BF6H-M Module Datasheet

Version: 20220301

Online Version

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BF6H-M is a low-power embedded Bluetooth audio module that Tuya has developed. It mainly consists of a highly integrated Bluetooth chip (FR8016HA) and a few peripheral circuits with the Bluetooth communication protocol stack and rich library functions inside. Based on the support of the Bluetooth intelligent firmware and protocol stack of the Freqchip, BF6H-M is completely compatible with the Bluetooth protocol V5.0 Meanwhile, users can develop various application programs on the basis of the ARM Cortex M3 in the 32-bit high-performance single-chip microcomputer. In the BF6H-M, audio CODEC, PMU (charger for lithium battery LDO), SPI flashROM with the XIP mode, IIC, UART, GPIO, ADC, and PWM are integrated into one chip, to use less power and offer stable connection.

1 Product overview

BF6H-M includes an ARM Cortex M3 32-bit processor, a Bluetooth 5.0/2.4G radio, a 150-KB ROM, a 48-KB SRAM, 15 reusable I/O ports, and a 16-bit single-channel audio CODEC.

1.1 Features

- ARM Cortex M3 32-bit processor
- Operating voltage: 1.8 to 4.3V
- Peripherals: 4 PWMs, 1 ADC, 3 GPIOs, 2 UARTs, 1 SPI, 1 MIC, and 1 speaker
- Support Li-Ion/Li-Polymer battery, programmable charging current, current up to 200mA for fast charging
- Bluetooth RF features:
  - Bluetooth LE 5.0
  - The RF data rate can be up to 2 Mbps.
  - TX power: +3 dBm
  - RX sensitivity: -93 dBm@ 1 Mbps
  - Support hardware encryption(AES/CCM)
  - PCB antenna with a gain of 3.37 dBi
  - Operating temperature: -20℃ to +85℃

1.2 Applications

- Smart LED
- Smart home

1.3 Change history

Update date	Updated content	Version after update
02/14/2022	This is the first release.	V1.0.0

2 Module interfaces

2.1 Dimensions and footprint

The dimensions of BF6H-M are 19±0.35 mm (L)×15.5±0.35 mm (W) ×2.5±0.15 mm (H). The thickness of the PCB is 0.8±0.1 mm, which are shown below:

image.png

image.png

2.2 Pin definition

The definitions of pins are shown in the following table:

Pin number	Symbol	Pin type	Function
1	GND	P	Power supply reference ground
2	SDO	I/O	Common I/O interface, which can be used as SPOUT of the SPI port and corresponds to Pin 25 of the IC
3	SDI	I/O	Common I/O interface, which can be used as SPDIN of the SPI interface and corresponds to Pin 24 of the IC

Pin number	Symbol	Pin type	Function
4	SCK	I/O	Common I/O interface, which can be used as SPCLK of the SPI interface and corresponds to Pin 23 of the IC
5	CS	I/O	Common I/O interface, which can be used as SPCSN of the SPI interface and corresponds to Pin 26 of the IC
6	NC	/	Not connected
7	PA1	I/O	Common I/O interface, which corresponds to Pin 29 of the IC
8	PA0	I/O	Common I/O interface, which corresponds to Pin 30 of the IC
9	TX1	I/O	UART1_TX for transmitting data, which can also be reused a common I/O pin and corresponds to Pin 27 of the IC chip

Pin number	Symbol	Pin type	Function
10	RX1	I/O	UART1_RX for receiving data, which can also be reused a common I/O pin and corresponds to Pin 28 of the IC chip
11	PMW4	I/O	Common I/O interface, which can be used as PWM output of the LED drive and corresponds to Pin 1 of the IC
12	PMW5	I/O	Common I/O interface, which can be used as PWM output of the LED drive and corresponds to P 2 of the IC
13	P26	I/O	Common I/O interface, which can be used as PWM output of the LED drive and corresponds to P 32 of the IC

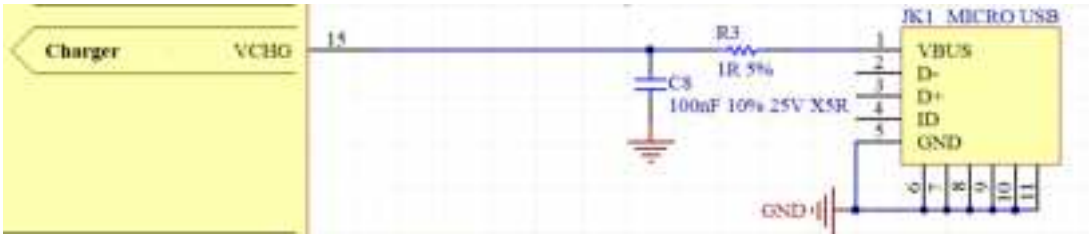
Pin number	Symbol	Pin type	Function
14	PMW1	I/O	Common I/O interface, which can be used as PWM output of the LED drive and corresponds to Pin 31 of the IC
15	NC	/	Not connected
16	VCHG	P	Charger, pin for charging, which corresponds to Pin 15 of the IC. It can be used to charge the external batteries
17	GND	P	Power supply reference ground
18	3V3	P	Power supply pin VCC (Typical value: 3.3V)
19	RXO	I/O	Serial port UART0_RX, which can be reused as a common I/O interface and corresponds to Pin 21 of the IC

Pin number	Symbol	Pin type	Function
20	TXO	I/O	Serial port UART0_TX, which can be reused as a common I/O interface and corresponds to Pin 20 of the IC. It can be used to output logs.
21	RST	I/O	Hardware reset pin (high active), correspond to Pin 14 of the IC
22	ADC	I/O	ADC port, 10 bit/s, which can be reused as a common I/O interface and corresponds to Pin 22 of the IC
23	MICB	AO	MIC_BIAS, microphone output, correspond to Pin 9 of the IC. The external microphone needs to be connected to a 2.2k resistor in series.

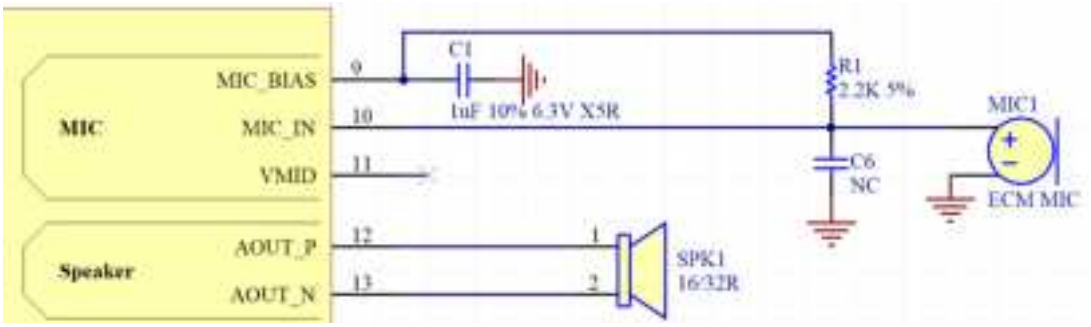
Pin number	Symbol	Pin type	Function
24	MIC	AI	MIC_IN, microphone input, correspond to Pin 10 of the IC. You should reserve an earth filter capacitor for the external microphone.
25	AN	AO	AOUT_N, audio differential output (negative), correspond to Pin 13 of the IC
26	NC	/	Not connected
27	AP	AO	AOUT_N, audio differential output (positive), correspond to Pin 12 of the IC
28	GND	P	Power supply reference ground

Note:

- The recommended voltage is 3.3V. The RF performance will be unstable when the operating voltage is under 2.5V.
- P indicates a power supply pin, I/O indicates an input/output pin, and AI/AO indicates an analog input/output pin.
- If you have any special requirements on the light colour controlled by the PWM output, please contact Tuya business personnel.
- The peripheral reference circuit of Charger is shown below:



- The peripheral reference circuits of MIC and Speaker are shown below:



3 Electrical parameters

3.1 Absolute electrical parameters

Parameter	Description	Minimum value	Maximum value	Unit
Ts	Storage temperature	-40	120	℃
I/O voltage	ALDO_OUT	1.6	3.3	V
VCC	Power supply voltage	1.8	4.3	V
ESD voltage (human body model)	TAMB-25℃	-	2	kV
ESD voltage (machine model)	TAMB-25℃	-	2	kV

3.2 Operating conditions

Parameter	Description	Minimum value	Typical value	Maximum value	Unit
Ta	Operating tempera-ture	-20	-	85	℃
VCC	Operating voltage	1.8	3.3	4.3	V
VCHG	Voltage for charger	4.75	5	5.25	V
V_{IL}	Voltage low input	-0.3	-	0.3* VDDIO	V

Parameter	Description	Minimum value	Typical value	Maximum value	Unit
V~IH	Voltage high input	0.7*VDDIO	-	VDDIO+0.3	V
V_{OL}	Voltage low output	-	-	0.33	V
V_{OH}	Voltage high output	1.8	-	-	V

> **Note**: The test condition for the above high/low voltage input/output is: VDDI/O = 3.3V

3.3 Power consumption in operating mode

Symbol	Conditions	Maximum value (Typical value)	Unit
Itx	Constantly transmit with the output power of 3 dBm	16.4	mA
Irx	Constantly receive	18.2	mA
IDC	Average value in mesh networking state	6.4	mA
IDC	Peak value in mesh networking state	23.3	mA
Ideepsleep	Average value in deep sleep state	6.1	uA

4 RF parameters

4.1 Basic RF features

Parameter	Description
Operating frequency	2.4 GHz ISM band
Wireless standard	Bluetooth LE 5.0
Data transmission rate	1 Mbps, 2 Mbps
Antenna type	PCB antenna

4.2 RF output power

Parameter	Minimum value	Typical value	Maximum value	Unit
Average RF output power	-20	3	-	dBm
Bandwidth of 20-dB modulation signal (1M)	-	2500	-	KHz

4.3 RF receiving sensitivity

Parameter	Minimum value	Typical value	Maximum value	Unit
Receiving sensitivity 1 Mbps	-	-93	-	dBm
Frequency offset error 1 Mbps	-250	-	+300	KHz

5 Audio CODEC parameters

5.1 Digital to analog converter (single channel)

Parameter	Condition	Minimum value	Typical value	Maximum value	Unit	
Conversior precision	-	-	-	16	Bits	
Sampling rate (Fs)*	Synchronous clock signal	8	-	48	V	uA
SNR	-		92		dB	uA
Digital gain	1/48dB	-48	-	32	dB	uA
Analog gain	3dB	0	-	30	dB	uA
Full-scale output voltage	VDDA=2.9V	-	1500	-	mV	uA
Stopband attenua-tion		65	-	-	V	uA

> **Note**: The test condition for sampling rate (Fs): Fin=1kHz B/W=20Hz—20KHz A-Weighted THD_N<0.01% Fs (8K, 16K, 32K, 44.1K, 48K)

5.2 Analog to digital converter (single channel)

Parameter	Condition	Minimum value	Typical value	Maximum value	Unit
Conversior precision	-	-	-	16	Bits

Parameter	Condition	Minimum value	Typical value	Maximum value	Unit	
Sampling rate (Fs)*	Synchronous clock signal	8	-	48	V	uA
SNR	Weighted/ı weighted	-	79	-	dB	uA
Digital gain	1/48dB	-48	-	32	dB	uA
Analog gain	3dB	0	-	30	dB	uA

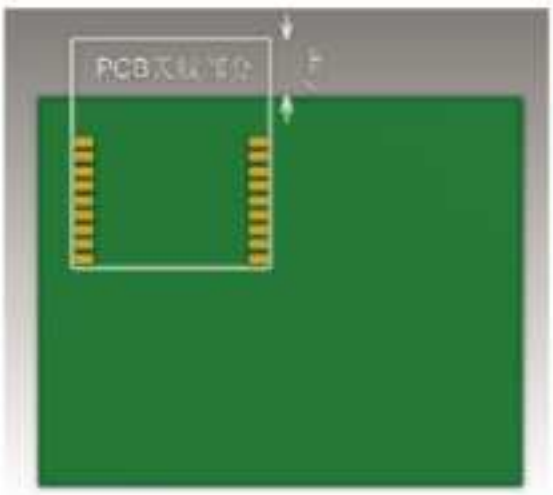
6 Antenna information

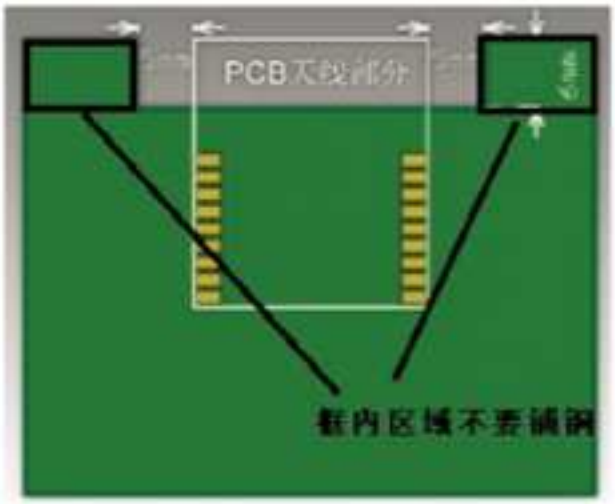
6.1 Antenna type

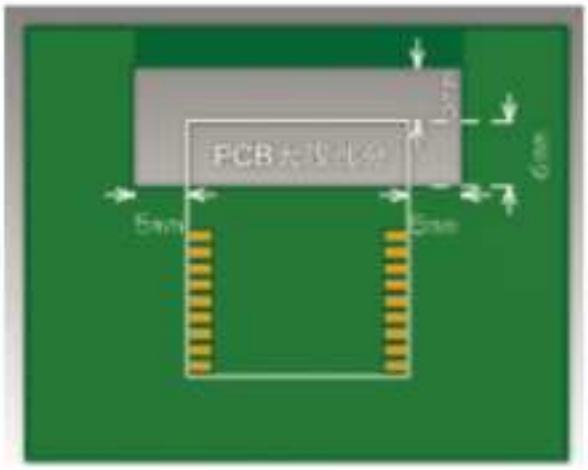
BF6H-M uses the PCB antenna with a gain of 3.37 dBi.

6.2 Interference reduction

To ensure the best RF performance, it is recommended that the antenna be at least 15 mm away from other metal parts. If metal materials are wrapped around the antenna, the wireless signal will be greatly attenuated, thereby deteriorating the RF performance. When you design a finished product, please leave enough space for the antenna, which is shown below:




PCB不铺铜部分
板内区域不要铺铜


PCB不铺铜部分
5mm
5mm

7 Packaging information and production instructions

7.1 Mechanical dimensions

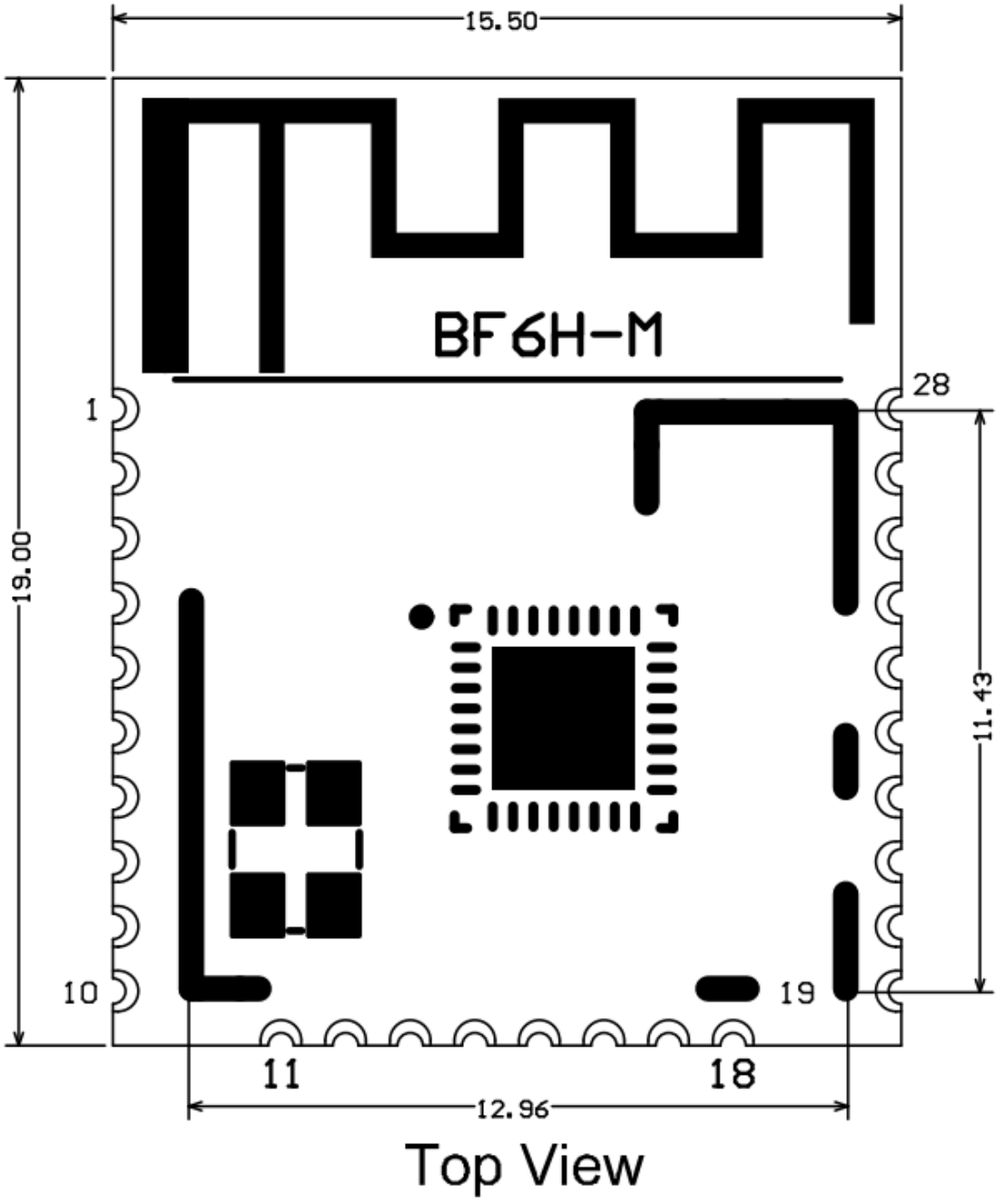
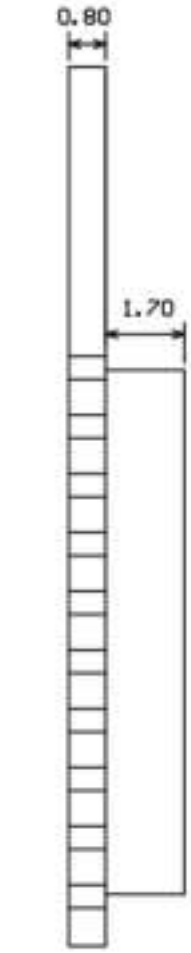


image.png

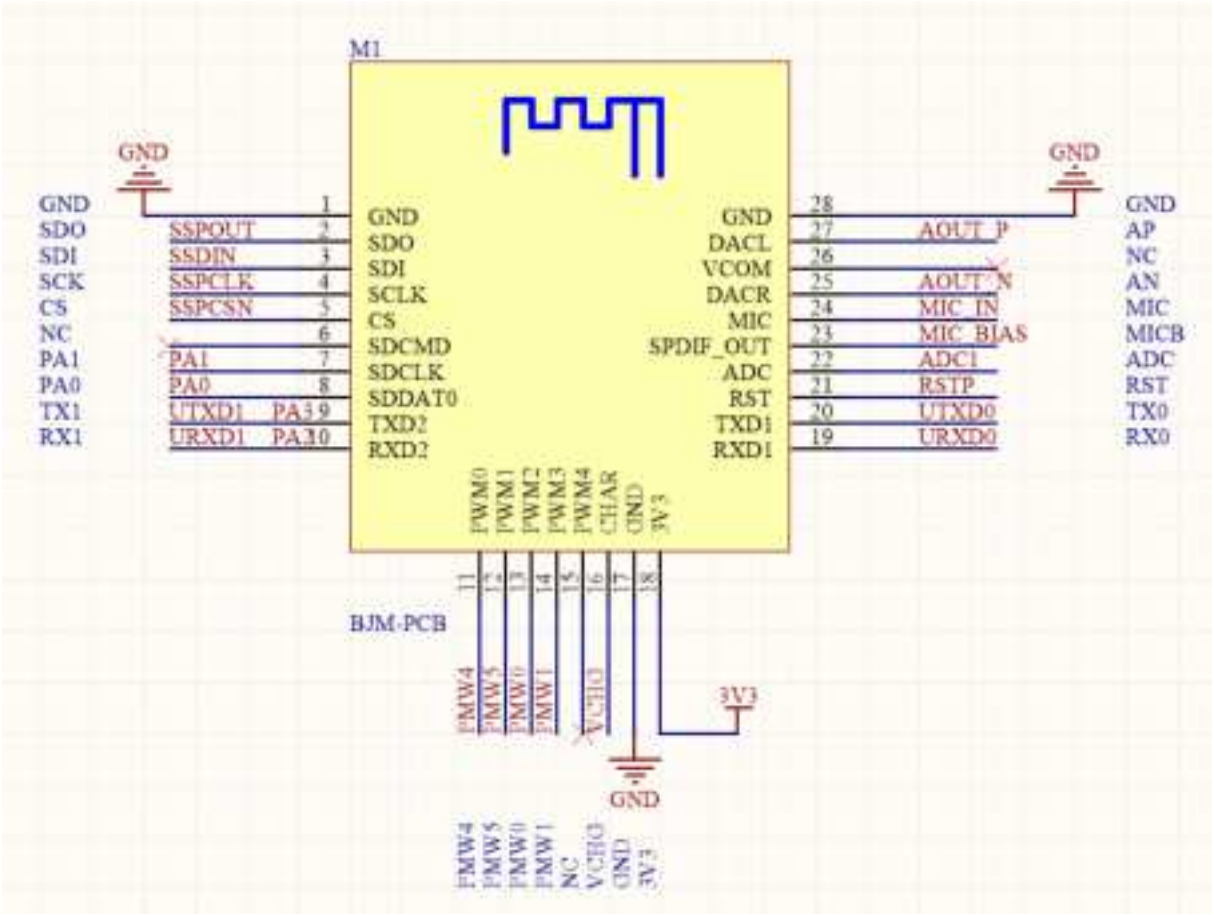


单位：mm
模组外形公差:±0.35mm
板厚公差:±0.1mm
屏蔽盖高度公差:±0.05mm

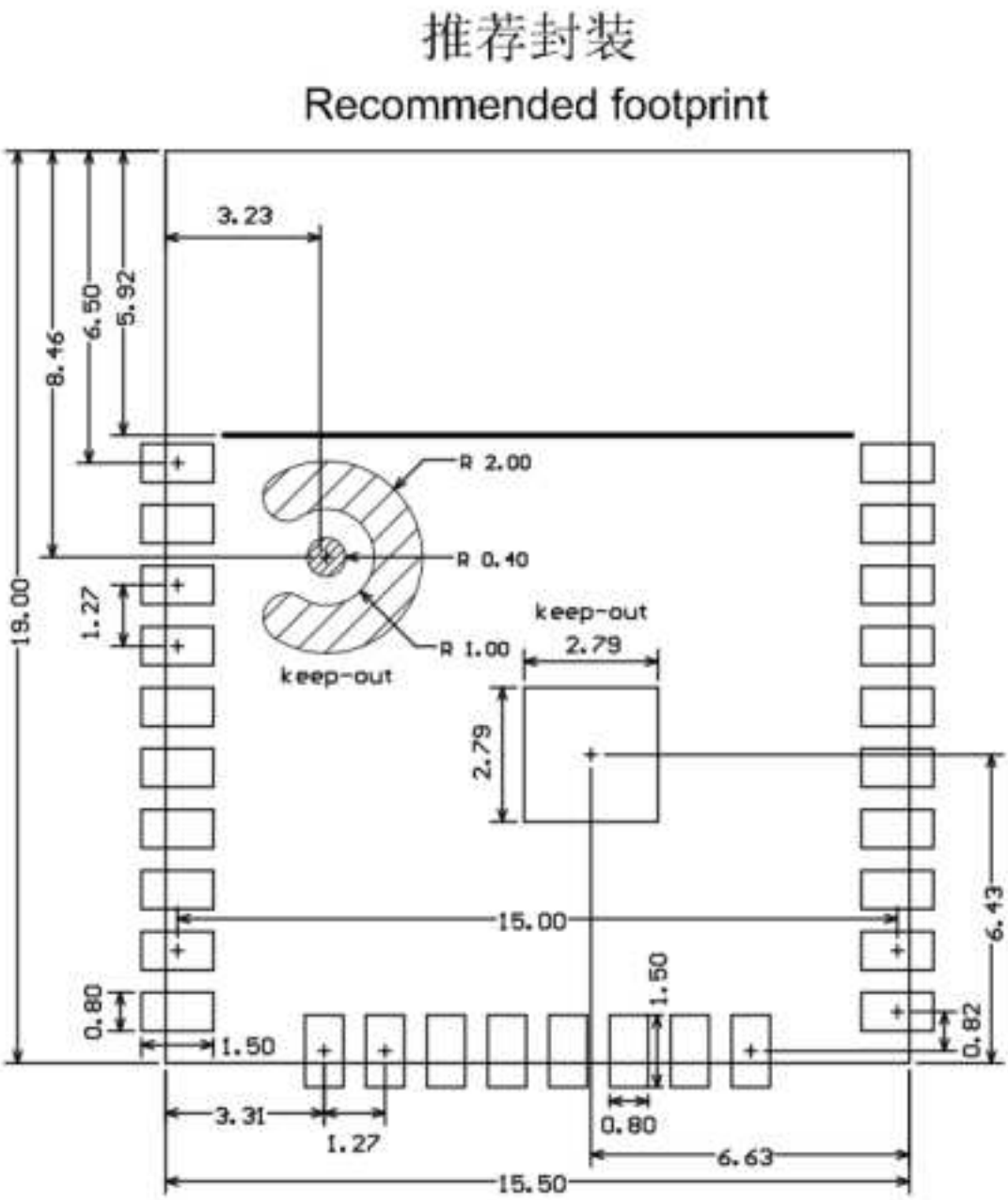
Unit：mm
Module form factor tolerance: ± 0.35mm
PCB thickness tolerance: ±0.1mm
Shield cover height tolerance: ±0.05mm

Side View

Schematic diagram of BF6H-M which shows how pins are located:



Recommended PCB footprint



:::info

> **Note**: The default outline dimension tolerance is ±0.35 mm, and the critical dimension tolerance is ±0.1 mm. If you have specific requirements on dimensions, specify them clearly in the datasheet after communication. :::

7.2 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 baseboard design solutions of customers. If a baseboard is designed to be SMT-packaged, package the module with the SMT. If a baseboard is designed to be in-line-packaged, package the module in the 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).

    - (Optional) SMT devices:
        - Mounter
        - SPI
        - Reflow soldering machine
        - Thermal profilter
        - Automated optical inspection (AOI) equipment
    - (Optional) Wave soldering devices
        - Wave soldering equipment
        - Wave soldering fixture
        - Constant-temperature soldering iron
        - Tin bar, tin wire and flux
        - Thermal profilter
    - 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 the 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.

```
1  ![HIC-SMT and in-line module.png](https://airtake-public-data-12541
2  53901.cos.ap-shanghai.myqcloud.com/goat/20210410/2c61fd34d2a6464d8cb
3  ee05f63689786.png)
```

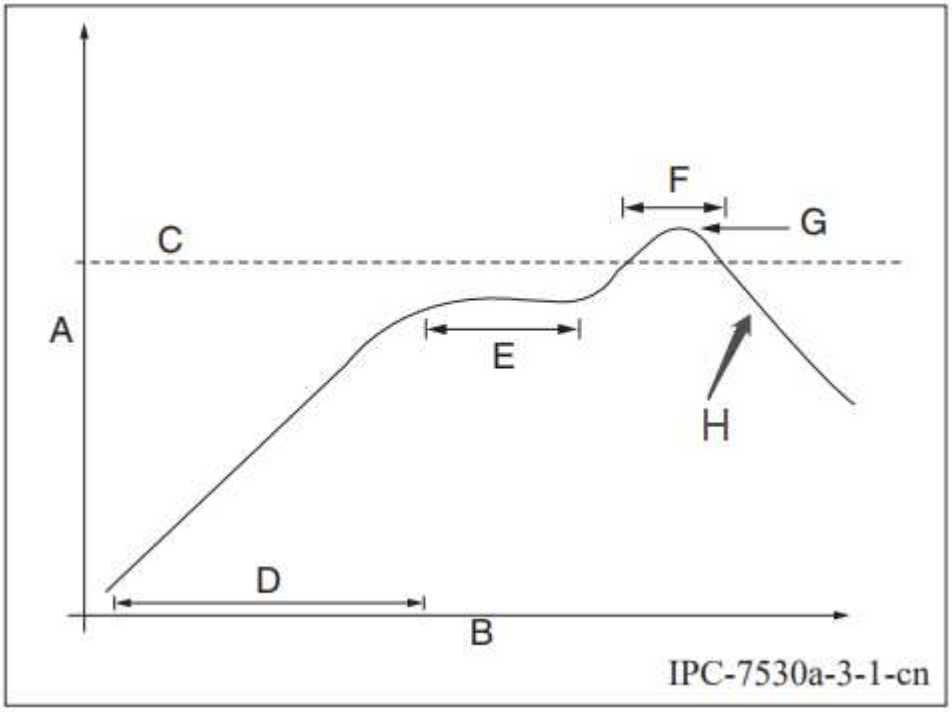
3. The module needs to be baked in the following cases:
    - The packaging bag is damaged before unpacking.
    - There is no humidity indicator card (HIC) in the packaging bag.
    - After unpacking, circles of 10% and above on the HIC become pink.
    - The total exposure time has lasted for over 168 hours since unpacking.
    - More than 12 months has passed since sealing of the bag.
4. Baking settings: -Temperature: 60°C and ≤ 5%RH for reel package and 125°C and ≤5%RH for tray package (please use the heat-resistant tray rather than plastic container)
    - Time: 48 hours for reel package and 12 hours for tray package
    - Alarm temperature: 65°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.

7.3 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.

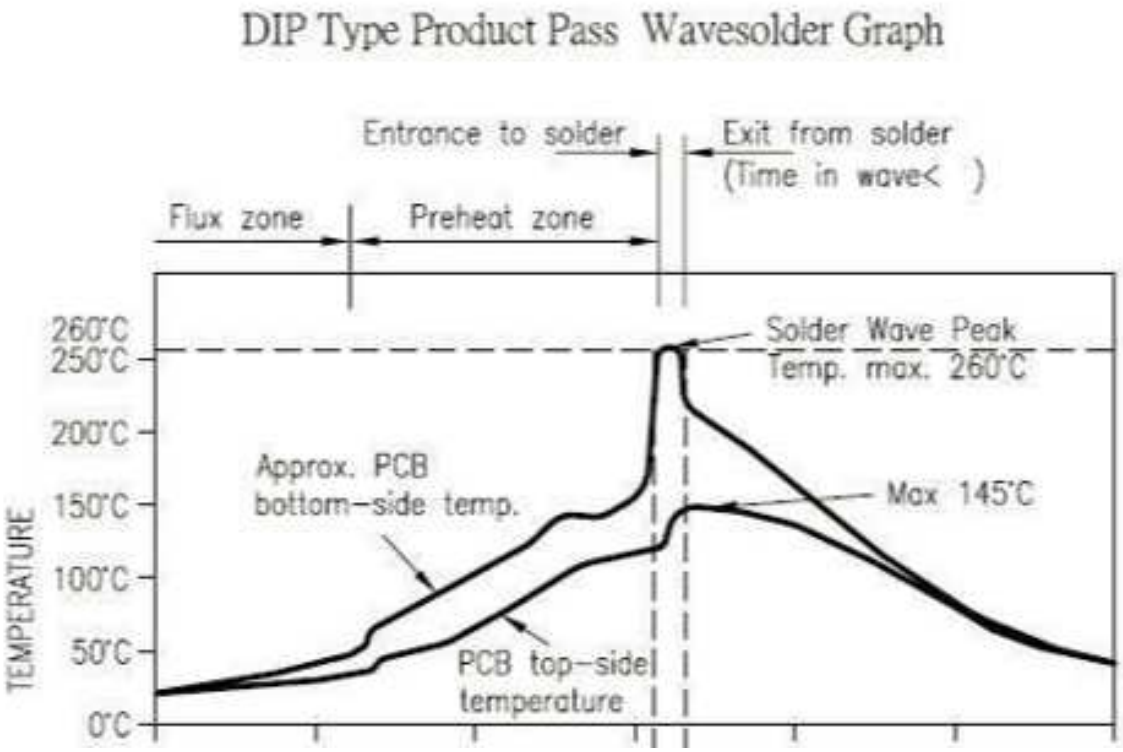


- A: Temperature axis
- B: Time axis
- C: Liquidus temperature: 217 to 220°C
- D: Ramp-up slope: 1 to 3°C/s
- E: Duration of constant temperature: 60 to 120s; the range of constant temperature: 150 to 200°C
- F: Duration above the liquidus: 50 to 70s
- G: Peak temperature: 235 to 245°C
- H: Ramp-down 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.

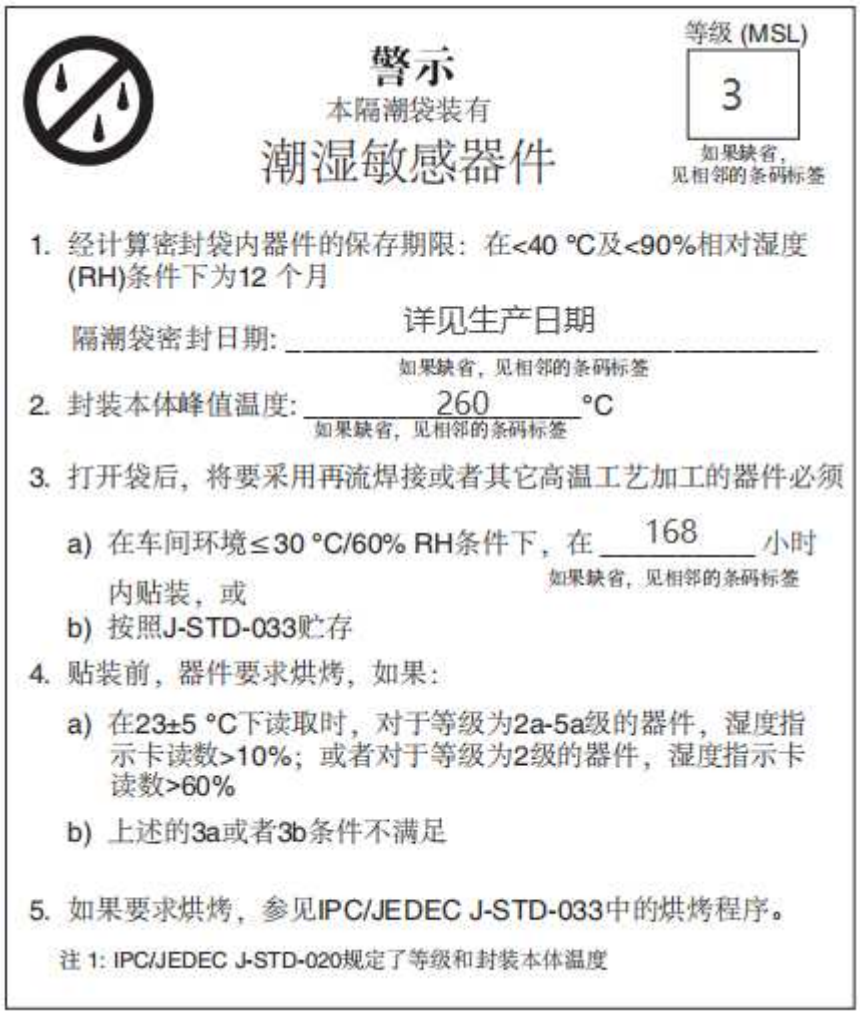
Manner 2: Wave soldering process (Oven temperature curve of wave soldering)

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



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

7.4 Storage conditions



警示

本隔潮袋装有

潮湿敏感器件

等级 (MSL)

3

如果缺省，
见相邻的条码标签

1. 经计算密封袋内器件的保存期限：在<40 °C及<90%相对湿度(RH)条件下为12 个月

   隔潮袋密封日期: 详见生产日期

   如果缺省，见相邻的条码标签

2. 封装本体峰值温度: 260 °C

   如果缺省，见相邻的条码标签

3. 打开袋后，将要采用再流焊接或者其它高温工艺加工的器件必须

   a) 在车间环境≤30 °C/60% RH条件下，在 168 小时内贴装，或

      如果缺省，见相邻的条码标签

   b) 按照J-STD-033贮存

4. 贴装前，器件要求烘烤，如果：

   a) 在23±5 °C下读取时，对于等级为2a-5a级的器件，湿度指示卡读数>10%；或者对于等级为2级的器件，湿度指示卡读数>60%

   b) 上述的3a或者3b条件不满足

5. 如果要求烘烤，参见IPC/JEDEC J-STD-033中的烘烤程序。

注 1: IPC/JEDEC J-STD-020规定了等级和封装本体温度

8 MOQ and packaging information

Product model	MOQ (pcs)	Packing method	Modules per reel	Reels per carton
BF6H-M	4400	Tape reel	1100	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.

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 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 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 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”.

This device has got an FCC ID: 2ANDL-BF6H-M. The end product must be labeled in a visible area with the following: “Contains Transmitter Module FCC ID: 2ANDL-BF6H-M”.

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 a municipal recycling collection point.

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