T3-E2 Module Datasheet

Version: 20240819

Contents

T3-E2 module is a Wi-Fi 6 and Bluetooth Low Energy (LE) combo module developed by Tuya Smart. It is composed of a highly integrated radio-frequency identification (RFID) chip T3 and a few peripheral components. It can run in the station (STA) mode and access point (AP) mode.

1. Overview

T3-E2 has a built-in 32-bit MCU with a maximum running speed of 320 MHz, built-in 4 MB flash memory, and 640 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, SDIO, I2C, ADC, and SPI. 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 320 MHz.
- Operating voltage range: 2.0V to 3.6V.
- Peripherals: 5 PWM pins, 3 UART pins, 1 SDIO pin, 1 I2C pin, 7 ADC pins, and 1 SPI
- Wi-Fi connectivity
- IEEE 802.11b/g/n/ax.
- Channels 1 to 14 at 2.4 GHz.
- Support WEP, WPA/WPA2, WPA/WPA2 PSK (AES), and WPA3 security modes.
- The maximum output power is +17 dBm for IEEE 802.11b transmission.
- Support STA, AP, STA + AP combo, and direct 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.
- The onboard PCB antenna has a peak gain of 1.73 dBi.
- Operating temperature range: −40°C to 105°C.
- Bluetooth connectivity
- Bluetooth Core Specification v5.4.
- The transmitter power in Bluetooth mode is 6 dBm.
- Integral Wi-Fi and Bluetooth coexistence interface.
- The onboard PCB antenna has a peak gain of 1.73 dBi.

1.2. Scope of 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 T3-E2 dimensions are 13.2±0.35 mm (W) × 16.6±0.35 mm (L) × 2.6±0.15 mm (H). The figure below shows the dimensions of the T3-E2 module.

2.2. Pin definition

Pin No.	Symbol	I/O type	Description
1	GND	P	Ground pin.
2	GND	P	Ground pin.

Pin No.	Symbol	I/O type	Description
3	3V3	P	3.3V power pin.
4	TX2	I/O	UART_TX2 , corresponding to P41 (Pin 39) on the IC.
5	RX2	I/O	UART_RX2 , corresponding to P40 (Pin 40) on the IC.
6	P18	I/O	Support hardware PWM, corresponding to Pin 37 on the IC.
7	P19	I/O	GPIO pin, corresponding to Pin 38 on the IC.
8	CEN	I/O	The reset pin, active low, and pulled up internally. Corresponding to Pin 26 on the IC.
9	NC	NC	NC.
10	NC	NC	NC.
11	GND	P	Ground pin.
12	P48	I/O	GPIO pin, corresponding to Pin 10 on the IC.
13	P24	I/O	Support hardware PWM, corresponding to Pin 11 on the IC.
14	GND	P	Ground pin.

Pin No.	Symbol	I/O type	Description
15	NC	NC	NC.
16	P25	I/O	GPIO pin, corresponding to Pin 12 on the IC.
17	NC	NC	NC.
18	P28	I/O	GPIO pin, corresponding to Pin 13 on the IC.
19	P32	I/O	Support hardware PWM, corresponding to Pin 14 on the IC.
20	P34	I/O	Support hardware PWM, corresponding to Pin 15 on the IC.
21	P36	I/O	Support hardware PWM, corresponding to Pin 16 on the IC.
22	RX1	I/O	UART_RX1 , corresponding to P1 (Pin 17) on the IC.
23	TX1	I/O	UART_TX1 to print logs, corresponding to P0 (Pin 18) on the IC.
24	NC	NC	NC.
25	NC	NC	NC.

Pin No.	Symbol	I/O type	Description
26	P12	I/O	A normal GPIO pin, corresponding to Pin 21 on the IC.
27	P13	I/O	A normal GPIO pin, corresponding to Pin 22 on the IC.
28	NC	NC	NC.
29	NC	NC	NC.
30	RX0	I/O	`UART_RX0` to receive user data, corresponding to P10 (Pin 20) on the IC.
31	TX0	I/O	`UART_TX0` to send user data, corresponding to P11 (Pin 19) on the IC.
32	P14	I/O	A normal GPIO pin, corresponding to Pin 33 on the IC. It can be reused as `SPI_SCK`.
33	P15	I/O	A normal GPIO pin, corresponding to Pin 34 on the IC. It can be reused as `SPI_CS`.

Pin No.	Symbol	I/O type	Description
34	P16	I/O	A normal GPIO pin, corresponding to Pin 35 on the IC. It can be reused as `SPI_MOSI` .
35	P17	I/O	A normal GPIO pin, corresponding to Pin 36 on the IC. It can be reused as `SPI_MISO` .
36 to 53	GND	P	Ground pin.

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> - `P` indicates the power pin, and I/O indicates the input and output pin.
> - For more information about MCU general integration, see Hardware Reference Design of T3-X Series Modules .

3. Reuse of GPIO features

For detailed usage, refer to the SDK instructions.

Pin No.	GPIO	Feature 1	Feature 2	Feature 3	Feature 4	Feature 5
4	P41	UART2_RX	-	-	-	-
5	P40	UART2_TX	-	-	-	-
6	P18	SDIO_D2	PWM0_0	-	-	-
7	P19	SDIO_D3	-	-	-	-
12	P48	-	-	-	-	-
13	P24	-	PWM0_4	ADC2	-	-
16	P25	IRDA	-	ADC1	-	-
18	P28	-	-	ADC4	TOUCH2*	-
19	P32	-	PWM1_0	-	TOUCH6*	-
20	P34	-	PWM1_2	-	TOUCH8*	-
21	P36	-	PWM1_4	-	TOUCH10*	-
22	P1	UART1_RX	I2C1_SDA	-	-	ADC13
23	P0	UART1_TX	I2C1_SCL	-	-	ADC12
26	P12	UART0_RTS	-	-	TOUCH0*	ADC14
27	P13	UART0_CTS	-	-	TOUCH1*	ADC15
30	P10	UART0_RX	-	-	-	-
31	P11	UART0_TX	-	-	-	-
32	P14	SDIO_CLK	SPI0_SCK	-	I2C1_SCL	-
33	P15	SDIO_CMD	SPI0_CSN	-	I2C1_SDA	-
34	P16	SDIO_D0	SPI0_MOSI	-	-	-
35	P17	SDIO_D1	SPI0_MISO	-	-	-

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∗ indicates this feature is not supported currently.

4. Electrical parameters

4.1. Absolute electrical parameters

Parameter	Description	Minimum value	Maximum value	Unit
Ts	Storage temperature	−55	125	°C
VBAT	Supply voltage	−0.3	3.6	V
Electrostatic discharge voltage (human body model)	TAMB −25°C	−4	4	kV
Electrostatic discharge voltage (machine model)	TAMB −25°C	−200	200	V

4.2. Normal operating conditions

Parameter	Description	Minimum value	Typical value	Maximum value	Unit
Ta	Operating temperature	−40	-	105	°C
VBAT	Supply voltage	2.0	3.3	3.6	V
VIL	I/O low-level input	−0.3	-	0.3 VBAT	V
VIH	I/O high-level input	0.7 VBAT	-	VBAT + 0.3	V

Parameter	Description	Minimum value	Typical value	Maximum value	Unit
VOL	I/O low-level output	-	-	0.1 VBAT	V
VOH	I/O high-level output	0.9 VBAT − 0.3	-	-	V
Imax	I/O drive current	5	-	20	mA

4.3. 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	230	241	mA
Transmit	802.11g	54 Mbit/s	+15 dBm	200	210	mA
Transmit	802.11n	MCS7	+14 dBm	170	186	mA
Transmit	802.11ax	MCS7	+13 dBm	160	170	mA
Receive	802.11b	11 Mbit/s	Continuous reception	14	15	mA
Receive	802.11g	54 Mbit/s	Continuous reception	14	15	mA
Receive	802.11n	MCS7	Continuous reception	14	15	mA
Receive	802.11ax	MCS7	Continuous reception	14	15	mA

4.4. Operating current

The working mode. Valid values:	Status (Ta = 25°C)	Average value	Max (Typical) value	Unit

The working mode. Valid values:	Status (Ta = 25°C)	Average value	Max (Typical) value	Unit
Quick pairing (Bluetooth)	The module is in EZ mode. The network status indicator blinks quickly.	75	360	mA
Quick pairing (AP)	The module is 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 hotspot is intermittent. The network status indicator is steady on.	135	360	mA

The working mode. Valid values:	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

5. RF parameters

5.1. Basic RF features

Parameter	Description
Operating frequency	2.412 to 2.484 GHz
Wi-Fi standard	IEEE 802.11b/g/n/ax (channels 1–14)
Data transmission rate	• IEEE 802.11b: 1, 2, 5.5, and 11 Mbit/s • IEEE 802.11g: 6, 9, 12, 18, 24, 36, 48, and 54 Mbit/s • IEEE 802.11n: HT20 MCS0-7, HT40 MCS0-7 • IEEE 802.11ax: HE20 MCS0-9, HE40 MCS0-9
Antenna type	PCB antenna

5.2. Wi-Fi transmitter (TX) performance

Parameter	Minimum value	Typical value	Maximum 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

Parameter	Minimum value	Typical value	Maximum value	Unit
RF average output power, 802.11n OFDM mode, HT20 MCS7	-	14	-	dBm
RF average output power, 802.11n OFDM mode, HT40 MCS7	-	13	-	dBm
RF average output power, 802.11ax OFDMA mode, HE20 MCS7	-	14	-	dBm
RF average output power, 802.11ax OFDMA mode, HE40 MCS7	-	13	-	dBm
Frequency error	−20	-	20	ppm

5.3. Wi-Fi receiver (RX) performance

Parameter	Minimum value	Typical value	Maximum value	Unit

Parameter	Minimum value	Typical value	Maximum value	Unit
PER < 8%, RX sensitivity, 802.11b DSSS mode, 11 Mbit/s	-	−89	-	dBm
PER < 10%, RX sensitivity, 802.11g OFDM mode, 54 Mbit/s	-	−76	-	dBm
PER < 10%, RX sensitivity, 802.11n OFDM mode, HT20 MCS7	-	−75	-	dBm
PER < 10%, RX sensitivity, 802.11n OFDM Mode, HT40 MCS7	-	−73	-	dBm
PER < 10%, RX sensitivity, 802.11ax OFDMA Mode, HE20 MCS7	-	−74	-	dBm
PER < 10%, RX sensitivity, 802.11ax OFDMA Mode, HE40 MCS7	-	−73	-	dBm

5.4. Bluetooth transmitter (TX) performance

Parameter	Minimum value	Typical value	Maximum value	Unit
Operating frequency	2402	-	2480	MHz
Transmission rate over the air	-	1	-	Mbit/s
Transmission power	−20	6	15	dBm
Frequency error	−150	-	150	KHz

5.5. Bluetooth receiver (RX) performance

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

6. Antenna information

6.1. Antenna type

The T3-E2 module uses an onboard PCB antenna.

6.2. Antenna interference reduction

When a PCB antenna is used on a Wi-Fi module, we recommend that the module antenna is at least 15 mm away from other metal components. This can optimize the Wi-Fi performance.
Make sure that the enclosure surrounding the antenna is not traced or filled with copper. Otherwise, the RF performance might be degraded.

7. Packing and production instructions

7.1. Mechanical dimensions

Dimensions of the T3-E2 PCB are 13.2±0.35 mm (W) × 16.6±0.35 mm (L) ×

0.8±0.1 mm (H).

7.2. 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, we recommend that you 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
- AOI
- 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
- Electro-static 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 indicator 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 ≤ 5%. And 125°C for tray packaging with relative humidity ≤ 5% (use the 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.

7.3. 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.

IPC-7530a-3-1-cn
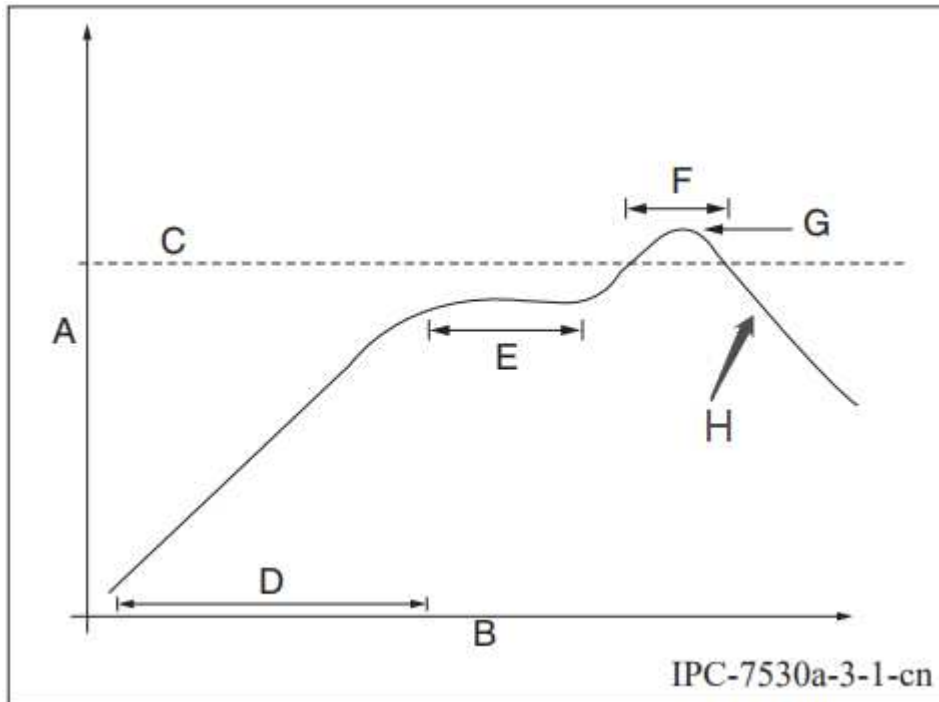
- A: temperature axis
- B: time axis
- C: alloy liquidus temperature from 217°C to 220°C
- D: ramp-up slope from 1°C/s to 3°C/s
- E: keep a constant temperature from 150°C to 200°C for a time period of 60s to 120s
- F: temperature above liquidus temperature for 50s to 70s
- G: peak temperature from 235°C to 245°C
- H: ramp-down slope from 1°C/s to 4°C/s

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> 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.

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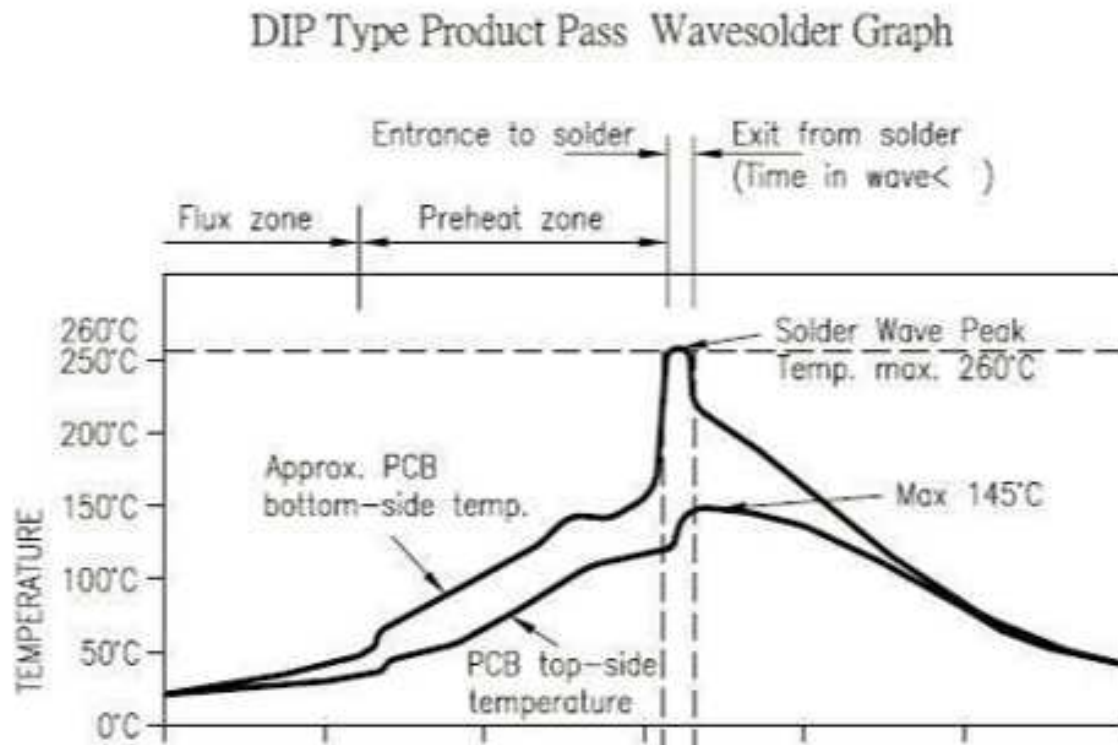
Suggestions on wave soldering		Suggestions on manual repair soldering	
Preheat temperature	80°C to 130°C	Soldering temperature	360°C ± 20°C
Preheat duration	75s to 100s	Soldering duration	Less than 3s/point
Contact duration at the peak	3s to 5s	N/A	N/A
Solder tank temperature	260°C ± 5°C	N/A	N/A
Ramp-up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

7.4. Storage conditions

Caution

This bag contains
MOISTURE-SENSITIVE DEVICES

LEVEL

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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: _____**260**_____ °C
   If blank, see adjacent bar code label

3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be

   a) Mounted within: _____**168**_____ hours of factory conditions
      If blank, see adjacent bar code label
      ≤30°C/60% RH, or

   b) Stored per J-STD-033

4. Devices require bake, before mounting, if:

   a) Humidity Indicator Card reads >10% for level 2a - 5a devices or >60% for level 2 devices when read at 23 ± 5°C

   b) 3a or 3b are not met

5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure

See Production Date

Bag Seal Date: _____
If blank, see adjacent bar code label

Note: Level and body temperature defined by IPC/JEDEC J-STD-020

8. MOQ and packaging information

Product model	MOQ (pcs)	Shipping packaging	Modules per reel	Reels per carton
T3-E2	4,400	Tape and reel	1,100	4

9. 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. The module is limited to installation in mobile or fixed applications.

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 by following FCC multi-transmitter

product procedures. Additional testing and device authorization may be required to operate simultaneously with other radios.

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 separate approval is required for all other operating configurations including portable configurations with respect to Part 2.1093 and different antenna configurations.

The end-user manual shall include all required regulatory information/warnings 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 OEM integrator is responsible for ensuring that the end-user has no manual instructions to remove or install the module.

This device has got an FCC ID: 2ANDL-T3-E2. The end product must be labeled in a visible area with the following: "Contains Transmitter Module FCC ID: 2ANDL-T3-E2".

This device is intended only for OEM integrators under the following conditions: The antenna must be installed such that 20cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna.

As long as the 2 conditions above are met, further transmitter tests 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 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.