

WiFi Module Data Sheet

**Cypress BCM43438 WLAN + ST Micro STM32F412 MCU
for 802.11b/g/n**

**Electric Imp P/N : Imp004m
Tentative P/N : LBEE5ZZ1MD-TEMP**

***This Datasheet is preliminary version, and subject
to change without notice.***

Revision history

| Issued Date | Revision Code | Revision Page | Changed Items | Change Reason |
|---------------|---------------|--|---|---|
| Jul. 6. 2016 | | | First Issue | |
| Sep. 9. 2016 | A | P3 P4 P6 P15 P17 | 2. Part Number 4.1. Dimensions 4.2. Terminal Configurations 11. Land pattern (Top View) 13. Tape and Reel Packing | |
| Oct. 11. 2016 | B | P3 P4 P6 P10 P12 | 2. Part Number 4.1. Dimensions (LMK) 42 Terminal Configurations 8. Power up sequence 9. RF Characteristics | |
| Oct. 13. 2016 | C | P6 P8 P9 P10 P11 P16 P17 | 4.2. Pin configurations 4.3. Pin mux table 5. LED drive 6. Phototransistor 7. SPI flash requirements 9. Operating condition 10. External 32kHz crystal 14. Reference circuit 15. Recommended components | |
| Oct. 20. 2016 | D | P10 | 6. Phototransistor | Correct imp003 reference |
| Oct. 21. 2016 | E | P3 | 1. Scope | Update cloud information |
| Mar. 14. 2017 | F | P5 | 4.1. Dimensions | Correct Pin 1 Marking |
| Apr. 13. 2017 | G | P5 P12 | 4. Dimensions, Marking and Terminal Configurations 9. Operating Condition | Correct Top view design Correct the range of VDD_WLAN, VDDA_MCU and VDD_IO_MCU |
| Apr. 20. 2017 | H | P5 | 4.1. Dimensions | Correct the marking. |
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Please be aware that an important notice concerning availability, standard warranty and use in critical applications of Murata products and disclaimers thereto appears at the end of this specification sheet.

1. Scope

This specification is for the LBEE5ZZ1MD (imp004m) module that provides connectivity to the internet via WiFi. The fully maintained, secure OS that is part of the Electric Imp cloud service comes pre-loaded.

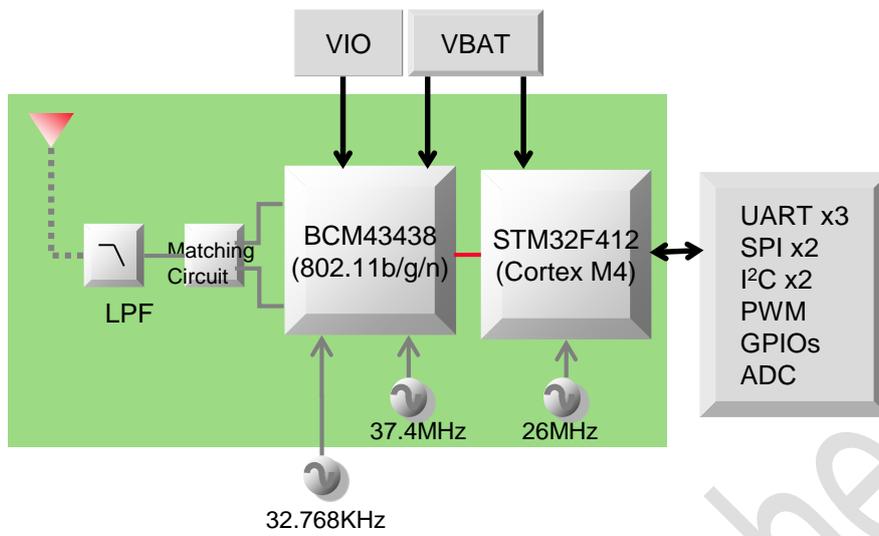
- 802.11 b/g/n 1x1 WiFi
 - 802.11b 17.0dBm +/-2.0dBm
 - 802.11g 13.0dBm +/-2.0dBm
 - 802.11n 12.0dBm +/-2.0dBm (20MHz channels)
 - RX Sensitivity -98dBm typical (@1Mbps)
 - On-board antenna
 - Supports WEP, WPA, WPA2, WPS
- 32-bit Cortex M4 processor
 - Robust embedded operating system with fail-safe firmware updates
 - Virtual machine for customer firmware
 - 256kB of application bytecode flash
 - Around 190kB of dedicated application RAM
- Electric Imp OS & service
 - Robust embedded operating system with fail-safe, secure OS & application updates
 - Pre-provisioned MAC address & per-device secrets
 - TLS1.2-RSA-ECDHE (forward secrecy) connection to cloud
 - Elliptic curve challenge-response to prevent device impersonation
 - Fully featured cloud VM for every device for easy integration with RESTful APIs
 - Open source integrations with AWS, Azure, etc services
- LED drive for red/green status LEDs
- Phototransistor input for Electric imp's patented BlinkUp™ technology for easy configuration from any smartphone, tablet, or web browser
- 23 user selectable I/Os
 - GPIO, PWM, Analog input & output, SPI, UART, I2C
 - Dedicated SPI bus for local storage
- Low power 4uA sleep mode (with external load switch)
 - Option for coin cell RTC battery backup
- Compliant with the RoHS directive

2. Part Number

| |
|--------------------|
| Sample Part Number |
| LBEE5ZZ1MD-TEMP |

| |
|------------------------|
| Production Part Number |
| LBEE5ZZ1MD-011 |

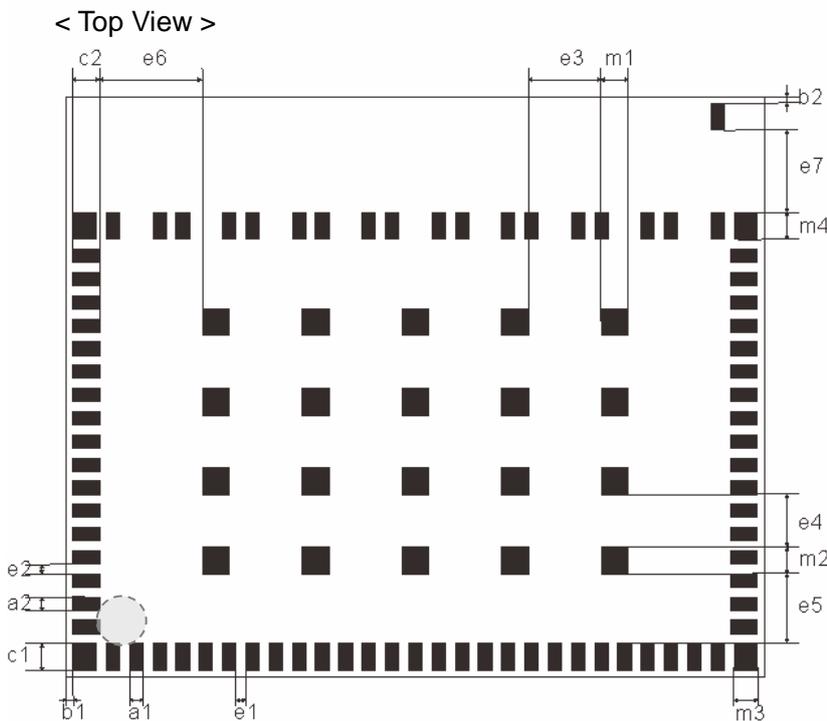
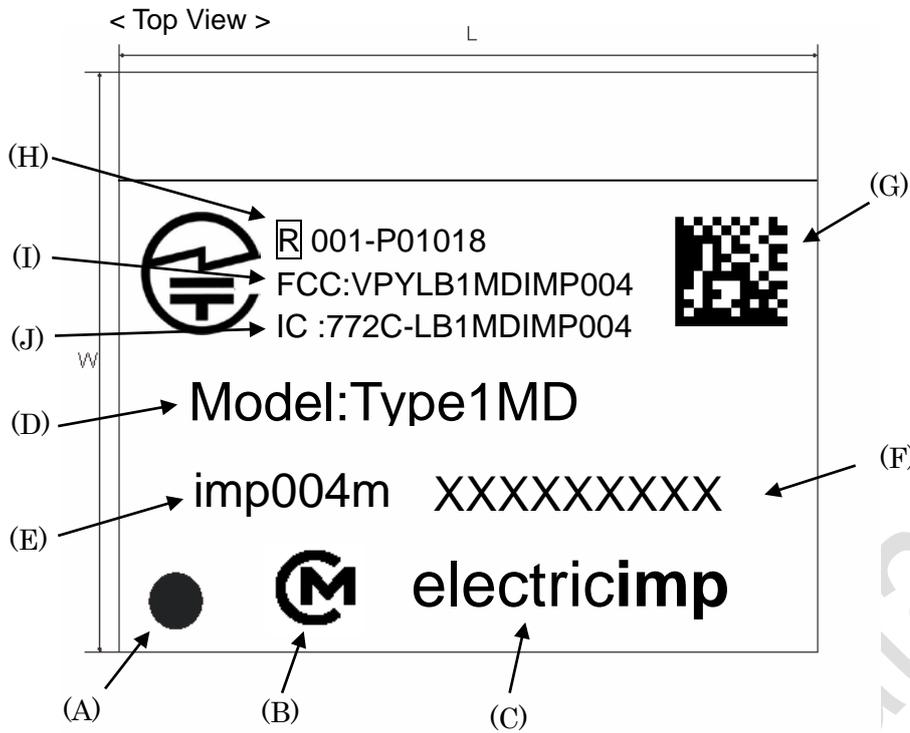
3. Block Diagram



Preliminary datasheet

4. Dimensions, Marking and Terminal Configurations

4.1. Dimensions



| Mark | Dimensions | Mark | Dimensions | Mark | Dimensions |
|------|--------------|------|--------------|------|-------------|
| L | 21.0 +/- 0.2 | W | 17.5 +/- 0.2 | T | 2.3 max. |
| a1 | 0.4 +/- 0.1 | a2 | 0.4 +/- 0.1 | b1 | 0.2 +/- 0.2 |
| b2 | 0.2 +/- 0.2 | c1 | 0.8 +/- 0.1 | c2 | 0.8 +/- 0.1 |
| e1 | 0.3 +/- 0.1 | e2 | 0.3 +/- 0.1 | e3 | 2.2 +/- 0.1 |
| e4 | 1.6 +/- 0.1 | e5 | 2.1 +/- 0.1 | e6 | 3.1 +/- 0.1 |
| e7 | 2.5 +/- 0.1 | m1 | 0.8 +/- 0.1 | m2 | 0.8 +/- 0.1 |
| m3 | 0.7 +/- 0.1 | m4 | 0.8 +/- 0.1 | | |

(unit : mm)

Marking

| Marking | Meaning |
|---------|---------------------------------|
| (A) | Pin 1 Marking |
| (B) | Murata Logo |
| (C) | Electric Imp Logo |
| (D) | Murata Module Type |
| (E) | Imp Module Type |
| (F) | Inspection Number |
| (G) | 2D code |
| (H) | Japanese Type certification No. |
| (I) | FCC certification ID |
| (J) | IC certification No. |

Structure



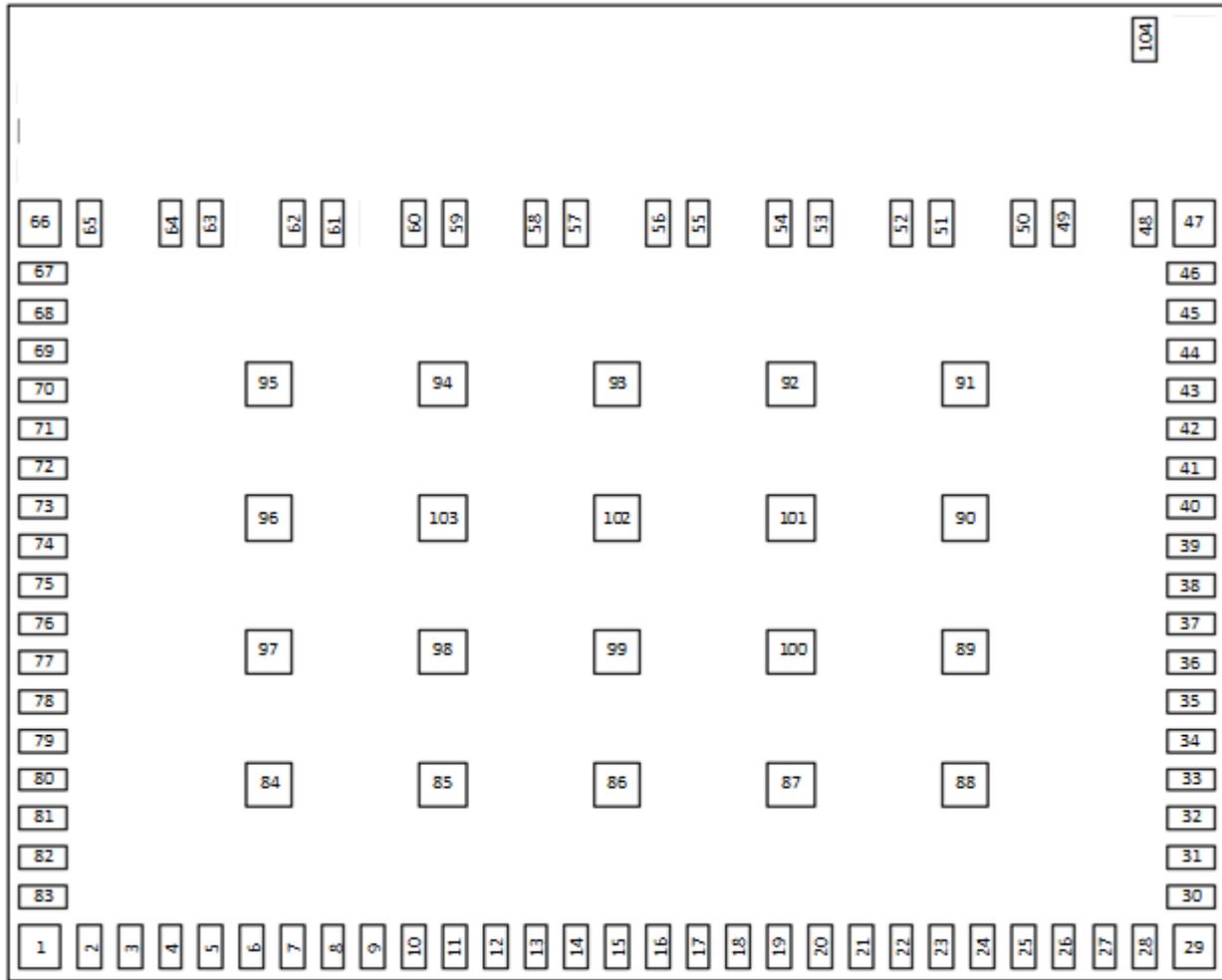
Mounting

The module is designed to be mounted on the edge of the board, with the antenna section hanging off in free space. The antenna is tuned for free space operation. Please see the design guide on Electric Imp dev center website at <http://www.electricimp.com/docs> for more information.



4.2. Terminal Configurations

Top view (through package)



| No. | Name | Type | Description |
|-----|------------|------|---|
| 1 | GND | GND | |
| 2 | CLK_REQ | O | Asserts CLK_REQ when WLAN directs the host to turn on the reference clock. The CLK_REQ polarity is active-high. |
| 3 | NC | - | |
| 4 | NC | - | |
| 5 | pinM | I/O | GPIO, i2cNM SDA, PWM |
| 6 | pinN | I/O | GPIO, i2cNM SCL, PWM |
| 7 | pinP | I/O | GPIO, i2cQP SDA, PWM, IRQ |
| 8 | pinW | I/O | GPIO, uartBCAW CTS, ADC, IRQ & wake from deep sleep (active high) |
| 9 | GND | GND | |
| 10 | pinA | I/O | GPIO, uartBCAW RTS, spiAHSR MOSI, ADC, PWM |
| 11 | pinB | I/O | GPIO, uartBCAW TX, ADC, PWM, IRQ |
| 12 | pinC | I/O | GPIO, uartBCAW RX, ADC, IRQ |
| 13 | LPO_IN | I | Sleep Clock |
| 14 | pinD | I/O | GPIO, ADC, PWM, IRQ |
| 15 | pinE | I/O | GPIO, IRQ |
| 16 | pinK | I/O | GPIO, spiGJKL SCLK, ADC, PWM |
| 17 | pinL | I/O | GPIO, spiGJKL NSS, ADC, IRQ |
| 18 | GND | GND | |
| 19 | VDD_IO_MCU | PWR | MCU/WLAN VIO |
| 20 | GND | GND | |
| 21 | pinQ | I/O | GPIO, uartQ TX, i2cQP SCL, IRQ |
| 22 | pinR | I/O | GPIO, spiAHSR NSS, IRQ |
| 23 | pinS | I/O | GPIO, spiAHSR SCLK, IRQ |
| 24 | PSU_ENABLE | O | Active high when WiFi needs 2.7v+ |
| 25 | pinF | I/O | GPIO, uartFGJH TX |
| 26 | pinG | I/O | GPIO, uartFGJH RX, spiGJKL MOSI |
| 27 | pinH | I/O | GPIO, uartFGJH CTS, uartHJ TX, spiAHSR MISO, IRQ |
| 28 | pinJ | I/O | GPIO, uartFGJH RTS, uartHJ RX, spiGJKL MISO, pulse counter |
| 29 | GND | GND | |
| 30 | LED_RED | O | Red LED drive |
| 31 | LED_GREEN | O | Green LED drive |
| 32 | OPTO_IN | I | Phototransistor input |
| 33 | OPTO_BIAS | O | Phototransistor supply |
| 34 | FLASH_MOSI | O | SPI flash connection |
| 35 | FLASH_SCLK | O | SPI flash connection |
| 36 | FLASH_CS_L | O | SPI flash connection |
| 37 | FLASH_MISO | I | SPI flash connection |
| 38 | NC | - | |
| 39 | nRESET | I | MCU reset, internally pulled up |
| 40 | VSSA/VREF- | GND | Must be connected to GND |
| 41 | OSC32_OUT | O | 32kHz xtal connection |

| | | | |
|------------|----------|-----|--|
| 42 | OSC32_IN | I | 32kHz xtal connection (ground if no xtal fitted) |
| 43 | GND | GND | |
| 44 | VBAT_MCU | PWR | MCU VBAT input |
| 45 | VDDA_MCU | PWR | MCU VDDA input |
| 46 | VDD_WLAN | PWR | WLAN VBAT input |
| 47 -70 | GND | GND | |
| 71 -74 | NC | - | |
| 75 -76 | GND | GND | |
| 77 -83 | NC | - | |
| 84 -103 | GND | GND | |
| 104 | NC | NC | Note this pad should not be touching any PCB |

4.3. Pin Mux table

| Pin | uart BCAW | uart FGJH | uart HJ | uart Q | i2c NM | i2c QP | spi AHSR | spi GJKL | ADC | PWM | Pulse count | State change |
|------|--------------|--------------|------------|-----------|-----------|-----------|-------------|-------------|-----|-----|----------------|-----------------|
| pinA | RTS | | | | | | MOSI | | Yes | Yes | | |
| pinB | TX | | | | | | | | Yes | Yes | | Yes |
| pinC | RX | | | | | | | | Yes | | | Yes |
| pinD | | | | | | | | | Yes | Yes | | Yes |
| pinE | | | | | | | | | | | | Yes |
| pinF | | TX | | | | | | | | | | |
| pinG | | RX | | | | | | MOSI | | | | |
| pinH | | CTS | TX | | | | MISO | | | | | Yes |
| pinJ | | RTS | RX | | | | | MISO | | | Yes | |
| pinK | | | | | | | | SCLK | Yes | Yes | | |
| pinL | | | | | | | | NSS | Yes | | | Yes |
| pinM | | | | | SDA | | | | | Yes | | |
| pinN | | | | | SCL | | | | | Yes | | |
| pinP | | | | | | SDA | | | | Yes | | Yes |
| pinQ | | | TX | | | SCL | | | | | | Yes |
| pinR | | | | | | | NSS | | | | | Yes |
| pinS | | | | | | | SCLK | | | | | Yes |
| pinW | CTS | | | | | | | | Yes | | | Yes |

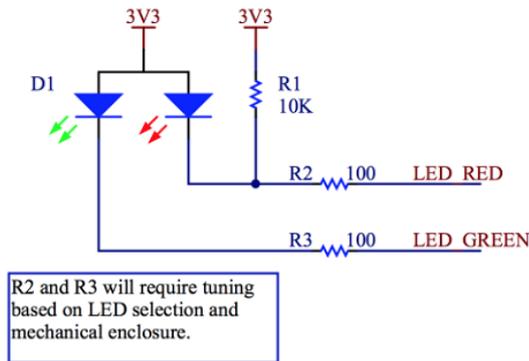
5. LED drive

The indicator LED should be bicolor, because red, green and amber (red+green) are used to indicate status.

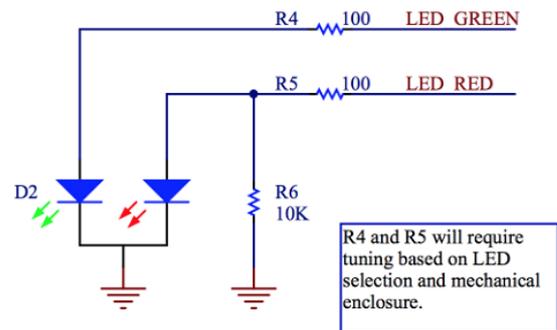
The LED drive pins will auto-detect common anode or common cathode parts. The detection is done by looking to see which way up the LED_RED pin is idling at boot; to ensure this works correctly, please place a 10k resistor in parallel with the red LED.

The current drive on these pins is 20mA maximum. Please refer to section 15 for the recommended LEDs.

<Common anode diagram>



<Common cathode diagram>



Two specific LED codes indicate errors when talking to the SPI flash:

| | | | |
|---------------------|-------|-------|-----|
| SPI flash not found | amber | red | off |
| SPI flash error | red | amber | off |

If you encounter either of these codes, then this indicates an electrical connection issue or an incompatible flash part.

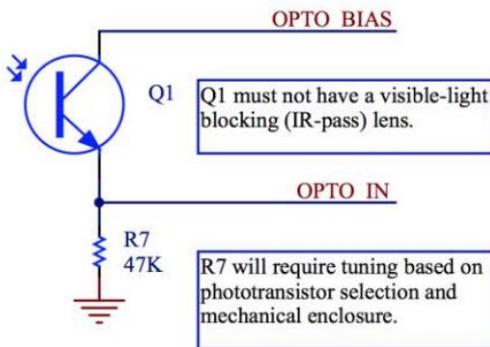
6. Phototransistor

The phototransistor is used to receive BlinkUp configuration data. The bias resistor connected between OPTO_IN and GND may need to be adjusted to ensure adequate sensitivity and response time - in general you need at least 500mV swing on the OPTO_IN pin between black and white states, with the worst (dimmiest) BlinkUp sender you can find. More information and sample code to tune blinkup is available on the Electric Imp dev center website.

End-user BlinkUp send data at between 30 and 60 bits per second, depending on the user's device. For factory configuration, data is typically sent at 142 bits per second using red LED(s) in a test fixture. If your application does not require optical configuration, config can be sent electrically at 142 bits per second from another micro using the OPTO_IN pin. Please contact us for more details.

It is also recommended to place 0402, 13pF capacitor footprints (Murata GRM1555C1H130JA01) close to the imp004m between OPTO_BIAS and GND, and OPTO_IN and GND. If issues are seen with RF coupling onto the blinkup circuit, then these components will address the issue by presenting a low impedance in the 2.4GHz band.

Please refer to paragraph 15 for the recommended phototransistors.



7. SPI flash requirements

An external SPI Flash part is required for operation, which must be pre-loaded with the correct WiFi firmware image before assembly. The required image is available from the Electric Imp dev center website at <http://www.electricimp.com/docs>

The minimum size of the SPI Flash is 8Mbit (1MB), and the maximum size is 128Mbit (16MB). The area below address 0xC2000 (776kB) is the pre-programmed area. The remainder of the flash device is made available to user code programmatically, and may optionally be pre-programmed for user applications before assembly.

The imp004m's SPI flash chip **must** support both 4KB and 64KB erases (command 0x20 and 0xD8) and Page Program (command 0x02). You must also ensure that the SPI flash you use is able to run down to the **minimum operational voltage** of your product to ensure that the SPI flash is operational at all times that the imp is operational. This is critical during upgrades in low battery states. If you are running from a single LiMnO₂ cell (eg. CR123), you should use a wide voltage range SPI flash that is operational from 1.7-3.6V such as the [Macronix MX25R8035FM2IH0](#).

| | |
|--------------------------------------|---------------------------------|
| Minimum Size | 8 Mbit (1024 kByte) |
| Reserved for OS (do not pre-program) | 0x000000 to 0xC2000 (776 kByte) |

8. Absolute Maximum Rating

| | | min. | max. | unit |
|---------------------|------------|------|------|-------|
| Storage Temperature | | -40 | 125 | deg.C |
| Supply Voltage | VBAT_MCU | -0.3 | 4 | V |
| | VDDA_MCU | -0.3 | 4 | |
| | VDD_WLAN | -0.5 | 6 | |
| | VDD_IO_MCU | -0.3 | 3.63 | |

Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability. No damage assuming only one parameter is set at limit at a time with all other parameters is set within operating condition.

9. Operating Condition

| | | min. | typ. | max. | unit |
|---------------------------------|------------|------|------|------|-------|
| Operating Temperature Range | | -30 | 25 | 70 | deg.C |
| Specification Temperature Range | | -20 | 25 | 55 | deg.C |
| Supply Voltage | VBAT_MCU | 1.65 | 3.3 | 3.6 | V |
| | VDDA_MCU | 1.8 | 3.3 | 3.6 | |
| | VDD_WLAN | 3.0 | 3.3 | 3.6 | |
| | VDD_IO_MCU | 1.8 | 3.3 | 3.6 | |

Notes :

- All RF characteristics in this datasheet are defined by Specification Temperature Range. Specifications require derating at extreme temperatures.
- VDDA_MCU and VDD_IO_MCU must be the same potential.

10. External 32.768 kHz Crystal

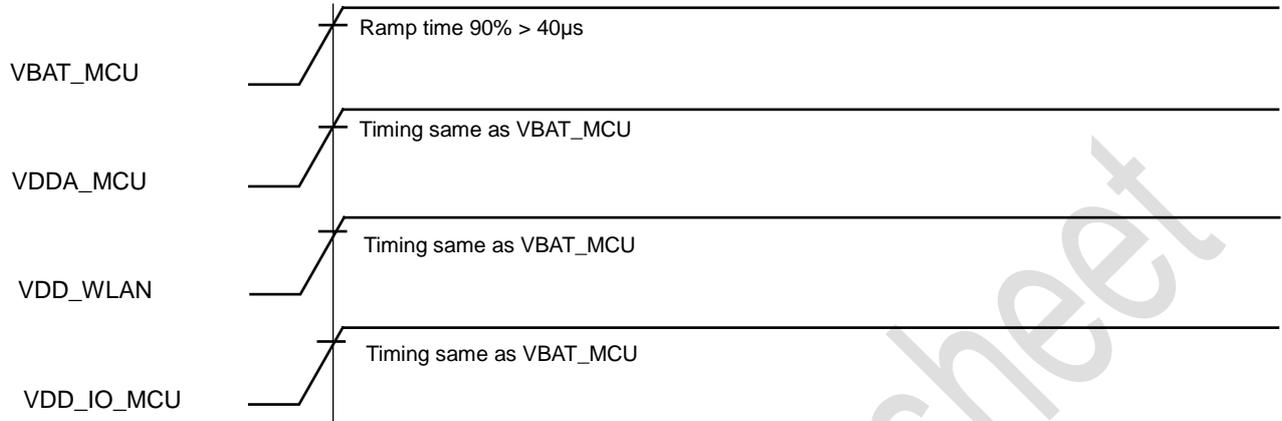
If the application requires the imp004m to enter deep sleep mode, a 32kHz crystal should be attached to the OSC32_IN and OSC32_OUT pins. Please refer to the STM32F412 datasheet and application note AN2867 for detailed crystal requirements.

If deep sleep mode is not required, OSC32_IN should be connected to GND and OSC32_OUT left floating. The imp004m will detect this state and disable the sleep APIs.

11. Power Up Sequence

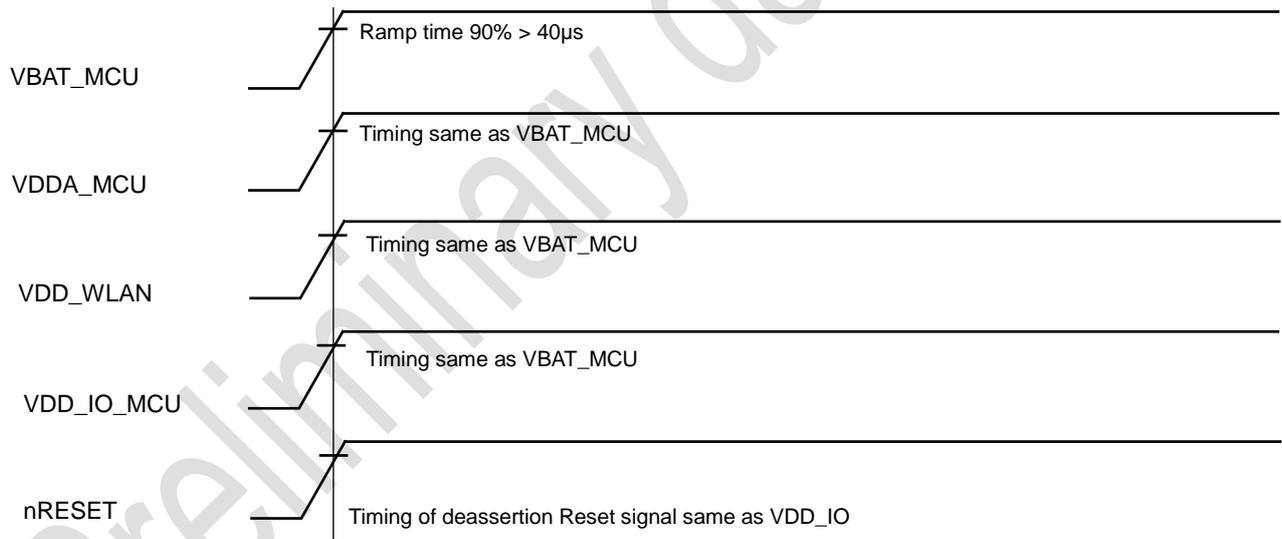
11.1. Without nRESET control

Following timing diagram explain module power up sequence.



*Power down sequence is opposite sequence of power up.

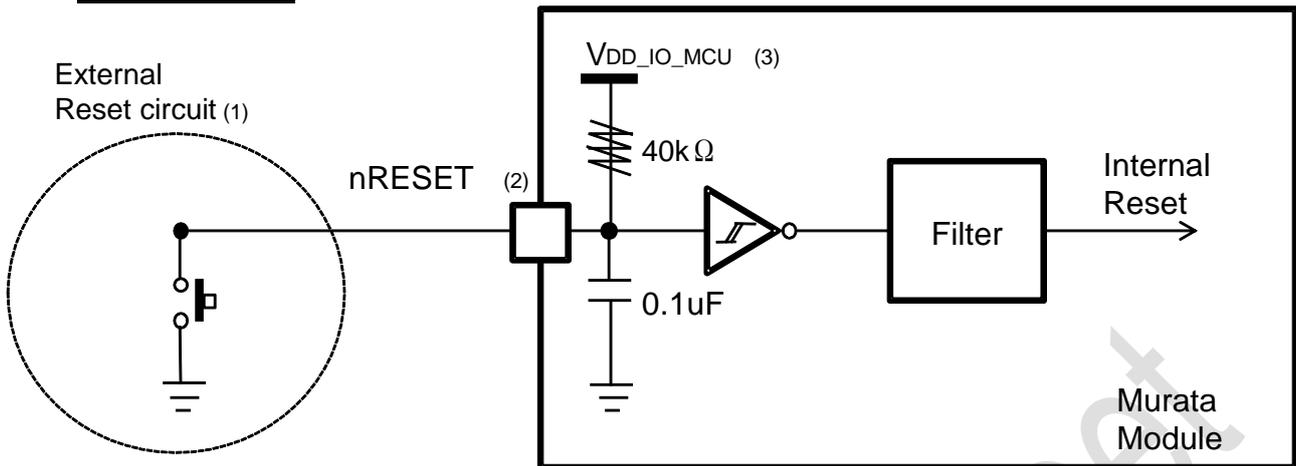
11.2. With nRESET control



*Power down sequence is opposite sequence of power up.

*nRESET pin must be controlled by Open Drain.

11.3. nRESET Circuit



- (1) The reset network protects the device against parasitic resets.
- (2) The use must ensure that the level on the nRESET pin can go below the $V_{IL}(NRST)$ max level specified in below table. Otherwise the reset is not taken into account by the device.
- (3) nRESET pin must be controlled by Open Drain. High signal must not input to this pin.

| Symbol | Parameter | Min | Typ | Max | Unit |
|----------|------------------------------------|-----|-----|------------------------------------|------|
| V_{IL} | nRESET I/O input low level voltage | - | - | $0.1 \times V_{DD_IO_MCU} + 0.1$ | V |

12. Electrical Characteristics

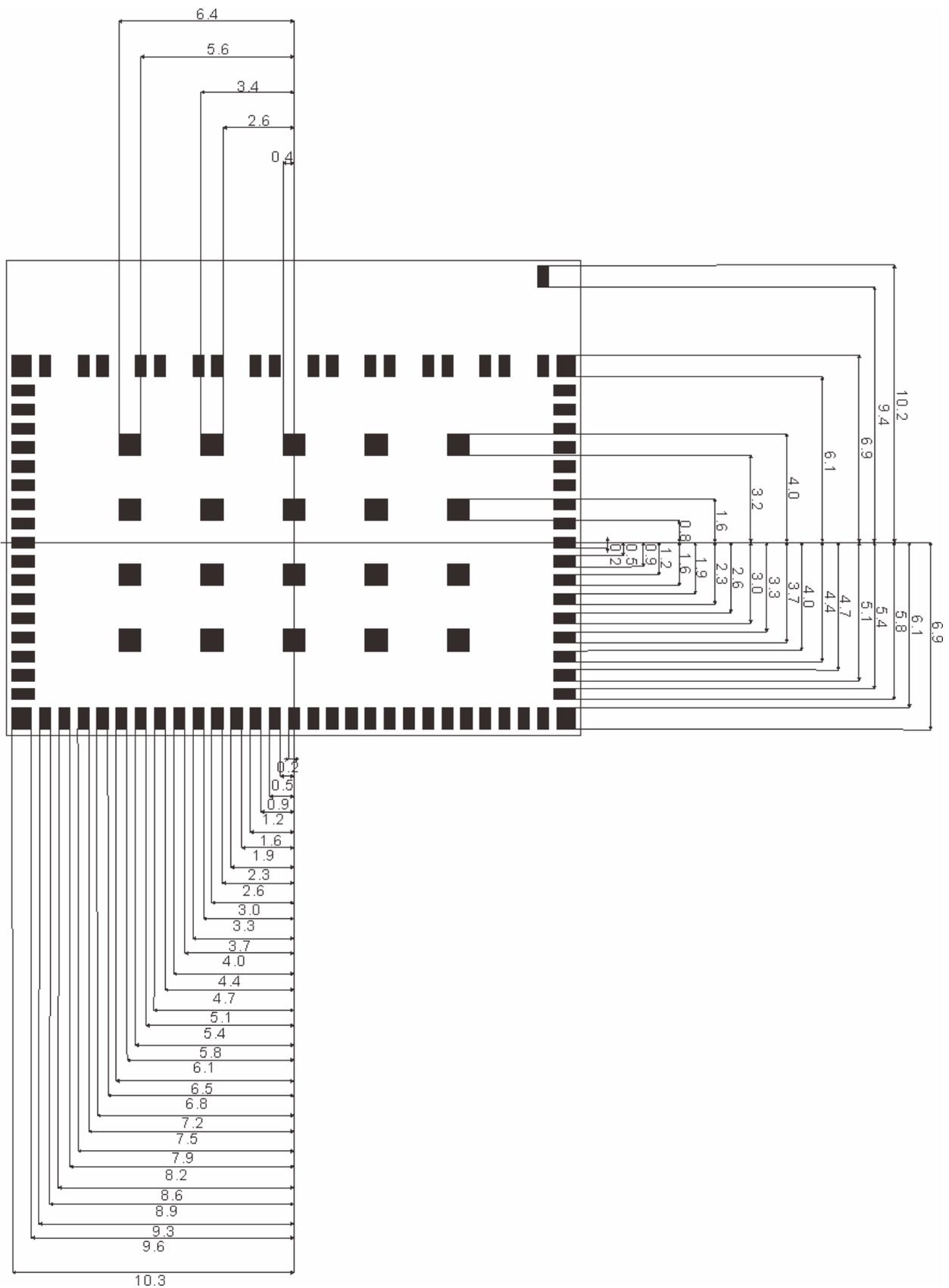
| - DC Characteristics - | min. | typ. | max. | unit |
|--------------------------|------|------|------|------|
| 1. DC current | | | | |
| 1) Tx mode ¹⁾ | | 300 | 370 | mA |
| 2) Rx mode | | 45 | 100 | mA |

- 1) Conditions: 25deg.C, VDD_WLAN=3.3V, VDD_IO_MCU=3.3V
(1Mbps mode unless otherwise specified.)

Note: The above mentioned values have been obtained according to our own measuring methods and may very depend on the circuit, in which the component is actually incorporated. Therefore, you are kindly requested to test the performance of the component actually in your set.

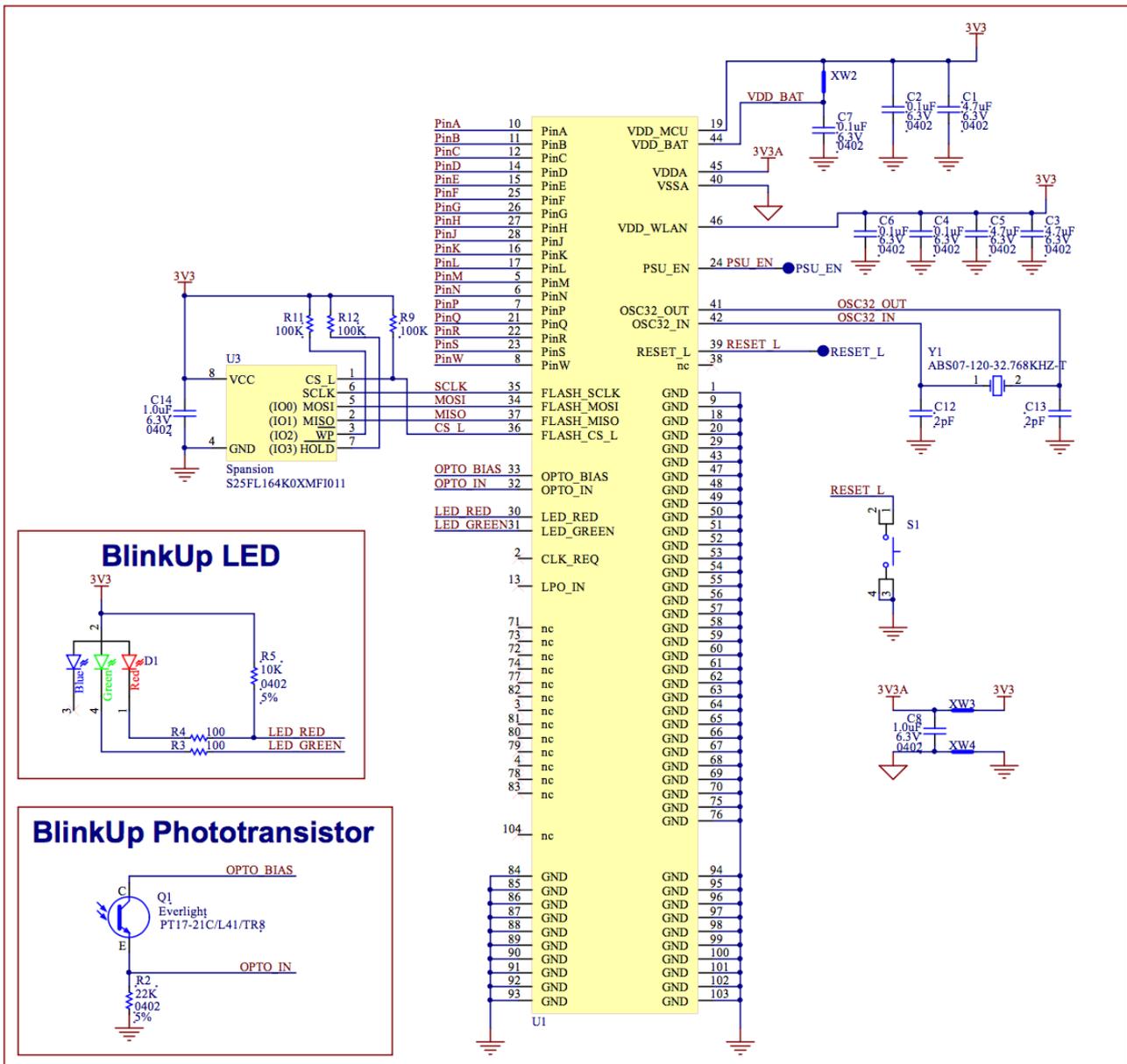
Preliminary datasheet

13. Land pattern (Top View)



Unit : mm

14. Reference Circuit



Preliminary

15. Recommended Components

15.1. Bi-color LED

| | Manufacturer | Manufacturer's part number |
|----------------------|--------------|----------------------------|
| Surface mount | | |
| top-view | SunLED | XZMDKVG59W-1 |
| | Liteon | LTST-C195KGJRKT |
| side-view | SunLED | XZMDKVG88W |
| | Bivar | SM1204BC |
| Through-hole | | |
| 3mm | SunLED | XLMDKVG34M |
| | Liteon | LTL1BEKVJNN |

15.2. Phototransistor

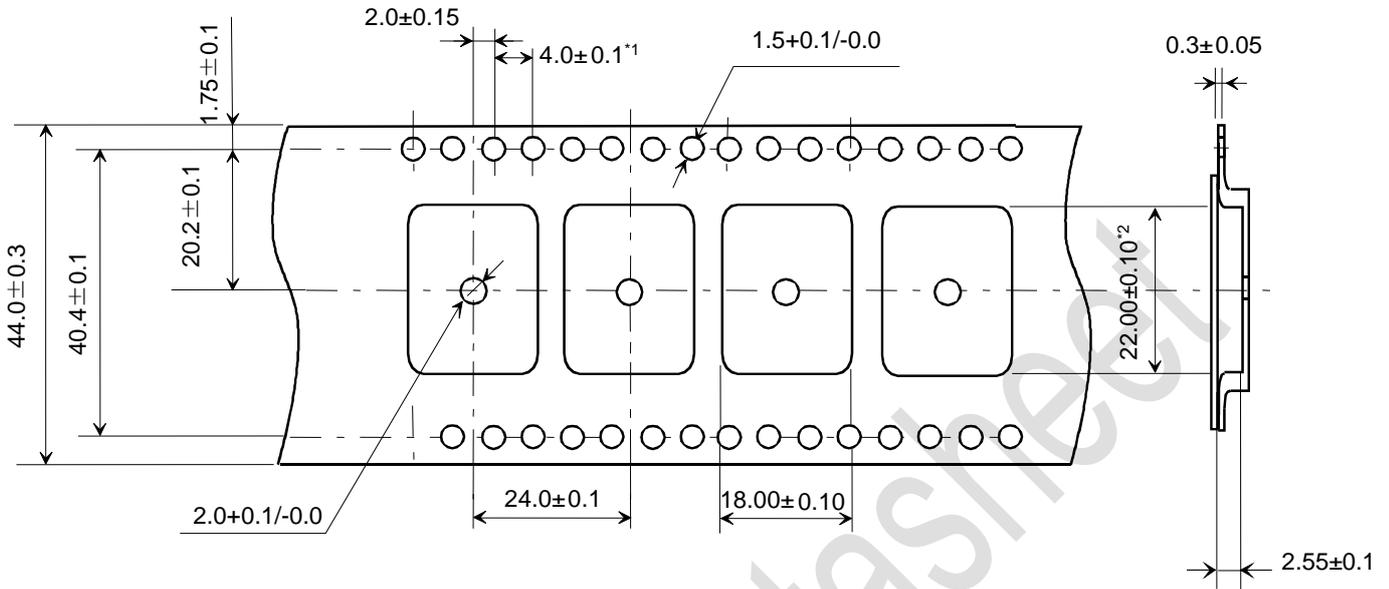
| | Manufacturer | Manufacturer's part number |
|----------------------|--------------|----------------------------|
| Surface mount | | |
| top-view | Everlight | PT17-21C/L41/TR8 |
| | Fairchild | KDT00030TR |
| side-view | SunLED | XZRNI56W-1 |
| | Everlight | PT12-21C/TR8 |
| Through-hole | | |
| 3mm | SunLED | XRNI30W-1 |
| | LiteOn | LTR-4206 |

15.3. SPI Flash

| Size | Manufacturer | Manufacturer's part number |
|---------|--------------|----------------------------|
| 8 Mbit | Adesto | AD25SF081 |
| 16 Mbit | Spansion | S25FL116K |
| 32 Mbit | Spansion | S25FL132K |
| 64 Mbit | Spansion | S25FL164K |

16. Tape and Reel Packing

(1) Dimensions of Tape (Plastic tape)

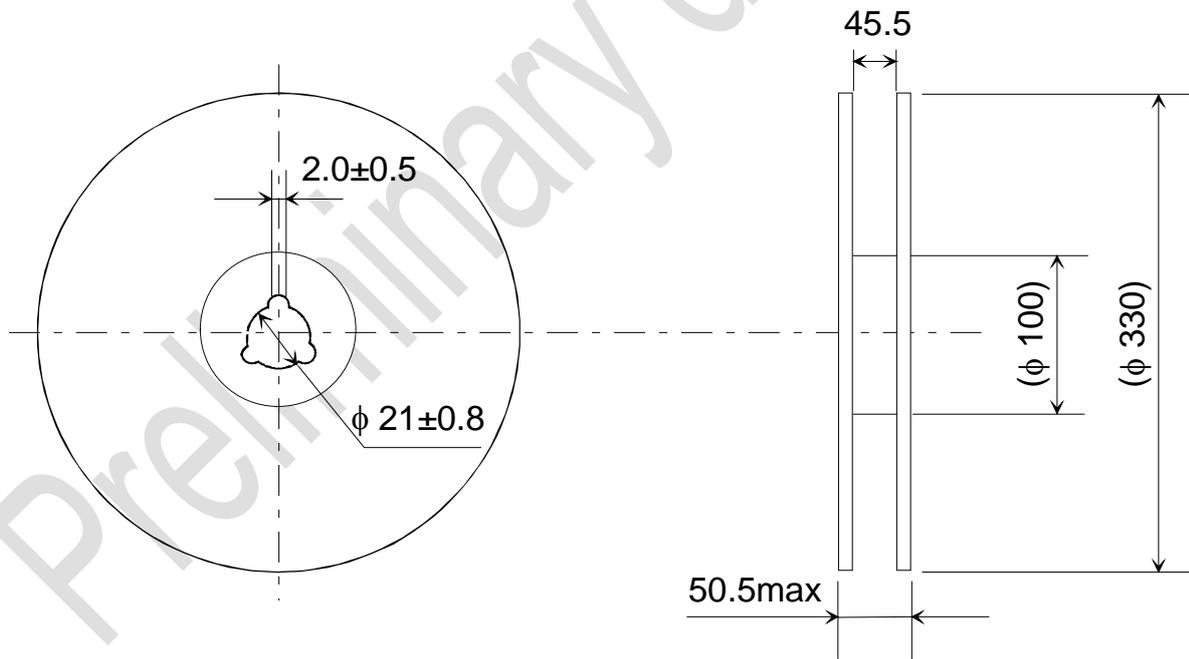


*1 Cumulative tolerance of max. ± 0.3 every 10 pitches

*2 Reference value

(Unit : mm)

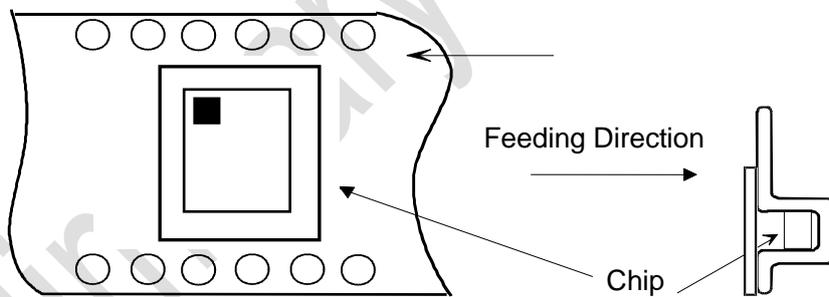
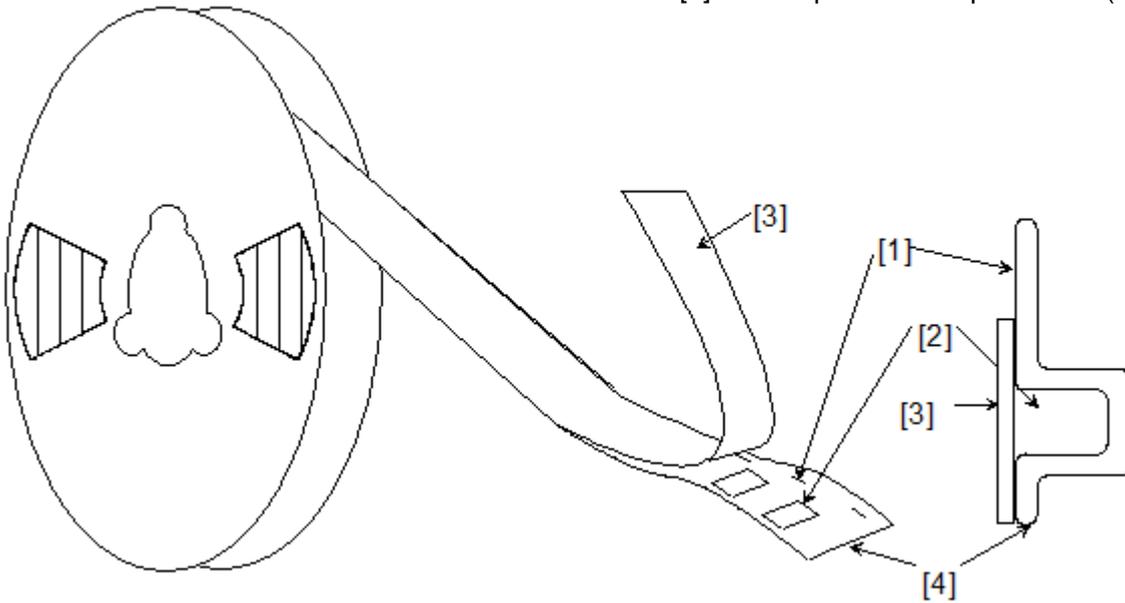
(2) Dimensions of Reel



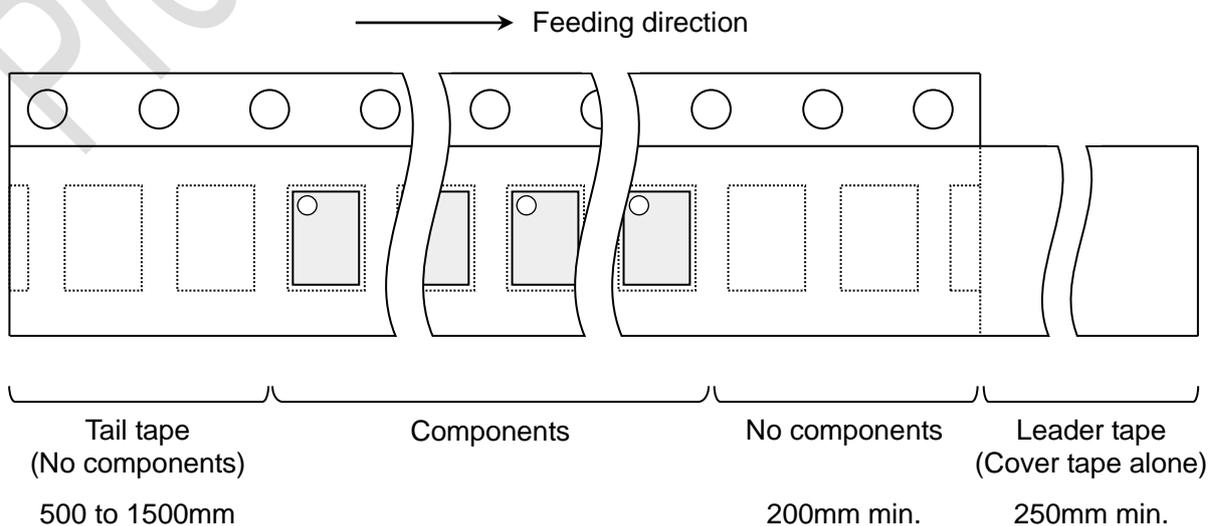
(Unit: mm)

(3) Taping Diagrams

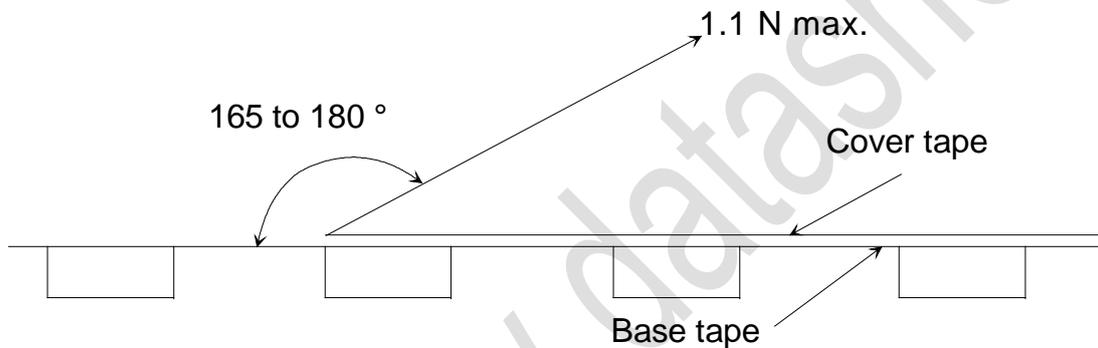
- [1] Feeding Hole : As specified in (1)
- [2] Hole for chip : As specified in (1)
- [3] Cover tape : 62μm in thickness
- [4] Base tape : As specified in (1)



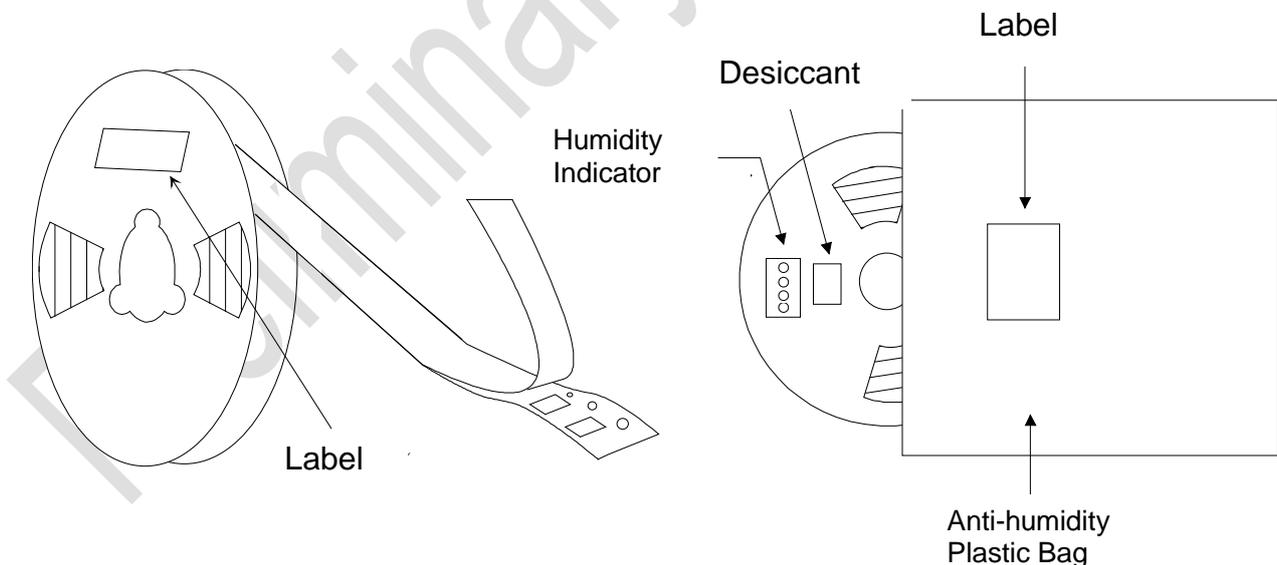
(4) Leader and Tail tape



- (5) The tape for chips are wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.
- (6) The cover tape and the base tape are not adhered at no components area for 250mm min.
- (7) Tear off strength against pulling of cover tape : 5N min.
- (8) Packaging unit: 500pcs./ reel
- (9) Material: Base tape : Plastic
Reel : Plastic
Cover tape, cavity tape and reel are made the anti-static processing.
- (10) Peeling of force: 1.1N max. in the direction of peeling as shown below.



- (11) Packaging (Humidity proof Packing)



Tape and reel must be sealed with the anti-humidity plastic bag. The bag contains the desiccant and the humidity indicator.

17. NOTICE

17.1. Storage Conditions:

Please use this product within 6month after receipt.

- The product shall be stored without opening the packing under the ambient temperature from 5 to 35deg.C and humidity from 20 to 70%RH.

(Packing materials, in particular, may be deformed at the temperature over 40deg.C.)

- The product left more than 6months after reception, it needs to be confirmed the solderbility before used.

- The product shall be stored in non corrosive gas (Cl₂, NH₃, SO₂, No_x, etc.).

- Any excess mechanical shock including, but not limited to, sticking the packing materials by sharp object and dropping the product, shall not be applied in order not to damage the packing materials.

This product is applicable to MSL3 (Based on JEDEC Standard J-STD-020)

- After the packing opened, the product shall be stored at ≤ 30 deg.C / ≤ 60 %RH and the product shall be used within 168hours.

- When the color of the indicator in the packing changed, the product shall be baked before soldering.

Baking condition: 125+5/-0deg.C, 24hours, 1time

The products shall be baked on the heat-resistant tray because the material (Base Tape, Reel Tape and Cover Tape) are not heat-resistant.

17.2. Handling Conditions:

Be careful in handling or transporting products because excessive stress or mechanical shock may break products.

Handle with care if products may have cracks or damages on their terminals, the characteristics of products may change. Do not touch products with bear hands that may result in poor solder ability and destroy by static electrical charge.

17.3. Standard PCB Design (Land Pattern and Dimensions):

All the ground terminals should be connected to the ground patterns. Furthermore, the ground pattern should be provided between IN and OUT terminals. Please refer to the specifications for the standard land dimensions.

The recommended land pattern and dimensions is as Murata's standard. The characteristics of products may vary depending on the pattern drawing method, grounding method, land dimensions, land forming method of the NC terminals and the PCB material and thickness. Therefore, be sure to verify the characteristics in the actual set. When using non-standard lands, contact Murata beforehand.

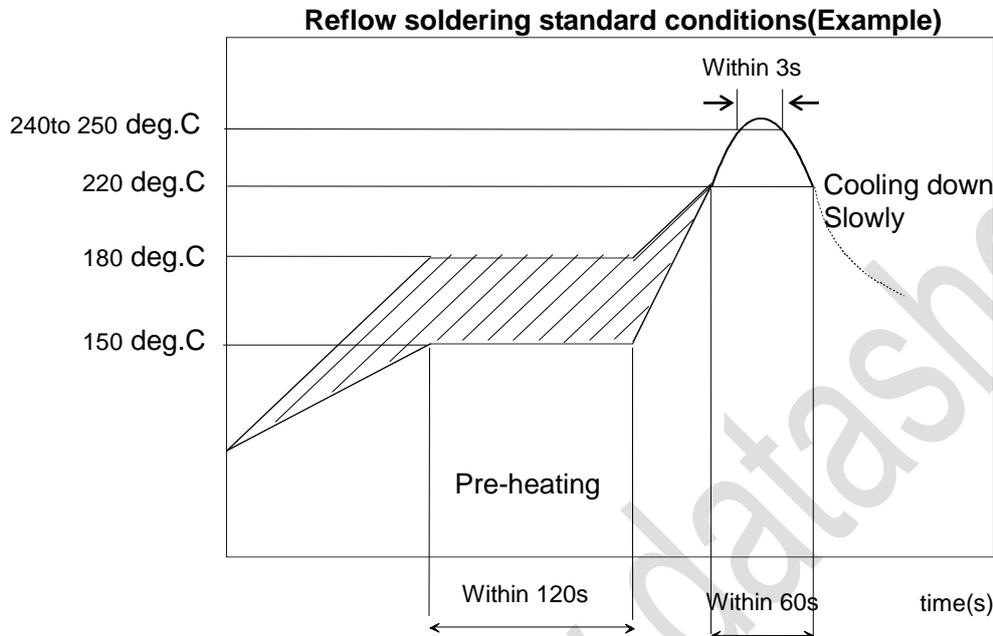
17.4. Notice for Chip Placer:

When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products on the PCB, be aware that mechanical chucking may damage products.

17.5. Soldering Conditions:

The recommendation conditions of soldering are as in the following figure.

When products are immersed in solvent after mounting, pay special attention to maintain the temperature difference within 100 °C. Soldering must be carried out by the above mentioned conditions to prevent products from damage. Set up the highest temperature of reflow within 260 °C. Contact Murata before use if concerning other soldering conditions.



Please use the reflow within 2 times.

Use rosin type flux or weakly active flux with a chlorine content of 0.2 wt % or less.

17.6. Cleaning:

Since this Product is Moisture Sensitive, any cleaning is not permitted.

17.7. Operational Environment Conditions:

Products are designed to work for electronic products under normal environmental conditions (ambient temperature, humidity and pressure). Therefore, products have no problems to be used under the similar conditions to the above-mentioned. However, if products are used under the following circumstances, it may damage products and leakage of electricity and abnormal temperature may occur.

- In an atmosphere containing corrosive gas (Cl₂, NH₃, SO_x, NO_x etc.).
- In an atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

If there are possibilities for products to be used under the preceding clause, consult with Murata before actual use.

As it might be a cause of degradation or destruction to apply static electricity to products, do not apply static electricity or excessive voltage while assembling and measuring.

17.8. Input Power Capacity:

Products shall be used in the input power capacity as specified in this specifications.

Inform Murata beforehand, in case that the components are used beyond such input power capacity range.

18. PRECONDITION TO USE OUR PRODUCTS

PLEASE READ THIS NOTICE BEFORE USING OUR PRODUCTS.

Please make sure that your product has been evaluated and confirmed from the aspect of the fitness for the specifications of our product when our product is mounted to your product.

All the items and parameters in this product specification/datasheet/catalog have been prescribed on the premise that our product is used for the purpose, under the condition and in the environment specified in this specification. You are requested not to use our product deviating from the condition and the environment specified in this specification.

Please note that the only warranty that we provide regarding the products is its conformance to the specifications provided herein. Accordingly, we shall not be responsible for any defects in products or equipment incorporating such products, which are caused under the conditions other than those specified in this specification.

WE HEREBY DISCLAIMS ALL OTHER WARRANTIES REGARDING THE PRODUCTS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, THAT THEY ARE DEFECT-FREE, OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS.

The product shall not be used in any application listed below which requires especially high reliability for the prevention of such defect as may directly cause damage to the third party's life, body or property. You acknowledge and agree that, if you use our products in such applications, we will not be responsible for any failure to meet such requirements. Furthermore, YOU AGREE TO INDEMNIFY AND DEFEND US AND OUR AFFILIATES AGAINST ALL CLAIMS, DAMAGES, COSTS, AND EXPENSES THAT MAY BE INCURRED, INCLUDING WITHOUT LIMITATION, ATTORNEY FEES AND COSTS, DUE TO THE USE OF OUR PRODUCTS IN SUCH APPLICATIONS.

- Aircraft equipment.
- Aerospace equipment
- Undersea equipment.
- Power plant control equipment
- Medical equipment.
- Transportation equipment (vehicles, trains, ships, elevator, etc.).
- Traffic signal equipment.
- Disaster prevention / crime prevention equipment.
- Burning / explosion control equipment
- Application of similar complexity and/ or reliability requirements to the applications listed in the above.

We expressly prohibit you from analyzing, breaking, reverse-engineering, remodeling altering, and reproducing our product. Our product cannot be used for the product which is prohibited from being manufactured, used, and sold by the regulations and laws in the world.

We do not warrant or represent that any license, either express or implied, is granted under any our patent right, copyright, mask work right, or our other intellectual property right relating to any combination, machine, or process in which our products or services are used. Information provided by us regarding third-party products or services does not constitute a license from us to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from us under our patents or other intellectual property.

Please do not use our products, our technical information and other data provided by us for the purpose of developing of mass-destruction weapons and the purpose of military use.

Moreover, you must comply with "foreign exchange and foreign trade law", the "U.S. export administration regulations", etc.

Please note that we may discontinue the manufacture of our products, due to reasons such as end of supply of materials and/or components from our suppliers.

By signing on specification sheet or approval sheet, you acknowledge that you are the legal representative for your company and that you understand and accept the validity of the contents herein. When you are not able to return the signed version of specification sheet or approval sheet within 30 days from receiving date of specification sheet or approval sheet, it shall be deemed to be your consent on the content of specification sheet or approval sheet. Customer acknowledges that engineering samples may deviate from specifications and may contain defects due to their development status. We reject any liability or product warranty for engineering samples. In particular we disclaim liability for damages caused by

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- deviation or lapse in function of engineering sample,
- improper use of engineering samples.

We disclaim any liability for consequential and incidental damages.

If you can't agree the above contents, you should inquire our sales.