



# **T1-M Module Datasheet**

Version: 20241127

Online Version

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T1-M module is a Wi-Fi and Bluetooth Low Energy (LE) combo module developed by Tuya Smart. It is composed of a highly integrated radio-frequency identification (RFID) chip T1 and a few peripheral components. It can run in the station (STA) mode and access point (AP) mode as well as support connection over Bluetooth LE.

## 1. Overview

T1-M has a built-in 32-bit MCU with a maximum running speed of 160 MHz, built-in 2 MB flash memory, and 288 KB SRAM. The module supports cloud connectivity, and the MCU's extended instructions for signal processing enable it to efficiently implement audio encoding and decoding. Various peripherals are available, such as PWM, UART, and ADC. Up to five channels of 32-bit PWM output make the chip ideal for high-quality LED control.

### 1.1. Features

- Built-in low-power 32-bit CPU that also acts as an application processor.
- Clock rate of 160 MHz.
- Operating voltage range: 3.0V to 3.6V.
- Peripherals: 5 PWM pins, 1 UART, and 1 ADC pin.
- Wi-Fi connectivity
- IEEE 802.11b/g/n.
- Channels 1 to 13 at 2.4 GHz for EN.Channels 1 to 11 at 2.4 GHz for US.
- Support WEP, WPA/WPA2, WPA/WPA2 PSK (AES), and WPA3 security modes.
- The maximum output power is +17 dBm for IEEE 802.11b transmission.
- Supports STA, AP, and STA + AP combo working modes.
- Two pairing modes are supported, namely Bluetooth and access point (AP) mode. Both modes are suitable for pairing with Android and iOS mobile phones.
- Ceramic antenna.
- Operating temperature range:  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ .
- Bluetooth connectivity
- Bluetooth Core Specification v5.2.
- The transmitter power in Bluetooth mode is 6 dBm.
- Integral Wi-Fi and Bluetooth coexistence interface.
- Ceramic antenna.

### 1.2. Applications

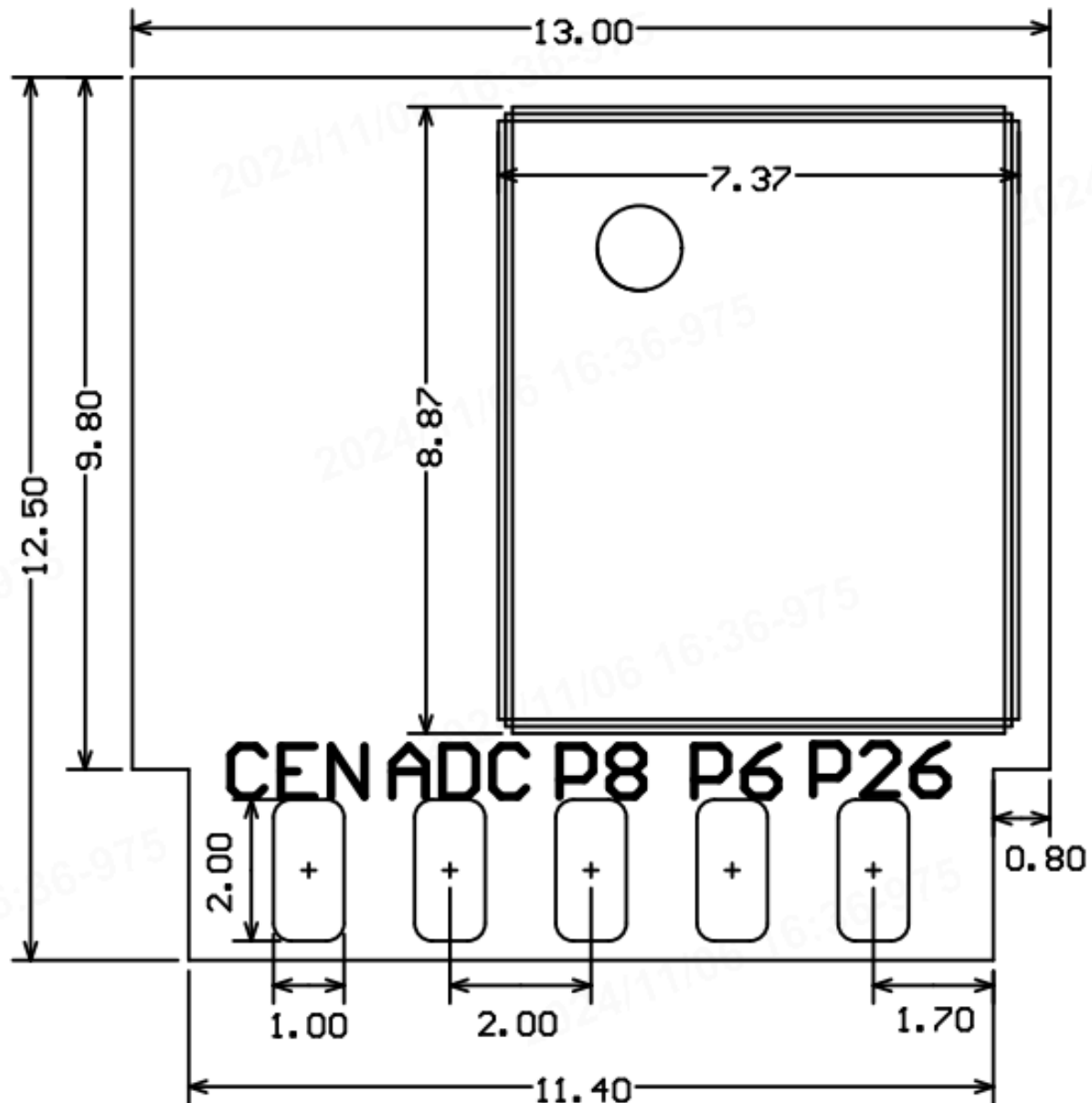
- Smart building

- Smart home and electrical appliance
- Smart socket and light
- Industrial wireless control
- Baby monitor
- IP camera
- Smart bus

## 2. Module interfaces

### 2.1. Dimensions and footprint

The T1-M dimensions are  $13\pm0.35$  mm (W)  $\times$   $12.5\pm0.35$  mm (L)  $\times$   $2.3\pm0.15$  mm (H). The figure below shows the dimensions of the T1-M module.



Top View

### 2.2. Pin definition

| Pin No. | Symbol | I/O type | Description                                                                |
|---------|--------|----------|----------------------------------------------------------------------------|
| 1       | 3V3    | P        | 3.3V power pin.                                                            |
| 2       | P26    | I/O      | Support hardware<br>PWM,<br>corresponding to<br>Pin 11 on the IC.          |
| 3       | GND    | P        | Ground pin.                                                                |
| 4       | P6     | I/O      | Support hardware<br>PWM,<br>corresponding to<br>Pin 12 on the IC.          |
| 5       | RX1    | I/O      | UART_RX1 to<br>receive user data,<br>corresponding to<br>Pin 15 on the IC. |
| 6       | P8     | I/O      | Support hardware<br>PWM,<br>corresponding to<br>Pin 13 on the IC.          |
| 7       | TX1    | I/O      | UART_TX1 to send<br>user data,<br>corresponding to<br>Pin 16 on the IC.    |
| 8       | ADC    | I/O      | ADC pin, GPIO 12,<br>corresponding to<br>Pin 17 on the IC.                 |
| 9       | P9     | I/O      | Support hardware<br>PWM,<br>corresponding to<br>Pin 14 on the IC.          |

| Pin No. | Symbol | I/O type | Description                                                                               |
|---------|--------|----------|-------------------------------------------------------------------------------------------|
| 10      | CEN    | I/O      | The reset pin, active low, and pulled up internally.<br>Corresponding to Pin 9 on the IC. |
| 11      | P24    | I/O      | Support hardware PWM, corresponding to Pin 10 on the IC.                                  |

**i**

- P indicates the power pin, and I/O indicates the input and output pin.
- For more information about MCU general integration, see [Hardware Design of CBx Series Modules](#) .

## 3. Electrical parameters

### 3.1. Absolute electrical parameters

| Parameter                                          | Description            | Min value | Max value | Unit |
|----------------------------------------------------|------------------------|-----------|-----------|------|
| T <sub>s</sub>                                     | Storage temperature    | −55       | 125       | °C   |
| V <sub>BAT</sub>                                   | Supply voltage         | −0.3      | 3.9       | V    |
| Electrostatic discharge voltage (human body model) | T <sub>AMB</sub> −25°C | −4        | 4         | kV   |
| Electrostatic discharge voltage (machine model)    | T <sub>AMB</sub> −25°C | −200      | 200       | V    |

### 3.2. Normal operating conditions

| Parameter        | Description           | Min value              | Typical value | Max value             | Unit |
|------------------|-----------------------|------------------------|---------------|-----------------------|------|
| T <sub>a</sub>   | Operating temperature | −40                    | -             | 105                   | °C   |
| V <sub>BAT</sub> | Supply voltage        | 3                      | 3.3           | 3.6                   | V    |
| V <sub>OL</sub>  | I/O low-level output  | V <sub>SS</sub>        | -             | V <sub>SS</sub> + 0.3 | V    |
| V <sub>OH</sub>  | I/O high-level output | V <sub>BAT</sub> − 0.3 | -             | V <sub>BAT</sub>      | V    |

| Parameter        | Description       | Min value | Typical value | Max value | Unit |
|------------------|-------------------|-----------|---------------|-----------|------|
| I <sub>max</sub> | I/O drive current | -         | 6             | 20        | mA   |

### 3.3. Radio frequency (RF) power

| Operating status | Mode    | Rate      | Transmit/Receive power | Average value | Peak (Typical) value | Unit |
|------------------|---------|-----------|------------------------|---------------|----------------------|------|
| Transmit         | 802.11b | 11 Mbit/s | +17 dBm                | 312           | 380                  | mA   |
| Transmit         | 802.11g | 54 Mbit/s | +15 dBm                | 280           | 344                  | mA   |
| Transmit         | 802.11n | MCS7      | +14 dBm                | 268           | 332                  | mA   |
| Receive          | 802.11b | 11 Mbit/s | Continuous reception   | 16            | 21                   | mA   |
| Receive          | 802.11g | 54 Mbit/s | Continuous reception   | 16            | 21                   | mA   |
| Receive          | 802.11n | MCS7      | Continuous reception   | 16            | 21                   | mA   |

### 3.4. Operating current

| Working mode              | Status (Ta = 25°C)                                                                    | Average value | Max (Typical) value | Unit |
|---------------------------|---------------------------------------------------------------------------------------|---------------|---------------------|------|
| Quick pairing (Bluetooth) | The module is pairing over Bluetooth.<br>The network status indicator blinks quickly. | 70            | 360                 | mA   |

| Working mode       | Status (Ta = 25°C)                                                                                                 | Average value | Max (Typical) value | Unit |
|--------------------|--------------------------------------------------------------------------------------------------------------------|---------------|---------------------|------|
| Quick pairing (AP) | The module is pairing in AP mode. The network status indicator blinks slowly.                                      | 105           | 370                 | mA   |
| Connected          | The module is connected to the cloud. The network status indicator is steady on.                                   | 45            | 300                 | mA   |
| Weakly connected   | The connection between the module and the access point is intermittent. The network status indicator is steady on. | 135           | 360                 | mA   |

| Working mode    | Status (Ta = 25°C)                                                                     | Average value | Max (Typical) value | Unit |
|-----------------|----------------------------------------------------------------------------------------|---------------|---------------------|------|
| Disconnected    | The module is disconnected from the cloud. The network status indicator is steady off. | 47            | 320                 | mA   |
| Module disabled | The module's clock enable (CEN) pin is pulled down.                                    | 330           | -                   | μA   |

## 4. RF parameters

### 4.1. Basic RF features

| Parameter              | Description                                                                                                                             |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Operating frequency    | 2.412 to 2.462 GHz                                                                                                                      |
| Wi-Fi standard         | IEEE 802.11b/g/n <ul style="list-style-type: none"><li>IEEE 802.11b: 1, 2, 5.5, and 11 Mbit/s</li></ul>                                 |
| Data transmission rate | <ul style="list-style-type: none"><li>IEEE 802.11g: 6, 9, 12, 18, 24, 36, 48, and 54 Mbit/s</li><li>IEEE 802.11n: HT20 MCS0-7</li></ul> |
| Antenna type           | Ceramic antenna.                                                                                                                        |

### 4.2. Wi-Fi transmitter (TX) performance

| Parameter                                               | Min value | Typical value | Max value | Unit |
|---------------------------------------------------------|-----------|---------------|-----------|------|
| RF average output power, 802.11b CCK mode, 11 Mbit/s    | -         | 17            | -         | dBm  |
| RF average output power, 802.11g OFDM mode, 54 Mbit/s   | -         | 15            | -         | dBm  |
| RF average output power, 802.11n OFDM mode, MCS7 (HT20) | -         | 14            | -         | dBm  |
| Frequency error                                         | -20       | -             | 20        | ppm  |

### 4.3. Wi-Fi receiver (RX) performance

| Parameter                                                    | Min value | Typical value | Max value | Unit |
|--------------------------------------------------------------|-----------|---------------|-----------|------|
| PER < 8%, RX sensitivity,<br>802.11b DSSS mode, 11 Mbit/s    | -         | -88           | -         | dBm  |
| PER < 10%, RX sensitivity,<br>802.11g OFDM mode, 54 Mbit/s   | -         | -75           | -         | dBm  |
| PER < 10%, RX sensitivity,<br>802.11n OFDM mode, MCS7 (HT20) | -         | -73           | -         | dBm  |
| PER < 10%, RX sensitivity,<br>Bluetooth, 1 Mbit/s            | -         | -96           | -         | dBm  |

### 4.4. Bluetooth TX performance

| Parameter                      | Min value | Typical value | Max value | Unit   |
|--------------------------------|-----------|---------------|-----------|--------|
| Operating frequency            | 2402      | -             | 2480      | MHz    |
| Transmission rate over the air | -         | 1             | -         | Mbit/s |
| Transmission power             | -20       | 6             | 20        | dBm    |

| Parameter       | Min value | Typical value | Max value | Unit |
|-----------------|-----------|---------------|-----------|------|
| Frequency error | -150      | -             | 150       | KHz  |

#### 4.5. Bluetooth RX performance

| Parameter                        | Min value | Typical value | Max value | Unit |
|----------------------------------|-----------|---------------|-----------|------|
| RX sensitivity                   | -         | -96           | -         | dBm  |
| Max RF signal input              | -10       | -             | -         | dBm  |
| Intermodulation                  | -         | -             | -23       | dBm  |
| Adjacent-channel rejection ratio | -         | 10            | -         | dB   |

## **5. Antenna information**

### **5.1. Antenna type**

The T1-M module uses a ceramic antenna.

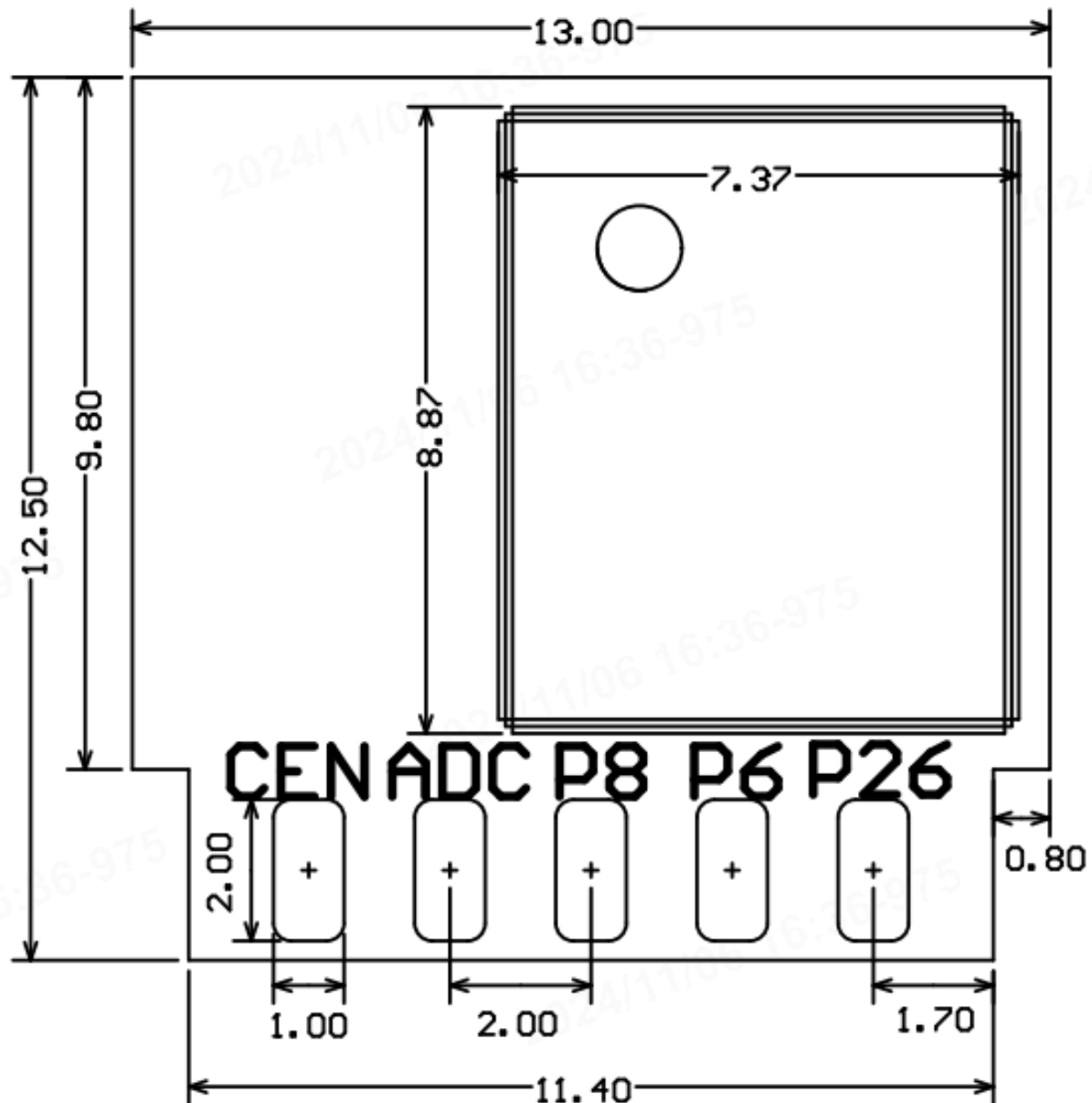
### **5.2. Antenna interference reduction**

The distance between the antenna and other mental components should be at least 15 mm to provide the best Wi-Fi performance.

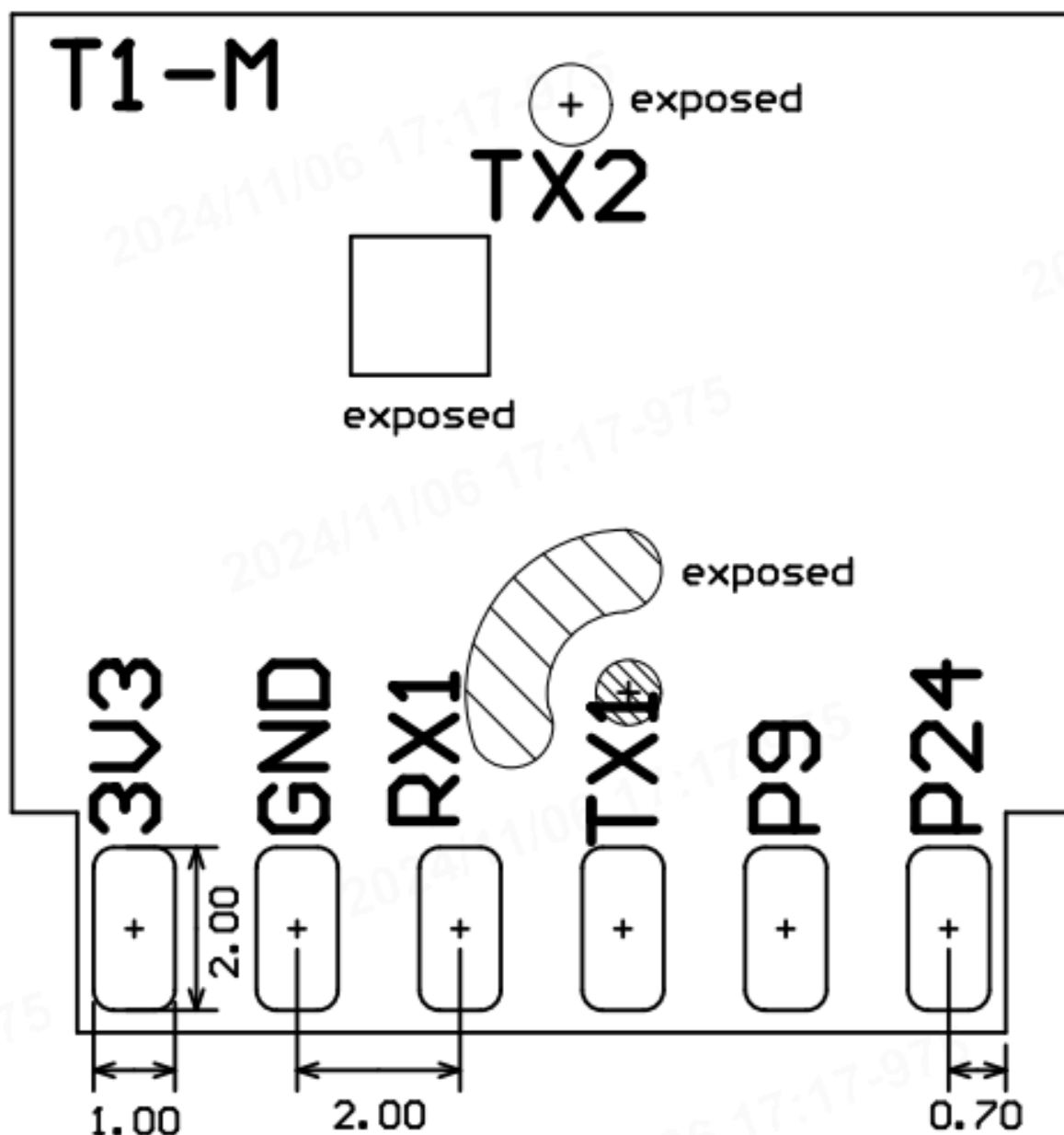
## 6. Packing and production instructions

### 6.1. Mechanical dimensions

Dimensions of the T1-M PCB are  $13\pm0.35$  mm (W)  $\times$   $12.5\pm0.35$  mm (L)  $\times$   $0.8\pm0.1$  mm (H).



Top View



Bottom View



Unit: mm

Module form factor tolerance:  $\pm 0.35\text{mm}$

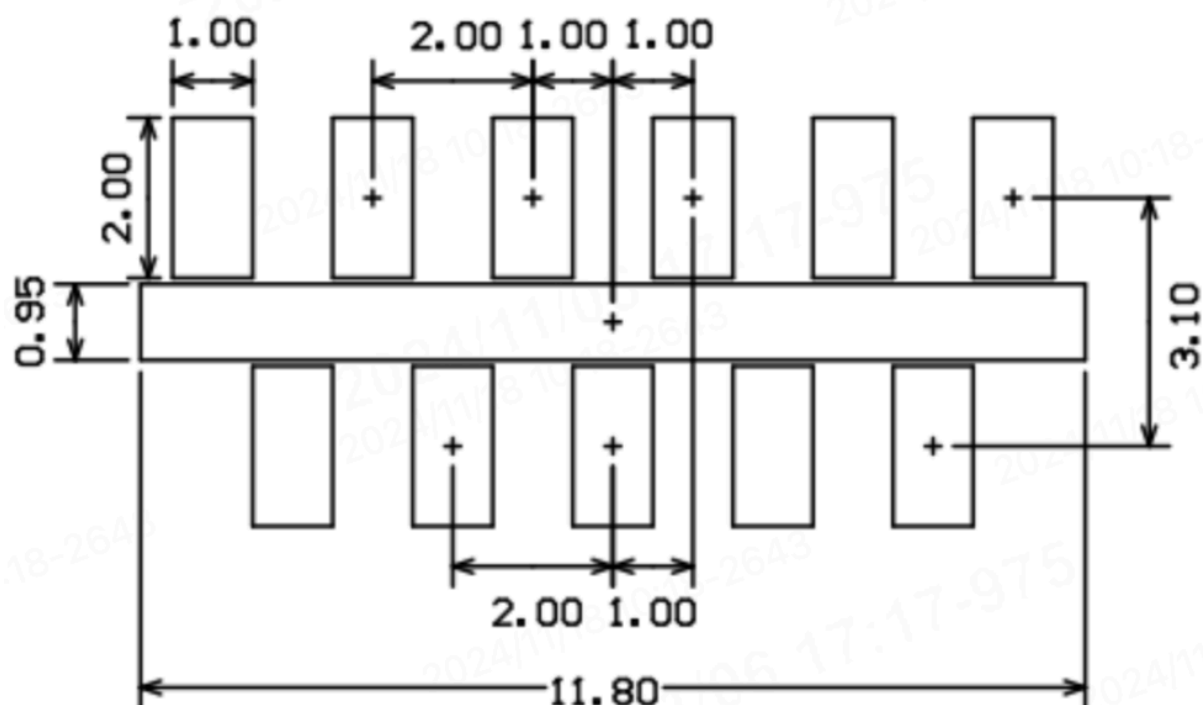
PCB thickness tolerance:  $\pm 0.1\text{mm}$

Shield cover height tolerance:  $\pm 0.05\text{mm}$

## Side View

The figure below shows the recommended footprint of the T1-M module.

## Recommended footprint



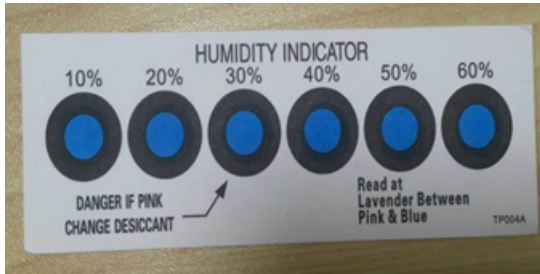


The area indicated as **keep-out** in the diagram above does not require tinning and should not have any traces routed through it.

## 6.2. Production instructions

1. For the modules that can be packaged with the surface-mount technology (SMT) or in in-line form, you can select either of them according to the PCB design solutions of customers. If a PCB is designed to be SMT-packaged, package the module with the SMT. If a PCB is designed to use an in-line package, use wave soldering. Complete soldering within 24 hours after the module is unpacked. Otherwise, place the module in a drying cupboard with a relative humidity level below 10%, or pack the module in vacuum again. Then, record the packing time and duration of exposure. The total exposure time cannot exceed 168 hours.
  - Instruments or devices required for the SMT process:
    - Surface mount system
    - SPI
    - Reflow soldering machine
    - Thermal profiler
    - Automated optical inspection (AOI) equipment
  - Instruments or devices required for the wave soldering process:
    - Wave soldering equipment
    - Wave soldering fixture
    - Constant-temperature soldering iron
    - Tin bar, tin wire, and flux
    - Thermal profiler
  - Instruments or devices required for the baking process:
    - Cabinet oven
    - Electrostatic discharge (ESD) protection and heat-resistant trays
    - ESD protection and heat-resistant gloves
2. A delivered module must meet the following storage requirements:

- The moisture-proof bag must be placed in an environment where the temperature is below 40°C and the relative humidity is lower than 90%.
- The shelf life of a dry-packaged product is 12 months from the date when the product is packaged and sealed.
- A humidity indication card (HIC) is put in the sealed package.



3. The module needs to be baked in the following cases:
  - The vacuum packaging bag is damaged before unpacking.
  - After unpacking, no HIC is found in the packaging bag.
  - After unpacking, the HIC indicates a humidity level of 10% or higher. In this case, the circle turns pink on the HIC.
  - The total exposure time has lasted for over 168 hours since unpacking.
  - More than 12 months have passed since the first sealing of the bag.
4. The baking parameter settings are described below:
  - Baking temperature: 40°C for reel packaging with relative humidity  $\leq 5\%$ . And 125°C for tray packaging with relative humidity  $\leq 5\%$  (use a heat-resistant tray, rather than plastic containers).
  - Baking time: 168 hours for reel packaging and 12 hours for tray packaging.
  - Temperature for triggering an alert: 50°C for reel packaging and 135°C for tray packaging.
  - Production can begin after a module has cooled down to below 36°C under natural conditions.
  - If a module remains unused for over 168 hours after being baked, it needs to be baked again.
  - If a batch of modules is not baked after exposure for more than 168 hours, do not use reflow soldering or wave soldering to solder them. Because these modules are level-3 moisture-sensitive devices, they are very likely to get damp when exposed beyond the allowable time. In this case, if they are

soldered at high temperatures, device failure or poor soldering performance might occur.

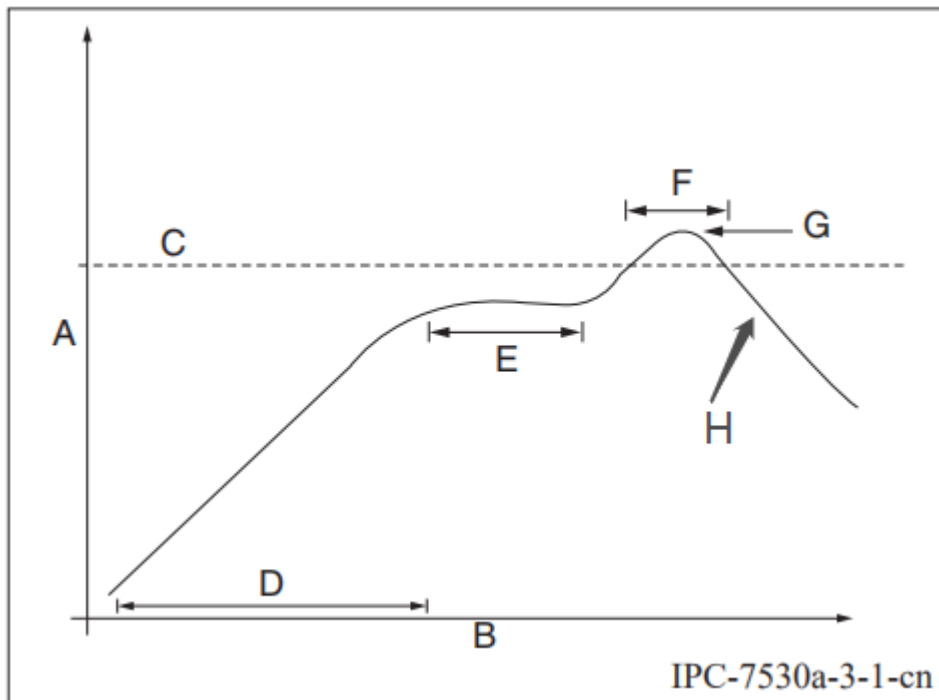
5. In the whole production process, take electrostatic discharge (ESD) protective measures.
6. To guarantee the pass rate, we recommend that you use the SPI and AOI to monitor the quality of solder paste printing and mounting.

### 6.3. Recommended oven temperature curve

Select a proper soldering technique according to the process. For more information, refer to the recommended oven temperature curve of either reflow soldering or wave soldering. The set temperatures might deviate from the actual temperature measurements. All temperatures shown in this module datasheet are obtained through actual measurements.

#### Technique 1: SMT process (recommended oven temperature curve of reflow soldering)

Set the oven temperatures according to the following curve.



- A: temperature axis
- B: time axis
- C: alloy liquidus temperature from 217°C to 220°C

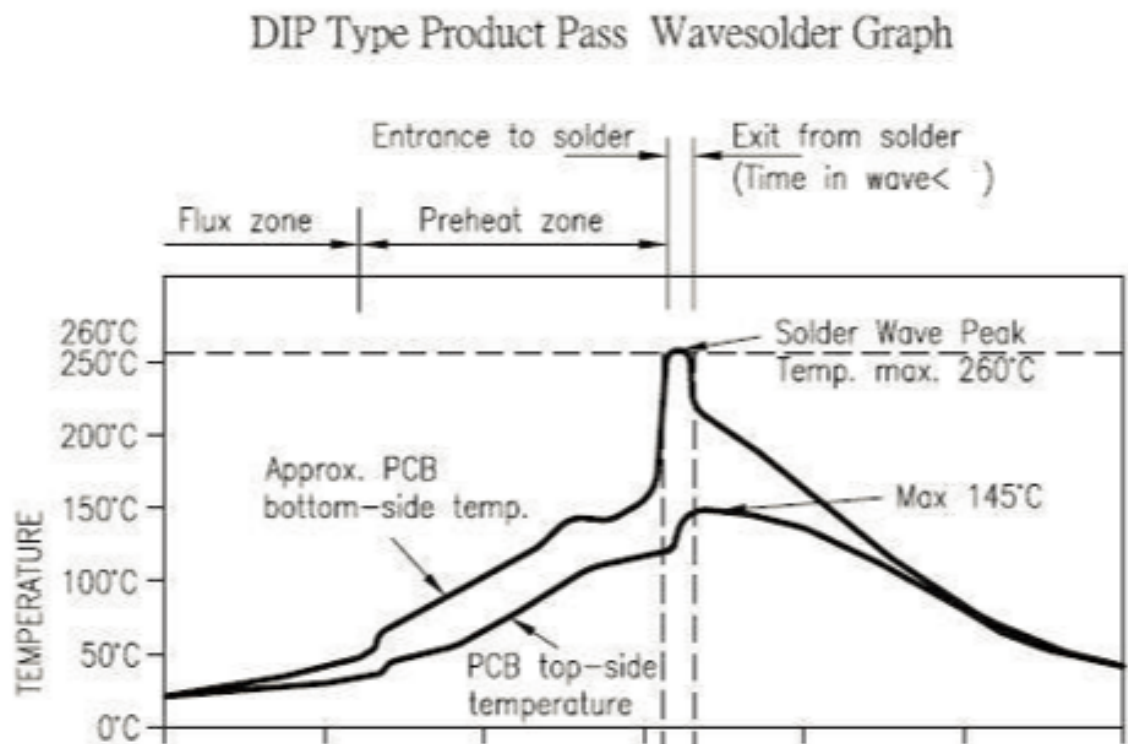
- D: ramp-up slope from 1°C/s to 3°C/s
- E: keep a constant temperature from 150°C to 200°C for a time period of 60s to 120s
- F: temperature above liquidus temperature for 50s to 70s
- G: peak temperature from 235°C to 245°C
- H: ramp-down slope from 1°C/s to 4°C/s



The curve above is based on solder paste SAC305. For more information about other solder pastes, see the recommended oven temperature curve in the specified solder paste specifications.

### Technique 2: Wave soldering process (oven temperature curve of wave soldering)

Set the oven temperatures according to the following temperature curve of wave soldering. The peak temperature is 260°C±5°C.



**Suggestions on  
wave soldering**

**Suggestions on  
manual repair  
soldering**

| <b>Suggestions on wave soldering</b> |               | <b>Suggestions on manual repair soldering</b> |                    |
|--------------------------------------|---------------|-----------------------------------------------|--------------------|
| Preheat temperature                  | 80°C to 130°C | Soldering temperature                         | 360°C ± 20°C       |
| Preheat duration                     | 75s to 100s   | Soldering duration                            | Less than 3s/point |
| Contact duration at the peak         | 3s to 5s      | N/A                                           | N/A                |
| Solder tank temperature              | 260°C ± 5°C   | N/A                                           | N/A                |
| Ramp-up slope                        | ≤ 2°C/s       | N/A                                           | N/A                |
| Ramp-down slope                      | ≤ 6°C/s       | N/A                                           | N/A                |

## 6.4. Storage conditions

|                                                                                                                                                                                         |                                                                                                                       |                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                        | <h2 style="margin: 0;">Caution</h2> <p style="margin: 0;">This bag contains<br/><b>MOISTURE-SENSITIVE DEVICES</b></p> | <div style="border: 1px solid black; padding: 5px; display: inline-block;"><b>LEVEL</b><br/><b>3</b></div> <p style="font-size: small; margin-top: 5px;">If blank, see adjacent<br/>bar code label</p> |
| <p>1. Calculated shelf life in sealed bag: 12 months at <math>&lt;40^{\circ}\text{C}</math> and <math>&lt;90\%</math> relative humidity (RH)</p>                                        |                                                                                                                       |                                                                                                                                                                                                        |
| <p>2. Peak package body temperature: <u>260</u> <math>^{\circ}\text{C}</math><br/><small>If blank, see adjacent bar code label</small></p>                                              |                                                                                                                       |                                                                                                                                                                                                        |
| <p>3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be</p>                                                                |                                                                                                                       |                                                                                                                                                                                                        |
| <p>a) Mounted within: <u>168</u> hours of factory conditions<br/><small>If blank, see adjacent bar code label</small><br/><math>\leq 30^{\circ}\text{C}/60\% \text{ RH}</math>, or</p>  |                                                                                                                       |                                                                                                                                                                                                        |
| <p>b) Stored per J-STD-033</p>                                                                                                                                                          |                                                                                                                       |                                                                                                                                                                                                        |
| <p>4. Devices require bake, before mounting, if:</p>                                                                                                                                    |                                                                                                                       |                                                                                                                                                                                                        |
| <p>a) Humidity Indicator Card reads <math>&gt;10\%</math> for level 2a - 5a devices or <math>&gt;60\%</math> for level 2 devices when read at <math>23 \pm 5^{\circ}\text{C}</math></p> |                                                                                                                       |                                                                                                                                                                                                        |
| <p>b) 3a or 3b are not met</p>                                                                                                                                                          |                                                                                                                       |                                                                                                                                                                                                        |
| <p>5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure</p>                                                                                                        |                                                                                                                       |                                                                                                                                                                                                        |
| <p>Bag Seal Date: <u>See Production Date</u><br/><small>If blank, see adjacent bar code label</small></p>                                                                               |                                                                                                                       |                                                                                                                                                                                                        |
| <p><b>Note: Level and body temperature defined by IPC/JEDEC J-STD-020</b></p>                                                                                                           |                                                                                                                       |                                                                                                                                                                                                        |

## 7. MOQ and packaging information

| Product model | MOQ (pcs) | Shipping packaging | Modules per reel | Reels per carton |
|---------------|-----------|--------------------|------------------|------------------|
| T1-M          | 6,000     | Tape and reel      | 1,500            | 4                |

## 8. Appendix: Statement

**FCC Caution:** Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this device. 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 device has been tested and found to comply with the limits for a Class B digital device, according to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This device generates, uses, and can radiate radio frequency energy and, if not installed and used following 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 device does cause harmful interference to radio or television reception, which can be determined by turning the device 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 device and receiver.
- Connect the device to 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 device complies with FCC radiation exposure limits set forth for an uncontrolled rolled environment. This device should be installed and operated with a minimum distance of 20cm between the radiator and your body.

### **Important Note**

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

The host product manufacturer is responsible for compliance with 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.

The end-user manual shall include all required regulatory information/warning as shown in this manual, including: This product must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

The RF module is considered as a limited modular transmitter according to FCC rules. Even though the RF module gets an FCC ID, the host product manufacturer can not use the FCC ID on the final product directly. In these circumstances, the host product manufacturer integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining the FCC authorization by a Class II permissive change application or a new application.

#### **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 the 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 from the human body.