

## 1 Product Overview

WBR2D is a low-power embedded Wi-Fi and Bluetooth module that Tuya has developed. It consists of a highly integrated RF chip (RTL8720DN) and several peripheral components, with an embedded Wi-Fi network protocol stack, Bluetooth network protocol, and robust library functions. WBR2D is embedded with a low-power 32-bit CPU, 512 KB static random-access memory (SRAM), and 4 MB flash memory, and has extensive peripherals.

WBR2D is an RTOS platform that integrates all function libraries of the Wi-Fi MAC and TCP/IP protocols. You can develop embedded Wi-Fi products as required.

### 1.1 Features

- ✧ Embedded low-power 32-bit CPU, which can also function as an application processor
  - Clock rates: 80 MHz and 160 MHz
- ✧ Working voltage: 2.8 V to 3.6 V
- ✧ Peripherals: three GPIOs, one universal asynchronous receiver/transmitter (UART), and one analog-to-digital converter (ADC)
- ✧ Wi-Fi connectivity
  - 802.11a/b/g/n 1x1, 2.4 GHz and 5 GHz capable
  - WPA and WPA2 security modes
  - STA, AP, and STA+AP working modes
  - Onboard PCB antenna with a gain of 2 dBi at 2.4 GHz and 2.6 dBi at 5 GHz
  - Smart and AP network configuration modes for Android and iOS devices
  - Working temperature: -20°C to +85°C

- ✧ Bluetooth connectivity
  - Support Bluetooth (V5.0)
  - Onboard PCB antenna with a gain of 2 dBi
  - Working temperature:  $-20^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

## 1.2 Applications

- ✧ Intelligent building
- ✧ Smart household and home appliances
- ✧ Smart socket and light
- ✧ Industrial wireless control
- ✧ Baby monitor
- ✧ Network camera
- ✧ Intelligent bus

## Change History

| No. | Date       | Change Description         | Version After Change |
|-----|------------|----------------------------|----------------------|
| 1   | 2019-10-10 | This is the first release. | 1.0.0                |

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## 2 WBR2D Label



## 3 Module Interfaces

### 3.1 Dimensions and Footprint

WBR2D has two rows of pins with a 2 mm pin spacing.

The WBR2D dimensions (H x W x D) are 3.5 mm x 15 mm x 18 mm. Figure 3-1 shows the WBR2D front and rear views.

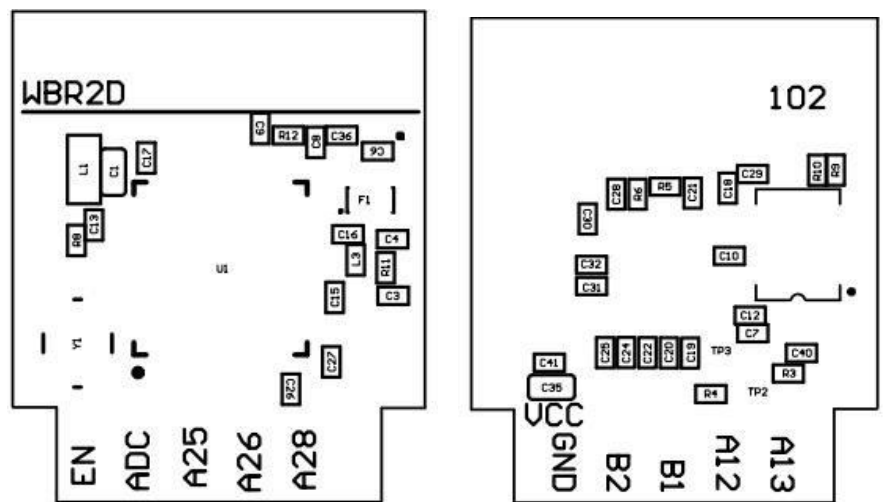
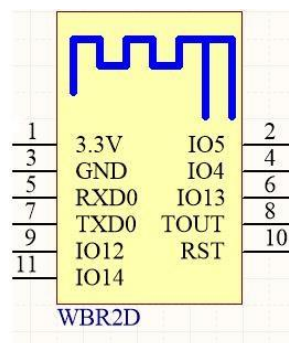


Figure 3-1 WBR2D front and rear views

Note:

The default dimensional tolerance is  $\pm 0.3$  mm, and the tolerance for some measurements is  $\pm 0.1$  mm. The PCB thickness is  $1.0 \pm 0.1$  mm.

### 3.2 Interface Pin Definition



**Table 3-1 WBR2D interface pins**

| Pin No. | Symbol | I/O Type | Function                            |
|---------|--------|----------|-------------------------------------|
| 1       | 3.3 V  | P        | Power supply pin (3.3 V)            |
| 2       | IO5    | I/O      | Common GPIO pin, hardware PWM       |
| 3       | GND    | P        | Power supply reference ground pin   |
| 4       | IO4    | I/O      | Common GPIO pin, hardware PWM       |
| 5       | RXD0   | I/O      | RXD pin of the serial interface     |
| 6       | IO13   | I/O      | Common GPIO pin, hardware PWM       |
| 7       | TXD0   | I/O      | TXD pin of the serial interface     |
| 8       | TOUT   | AI       | ADC pin (See the following Note 2.) |
| 9       | IO12   | I/O      | Common GPIO pin, hardware PWM       |
| 10      | RST    | I/O      | External reset pin                  |
| 11      | IO14   | I/O      | Common GPIO pin, hardware PWM       |

Note:

1. **P** indicates power supply pins, **I/O** indicates input/output pins, and **AI** indicates analog input pins. RST is only a hardware reset pin and cannot clear the Wi-Fi network configuration.
2. This pin can only function as an ADC input and not a common I/O. If this pin is not used, it must be disconnected. When this pin is used as an ADC input, the input voltage range is 0 V to 1.0 V.

### 3.3 Test Pin Definition

**Table 3-2 WBR2D test pins**

| Pin No. | Symbol | I/O Type | Function                            |
|---------|--------|----------|-------------------------------------|
| N/A     | TEST   | Input    | Used for the module production test |

Note:

Test pins are not recommended.

## 4 Electrical Parameters

### 4.1 Absolute Electrical Parameters

Table 4-1 Absolute electrical parameters

| Parameter                                     | Description             | Minimum Value | Maximum Value | Unit |
|-----------------------------------------------|-------------------------|---------------|---------------|------|
| T <sub>s</sub>                                | Storage temperature     | −20           | 85            | °C   |
| VCC                                           | Power supply voltage    | −0.3          | 3.6           | V    |
| Static electricity voltage (human body model) | T <sub>amb</sub> = 25°C | N/A           | 2             | kV   |
| Static electricity voltage (machine model)    | T <sub>amb</sub> = 25°C | N/A           | 0.5           | kV   |

### 4.2 Electrical Conditions

Table 4-2 Normal electrical conditions

| Parameter        | Description           | Minimum Value | Typical Value | Maximum Value | Unit |
|------------------|-----------------------|---------------|---------------|---------------|------|
| T <sub>a</sub>   | Working temperature   | −20           | N/A           | 85            | °C   |
| VCC              | Power supply voltage  | 2.8           | 3.3           | 3.6           | V    |
| V <sub>IL</sub>  | I/O low-level input   | −0.3          | N/A           | VCC x 0.25    | V    |
| V <sub>IH</sub>  | I/O high-level input  | VCC x 0.75    | N/A           | VCC           | V    |
| V <sub>OL</sub>  | I/O low-level output  | N/A           | N/A           | VCC x 0.1     | V    |
| V <sub>OH</sub>  | I/O high-level output | VCC x 0.8     | N/A           | VCC           | V    |
| I <sub>max</sub> | I/O drive current     | N/A           | N/A           | 12            | mA   |

### 4.3 RF Current Consumption

Table 4-3 Power consumption during constant transmission

| Working Status | Mode         | TX Power                                                                                                             |
|----------------|--------------|----------------------------------------------------------------------------------------------------------------------|
| TX at 2.4 GHz  | 802.11b      | +18.02 dBm                                                                                                           |
|                | 802.11g      | +18.25 dBm                                                                                                           |
|                | 802.11n HT20 | +17.35 dBm                                                                                                           |
|                | 802.11n HT40 | +16.21 dBm                                                                                                           |
|                | BLE          | +7.86dBm(1Mbps); +7.68(2Mbps)                                                                                        |
| TX at 5GHz     | 802.11a      | 5150MHz-5250MHz: +16.55dBm<br>5250MHz-5350MHz: +16.48dBm<br>5470MHz-5725MHz: +16.92dBm<br>5725MHz-5850MHz: +13.69dBm |
|                | 802.11n HT20 | 5150MHz-5250MHz: +15.64dBm<br>5250MHz-5350MHz: +15.87dBm<br>5470MHz-5725MHz: +16.04dBm<br>5725MHz-5850MHz: +11.80dBm |
|                | 802.11n HT40 | 5150MHz-5250MHz: +14.77dBm<br>5250MHz-5350MHz: +14.43dBm<br>5470MHz-5725MHz: +17.88dBm<br>5725MHz-5850MHz: +11.88dBm |

Table 4-4 Power consumption during constant receiving

| Working Status | Mode         | Rate      | Typical Value | Unit |
|----------------|--------------|-----------|---------------|------|
| 2.4 GHz        | 802.11b      | 11 Mbit/s | 70            | mA   |
|                | 802.11g      | 54 Mbit/s | 72            | mA   |
|                | 802.11n HT20 | MCS7      | 70            | mA   |
|                | 802.11n HT40 | MCS7      | 73            | mA   |
| 5 GHz          | 802.11a      | 54 Mbit/s | 71            | mA   |
|                | 802.11n HT20 | MCS7      | 72            | mA   |
|                | 802.11n HT40 | MCS7      | 76            | mA   |

## 4.4 Working Current

Table 4-5 WBR2D working current

| Working Mode | Working Status (Ta = 25°C)                                                          | Average Value | Maximum Value | Unit |
|--------------|-------------------------------------------------------------------------------------|---------------|---------------|------|
| EZ           | The module is in EZ mode, and the Wi-Fi indicator blinks quickly.                   |               |               | mA   |
| AP           | The module is in AP mode, and the Wi-Fi indicator blinks slowly.                    |               |               | mA   |
| Connected    | The module is connected to the network, and the Wi-Fi indicator is steady on.       |               |               | mA   |
| Disconnected | The module is disconnected from the network, and the Wi-Fi indicator is steady off. |               |               | mA   |

## 5 RF Features

### 5.1 Basic RF Features

**Table 5-1 Basic RF features**

| Parameter              | Description                                                                                                                                                                      |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency band         | BT:2.400GHz to 2.4835GHz<br>WIFI:2.412 GHz to 2.484 GHz; 5.15 GHz to 5.885 GHz                                                                                                   |
| standard               | IEEE 802.11a/b/g/n (channels 1 to 14 and 36 to 177, channels 1 to 11 for US, channels 1 to 13 for EU)<br>Bluetooth LE 5.0                                                        |
| Data transmission rate | 802.11b: 1, 2, 5.5, or 11 (Mbit/s)<br>802.11a/g: 6, 9, 12, 18, 24, 36, 48, or 54 (Mbit/s)<br>802.11n: HT20 MCS0 to MCS7<br>802.11n: HT40 MCS0 to MCS7<br>Bluetooth: 1Mbps, 2Mbps |
| Antenna type           | PCB antenna with a gain of 2 dBi at 2.4 GHz and 2.6 dBi at 5 GHz                                                                                                                 |

### 5.2 TX Performance

**Table 5-2 Performance during constant transmission at 2.4 GHz**

| Parameter                                  |           | Minimum Value | Typical Value | Maximum Value | Unit |
|--------------------------------------------|-----------|---------------|---------------|---------------|------|
| Average RF output power, 802.11b CCK mode  | 11 Mbit/s | N/A           | 18.02         | N/A           | dBm  |
| Average RF output power, 802.11g OFDM mode | 54 Mbit/s | N/A           | 18.25         | N/A           | dBm  |
| Average RF output power, 802.11n HT20 mode | MCS7      | N/A           | 17.35         | N/A           | dBm  |
| Average RF output power, 802.11n HT40 mode | MCS7      | N/A           | 16.21         | N/A           | dBm  |
| Frequency error                            |           | -10           | N/A           | +10           | ppm  |
| EVM under 802.11b CCK, 11 Mbit/s           |           |               | -16.5         |               | dB   |

| Parameter                         | Minimum Value | Typical Value | Maximum Value | Unit |
|-----------------------------------|---------------|---------------|---------------|------|
| EVM under 802.11g OFDM, 54 Mbit/s |               | -33.1         |               | dB   |
| EVM under 802.11n OFDM, MCS7      |               | -32.2         |               | dB   |

**Table 5-3 Performance during constant transmission at 5 GHz**

| Parameter                                  |           | Minimum Value | Typical Value | Maximum Value | Unit |
|--------------------------------------------|-----------|---------------|---------------|---------------|------|
| Average RF output power, 802.11a OFDM mode | 54 Mbit/s | N/A           | 16.92         | N/A           | dBm  |
| Average RF output power, 802.11n HT20 mode | MCS7      | N/A           | 16.04         | N/A           | dBm  |
| Average RF output power, 802.11n HT40 mode | MCS7      | N/A           | 17.88         | N/A           | dBm  |
| Frequency error                            |           | -10           | N/A           | +10           | ppm  |
| EVM under 802.11b CCK, 11 Mbit/s           |           |               | -16.5         |               | dB   |
| EVM under 802.11g OFDM, 54 Mbit/s          |           |               | -33.1         |               | dB   |
| EVM under 802.11n OFDM, MCS7               |           |               | -32.2         |               | dB   |

## 5.3 RX Performance

**Table 5-4 RX sensitivity**

| Parameter                      |           | Minimum Value | Typical Value | Maximum Value | Unit |
|--------------------------------|-----------|---------------|---------------|---------------|------|
| PER < 8%, 802.11b CCK mode     | 11 Mbit/s | N/A           | -91           | N/A           | dBm  |
| PER < 10%, 802.11a/g OFDM mode | 54 Mbit/s | N/A           | -75           | N/A           | dBm  |
| PER < 10%, 802.11n OFDM mode   | HT20 MCS7 | N/A           | -72           | N/A           | dBm  |

## 6 Antenna Information

### 6.1 Antenna Type

WBR2D uses an onboard PCB antenna.

### 6.2 Antenna Interference Reduction

To ensure optimal Wi-Fi performance when the Wi-Fi module uses an onboard PCB antenna, it is recommended that the antenna be at least 15 mm away from other metal parts.

To prevent adverse impact on the antenna radiation performance, avoid copper or traces along the antenna area on the PCB. Ensure that there are no substrate media above or below the antenna and that copper is at a certain distance away from the antenna to maximize the antenna radiation performance.

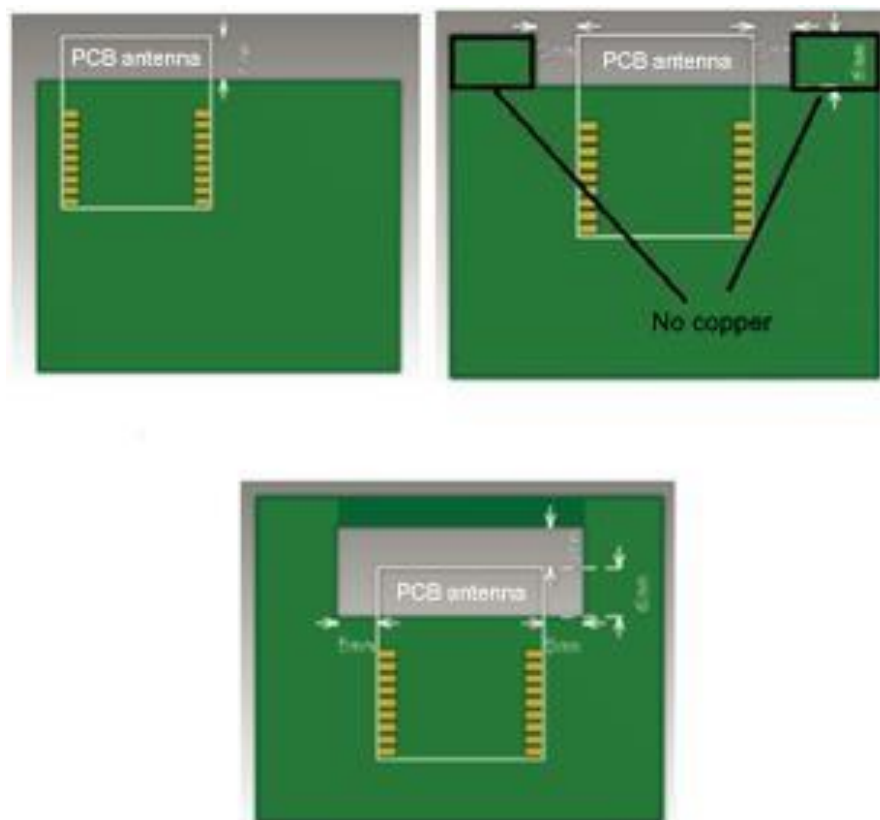


Figure 6-1 Antenna clearance part

For details about the onboard PCB antenna area on WBR2D, see Figure 7-1.

## 6.3 Antenna Connector Specifications

WBR2D does not use an antenna connector.

## 7 Packaging Information and Production Instructions

### 7.1 Mechanical Dimensions

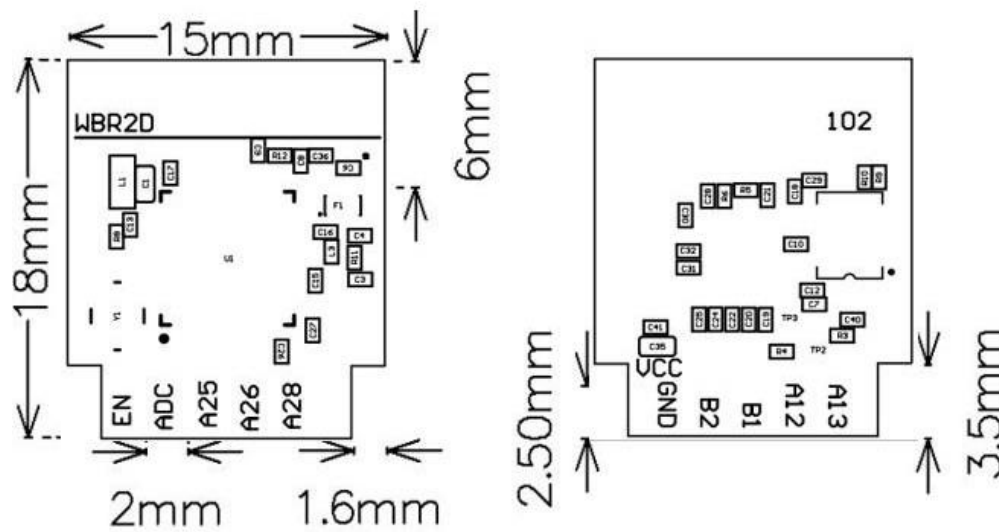


Figure 7-1 WBR2D mechanical dimensions

Note:

The default dimensional tolerance is  $\pm 0.3$  mm. If a customer has other requirements, clearly specify them in the datasheet after communication.

## 7.2 Recommended PCB Layout

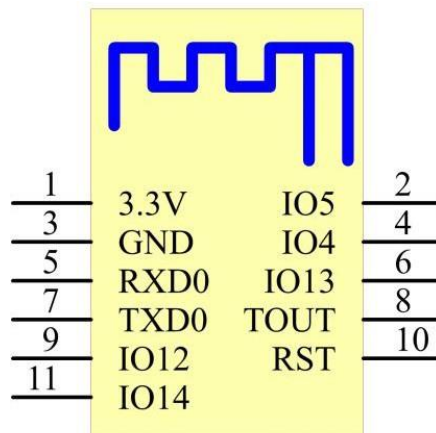


Figure 7-2 WBR2D pins

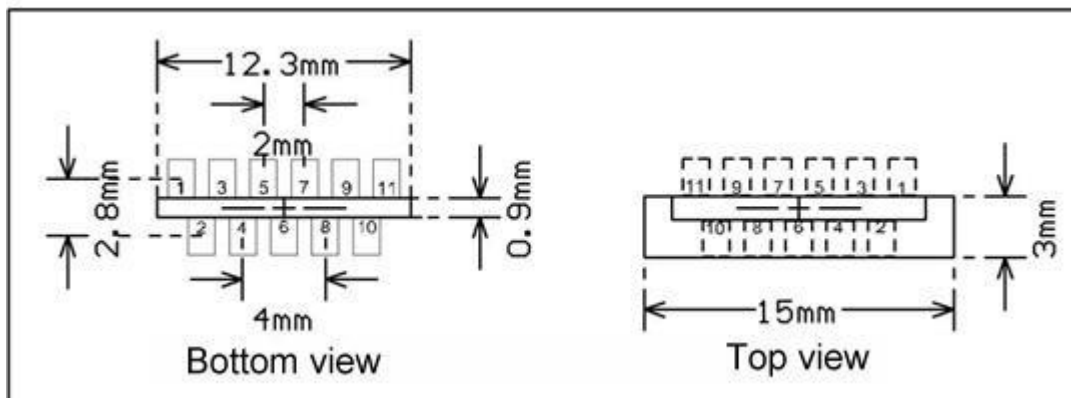
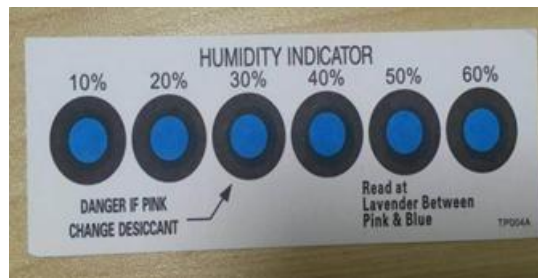


Figure 7-3 Top and bottom views of the PCB to which WBR2D applies

## 7.3 Production Instructions

1. Use an SMT placement machine to mount the stamp hole module that Tuya produces onto the PCB within 24 hours after the module is unpacked and the firmware is burned. If not, vacuum pack the module again. Bake the module before mounting it onto the PCB.

- (1) SMT placement equipment
  - i. Reflow soldering machine
  - ii. Automated optical inspection (AOI) equipment
  - iii. Nozzle with a 6 mm to 8 mm diameter
- (2) Baking equipment
  - i. Cabinet oven
  - ii. Anti-static heat-resistant trays
  - iii. Anti-static heat-resistant gloves
2. Storage conditions for a delivered module are as follows:
  - (1) The moisture-proof bag is placed in an environment where the temperature is below 30°C and the relative humidity is lower than 70%.
  - (2) The shelf life of a dry-packaged product is six months from the date when the product is packaged and sealed.
  - (3) The package contains a humidity indicator card (HIC).



**Figure 7-4 HIC for WBR2D**

3. Bake a module based on HIC status as follows when you unpack the module package:
  - (1) If the 30%, 40%, and 50% circles are blue, bake the module for 2 consecutive hours.
  - (2) If the 30% circle is pink, bake the module for 4 consecutive hours.
  - (3) If the 30% and 40% circles are pink, bake the module for 6 consecutive hours.
  - (4) If the 30%, 40%, and 50% circles are pink, bake the module for 12 consecutive hours.
4. Baking settings:
  - (1) Baking temperature: 125±5°C
  - (2) Alarm temperature: 130°C

- (3) SMT placement ready temperature after natural cooling:  $< 36^{\circ}\text{C}$
- (4) Number of drying times: 1
- (5) Rebaking condition: The module is not soldered within 12 hours after baking.
5. Do not use SMT to process modules that have been unpacked for over three months. Electroless nickel immersion gold (ENIG) is used for the PCBs. If the solder pads are exposed to the air for over three months, they will be oxidized severely and dry joints or solder skips may occur. Tuya is not liable for such problems and consequences.
6. Before SMT placement, take electrostatic discharge (ESD) protective measures.
7. To reduce the reflow defect rate, draw 10% of the products for visual inspection and AOI before first SMT placement to determine a proper oven temperature and component placement method. Draw 5 to 10 modules every hour from subsequent batches for visual inspection and AOI.

## 7.4 Recommended Oven Temperature Curve

Perform SMT placement based on the following reflow oven temperature curve. The highest temperature is  $245^{\circ}\text{C}$ .

Refer to IPC/JEDEC standard ; Peak Temperature :  $< 250^{\circ}\text{C}$  ; Number of Times:  $\leq 2$  times ;

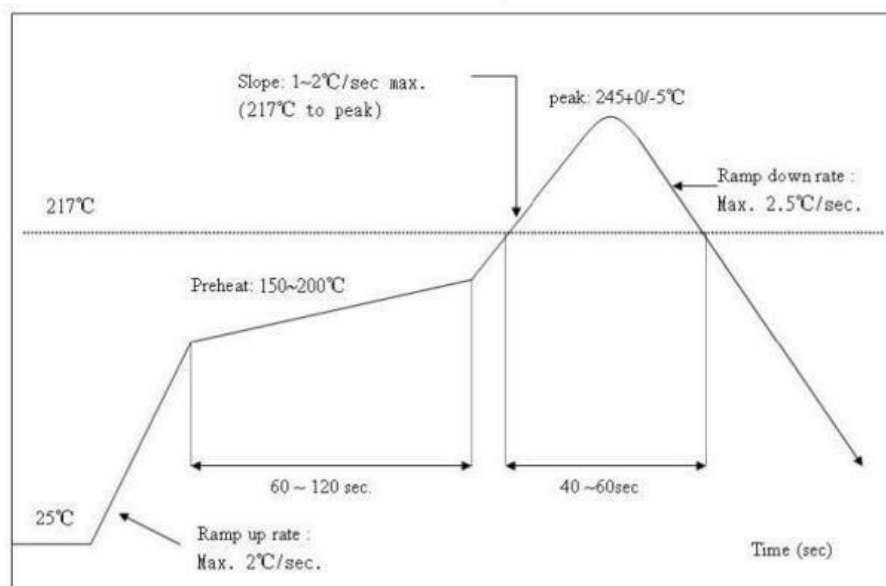


Figure 7-5 Oven temperature curve

## 7.5 Storage Conditions

|                                                                                                                                                             |                                                                                 |                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
|                                                                            | <b>CAUTION</b><br><b>This bag contains</b><br><b>MOISTURE-SENSITIVE DEVICES</b> | <b>LEVEL</b><br><div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>3</b> </div> |
| If Blank, see adjacent bar code label                                                                                                                       |                                                                                 |                                                                                                             |
| 1. Calculated shelf life in sealed bag: 12 months at < 40°C and < 90% relative humidity (RH)                                                                |                                                                                 |                                                                                                             |
| 2. Peak package body temperature: <u>260</u> °C<br><small style="display: block; text-align: right;">If Blank, see adjacent bar code label</small>          |                                                                                 |                                                                                                             |
| 3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must                                              |                                                                                 |                                                                                                             |
| a) Mounted within: <u>168</u> hrs. of factory conditions<br><small style="display: block; text-align: right;">If Blank, see adjacent bar code label</small> |                                                                                 |                                                                                                             |
| ≤ 30°C/60%RH, OR                                                                                                                                            |                                                                                 |                                                                                                             |
| b) Stored at <10% RH                                                                                                                                        |                                                                                 |                                                                                                             |
| 4. Devices require bake, before mounting, if:                                                                                                               |                                                                                 |                                                                                                             |
| a) Humidity Indicator Card is > 10% when read at 23 ± 5°C                                                                                                   |                                                                                 |                                                                                                             |
| b) 3a or 3b not met.                                                                                                                                        |                                                                                 |                                                                                                             |
| 5. If baking is required, devices may be baked for 48 hrs. at 125 ± 5°C                                                                                     |                                                                                 |                                                                                                             |
| Note: If device containers cannot be subjected to high temperature or shorter bake times are desired, reference IPC/JEDEC J-STD-033 for bake procedure      |                                                                                 |                                                                                                             |
| Bag Seal Date: _____<br><small style="display: block; text-align: right;">If Blank, see adjacent bar code label</small>                                     |                                                                                 |                                                                                                             |
| Note: Level and body temperature defined by IPC/JEDEC J-STD-020                                                                                             |                                                                                 |                                                                                                             |

## 8 Appendix: Statement

### **Federal Communications Commission (FCC) Declaration of Conformity**

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

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.

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 rolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

### **Important Note**

This radio module must not be installed to co-locate and operating simultaneously with other radios in host system except in accordance with FCC multi-transmitter product procedures. Additional testing and equipment authorization may be required to operating simultaneously with other radio.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination. The firmware setting is not accessible by the end user. The host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

This device have got a FCC ID: 2ANDL-WBR2D. The final end product must be labeled in a visible area with the following: "Contains Transmitter Module FCC ID: 2ANDL-WBR2D"

This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

#### Declaration of Conformity European notice



Hereby, Hangzhou Tuya Information Technology Co., Ltd declares that this module product is in compliance with essential requirements and other relevant provisions of Directive 2014/53/EU, 2011/65/EU. A copy of the Declaration of conformity can be found at <https://www.tuya.com>



This product must not be disposed of as normal household waste, in accordance with EU directive for waste electrical and electronic equipment (WEEE- 2012/19/EU). Instead, it should be disposed of by returning it to the point of sale, or to a municipal recycling collection point.

The device could be used with a separation distance of 20cm to the human body.

The device is restricted to indoor use only when operating in the 5150 to 5350 MHz frequency range.

|                                                                                     |    |    |    |    |    |    |    |
|-------------------------------------------------------------------------------------|----|----|----|----|----|----|----|
|  | AT | BE | BG | HR | CY | CZ | DK |
|                                                                                     | EE | FI | FR | DE | EL | HU | IE |
|                                                                                     | IT | LV | LT | LU | MT | NL | PL |
|                                                                                     | PT | RO | SK | SI | ES | SE | UK |