TCS905-U Module Datasheet

Version: 20230117

Contents

TCS905-U is a low-power embedded Wi-Fi module that Tuya has developed. It consists of a highly integrated RF chip BK7231N and a few peripherals, and not only supports the AP and STA dual-network-connection manner but supports the Bluetooth LE network connection manner.

1 Overview

TCS905-U is built-in with a 32-bit MCU with a running speed of up to 120 MHz, 2Mbyte flash, and 256-KB RAM, so as to support the Tuya IoT cloud connection. The MCU's specially extended instructions for processing signals can effectively implement audio encoding and decoding. Besides, it has rich peripherals, such as PWM, UART, and SPI. The five 32-bit PWM output makes the chip very suitable for high-quality LED control.

1.1 Features

- Embedded low-power 32-bit CPU, which can also function as an application processor
- The clock rate: 120 MHz
- Operating voltage: 3.0V to 3.6V
- Peripherals: 5 PWMs, 2 UARTs, and 1 SPI
- Wi-Fi connectivity

    – 802.11 b/g/n
    – Channels 1 to 14@2.4 GHz
    – Support WEP, WPA/WPA2, WPA/WPA2 PSK (AES), WPA3 security modes
    – Up to + 16 dBm output power in 802.11b mode
    – Support STA/AP/STA+AP working mode
    – Support SmartConfig and AP network configuration manners for Android and iOS devices
    – Onboard PCB antenna with a gain of 2.2 dBi
    – Operating temperature: -40℃ to 105℃

- Bluetooth LE connectivity

    – Support the Bluetooth LE V5.2
    – 6 dBm transmit power in Bluetooth mode
    – Complete Bluetooth coexistence interface
    – Onboard PCB antenna with a gain of 2.2 dBi

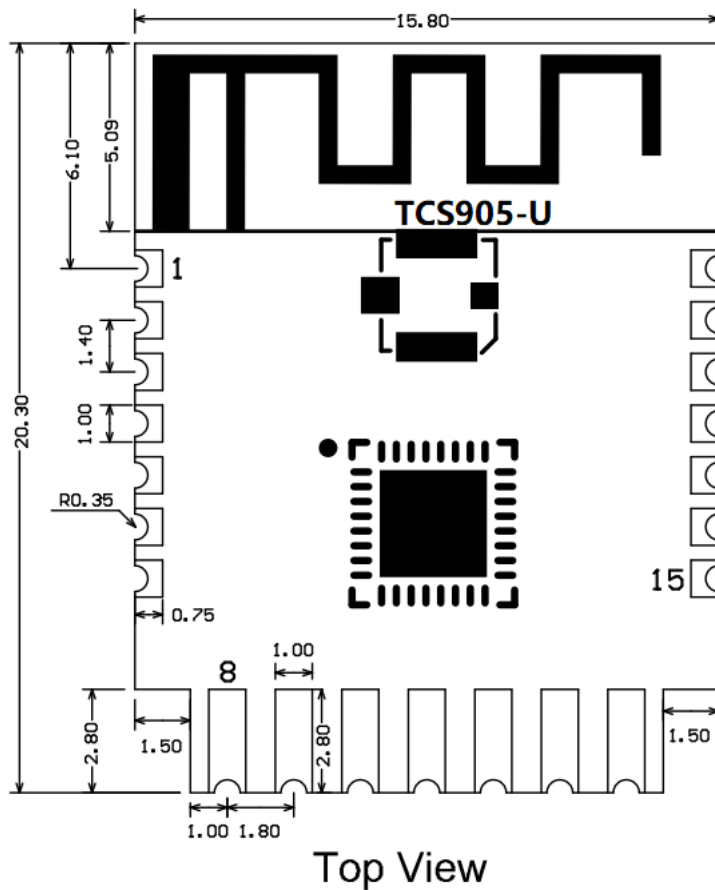## 1.2 Applications

- Intelligent building

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

2 Module interfaces

2.1 Dimensions and package

The TCS905-U dimensions are 15.8±0.35 mm (W)×20.3±0.35 mm (L) ×2.7±0.15 mm (H). The dimensions of TCS905-U are as follows:

Top View

2.2 Pin definition

Pin number	Symbol	I/O type	Function
1	P14	I/O	Common GPIO, which can be reused as SPI_SCK (Correspond to Pin 11 of the IC)
2	P16	I/O	Common GPIO, which can be reused as SPI_MOSI (Correspond to Pin 12 of the IC)
3	P20	I/O	Common GPIO (Correspond to Pin 20 of the IC)
4	P22	I/O	Common GPIO (Correspond to Pin 18 of the IC)
5	ADC	I/O	ADC, which corresponds to P23 on the internal IC (Correspond to Pin 17 of the IC)
6	RX2	I/O	`UART_RX2`, which corresponds to P1 on the internal IC. (Correspond to Pin 28 of the IC)

Pin number	Symbol	I/O type	Function
7	TX2	I/O	`UART_TX2`, which is used for outputting logs and corresponds to P0 of the internal IC (Correspond to Pin 29 of the IC)
8	P8	I/O	Support hardware PWM (Correspond to Pin 24 of the IC)
9	P7	I/O	Support hardware PWM (Correspond to Pin 23 of the IC)
10	P6	I/O	Support hardware PWM (Correspond to Pin 22 of the IC)
11	P26	I/O	Support hardware PWM (Correspond to Pin 15 of the IC)
12	P24	I/O	Support hardware PWM (Correspond to Pin 16 of the IC)
13	GND	P	Power supply reference ground
14	3V3	P	Power supply 3V3

Pin number	Symbol	I/O type	Function
15	TX1	I/O	`UART_TX1`, which is used for transmitting user data and corresponds to Pin 27 of the IC. For the MCU solution, please refer to CBx Module .
16	RX1	I/O	`UART_RX1`, which is used for receiving user data and corresponds to Pin 26 of the IC. For the MCU solution, please refer to CBx Module .
17	P28	I/O	Common GPIO (Correspond to Pin 10 of the IC)
18	CEN	I/O	Reset pin, low active (internally pulled high), compatible with other modules (Correspond to Pin 21 of the IC)
19	P9	I/O	Common GPIO (Correspond to Pin 25 of the IC)

Pin number	Symbol	I/O type	Function
20	P17	I/O	Common GPIO, which can be reused as `SPI_MISO` (Correspond to Pin 14 of the IC)
21	P15	I/O	Common GPIO, which can be reused as `SPI_CS` (Correspond to Pin 13 of the IC)
Test point	CSN	I/O	Mode selection pin. If it is connected to the ground before being powered on, enter the firmware test mode. If it is not connected or connected to VCC before being powered on, enter the firmware application mode. Correspond to Pin 19 on the internal IC.

Note: `P` indicates a power supply pin and I/O indicates an input/output pin. For the MCU solution, please refer to CBx Module.

3 Electrical parameters

3.1 Absolute electrical parameters

Parameter	Description	Minimum value	Maximum value	Unit
Ts	Storage temperature	-55	125	℃
VBAT	Power supply voltage	-0.3	3.9	V
ESD voltage (human body model)	TAMB-25℃	-4	4	KV
ESD voltage (machine model)	TAMB-25℃	-200	200	V

3.2 Normal working conditions

Parameter	Description	Minimum value	Typical value	Maximum value	Unit
Ta	Operating temperature	-40	-	105	℃
VBAT	Power supply voltage	3.0	3.3	3.6	V
VOL	I/O low level output	VSS	-	VSS+0.3	V
VOH	I/O high level output	VBAT-0. 3	-	VBAT	V

Parameter	Description	Minimum value	Typical value	Maximum value	Unit
Imax	I/O drive current	-	6	20	mA

3.3 RF power consumption

Working status	Mode	Rate	Transmit power/receive	Average value	Peak value (Typical value)	Unit
Transmit	11b	11Mbps	+16dBm	270	300	mA
Transmit	11g	54Mbps	+15dBm	260	280	mA
Transmit	11n	MCS7	+14dBm	253	273	mA
Receive	11b	11 Mbps	Constantly receive	73	82	mA
Receive	11g	54 Mbps	Constantly receive	75	82	mA
Receive	11n	MCS 7	Constantly receive	75	82	mA

3.4 Operating current

Working mode	Working status, Ta = 25°C	Average value	Maximum value (Typical value)	Unit
Quick network connection state (Bluetooth)	The module is in the fast network connection state and the Wi-Fi indicator flashes fast	85	360	mA
Quick network connection state (AP)	The module is in the hotspot network connection state and the Wi-Fi indicator flashes slowly	80	380	mA
Quick network connection state (EZ)	The module is in the fast network connection state and the Wi-Fi indicator flashes fast	87	360	mA
Connected	The module is in connected state and the Wi-Fi indicator light is always on	85	390	mA

Working mode	Working status, Ta = 25°C	Average value	Maximum value (Typical value)	Unit
Weakly connected	The module and the hotspot are weakly connected and the Wi-Fi indicator light is always on	208	395	mA
Disconnected	The module is in disconnected state and the Wi-Fi indicator light is always off	78	380	mA
Module disabled	The CEN pin of the module is connected to the ground.	330	-	μA

4 RF parameters

4.1 Basic RF features

Parameter	Description
Working frequency	2.412 to 2.480 GHz
Wi-Fi standard	IEEE 802.11 b/g/n (channels 1 to 14)
Data transmission rate	11b: 1, 2, 5.5, 11 (Mbps)
	11g: 6, 9, 12, 18, 24, 36, 48, 54 (Mbps)
	11n: HT20 MCS0-7
Antenna type	PCB antenna

4.2 Wi-Fi transmission performance

Parameter	Minimum value	Typical value	Maximum value	Unit
Average output power, 802.11b CCK Mode 11M	-	16	-	dBm
Average output power, 802.11g OFDM Mode 54M	-	15	-	dBm
Average output power, 802.11n OFDM Mode MCS7 (HT20)	-	14	-	dBm

Parameter	Minimum value	Typical value	Maximum value	Unit
Frequency error	-20	-	20	ppm

4.3 Wi-Fi receiving performance

Parameter	Minimum value	Typical value	Maximum value	Unit
PER<8%, RX sensitivity, 802.11b DSSS Mode 11M	-	-88	-	dBm
PER<10%, RX sensitivity, 802.11g OFDM Mode 54M	-	-74	-	dBm
PER<10%, RX sensitivity, 802.11n OFDM Mode MCS7 (HT20)	-	-72	-	dBm
PER<10%, RX sensitivity, Bluetooth LE 1M	-	-93	-	dBm

4.4 Bluetooth LE transmission performance

Parameter	Minimum value	Typical value	Maximum value	Unit
Working frequency	2402	-	2480	MHz
Air rate	-	1	-	Mbps
TX power	-20	6	20	dBm
Frequency error	-150	-	150	kHz

4.5 Bluetooth LE receiving performance

Parameter	Minimum value	Typical value	Maximum value	Unit
RX sensitivity	-	-93	-	dBm
Maximum RF signal input	-10	-	-	dBm
Inter-modulation	-	-	-23	dBm
Co-channel suppression ratio	-	10	-	dB

5 Antenna information

5.1 Antenna type

The TCS905-U module uses the PCB antenna.

5.2 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.
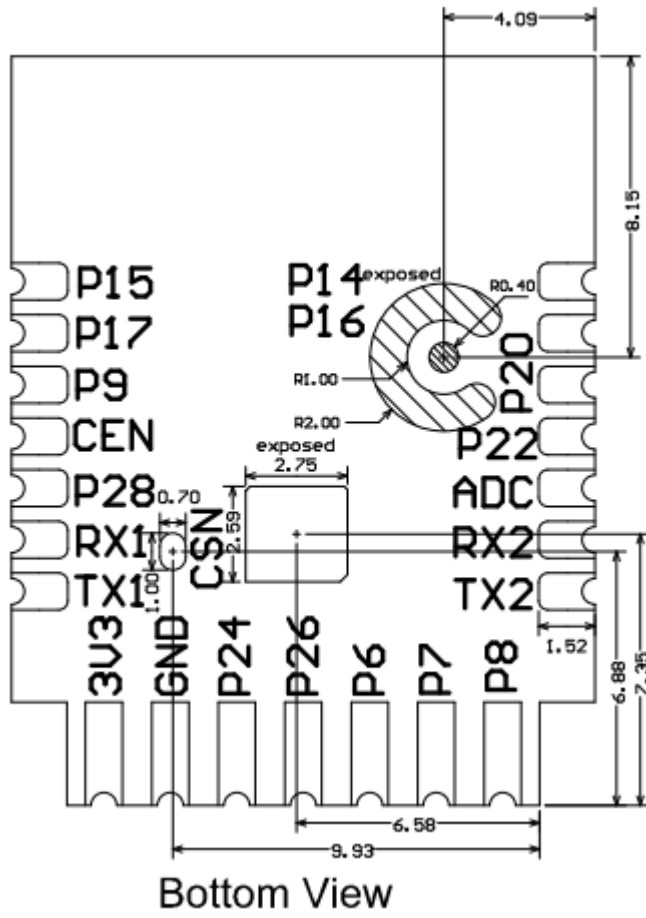To prevent an adverse impact on the antenna radiation performance, avoid copper or traces within the antenna area on the PCB.

6 Packaging information and production instructions

6.1 Mechanical dimensions

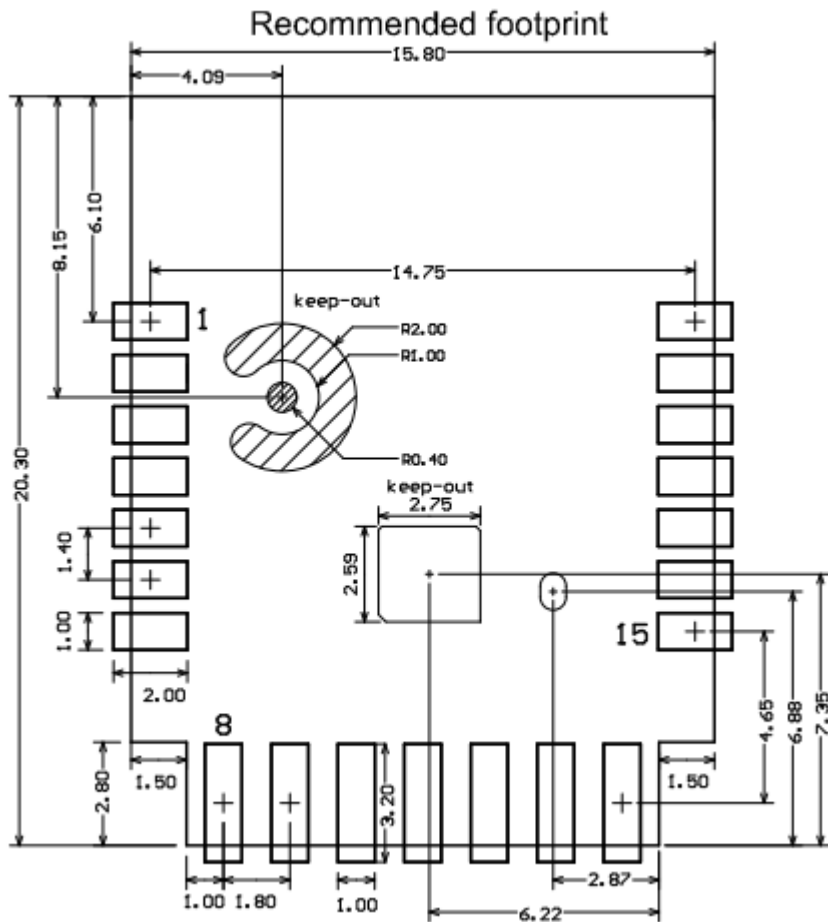The PCB dimensions are 15.8±0.35 mm (W)×20.3±0.35 mm (L) ×1.0±0.1 mm (H).

Top View

Bottom View
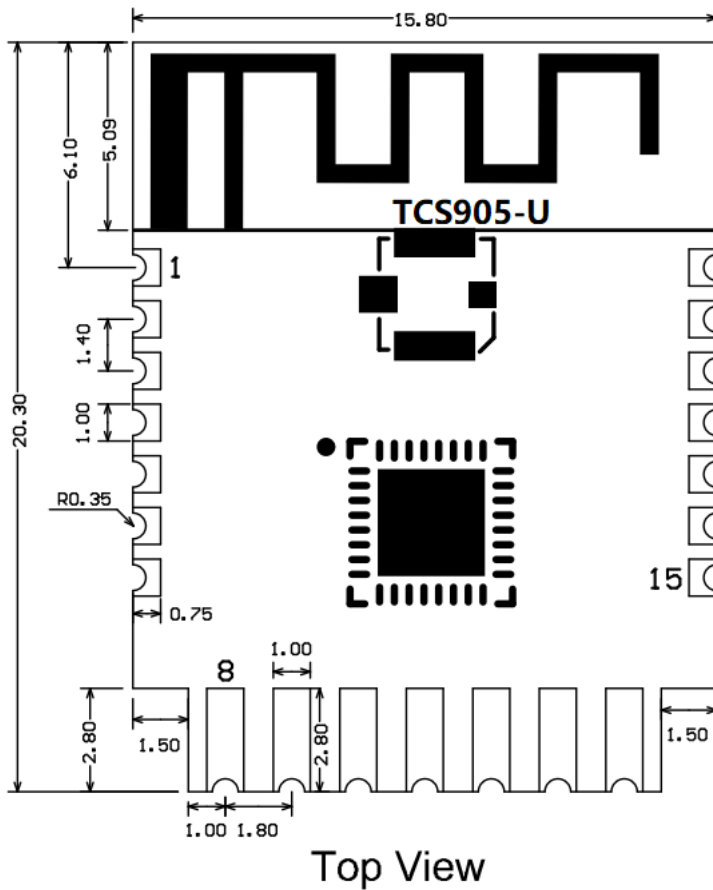
Unit：mm

Module form factor tolerance: ± 0.35mm

Plate thickness tolerance: ±0.1mm

Shield cover height tolerance: ±0.05mm

Side View

Recommended TCS905-U footprint:

Recommended footprint

6.2 Production instructions

1. For the modules that can be packaged with the SMT or in the in-line way, 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 be in-line-packaged, package the module in an in-line way. After being unpacked, the module must be soldered within 24 hours. Otherwise, it needs to be put into the drying cupboard where the relative humidity is not greater than 10%; or it needs to be packaged again under vacuum and the exposure time needs to be recorded (the total exposure time cannot exceed 168 hours).

   - (SMT process) SMT devices:
     - Mounter

- SPI
- Reflow soldering machine
- Thermal profiler
- Automated optical inspection (AOI) equipment

- (Wave soldering process) Wave soldering devices:

  - Wave soldering equipment
  - Wave soldering fixture
  - Constant-temperature soldering iron
  - Tin bar, tin wire, and flux
  - Thermal profiler

- Baking devices:

  - Cabinet oven
  - Anti-electrostatic and heat-resistant trays
  - Anti-electrostatic and heat-resistant gloves

2. Storage conditions for a delivered module:

   - 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.

   - There is a humidity indicator card (HIC) in the packaging bag.
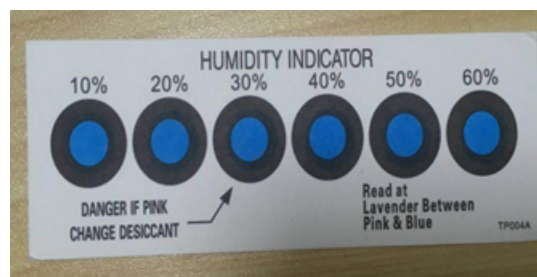

Figure 1: HIC-SMT and in-line module.png

3. The module needs to be baked in the following cases:

   - The packaging bag is damaged before unpacking.
   - There is no humidity indicator card (HIC) in the packaging bag.
   - After unpacking, circles of 10% and above on the HIC become pink.
   - The total exposure time has lasted for over 168 hours since unpacking.

- More than 12 months have passed since the sealing of the bag.

4. Baking settings:

- Temperature: 40°C and ≤ 5% RH for reel package and 125°C and ≤5% RH for tray package (please use the heat-resistant tray rather than a plastic container)
- Time: 168 hours for reel package and 12 hours for tray package
- Alarm temperature: 50°C for reel package and 135°C for tray package
- Production-ready temperature after natural cooling: < 36°C
- Re-baking situation: 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 within 168 hours, do not use the 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, it may result in device failure or poor soldering.

5. In the whole production process, take electrostatic discharge (ESD) protective measures.

6. To guarantee the passing rate, it is recommended 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 manner according to the process. For the SMT process, please refer to the recommended oven temperature curve of reflow soldering. For the wave soldering process, please refer to the recommended oven temperature curve of wave soldering. There are some differences between the set temperatures and the actual temperatures. All the temperatures shown in this module datasheet are obtained through actual measurements.

Manner 1: SMT process (Recommended oven temperature curve of reflow soldering)

Set oven temperatures according to the following curve.
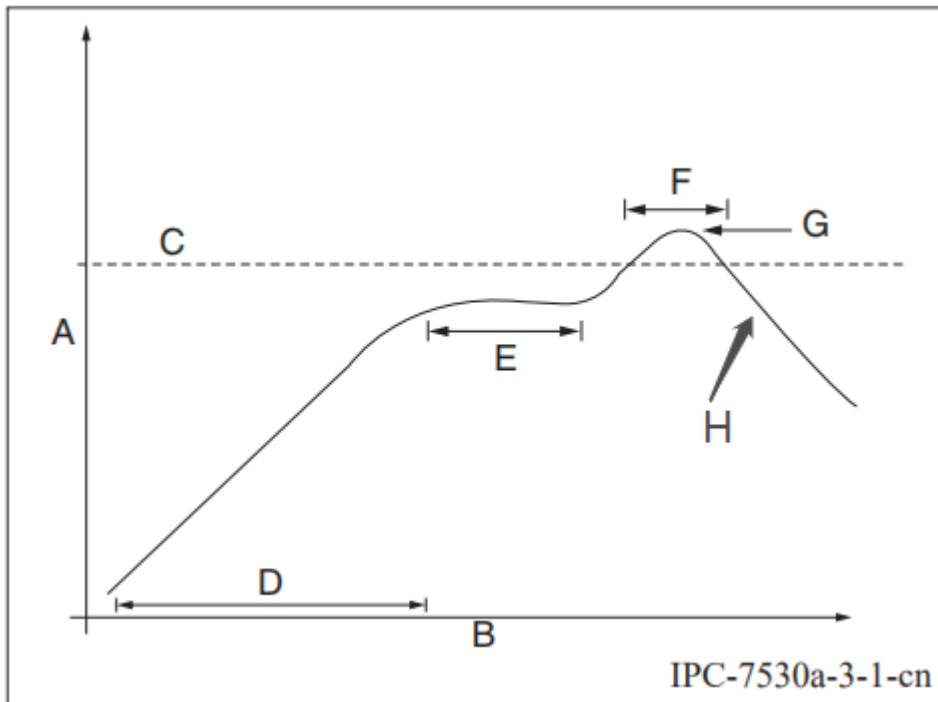
- A: Temperature axis

- B: Time axis

- C: Liquidus temperature: 217 to 220°C

- D: Ramp-up slope: 1 to 3°C/s

- E: Duration of constant temperature: 60 to 120s; the range of constant temperature: 150 to 200°C

- F: Duration above the liquidus: 50 to 70s

- G: Peak temperature: 235 to 245°C

- H: Ramp-down slope: 1 to 4°C/s

> **Note**: The above curve is just an example of the solder paste SAC305. For more details about other solder pastes, please refer to Recommended oven temperature curve in the solder paste specifications.

Manner 2: Wave soldering process (Oven temperature curve of wave soldering)

Set 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
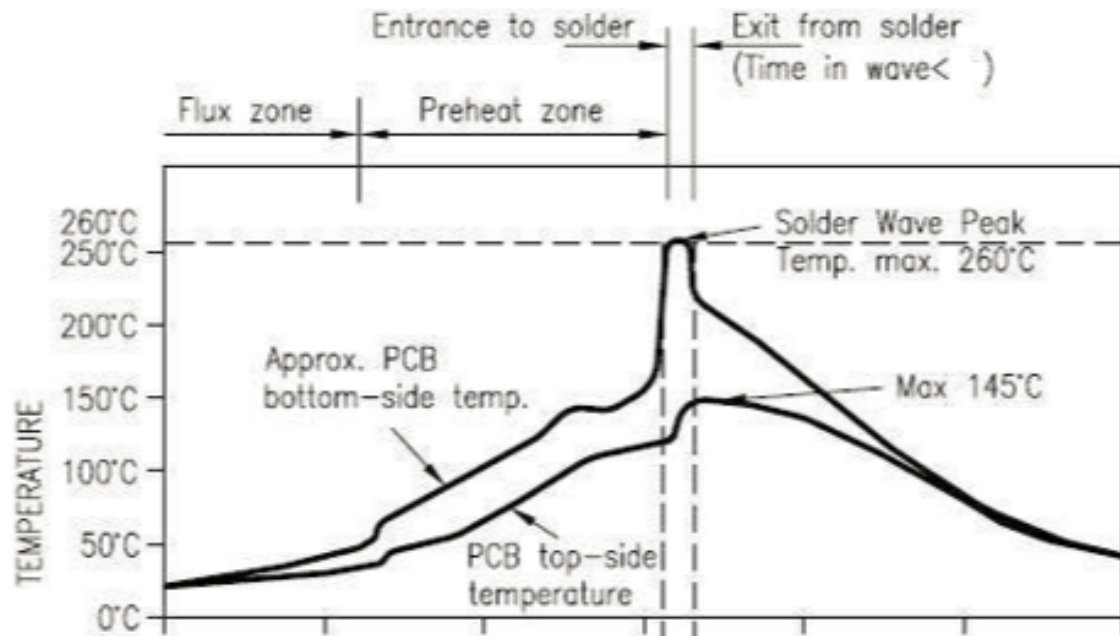
Suggestions on oven temperature curve of wave soldering		Suggestions on manual soldering temperature	
Preheat temperature	80 to 130 °C	Soldering temperature	360±20°C
Preheat time	75 to 100s	Soldering time	< 3s/point
Peak contact time	3 to 5s	NA	NA
Temperature of tin cylinder	260±5°C	NA	NA
Ramp-up slope	≤2°C/s	NA	NA
Ramp-down slope	≤6°C/s	NA	NA

6.4 Storage conditions

LEVEL

3

If blank, see adjacent bar code label

Caution
This bag contains
MOISTURE-SENSITIVE DEVICES

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

7 MOQ and packaging information

Product number	MOQ (pcs)	Shipping packaging method	The number of modules per reel	The number of reels per carton
TCS905-U	4400	Tape reel	1100	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. 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 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 by 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 configuration.

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 module.

This device has got an FCC ID: 2ANDL-TCS905-U. The end product must be labeled in a visible area with the following: "Contains Transmitter Module FCC ID: 2ANDL-TCS905-U".

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 to the human body.