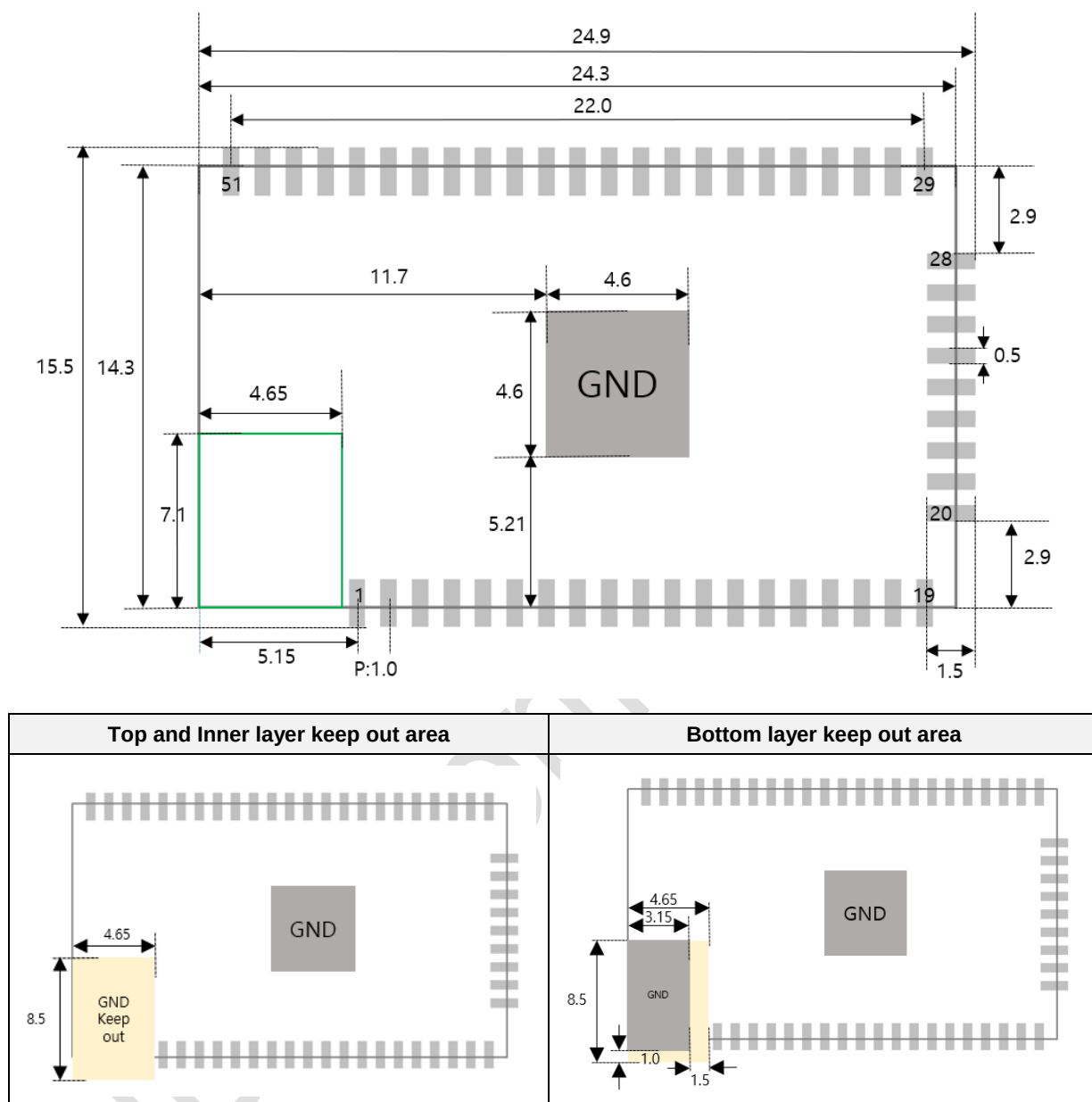


Figure 9: Module Bottom Top-View

### 6.3 PCB Land Pattern

Unit: millimeters (mm)



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

## 6.4 Soldering Information

### 6.4.1 Recommended Condition for Reflow Soldering

Figure 11 shows the typical process flow for mounting surface mount packages to PCB.

The reflow profile depends on the solder paste being used and the recommendations from the paste manufacture should be followed to determine the proper reflow profile. Figure 11 shows a typical reflow profile when a no-clean paste is used. Oven time above liquidus (260 °C for lead-free solder) is 20 to 40 seconds.

The rework process involves the following steps:

1. Component removal
2. Site redress
3. Solder paste application
4. Component placement
5. Component attachment

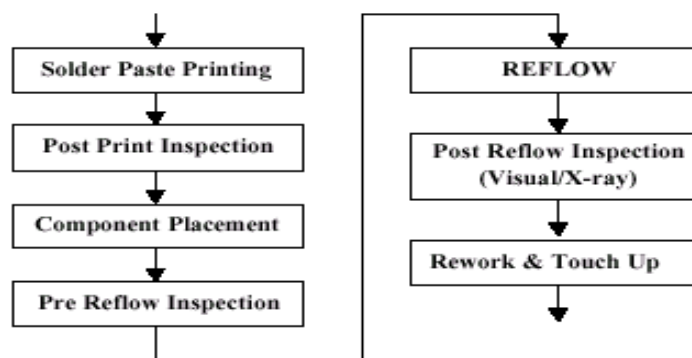


Figure 11: Typical PCB Mounting Process Flow

Table 14: Typical Reflow Profile (Lead Free): J-STD-020C

| Profile Feature                                                                                                                                                                                                       | Lead Free SMD                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| Average ramp up rate ( $T_{S_{max}}$ to $T_p$ )                                                                                                                                                                       | 3 °C/s Max.                                                                                         |
| Preheat                                                                                                                                                                                                               |                                                                                                     |
| <ul style="list-style-type: none"> <li>Temperature Min (<math>T_{S_{min}}</math>)</li> <li>Temperature Max (<math>T_{S_{max}}</math>)</li> <li>Time (<math>T_{S_{max}}</math> to <math>T_{S_{min}}</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.                                                                                      |

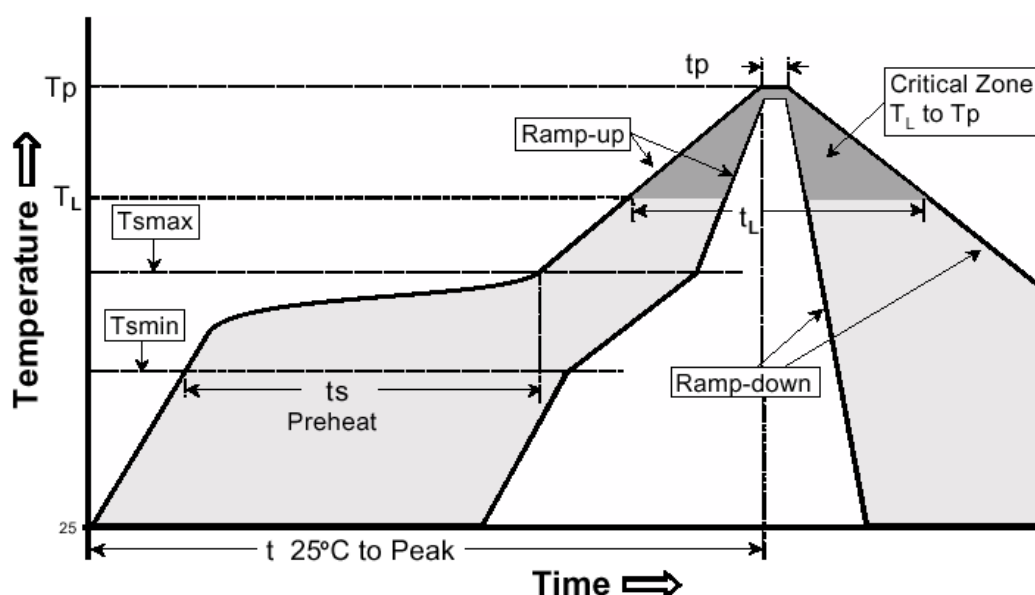


Figure 12: Reflow Condition

## 7 Ordering Information

The order number consists of the part number followed by a suffix indicating the packing method. For details and availability, please consult Dialog Semiconductor's [customer support portal](#) or your local sales representative.

**Table 15: Ordering Information (Samples)**

| Part Number    | Pins | Size (mm)         | Shipment Form | Pack Quantity |
|----------------|------|-------------------|---------------|---------------|
| DA16600MOD-AAC | 51   | 14.2 x 24.6 x 3.0 | Reel          |               |
| DA16600MOD-AAE | 51   | 14.2 x 24.6 x 3.0 | Reel          |               |

**Table 16: Ordering Information (Production)**

| Part Number    | Pins | Size (mm)         | Shipment Form | Pack Quantity |
|----------------|------|-------------------|---------------|---------------|
| DA16600MOD-AAC | 51   | 14.2 x 24.6 x 3.0 | Reel          | 500           |
| DA16600MOD-AAE | 51   | 14.2 x 24.6 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] 2Mbyte

W: Voltage range

[W] 3.3 V, [L] 1.8 V

A3: Package No.

2: T&amp;R packing

## Revision History

| Revision | Date          | Description                                      |
|----------|---------------|--------------------------------------------------|
| 1.3      | 15-July-2020  | Modified application schematic                   |
| 1.2      | 22-May-2020   | Added ESD performance, <a href="#">Table 122</a> |
| 1.1      | 29-April-2020 | Preliminary datasheet                            |

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## 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.dialog-semiconductor.com">www.dialog-semiconductor.com</a> . |
| 4.<n>    | Obsolete         | Archived       | This datasheet contains the specifications for discontinued products. The information is provided for reference only.                                                                                                                                                                                                                                                                                |

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## Contacting Dialog Semiconductor

**United Kingdom (Headquarters)**  
Dialog Semiconductor (UK) LTD  
Phone: +44 1793 757700

**Germany**  
Dialog Semiconductor GmbH  
Phone: +49 7021 805-0

**The Netherlands**  
Dialog Semiconductor B.V.  
Phone: +31 73 640 8822

**Email:**  
[enquiry@diasemi.com](mailto:enquiry@diasemi.com)

**North America**  
Dialog Semiconductor Inc.  
Phone: +1 408 845 8500

**Japan**  
Dialog Semiconductor K. K.  
Phone: +81 3 5769 5100

**Taiwan**  
Dialog Semiconductor Taiwan  
Phone: +886 281 786 222

**Web site:**  
[www.dialog-semiconductor.com](http://www.dialog-semiconductor.com)

**Hong Kong**  
Dialog Semiconductor Hong Kong  
Phone: +852 2607 4271

**Korea**  
Dialog Semiconductor Korea  
Phone: +82 2 3469 8200

**China (Shenzhen)**  
Dialog Semiconductor China  
Phone: +86 755 2981 3669

**China (Shanghai)**  
Dialog Semiconductor China  
Phone: +86 21 5424 9058

## **2.2 List of applicable FCC rules**

CFR 47 FCC PART 15 SUBPART C has been investigated. It is applicable to the modular Transmitter

## **2.3 Specific operational use conditions**

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

## **2.4 Limited module procedures**

Single modular Approval.

## **2.5 Trace antenna designs**

Not applicable

## **2.6 RF exposure considerations**

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

## **2.7 Antennas**

This radio transmitter 2AU49-DA16600MC has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

| Operating frequency band | Antenna type    | Maximum Antenna gain |
|--------------------------|-----------------|----------------------|
| 2000-2500Mhz             | Ceramic Antenna | 2dbi                 |

## **2.8 Label and compliance information**

The final end product must be labeled in a visible area with the following" Contains FCC ID: 2AU49-DA16600MC.

## **2.9 Information on test modes and additional testing requirements**

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

## **2.10 Additional testing, Part 15 Subpart B disclaimer**

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.



#### FCC Warning

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications 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.

#### Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

**ISED Statement**

- English: This device complies with Industry Canada license - exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device. The digital apparatus complies with Canadian CAN ICES - 3 (B)/NMB - 3(B).

- French: Le présent appareil est conforme aux CNR d'Industrie 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, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.