

# BLUETOOTH MODULE DATASHEET FOR CH16HL

Version: V1.0  
Date: 2023-12-23

## Release History

Version	Modification	Written	Approval	Date	Department
V1.0	Initial Version	WAN	DAVID	2020/10/10	R&D Dept

## 1. Product Introduction

## 1.1 Product Overview

CH16HL is a Bluetooth BLE control module developed and designed by Boshan based on Bluetooth Low Energy (Bluetooth Low Energy) technology for IOT, using FR801x Bluetooth BLE IC. With high cost performance and high reliability, it provides the best solution and service in IOT era.

For IOT applications, CH16HL module with a series of hardware design reference materials and APP, firmware, can quickly help developers and manufacturers to achieve the development of Bluetooth smart products and rapid finished mass production.

For customization and in-depth design, we will also provide API interface, development tools SDK, Some more details on the company's website <https://www.chuanthink.com>

## 1.2 Product Pictures

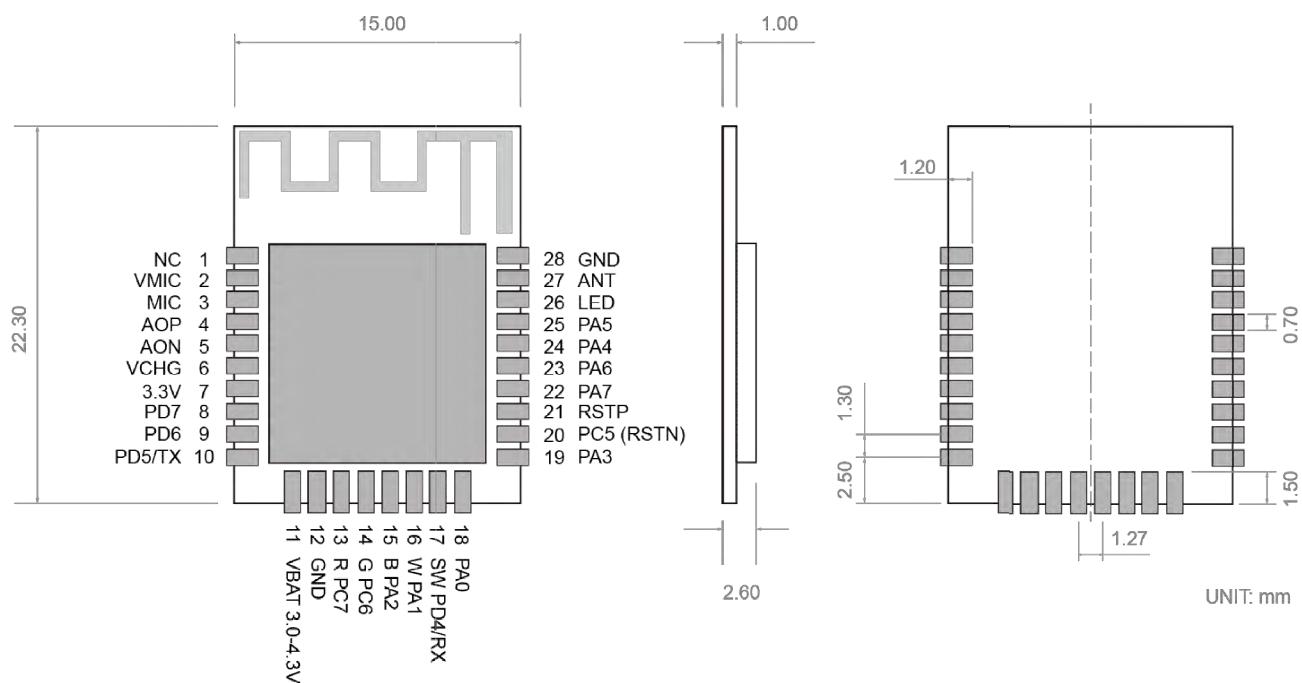
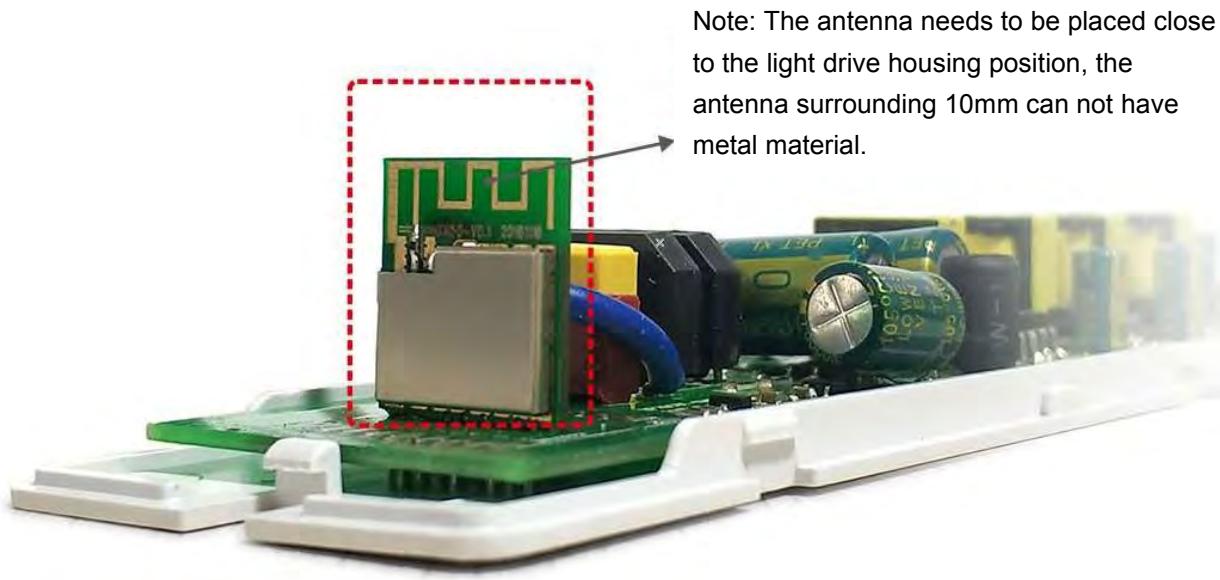


Figure 0.1 CH16HL Module (No IPEX Holders)

## 1.3 Application illustrations



Note: The antenna needs to be placed close to the light drive housing position, the antenna surrounding 10mm can not have metal material.

## 1.4 Intelligent Control System Introduction

With the integrated CH16HL module developers can implement the Bluetooth control function in the following figure, using Bluetooth or cloud-based system to installed APP software, Smart devices can be controlled by mobile APP/common switch/voice etc. We will create the perfect human-machine interaction mechanism and device to device interconnection to bring the best user experience.

Need to install the APP before Bluetooth pairing, Wireless connection between smart devices and cell phone Bluetooth or Bluetooth router through APP.



## 1.5 Modules & Applications

### Module Features

- Support 2.4GHz Bluetooth Low Energy BLE (Bluetooth Low Energy) 5.0
- Bluetooth specification V5.0 LE, support 2M, 1M, 500K and 125K data rates
- Supports up to 14 Bluetooth device connections , support master-slave role operation
- ARM CortexM3 32-bit processor and 12-48Mhz main frequency
- Built-in 150KB ROM, and up to 48KB SRAM
- Built-in 4Mbits memory for user program and data storage
- Interfaces: General GPIO, UART, SPI, I2C, PWM output, I2S, LED driver
- Built-in charge management unit
- Standalone watchdog circuit
- Support 240\*240 pixel LCD color screen
- Support MIC microphone input, AUDIO speaker output
- Support AT remote upgrade and cloud OTA upgrade
- Support BLUETOOTH SIG MESH self-organizing network function
- Support PCB on-board antenna (external antenna can be supported if needed)

### Applications

- Bluetooth Voice Remote Control
- Smart Toys
- Smart Lighting Fixtures
- Smart Sports and Fitness Equipment
- Smart Toothbrushes, Smart Weighing Scale and Smart Personal Care Devices
- Smart Home Appliances, Smart Home Devices
- Smart Medical Devices: Health Thermometer, Heart Rate, Blood Pressure, Blood Sugar, etc...

## 1.6 Product Specifications

Table 1-6-1 Product Specifications:

Protocols and Interface Standard	
Bluetooth Standard	Bluetooth V5.0 LE standard
Data Interface	UART/SPI/I2C/I2S/IR Remote Control (Not for Lighting Control) GPIO,UART,SPI,I2C,PWM,I2S,LED
I/O Port	17 General I/O ports, all can be set as interrupts
CPU	
Main frequency processing speed	12-48 Mhz

Memory Capacity	
SRAM	128KB ROM, up to 48KB RAM
FLASH	512KB FLASH ROM
Bluetooth BLE Features	
Transmit Power	Up to 10dBm Transmit Power
Encryption Type	AES/CCM
Bluetooth RF Parameters (Typical)	
Operating Frequency	2400-2483.5 mhz
Transmit Power	≤ 20 dbM
Operating Current (Typical)	
Power Input VCC	1.8~4.3V
Operating Current	8 mA
Operating Conditions	
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +125°C
Operating Humidity	5% to 95% (No Condensation)
Physical Parameters	
Antenna Type	PCB built-in Antenna, can choose whether IPEX holder is required (connect to external antenna)
Product Size	15.00*20.00*2.60(H) mm
Wireless Transmission Distance	
Wireless Transmission Distance	Indoor: 20m, Outdoor: 30m (depending on the environment)

## 1.7 Interface Definition

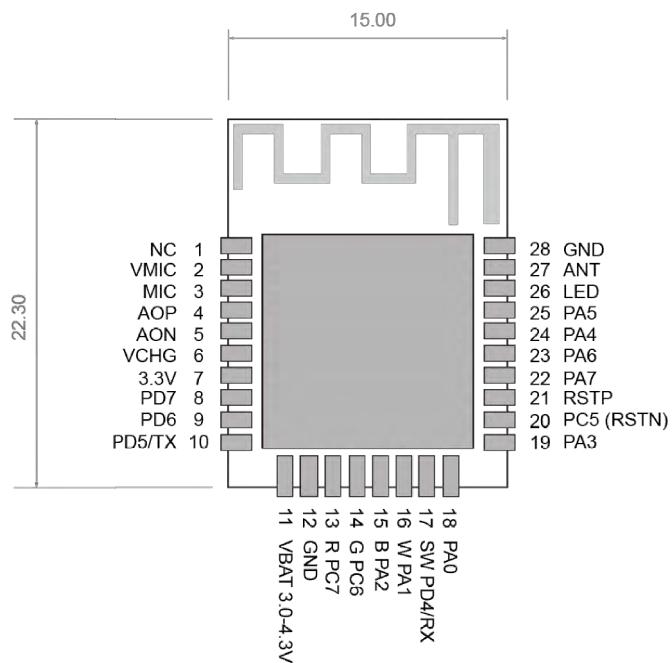


Figure 1-7-1 Pin Identification

Table 1-7-1 CH16HL BLE Module Pin Function Definition

No.	Pi Define	Pin Type	Function Description
1	NC	NC	Not applicable
2	VMIC	AO	Microphone bias out
3	MIC	AI	Microphone input
4	AOP	AO	Speaker output positive
5	AON	AO	Speaker output negative
6	VCHG	PWR	Charger supply input
7	3.3V	AO	Analog linear regulator output
8	PD7	DIO	SDA1/I2SDIN/PWM1/SSPDIN/UTXD0/UTXD1/ANT CTL1/PDMDAT/PWM0/ADC3
9	PD6	DIO	SCL1/I2SDOUT/PWM0/SSPDOUT/URXD0/URXD1/ CLKOUT/PDMCLK/PWM1/ADC2
10	PD5/TX	DIO	SDA0/I2SFRM/PWM5/SSPCSN/UTXD0/UTXD1/ANT CTL0/PDMDAT/PWM4/ADC1
11	VBAT	PWR	Battery positive supply input
12	GND	GND	Ground
13	R PC7	DIO	SDA1/I2SDIN/PWM5/SSPDIN/UTXD0/UTXD1/SWD IO/PDMDAT/PWM4

14	G PC6	DIO	SCL1/I2SDOUT/PWM4/SSPDOUT/URXD0/URXD1/SWTCK/PDMCLK/PWM5
15	B PA2	DIO	SCL1/I2SDOUT/PWM2/SSPDOUT/URXD0/URXD1/ANTCTL0/PDMCLK/PWM3
16	W PA1	DIO	SDA0/I2SFRM/PWM1/SSPCSN/UTXD0/UTXD1/ANTCTL0/PDMDAT/PWM0
17	SW PD4/RX	DIO	SCL0/I2SCLK/PWM4/SSPCLK/URXD0/URXD1/ANTCTL0/PDMCLK/PWM5/ADC0
18	PA0	DIO	SCL0/I2SCLK/PWM0/SSPCLK/URXD0/URXD1/CLKOUT/PDMCLK/PWM1
19	PA3	DIO	SDA1/I2SDIN/PWM3/SSPDIN/UTXD0/UTXD1/ANTCTL1/PDMDAT/PWM2
20	PC5	DIO	SDA0/I2SFRM/PWM5/SSPCSN/UTXD0/UTXD1/SWV/PDMDAT/PWM4
21	RSTP	AI	Global reset (high active)
22	PA7	DIO	SDA1/I2SDIN/PWM1/SSPDIN/UTXD0/UTXD1/ANTTL0/PDMDAT/PWM0
23	PA6	DIO	SCL1/I2SDOUT/PWM0/SSPDOUT/URXD0/URXD1/CLKOUT/PDMCLK/PW1M1
24	PA4	DIO	SCL0/I2SCLK/PWM4/SSPCLK/URXD0/URXD1/CLKOUT/PDMCLK/PWM5
25	PA5	DIO	SDA0/I2SFRM/PWM5/SSPCSN/UTXD0/UTXD1/ANTCTL1/PDMDAT/PWM4
26	LED	DO	LED2 control
27	ANT	AIO	RF input
28	GND	GND	Ground

Table 1-7-1 CH16HL BLE Module Pin Function Definition

Mark	Description
I	Digital Input
O	Digital Output
AI	Analog Input
AO	Analog Output
IO	Bidirectional(digital)
OD	Open Drain
PWR	Power
GND	Ground

## 2. Electrical Characteristics

Table 2-1 Electrical Recommended Use Parameters

Parameters	Description	Min	Typical	Max	Unit
Operating Temperature	Operating Temperature of 2 hours after power-on	-20	20	105	°C
Nuclear Voltage	N/A	0.9	1.2	1.3	V
I/O Voltage	VDDIO	1.65	2.5	3.5	V
Supply Voltage	VBAT	1.8	3.3	4.3	V
Charger Voltage	VCHG	4.75	5	5.25	V

Table 2-2 DC Electric Gas Parameters Table

Type	Name	Min	Max	Unit
Input Logic LOW	VIL	-0.3	0.3*VDDIO	V
Input Logic HIGH	VIH	0.7*VDDIO	VDDIO+0.3	V
Output Logic LOW	VOL	-	0.1*VDDIO	V
Output Logic HIGH	VOH	0.8*VDDIO	-	V

Table 2-3 Power Consumption Parameters

Operating Mode	Average	Max	Unit
TX Peak Current (0dB)	N/A	8	mA
RX Peak Current	N/A	9.7	mA
Deep Sleep Current(48K RAM Keep)	6.1	N/A	µA
Shutdown Current	2.7	N/A	µA

Table 2-4 Environmental Parameters

Operating Mode	Min	Max	Unit
Operating Temperature	-45	+85	°C
Storage Temperature	-55	+125	°C
Operating Humidity (non-condensing)	5%	95%	-
Storage Humidity (non-condensing)	5%	95%	-

### 3. RF Parameter

#### 3.1 General Wireless Characteristics Parameters

Table 3-1 General Wireless Characteristics

Name	Conditions	Min	Typical	Max
Frequency Range(MHz)	-	2402	-	2480

#### 3.2 Bluetooth receive (Rx) characteristics parameters

Table 3-2 Bluetooth receive characteristics parameters table

Name	Conditions	Min	Typical	Max
Sensitivity (dBm)	PER ≤30.8%	-95	-	-
Maximum Input Level (dBm)	PER ≤30.8%		1	-
C/I	C/I co-channel (dB)	21	-	-
	C/I +1MHz (dB)	15	-	-
	C/I -1MHz (dB)	15	-	-
	C/I +2MHz (dB)	-15	-	-
	C/I -2MHz (dB)	-17	-	-
	C/I +3MHz (dB)	-9	-	-
	C/I -3MHz (dB)	-27	-	-
	C/I Image+1MHz (dB)	-15	-	-
	C/I Image-1MHz (dB)	-15	-	-
Blocker Power (dBm)	70~2000MHz, Wanted signal level =-67dBm	-30	-	-
	2003~2399MHz, Wanted signal level =-67dBm	-35	-	-
	2484~2997MHz, Wanted signal level =-67dBm	-35	-	-
	3000MHz~6000MHz, Wanted signal level =-67dBm	-30	-	-
Max PER Report Integrity	Wanted signal: -30dBm	-	50%	-
Max Inter modulation level (dBm)	Wanted signal (f0): -64dBm Worst inter modulation level @2f1-f2=f0,  f1-f2 =n MHz, n=3, 4, 5... -	-50	-	-

### 3.3 Bluetooth Transmit (Tx) Characteristics Parameters

Table 3-3 Bluetooth Transmission Characteristics Parameters Table

Name	Conditions	Min	Typical	Nax
Maximum Output Power (dBm)	N/A	-30	0	10
Adjacent Channel Power Ratio (dBm)	+2MHz	-	-	-41
	-2MHz	-	-	-41
	$\geq +3\text{MHz}$	-	-	-42
	$\leq -3\text{MHz}$	-	-	-42
Modulation Characteristics	$\Delta f_1$ avg (kHz)	-	240	-
	$\Delta f_2$ max (kHz)	185	-	-
	$\Delta f_2$ max Pass Rate (%)	-	100	-
	$\Delta f_2$ avg / $\Delta f_1$ avg	-	0.9	-
Carrier Frequency Offset and Drift	Average Fn (kHz)	-	12.5	-
	Drift Rate (kHz/50μs)	-	10	-
	Avg Drift (kHz/50μs)	-	10	-
	Max Drift (kHz/50μs)	-	10	-
Output power of second harmonic(dBm)	N/A	-	-50	-
Output power of third harmonic(dBm)	N/A	-	-50	-

## 4. Operating Environment

### 4.1 Electrostatic Discharge Parameters

Table 4-1 Electrostatic Discharge Parameters Table

Name	Symbol	Reference	Level	Max	Unit
Electrostatic Discharge Voltage (manikin)	VESD (HBM)	Degree: 16°C~35°C Follow ANSI/ESDA/JEDEC JS-001-2014	2	2000	V

### 4.2 Recommended Operating Conditions

4-2 Table of Recommended Operating Conditions

Symbol	Parameters	Min	Mid	Max	Unit
VDD3	3.3V Supply Voltage	1.8	3	4.3	V
TA	Ambient operating temperature	-40	25	105	°C
TS	Storage temperature	-40	25	125	°C

## 5. Reflow Soldering Conditions

- (1) Heating Method: conventional convection or IR convection
- (2) Allowable reflow times: 2 times, based on the following tilt-up temperature conditions
- (3) Peak Temperature: < 250°C

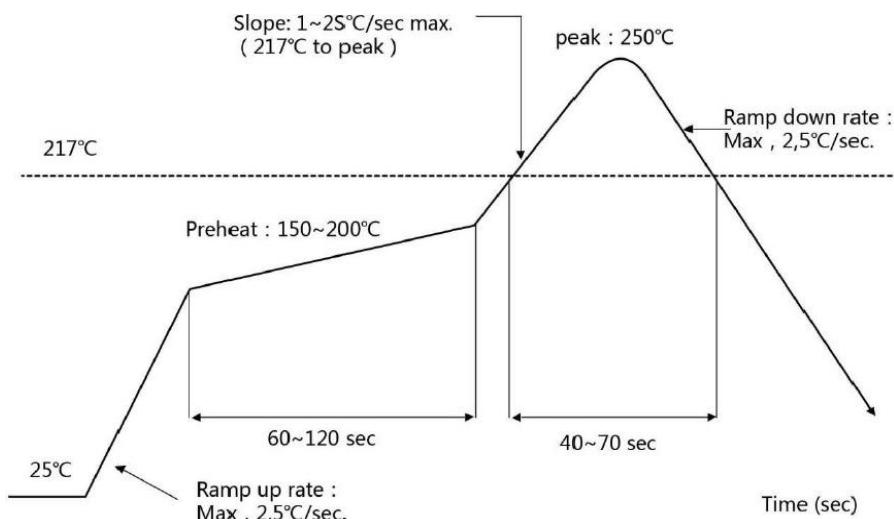
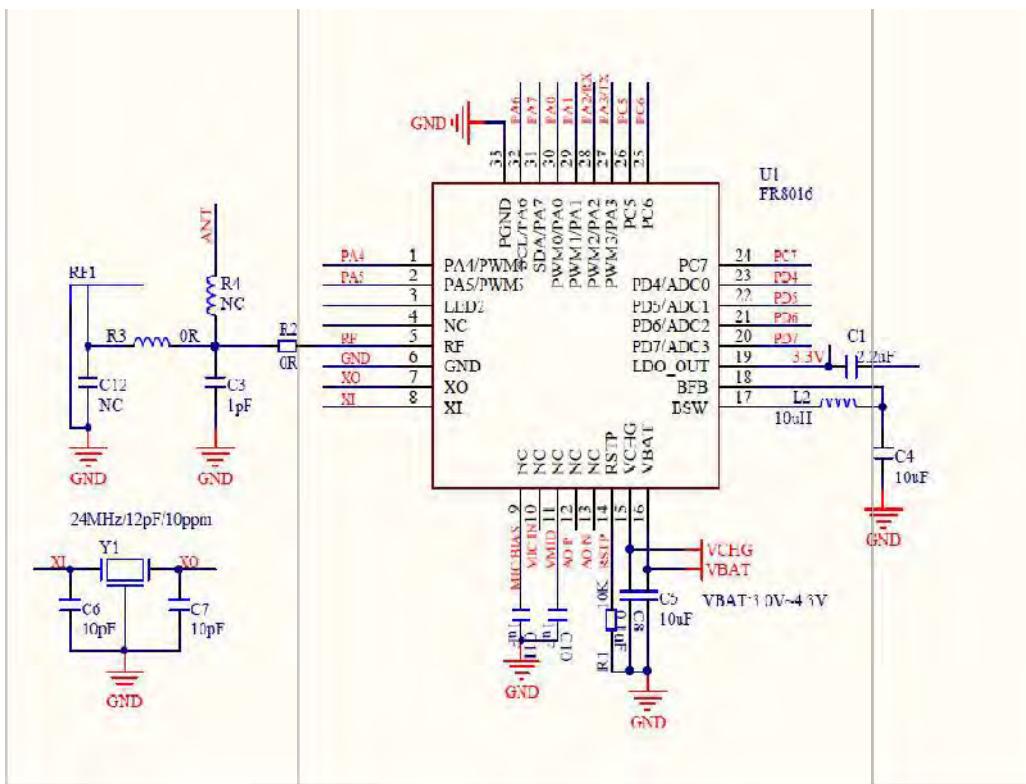


Table 5-1 Reflow Soldering Conditions Chart

# 6. Application Circuits

Table 6-1 Application Circuit Diagram



# 7. AT Command

## 8.1 AT Command Configuration

- The AT+ command is that in command mode the user through UART and module command transmission instruction set , and the format of the AT+ command will be explained later.
- After power-up successfully, the module can be set up via UART.
- The module UART port parameters are: Baud rate 9600, no Parity, 8 data bits, 1 stop bit

## 8.2 AT Command Overview

The AT+ command can be entered directly through CRT or a serial debugger. The AT+ command uses an ASCII-based command line, and the format of the command is as follows:

### 1. Format Description

< >: Mandatory Part

[ ]: Optional Parts

### 2. Command Message

AT+[op][para-1,para-2,para-3,para-4...] <CR> <LF>

AT+: Command Message Prefix;

[op]: Command Operation Symbol, Parameter Setting or Inquiry

“=” : Parameter Setting

“?” : Inquiry

[para-n]: Input for Parameter Setting, not required if Inquiry.

<CR>: End, Enter, ASCII Code 0X0D;

<LF>: End, Line Breaks, ASCII Code 0X0A;

[SPACE]: Blank Spaces, Spaces, ASCII Code 0X20

## 8.3 Response Message

<CR><LF>+<RSP>[op][para-1,para-2,para-3,para-4...]<CR><LF>

+: Response Message Prefix;

RSP: Response Strings, including:

“OK” : Success

“ERR” : Fail

[para-n] : Error Code when Returns Parameters or Errors

<CR>: ASCII Code 0x0d;

<LF>: ASCII Code 0x0a;

[SPACE]: Blank Spaces, Spaces, ASCII Code 0X20

## 7. Packaging Method

Packing method A: Adopt Anti-Static Blister Tray Box, 100 PCS in one Box, and the tray box size as below.

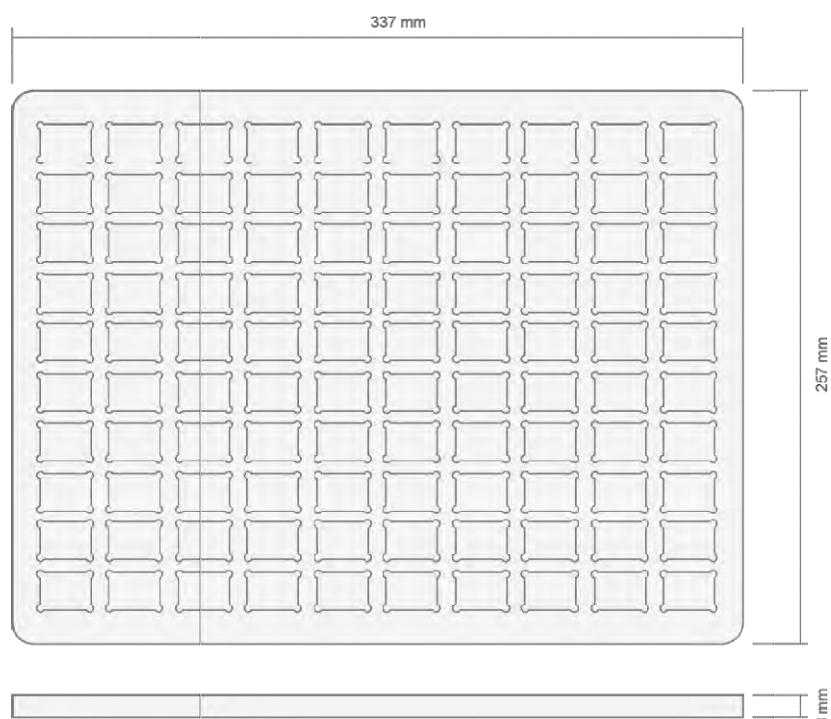


Figure 7-1 Blister tray box size

Packing method B: 2000 PCS per roll by Braided Tape, the size of the Tape is as below.

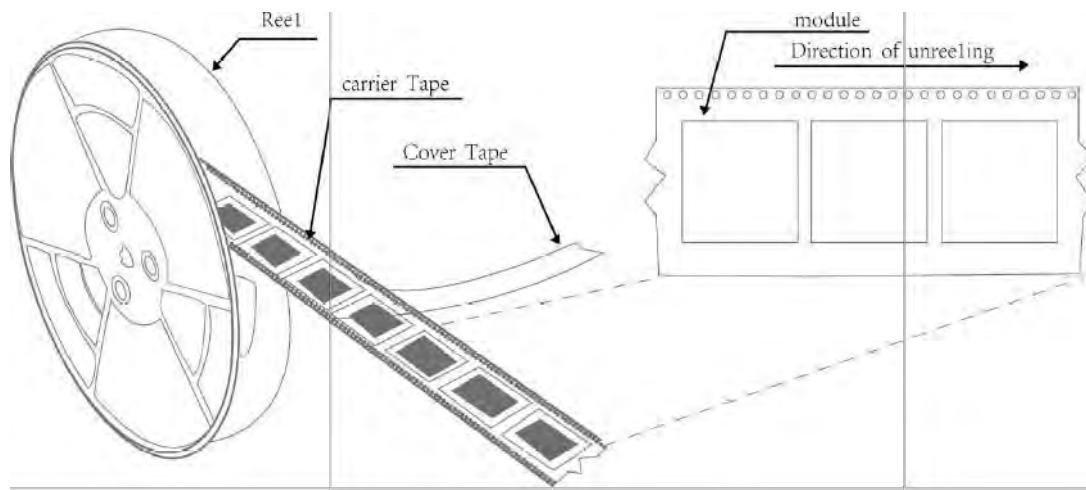
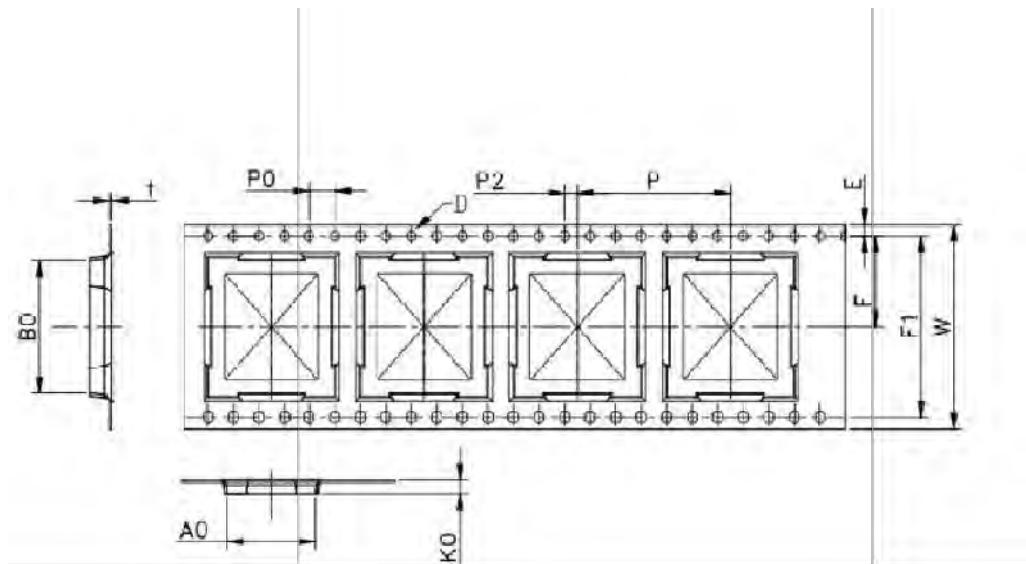


Figure 7-2 Braided Tape Picture



## 8. Order Information

As CH16HL module is divided into two types, shielded and unshielded, and there are two types of packaging: Reel-to-reel and braided tape, please read the details in the following table carefully before placing an order.

If the module is shipped with a special program to be burned, please specify  
 If the module is shipped with special MAC code requirements, please specify

Table 3-1 Order Information

Model	Shield	Pre-burn Program	MAC Code	MOQ
CH16HL-1	Yes	No	No	1K
CH16HL-2	No	No	No	1K

## 9. Certification and Safety Regulations

Certification	Description
FCC	
CE	
RoHS	PASS
BQB	
SRRC	
Huawei Hilink Certification	
HuaweiHarmonyOS Connect Certification	
Tuya Certification	

## 10. Notes

The CH16HL module is mounted with a double row of pins. In order to obtain the best RF performance for the end product, the following principles must be observed:

1. Power supply part: Use independent LDO to power this module, it is recommended to use LDO with small ripple coefficient, and the module needs to be reliably grounded. Please note that the positive and negative poles of the power supply are the correct connection, if the reverse connection may cause permanent damage to the module.

2. Layout: The module is recommended to be placed at the open edge of the base plate as much as possible, and the antenna should face outward.

3. Routing: the power supply to the module on the bottom board is as thick as possible (0.5A current), the PCB board below the antenna in the module on the bottom board (double-sided and multi-layer board) needs to be clear, not copper, that is, all layout layers below the antenna cannot have grounding or signal trace.

4. It is better not to have metal devices near the line, otherwise the communication distance of the module will be reduced to different degrees in different environments.

## 11. Static Electricity and other Considerations

Modules may be damaged by static discharge and it is recommended that all modules should be handled under several precautions

1. Anti-static measures must be followed and modules must not be held in bare hands.
2. The module must be placed in a placement area that prevents static electricity.
3. Anti-static circuits at high voltage inputs or high frequency inputs should be considered in the product design.
4. Static electricity can result in subtle performance degradation to the failure of the entire device.

Modules can be more vulnerable to damage as very small changes in parameters can cause the device to fail to meet the value limits required for its certification.

### **Humidity Sensitivity:**

The module is a Class 3 humidity sensitive device according to standard IPC/JEDEC J-STD-020, please observe all requirements related to the use of such components. In addition, the customer must be aware of the following conditions.

- a) Calculated shelf life of sealed bags: 12 months at < 40°C and < 90% relative humidity (RH).
- b) Environmental conditions during production: 30 °C / 60% RH according to IPC/JEDEC J-STD-033A, paragraph 5
- c) If conditions permit, the maximum time between opening the sealed bag and the reflow process must be 168 hours.
- d) Compliance with "IPC/JEDEC J-STD-033A, paragraph 5.2" is observed.
- e) If condition b) or c) is not complied with, baking is required.
- f) If the humidity indicator inside the bag indicates 10% or more, baking is required.

## **FCC Warning**

### **15.19 Labeling requirements.**

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.

### **15.21 Information to user.**

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **15.105 Information to the user.**

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### **FCC RF Radiation Exposure Statement:**

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance 5mm between the radiator and your body.

## **Additional Section: Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01**

### **2.1 Conditions on using Shenzhen Boshan Intelligent Electronics Co., Ltd regulatory approvals:**

A. Customer must ensure that its product (The "CUSTOMER Product") is electrically identical to **Shenzhen Boshan Intelligent Electronics Co., Ltd** reference designs. Customer acknowledges that any modifications to **Shenzhen Boshan Intelligent Electronics Co., Ltd** reference designs may invalidate regulatory approvals in relation to the CUSTOMER Product, or may necessitate notifications to the relevant regulatory authorities.

B. Customer is responsible for ensuring that antennas used with the product are of the same type, with same or lower gains as approved and providing antenna reports to **Shenzhen Boshan Intelligent Electronics Co., Ltd**.

C. Customer is responsible for regression testing to accommodate changes to **Shenzhen Boshan Intelligent Electronics Co., Ltd** reference designs, new antennas, and portable RF exposure safety testing/approvals.

D. Appropriate labels must be affixed to the CUSTOMER Product that comply with applicable regulations in all respects.

E. A user's manual or instruction manual must be included with the customer product that contains the text as required by applicable law. Without limitation of the foregoing, an example (for illustration purposes only) of possible text to include is set forth below:

## **2.2 List of applicable FCC rules (customers' product must also compliant with these rules)**

FCC Part 15 Subpart C 15.247

## **2.3 Specific operational use conditions**

Operation Frequency: 2402MHz to 2480MHz

Number of Channels: 40

Modulation Type: GFSK

Antenna Type: PCB Antenna

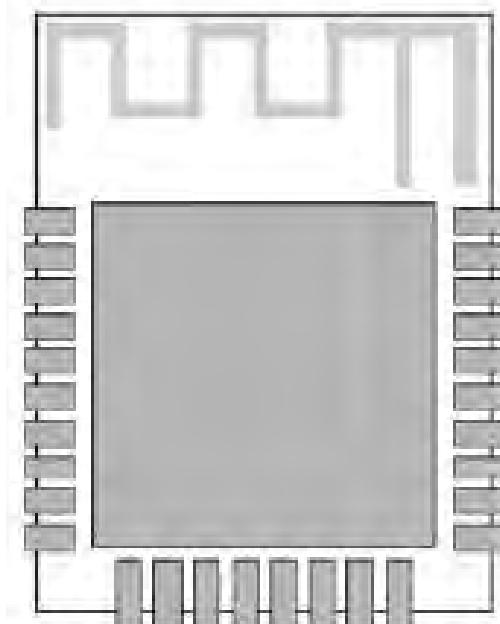
Antenna Gain#: 0.994dBi

The module can be used for mobile applications with the same ant. type with maximum 0.994dBi antenna. The host manufacturer installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation. The host manufacturer has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual. If the end product manufacturer use it to a portable product, please provide the SAR compliance.

## **2.4 Limited module procedures**

Not applicable. The module is a Single module and complies with the requirement of FCC Part 15.212.

## **2.5 Trace antenna designs**



## **2.6 RF exposure considerations**

The device can be used in mobile exposure condition without restriction and if RF exposure statement or module layout is changed, then the host product manufacturer required to take responsibility of the module through a change in FCC ID or new application. The FCC ID of the module cannot be used on the final product. In these circumstances, the host manufacturer will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

## **2.7 Antennas**

Antenna Type: PCB antenna

Antenna Gain: 0.994 dBi

This device is intended only for host manufacturers under the following conditions:

The transmitter module may not be co-located with any other transmitter or antenna;

The module shall be only used with the PCB antenna that has been originally tested and certified with this module. The antenna must be either permanently attached or employ a 'unique' antenna coupler. As long as the conditions above are met, further transmitter test will not be required. However, the host manufacturer is still responsible for testing their end product for any additional compliance requirements required with this module installed.

## **2.8 Label and compliance information**

Host product manufacturers need to provide a physical or e-label stating "Contains FCC ID:2BD7S-BS16HL" With their finished product.

## **2.9 Information on test modes and additional testing requirements**

Operation Frequency: 2402MHz to 2480MHz

Number of Channels: 40

Modulation Type: GFSK

Data Rate : 1Mpbs/2Mbps

Antenna Type: PCB Antenna

Antenna Gain: 0.994dBi

Host manufacturer must perform test of radiated & conducted emission and spurious emission, etc according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. If no other module used and no change to this module, the product can only to compliance with FCC part 15 B to meet the sale requirement. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

## **2.10 Additional testing, Part 15 Subpart B disclaimer**

The modular transmitter is only FCC authorized for FCC Part 15 Subpart C 15.247 that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.