

BJHH HHM302 series

Hardware Design Manual

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Document Revision History

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Rev1.0	25-03-29	YY	HZH	First edition
Rev1.1	26-06-02	YY	HZH	NAME CHANGE

Safety Instructions

Users are responsible for complying with the relevant regulations on wireless communication modules and devices in other countries and specific environmental regulations for use. By following the following safety principles, personal safety can be ensured and help protect products and work environments from potential damage. Our company is not responsible for any related losses caused by customers' failure to comply with these regulations.



Safety first when driving! Do not use handheld mobile devices while driving, unless they have a hands-free function. Please pull over before making a call!



Please turn off your mobile device before boarding. The wireless function of mobile devices is prohibited from being turned on in the aircraft to prevent interference with the aircraft communication system. Ignoring this prompt may jeopardize flight safety and even violate the law.



When in a hospital or healthcare facility, pay attention to any restrictions on the use of mobile terminal devices. RF interference can cause medical equipment to malfunction, so it may be necessary to turn off mobile terminal devices.



Mobile terminal devices do not guarantee effective connection in all situations, such as when the mobile terminal device has no credit or the SIM card is invalid. In case of emergency situations with the above conditions, remember to use emergency calls, ensuring that your device is powered on and in an area with sufficient signal strength.



Your mobile terminal device will receive and emit radio frequency signals when it is powered on, which may cause radio frequency interference when near a TV, radio, computer, or other electronic devices.



Please keep mobile terminal devices away from flammable gases. When you are near gas stations, oil depots, chemical plants, or explosive operation sites, please turn off the mobile terminal devices. Operating electronic devices in any potentially explosive environment poses a safety hazard.

Module selection for application

Serial number	Module Model	Feature symbol	Support frequency band	Dimensions	Module introduction
1	HHM302	HHM302	Band3/5/8/20/28	17.7×15.8×2.2(mm)	Does not support GNSS, VDD_EXT power off in sleep mode.

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1 Introduction

This document defines the application specifications of the BJHH HHM302 series NB-IoT module, describing its hardware interface, electrical characteristics, application methods, and mechanical specifications.

This document can help users quickly understand the hardware interface specifications, electrical, mechanical characteristics, and other related information of the module. Combined with other corresponding documents, users can quickly master the application methods of the NB-IoT module.

1.1 Special characters

Table 1-1 Special Symbol Description

Symbol	Definition
※	If not specifically stated, the asterisk (*) marked after the module function, feature, interface, pin name, AT command name, or parameter indicates that the development of the module function, feature, interface, pin name, AT command name, or parameter is in progress and not supported temporarily.

2 Product Overview

The HHM302 series module is a leading global NB-IoT model wireless communication module, compliant with 3GPP standards, supporting Band03, Band05, Band08, Band20, Band28 frequency bands. It features small size, low power consumption, long transmission distance, strong anti-interference capability, etc. By using this module, customers can easily and flexibly design products such as smart meter reading, smart parking, smart cities, smart security, asset tracking, smart home appliances, agriculture, and environmental monitoring.

2.1 Frequency bands and functions

The HHM302 referred to in this document represents the generic term for this series of models, Table 2-1 provides partial Band descriptions supported by the module.

Table 2-1 Module Supports Wireless Network Functions

Network function	Explanation
LTE-FDD	B3/B5/B8/B20/B28

Note

◆HHM302 does not support GNSS

2.2 Key Features

The table below shows the key product features description:

Table 2-2 Module Key Features Description

Parameters	Explanation
Module packaging	LCC
Ultra-small module size	$(17.7\pm0.15)\times(15.8\pm0.15)\times(2.2\pm0.2)\text{mm}$

Module weight	About 1.1 grams
Operating voltage	Normal operating voltage range: 2.2~4.5V ⁽¹⁾
Operating temperature	Operating Temperature Range: -40 to 85°C
Storage temperature	Storage temperature range: -40~90°C
VDD_EXT characteristics	Sleep mode: VDD_EXT power off, driving capability 120mA
Ultra-low power	1.5uA@PSM
Transmit Power	23dBm±2.7dB(Max)
Antenna interface	50Ω characteristic impedance
USIM interface	Provide an external SIM card interface, support 1.8/3.0V USIM card.
Serial port	Main Serial Port: ◆ Used for AT command transmission and data transfer, the supported baud rate defaults to 9600 bps. For more details, Please refer to section 4.1. ◆ Used for firmware upgrade. Debugging serial port: ◆ Assist in troubleshooting some abnormal restarts, network issues, and application protocol problems in conjunction with debugging tools. ◆ The default baud rate of the serial port is 3Mbps.
Communication Interface Characteristics	Support 3GPP Rel.13/14 NB-IoT wireless radio communication interface and protocol.
Features of network protocols ※	Embedded TCP/IP, UDP/IP, LWM2M and other network protocol stacks.
Data Transmission Characteristics (4)	◆ Single-Tone (maximum): 25.5 kbps (downlink); 16.7 kbps (uplink) ◆ Multi-Tone (Max): 127 kbps (downlink); 158.5 kbps (uplink)
Firmware upgrade	◆ Main serial port upgrade ◆ DFOTA upgrade
RoHS	All components comply with EU RoHS standards.

Note

(1) See section 6.2 for a detailed description of voltage.

See Chapter 6.6 for specific descriptions about temperature.

Different software versions support different network protocols, for detailed information please consult technical support.

The data transmission rate is theoretical.

2.3 Function diagram

The following is the product function block diagram:

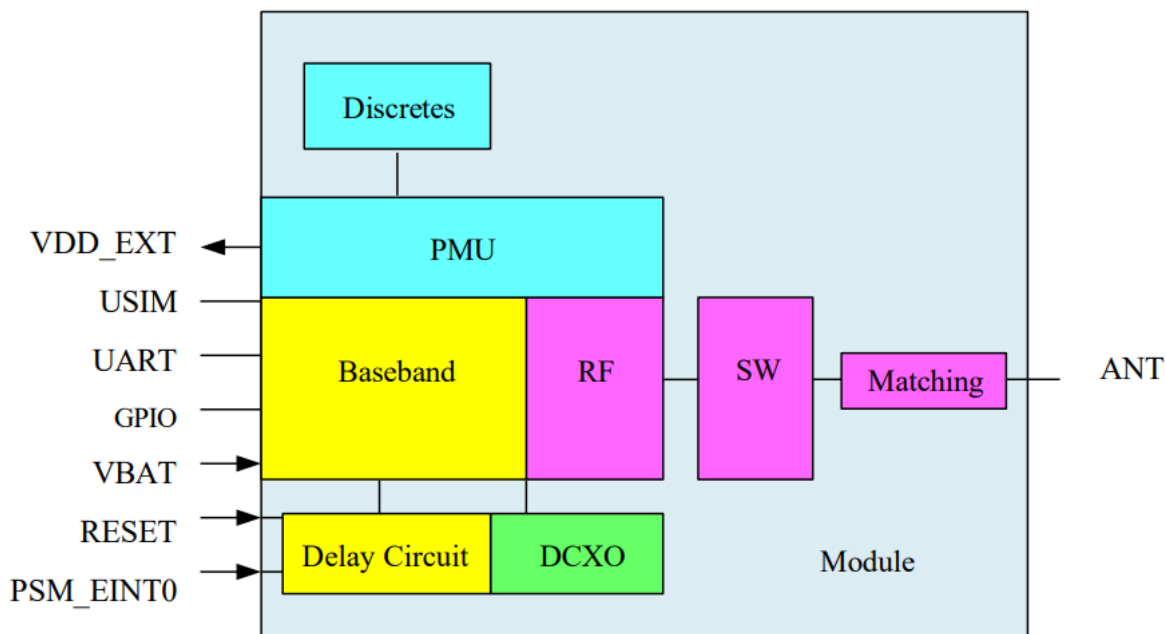


Figure 2-1 Functional Block Diagram

2.4 Pinout diagram

The HHM302 module has a total of 44 LCC pins:

Figure 2-2 Pin Assignment Diagram (for HHM302 series)

2.5 Pin Description Table

For better understanding of the application, the following table provides explanations of the types of I/O parameters:

Table 2-3 Definition of I/O Parameter Types

I/O parameters Type	Explanation
IO	Input and output
DI	Numeric input
DO	Number output
PI	Power input

PO	Power output
AI	Simulated input
AO	Simulated output

For better understanding of the application, the following table provides a description of the characteristics of the power domain parameters:

Table 2-4 Module Power Domain Characteristics Description

Power domain parameters Type	DC characteristics	Explanation	Power supply target
VBAT	Vmax=4.5V Vmin=2.2V Vnorm=3.6V	Module power input, recommended to use 3.6V/0.5A power supply	Module
VO_LDOIO	VILmax=0.2×VO_LDOIO VIHmin=0.7×VO_LDOIO VOLmax=0.15×VO_LDOIO VOHmin=0.8×VO_LDOIO	Configurable from 1.8V to 3.3V, default is 3.3V. Maximum driving capability 120mA; When configured in any one of the three power modes: Sleep Mode 1, Sleep Mode 2, or Hibernation, with VO_LDOIO=0V, the associated IO port will be powered off simultaneously.	UART GPIO VDD_EXT
VDD18AON	VILmax=0.2×VDD18AON VIHmin=0.75×VDD18AON	Not power off in sleep mode, see sections 3.5 and 3.6 for details.	RESET PSM_EINT0
VO_LDOSIM	Vnorm=1.8/3.0V VOLmax=0.15×VO_LDOSIM VOHmin=0.8×VO_LDOSIM VILmax=0.2×VO_LDOSIM VIHmin=0.7×VO_LDOSIM	SIM card dedicated power supply, supports cards with 1.8/3.0V.	USIM

Table 2-5 Module Pin Description

1. Power - POWER					
Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
42,43	VBAT	PI	Power supply	VBAT	See Table 2-

					4.
24	VDD_EXT	PO	Reference level output	VO_LDOIO	Please refer to Table 2-4.
44	VBCKP	PI	GNSS backup power supply	VBCKP	Please refer to Table 2-4.
1,10,27,34,36,37,40,41	GND		GND		

2. RESET

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
15	RESET	DI	Reset module	VDD18AON	Low level valid

3. Wake up PSM_EINT0

Pin number	Pin names	I/O	Describe	Power domain/DC characteristics	Note
19	PSM_EINT0	DI	External wake-up module	VDD18AON	Low level effective

4. Network status indicator

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
16	NETLIGHT [※]	DO	Network status indicator	VO_LDOIO	

5. RI interface

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
20	RI [※]	DI	Ring signal	VDD18AON	

6. Antenna interface RF

Pin number	Pin names	I/O	Describe	DC characteristics	Note
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35	RF_ANT	IO	RF antenna interface	50 ohm characteristic impedance	Please refer to Chapter 5.
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7. External USIM card interface

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
11	USIM_DATA	IO	SIM card data cable	VO_LDOSIM	Please refer to section 4.2.
12	USIM_RST	DO	SIM card reset line		
13	USIM_CLK	DO	SIM card clock line		
14	USIM_VDD	PO	SIM card power supply		

8. Serial Port UART

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
17	MAIN_RXD	DI	Main Serial Port: Module receives data	VO_LDOIO	In sleep mode, MAIN_RXD will automatically switch to the VDD18AON power domain, and other serial ports will be powered off. Please set the working mode of RXD according to the actual situation, see section 4.1 for details.
18	MAIN_TXD	DO	Main Serial Port: Module sends data		
38	DBG_RXD	DI	Debugging serial port: Module receives data		
39	DBG_TXD	DO	Debug serial port: Module sends data		

9、ADC interface

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
9	ADC0	AI	Analog-to-Digital Conversion	Input voltage range: 0~1.6V	If not used, leave floating
23	ADC1	AI	Universal Modulus		

			Conversion		
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10. SPI Interface *

Pin number	Pin name	I/O	Description	Power Domain/DC Characteristics	Note
3	SPI_MISO	DI	SPI master input slave output	VO_LDOIO	
4	SPI_MOSI	DO	SPI master output from input		
5	SPI_SCLK	DO	SPI serial clock		
6	SPI_CS	DO	SPI chip select		

11. General-purpose IO Interface

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
7	GPIO0	IO	Internal connect GPIO0	VO_LDOIO	
21	GPIO9	IO	Internal connect GPIO9		
30	GPIO13	IO	Internal connect GPIO13		
31	GPIO14	IO	Internal connect GPIO14		

12. Reserved interface

Pin number	Pin names	I/O	Description	Power Domain/DC Characteristics	Note
8,22,25,26 ,28,29,32, 33	REV	-	-	-	Undefined, please keep suspended when in use

2.6 Assessment suite

BJHH can provide a complete evaluation and development kit, including development

boards with USB interfaces. Feel free to contact us for more information.

11 12 13

3 Nature of work

3.1 Working mode

The table briefly describes the three states of the module under normal operation mode.

Table 3-1 Three States in Working Mode

Pattern	Status	Status Description
Working mode	Active	The module is in active mode; all functions are working properly and available for data transmission and reception; the module can switch to Idle mode or PSM mode in this state.
	Idle	The module is in a shallow sleep state, the network is in a connected state, and can receive paging messages. The module can switch to active mode or PSM mode in this state.
	PSM	The module only has the RTC working, the network is in a non-connected state, and no longer accepts paging messages. The module will be awakened when the DTE (Data Terminal Equipment) actively sends data or when the timer T3412 (periodic update) times out.

Different from the three states (Active, Idle, PSM) under the NB working mode, the module also supports multiple power saving modes, each of which can be configured via AT commands.

The former is the working state of the NB protocol, and the latter is the power consumption mode of the module itself.

The former is determined by the network, while the latter can be freely configured by users.

Table 3-2 Power Consumption Mode Types and Configuration

Power consumption mode	AT configuration command	Status Description
Operating mode	AT+ECPMUCFG=1,0	Without enabling the low power mode, even if there is nothing to do, the module's MCU remains in a loop waiting state, consuming high power.
Idle mode	AT+ECPMUCFG=1,1	The MCU module will shut down the core working clock when there is no task, and any interrupt can wake up the system and restart the core clock.

Sleep mode 1	AT+ECPMUCFG=1,2	On the basis of idle mode, power off all external devices, keep the content of 256KB/16KBSRAM, and external interrupts cannot wake up the system.
Sleep Mode 2	AT+ECPMUCFG=1,3	Turn off 256KBSRAM based on sleep mode 1, leaving only 16KB SRAM.
Hibernation	AT+ECPMUCFG=1,4	On the basis of Sleep Mode 2, turn off the 16KBSRAM. (SRAM does not retain content)

3.2 Hibernate mode

The main purpose of PSM is to reduce module power consumption and extend the battery's supply time. The following figure shows the power consumption of the module in different modes.

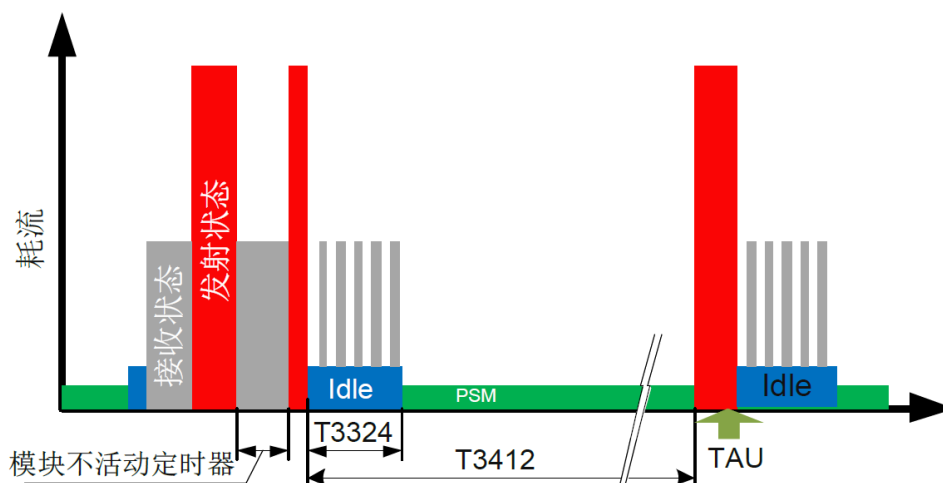


Figure 3-1 Functional Block Diagram

The process for a module to enter PSM is as follows: When the module establishes a connection with the network or updates the Tracking Area Update (TAU), it will request to enter PSM in the request message. The network will configure the T3324 timer value in the response message to the module and start the Reachable Timer. When the T3324 timer expires, the module enters PSM. The module cannot apply to enter PSM when connecting for emergency services or initializing public data networks.

When the module is in PSM, network activities will be disabled, including searching for

cell messages, cell reselection, etc. However, the T3412 timer (related to periodic TAU updates) will still continue to function.

Two ways to make the module exit PSM are as follows:

- ◆ DTE actively sends data to exit PSM.
- ◆ When the T3412 timer times out, the Tracking Area Update (TAU) is triggered, and the module exits Power Saving Mode (PSM).

In PSM mode, users can configure three power consumption modes according to their needs: Sleep Mode 1, Sleep Mode 2, and Hibernation Mode.

3.3 Power supply design

The HHM302 series module provides 2 VBAT pins for connecting external power sources, the interface description is as follows:

Table 3-3 Power Supply Pin Definitions

Pin number	Pin names	I/O	Description	Note
42,43	VBAT	PI	Power supply	The power supply must be able to provide a current of up to 0.5A.
44	VBCKP	PI	GNSS backup power supply	
1,10,27,34, 36,37,40,41	GND		GND	

3.3.1 Power circuit reference design

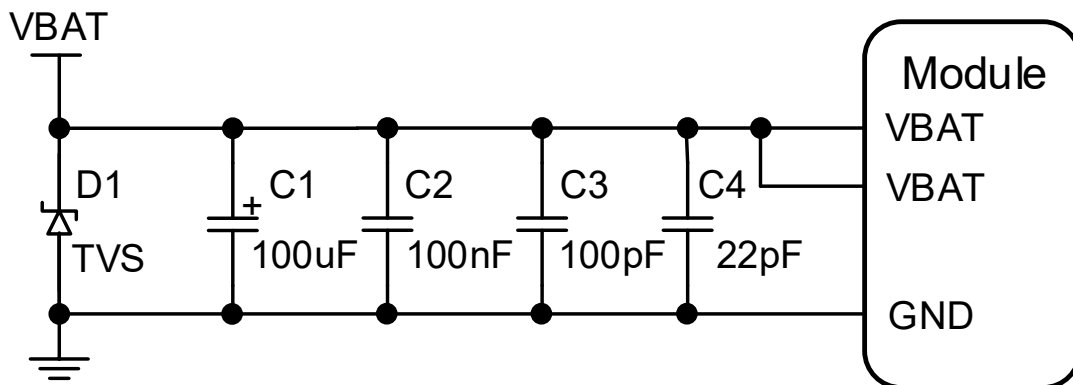


Figure 3-2 VBAT Input Reference Circuit

Power supply design has a significant impact on the performance of the module, it is important to choose a power supply that can provide at least 0.5A current capability.

If the voltage difference between the input voltage and the module's supply voltage is not large, it is recommended to choose LDO as the power supply. If there is a significant voltage difference between the input and output, then use DC-DC for power conversion, while paying attention to the EMI issues brought by DC-DC.

Ensure that the voltage supplied to the module's VBAT power input does not fall below the minimum operating voltage of VBAT (pay attention to voltage drop issues). To ensure better power supply performance, the VBAT input terminal reference circuit is as shown in the above figure. The longer the VBAT trace on the PCB design, the wider the trace width should be. It is recommended that the trace width should not be less than 1mm. The GND plane of the power section should be as complete as possible with multiple GND vias. Also, capacitors should be placed as close as possible to the VBAT pin of the module.

C1 is a 100uF tantalum capacitor with low ESR, which helps to improve the power supply's ripple current capability and stabilize the voltage.

C2, C3, and C4 are 100nF, 100pF, and 22pF filter capacitors in 0402 packages respectively, used to eliminate high-frequency interference.

At the same time, it is recommended to add a TVS tube near the VBAT input to

enhance the module's ability to withstand surge voltage.

3.4 Power on

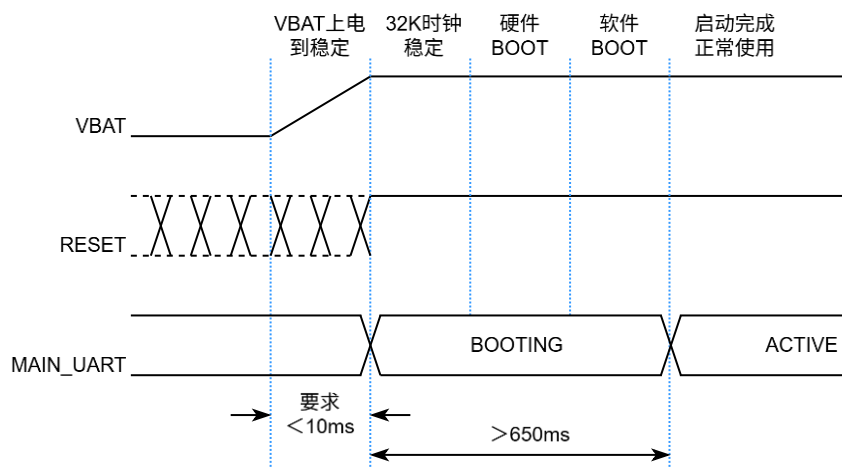


Figure 3-3 Power-up Timing Diagram

Notes

◆ The initial state of VBAT upon power-up needs to be less than 0.7V. If it is greater than 0.7V but less than 2.2V, it cannot guarantee successful power-up in all scenarios and normal chip operation. The rise time of VBAT from 0V to 2.2V should be less than 10ms.

After VBAT power-off, it is necessary to ensure that the RESET voltage is below 0.35V. The specific discharge time needs to be evaluated based on actual circuit testing and with sufficient margin reserved to avoid abnormal startup when powered on again.

◆ RESET has a weak pull-up internally, it needs to be pulled up before the 32K clock stabilizes, so it is recommended to ensure that the RESET pin cannot be pulled low during the startup phase.

◆ The typical time for VBAT to power up to module entering Active state is >650ms. If the module outputs "BJHH" via AT serial port, it indicates that the module has completed startup.

◆ It is recommended that the MCU reserve the RESET control pin. In case of abnormal

power-on sequence leading to abnormal module startup, control the module to reset to exit the abnormal state.

3.5 Reset

The module is reset in the following way:

- ◆ Hardware reset: RESET pin, low level effective (pull down to reset, time greater than 10ms).
- ◆ Software reset: send the command "AT+ECRST" to reset.

Table 3-4 Reset Pin Description

Pin number	Pin names	I/O	Description	Note
15	RESET	DI	Reset module	Low level effective

When the external control of the module RESET outputs a high level greater than 1.45V and less than 3.6V, and outputs a low level less than 0.35V, the RESET pin of the module can be controlled directly. In other cases, an open-drain drive circuit must be used for control, as shown below.

3.5.1 Circuit reference design

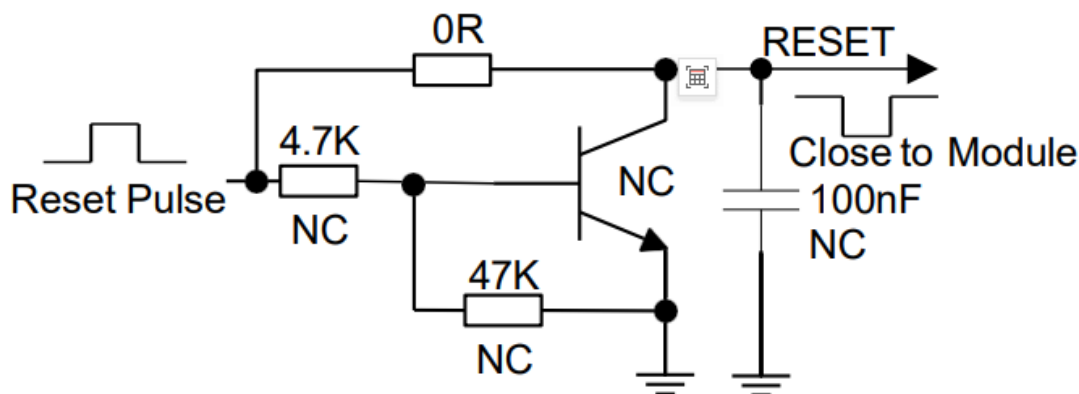


Figure 3-4 Transistor Reset Reference Circuit

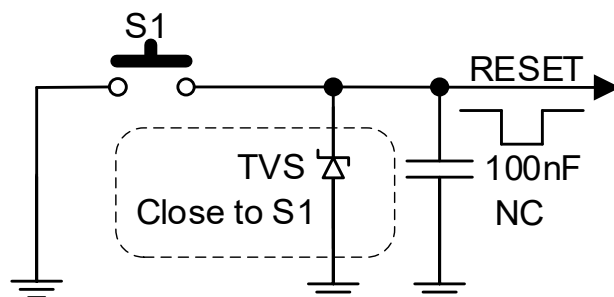


Figure 3-5 Key Reset Reference Circuit

Notes

During the reset process, VBAT/32K clock need to be in a stable state.

◆ The RESET pin takes effect when pulled low for more than 10ms.

◆ The reset line should not be too long, pay attention to grounding protection, keep away from RF, VBAT power sources, and strong signal interference sources. The transistor should be placed close to the module's RESET pin to avoid external signal interference.

◆ It is recommended to reserve a capacitor position of 100 nF to 1μF on the RESET pin of the module by default without soldering.

3.6 Awaken

The module needs to be woken up through the PSM_EINT0 pin in PSM mode.

Table 3-5 Reset Pin Description

Pin number	Pin names	I/O	Description	Note
19	PSM_EINT0	DI	External wake-up module	Low level effective

Note: In addition to waking up the module through the PSM_EINT0 pin, the module can also be woken up through the low power serial port. Please refer to section 4.1.1 for details.

3.6.1 Wake-up circuit reference design

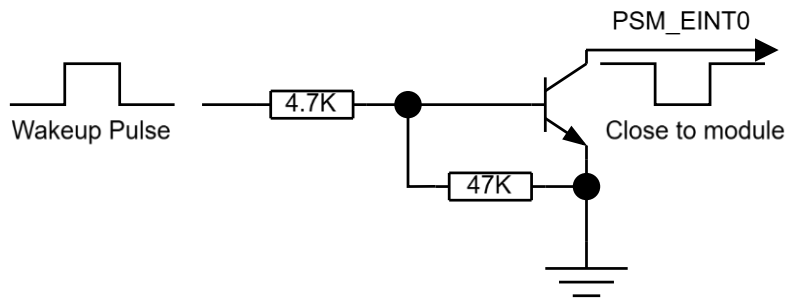


Figure 3-6 Transistor Wake-up Reference Circuit

Precautions

During the wake-up process, both VBAT and the 32K clock need to be in a stable state. Lowering PSM_EINT0 (low level) can wake up the module from sleep mode.

◆ The wake-up line should not be too long, pay attention to grounding protection, stay away from RF, VBAT power sources, and strong signal interference sources. The transistor should be placed as close as possible to the module's PSM_EINT0 pin to avoid external signal interference.

4 Application interface

The HHM302 series module provides the following application interfaces:

- ◆Three-way UART interface
- ◆USIM interface all the way
- ◆Three GPIO interfaces
- ◆SPI interface all the way※
- ◆Two-way ADC interface ※
- ◆Ring signal RI※
- ◆Network status indicator NETLIGHT※

Note: "※" indicates that this function is not supported by default and needs to be enabled by the software.

4.1 UART communication

The module provides three general asynchronous transceivers: main serial port, debug serial port, and application serial port. The baud rate of the main serial port can be configured as 4800bps/9600bps/115200bps/921600bps (for burning firmware), the baud rate of the debug serial port is 3Mbps, used for debugging only, and the application serial port can be used normally for communication with peripherals.

Table 4-1 Serial Port Pin Definitions

Pin number	Pin names	I/O	Description	Note
17	MAIN_RXD	DI	Main Serial Port: Module receives data	In sleep mode, all serial ports except MAIN_RXD will be powered off.
18	MAIN_TXD	DO	Main Serial Port: Module sends data	
38	DBG_RXD	DI	Debugging serial port: Module receives data	
39	DBG_TXD	DO	Debugging serial port: Module sends data	

Notes

- ◆ The serial port interface belongs to the VO_LDOIO power domain, and the maximum voltage should not exceed 3.6V.
- ◆ VO_LDOIO power domain will lose power in sleep mode, MAIN_RXD switches to internal 1.2V power.
- ◆ The serial port RXD pin has an internal pull-up, so no external pull-up resistor is needed, and it has anti-reverse function.
- ◆ Pay attention to the consistency of the voltage levels when using the serial port, otherwise it may cause leakage current.

4.1.1 Main serial port

Main serial port characteristics:

Used for AT command communication and data transmission, with a default baud rate of 9600bps.

- Configurable to 2400/4800bps/9600bps/115200bps* (not supported in sleep mode)
- Used for firmware upgrade, the baud rate is 921600bps during the upgrade.

The main serial port wakes up by holding the low-power serial port, and in sleep mode, RXD will switch to the internal 1.2V power domain.

The main serial port supports low-power serial port wake-up. Pulling down RXD will wake up the module in sleep mode, while VDD_EXT will be powered off in sleep mode, so VDD_EXT cannot be used as a pull-up.

The schematic diagram of the main serial port connection is as follows:

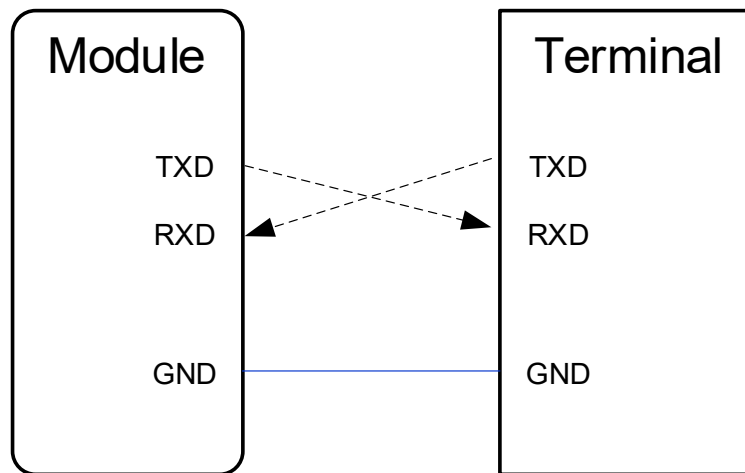


Figure 4-1 Main Serial Port Connection Diagram

4.1.2 Debug serial port

Characteristics of serial port debugging:

◆By using the dedicated tools provided by the platform, you can debug the software by viewing log information through the serial port, with a baud rate of 3Mbps.

Schematic diagram of debugging serial port connection is as follows:

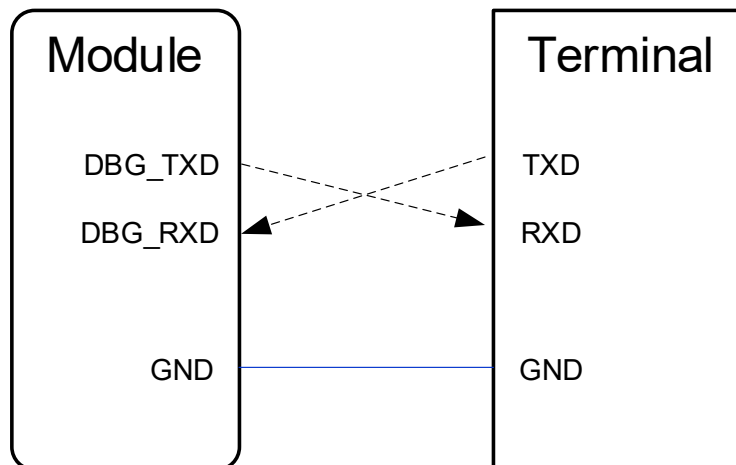


Figure 4-2 Schematic Diagram of Debugging Serial Port Connection

4.1.3 Serial port circuit reference design

The main considerations for a suitable serial port level conversion circuit include whether it meets the working speed of the serial port, scenarios with low power

requirements, and whether the power consumption meets the requirements. The following provides a level matching circuit scheme for reference, choose or define according to the actual needs of the product.

The RXD pin of the serial port has an internal pull-up resistor, external pull-up resistors are not allowed to be connected.

Typical level conversion reference circuit

This circuit has low cost and a wide range of applicable voltage levels for level conversion (main control levels from 1.8V to 5.0V can be used), but it has limitations on the serial port baud rate, with a maximum baud rate of only 921600bps. The reference design is as follows, pay attention to the direction of level conversion.

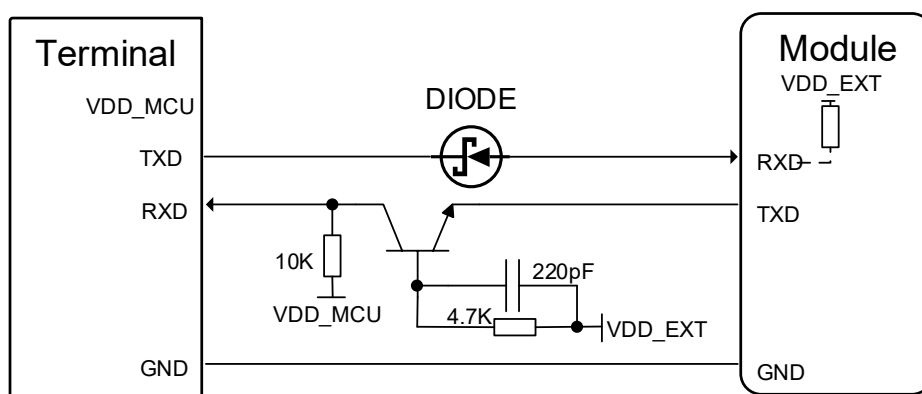


Figure 4-3 Level Conversion Reference Circuit

Recommend three transistors for reference:

Brand: CJ Specification model: S8050 J3Y Package: SOT-23

Recommend Schottky diodes for reference (note the forward voltage of the diode):

Brand: LRC Model: LRB520S-30T1G Package: SOD-523

4.2 USIM card interface

The module includes an external USIM card interface, which supports the module to

access the USIM card. The USIM card interface supports functions according to the 3GPP specification. The external USIM card is powered by the module internally, supporting cards powered at 1.8/3.0V.

Table 4-2 Definition of External USIM Card Interface Pins

Pin number	Pin names	I/O	Description	Note
11	USIM_DATA	IO	SIM card data cable	
12	USIM_RST	DO	SIM card reset line	
13	USIM_CLK	DO	SIM card clock line	
14	USIM_VDD	PO	SIM card power supply	Supports 1.8V/3V USIM card when $3.0V \leq VBAT \leq 4.5V$. Only supports 1.8V USIM card when $2.1V \leq VBAT \leq 3V$. Maximum supply current: approximately 30mA

4.2.1 USIM card circuit reference design

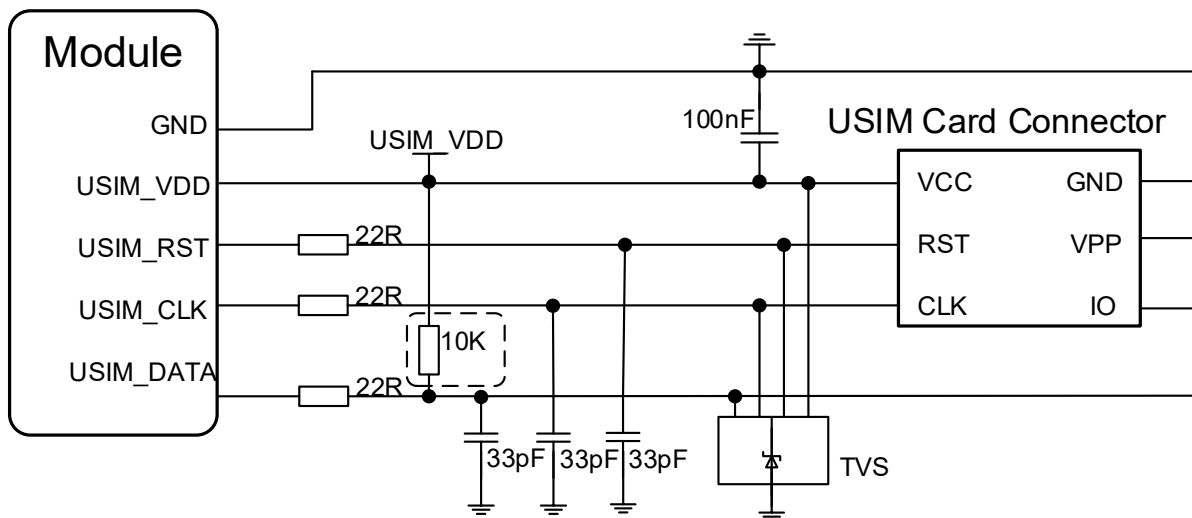


Figure 4-4 6PIN external SIM card reference circuit

4.2.2 Considerations for USIM card circuit design

To ensure the reliability and availability of the SIM card in the application, please read and follow the following standards for SIM card circuit design:

- ◆When laying out, try to place the SIM card as close to the module as possible, and keep the signal wire routing length within 200mm if possible.
- ◆SIM card signal line should be kept away from RF traces and VBAT power lines.
- ◆The GND wiring of the SIM card should be short and thick, ensuring that the wiring width is not less than 0.5mm. The decoupling capacitor of USIM_VDD should not exceed 1uF, and the capacitor should be placed close to the external SIM card's VCC.
- ◆To avoid signal interference between USIM_DATA and USIM_CLK, the wiring between them should not be too close. Ground shielding should be added between the two traces. In order to prevent the negative impact of excessive wire length, a pull-up resistor is generally added to USIM_DATA to USIM_VDD to enhance the driving capability. Since there is a built-in pull-up resistor (10K) to USIM_VDD inside the module, it is recommended to externally reserve a 10K resistor close to the card slot if the wire length is too long. In addition, the USIM_RST signal also needs to be ground protected.
- ◆The SIM card peripheral circuit should be close to the placement of the SIM card. To ensure good ESD protection performance, it is recommended to add TVS diodes to the pins of the external USIM card. The parasitic capacitance of the selected TVS diode should not be greater than 15pF. ESD protection devices should be placed as close as possible to the external SIM card placement, and ensure that the protected SIM card signal lines pass through the ESD protection devices before reaching the module. A 22Ω resistor should be connected in series between the module and SIM card signal lines to suppress stray EMI and enhance ESD protection. In addition, a parallel 33pF capacitor is used to filter out RF interference.

4.3 General IO interface

The module provides two GPIO interfaces.

Table 4-3 GPIO Pin Definitions

Pin number	Pin names	I/O	Description	Note
7	GPIO0	IO	Internal connection GPIO0	
21	GPIO9	IO	Internal connection GPIO9	
30	GPIO13	IO	Internal link GPIO13	
31	GPIO14	IO	Internal connect GPIO14	

4.4 SPI interface ※

The module provides a SPI interface.

Table 4-4 SPI Pin Definitions

Pin number	Pin name	I/O	Describe	Note
3	SPI_MISO	DI	SPI master sends, slave receives.	
4	SPI_MOSI	DO	SPI master output from input	
5	SPI_SCLK	DO	SPI Serial Clock	
6	SPI_CS	DO	SPI chip select	

4.5 ADC interface ※

Table 4-5 ADC Interface Pin Definitions

Pin number	Pin names	I/O	Description	Note
9	ADC0	AI	Analog-to-Digital Conversion	Default 1.6V
44	ADC1	AI	Analog-to-Digital Conversion	

4.6 Ring signal RI※

When the module receives the URC information report, it notifies the DTE through the RI pin. This function is not supported by default and needs to be enabled through software.

Table 4-6 RI Signal Status

Module status	RI signal status
Standby	/
URC	/

4.7 Network Status Indicator ※

The NETLIGHT signal can be used to indicate the network status of the module. This function is not supported by default and needs to be enabled through software.

The reference connection circuit for the network status indicator is shown in the following figure:

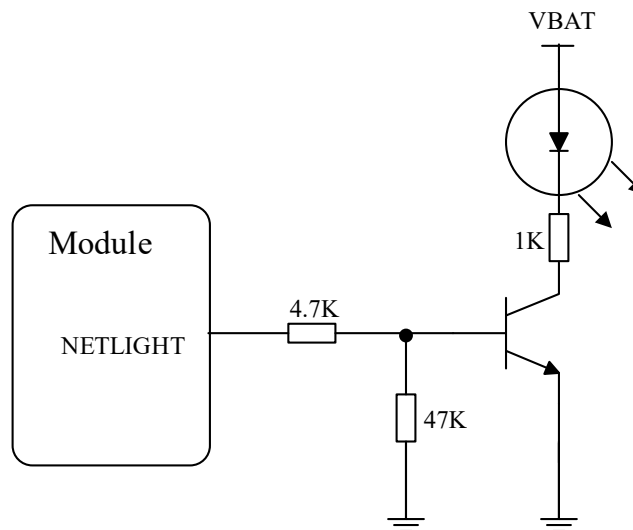


Figure 4-5 Network indicator light interface reference circuit

5 Radio Frequency Characteristics

The module provides one NB-IoT RF interface and one GNSS RF interface, with a characteristic impedance of 50Ω.

5.1 Cellular network

5.1.1 Antenna interface and operating frequency band

ANT_RFIO is the RF antenna interface of the module, with a characteristic impedance of 50Ω. The frequency bands are Band3/5/8/20/28.

Table 5-1 RF Antenna Pin Definitions

Pin number	Pin names	I/O	Description
35	RF_ANT	IO	RF antenna interface, 50Ω characteristic impedance

Table 5-2 RF Antenna Frequency Bands

Frequency band	Uplink frequency band	Downlink frequency band	Network standard
Band3	1710MHz-1785MHz	1805MHz-1880MHz	H-FDD
Band5	824MHz-849MHz	869MHz-894MHz	H-FDD
Band8	880MHz-915MHz	925MHz-960MHz	H-FDD
Band20	832MHz-862MHz	791MHz-821MHz	H-FDD
Band28	703MHz-748MHz	758MHz-803MHz	H-FDD

5.1.2 Transmit power

Table 5-3 Conduction Power

Frequency	Maximum value	Minimum value	Note
Band3	23dBm±2.7dB	<-40dBm	Compliant with NB-IoT protocol in 3GPP Rel-13 and Rel-14.
Band5	23dBm±2.7dB	<-40dBm	
Band8	23dBm±2.7dB	<-40dBm	

Band20	23dBm±2.7dB	<-40dBm	
Band28	23dBm±2.7dB	<-40dBm	

5.1.3 Sensitivity reception

Table 5-4 Conduction reception sensitivity under single transmission (throughput ≥ 95%)

Frequency	Receive Sensitivity (dBm)	3GPP standard (dBm)
Band3	-116.4	-107.5
Band5	-117.3	-107.5
Band8	-117.2	-107.5
Band20	-117.4	-107.5
Band28	-117.2	-107.5

Table 5-5 Conduction Reception Sensitivity under 128 Retransmissions (Throughput ≥95%)

Frequency	Receive Sensitivity (dBm)	
Band3	-134	
Band5	-134	
Band8	-134	
Band20	-134	
Band28	-134	

5.1.4 Antenna circuit reference design

When using the module, a π -type matching circuit needs to be added between the RF antenna interface of the module and the antenna interface of the user's baseboard. The typical antenna matching circuit and initial parameters are shown in the figure below. The resistor is 0 ohms, the capacitor position is not populated by default, and the recommended device package is 0201 or 0402 package.

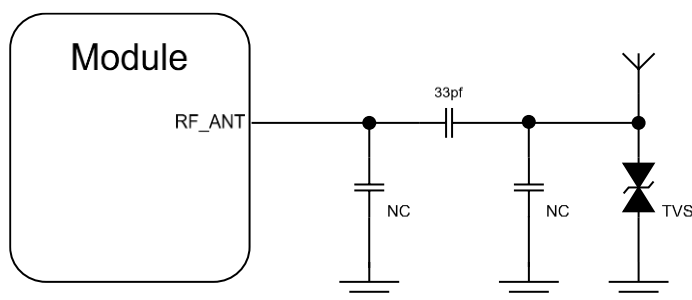


Figure 5-1 RF Antenna Reference Circuit

If an external antenna is used, or if users can touch the antenna, it is recommended to reserve a TVS diode to enhance electrostatic protection. Because the parasitic capacitance of the TVS diode may affect the antenna performance, it is recommended to re-calibrate the antenna after adding the TVS diode.

The wiring requirements between RF_ANT and the user antenna must meet the 50Ω RF characteristic impedance requirements, while keeping the RF routing distance as short as possible to ensure minimal insertion loss of the RF routing. Detailed wiring requirements are provided in the following section.

5.2 RF signal cable wiring guide

◆ RF routing design requirements

The characteristic impedance of the RF signal line in the system applied by this module should be controlled at 50Ω. Generally, the impedance of the RF signal line is determined by the material's dielectric constant ϵ_r , trace width W , spacing to GND D , and the thickness H of the reference GND plane. In the field of IoT applications, the design of PCB characteristic impedance is usually achieved through a coplanar waveguide approach, which helps the RF signal line to achieve better shielding and higher integration for compact design. The following diagram illustrates the structural requirements of PCB designs with different layers.

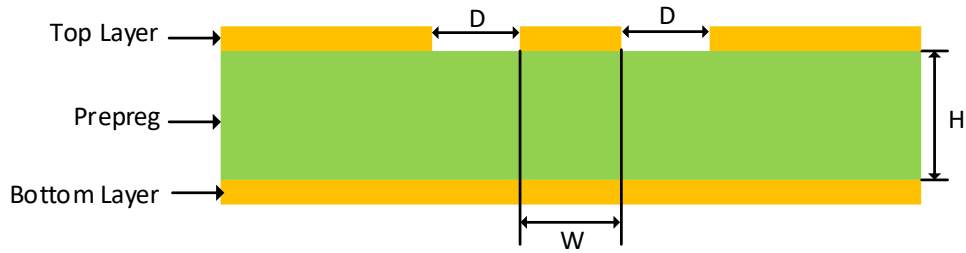


Figure 5-2 Two-layer PCB coplanar waveguide structure

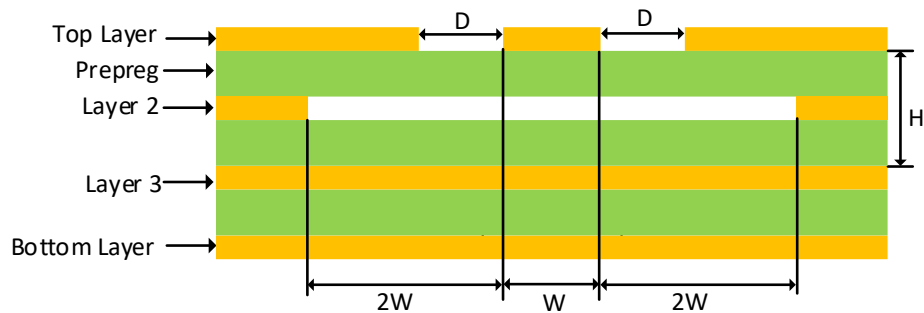


Figure 5-3 Four-layer PCB coplanar waveguide structure (reference ground is the third layer)

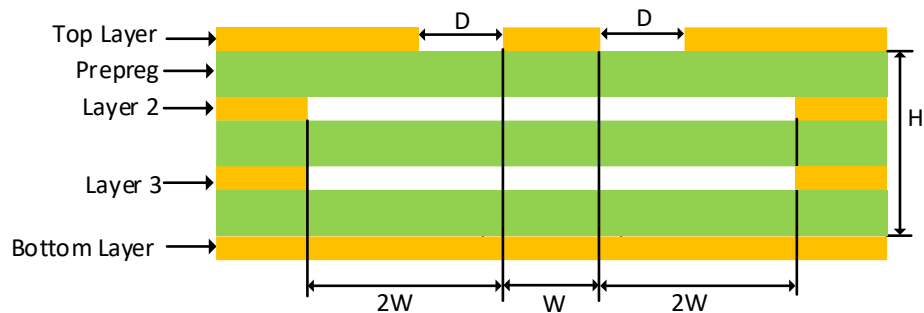
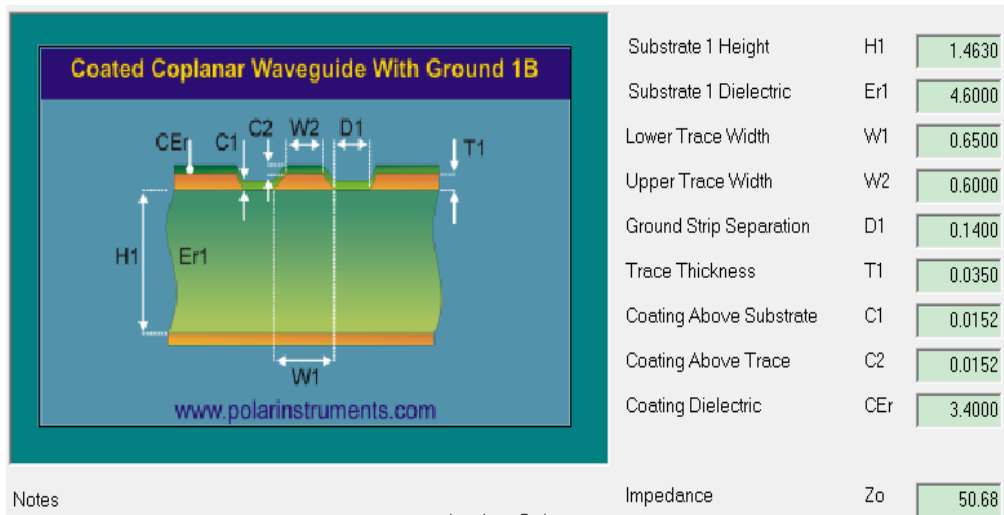


Figure 5-4 Four-layer PCB coplanar waveguide structure (reference ground is the fourth layer)

The control method of 50Ω impedance in LAYOUT design can be achieved using the Polar Si9000 design software tool. The calculation method in the figure below, taking the finished PCB thickness as 1.6mm as an example, can obtain the RF trace width $W=0.65\text{mm}$ and the spacing between lines $D=0.14\text{mm}$.



Reference for Calculation of 50Ω Impedance in Figure 5-5

The following is a schematic diagram of the layout of the PCB RF circuit, as shown below:

- ◆ Design based on the design results of RF line width W and line spacing D .
- ◆ In the π -type circuit, three external matching reserved components are closely arranged, and the reserved NC component can be placed on the same side or on both sides in the LAYOUT design (as shown).
- ◆ The GND plane on both sides of the RF trace must have irregular through-hole VIAs placed to ensure that there are VIAs on the GND planes closest to the RF trace (as shown in the green boxed area in the diagram), and there must be a complete GND plane below the entire RF trace space (as shown in the blue area in the diagram).

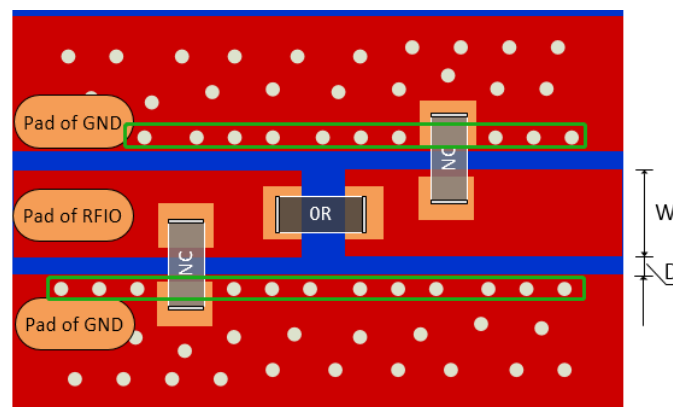


Figure 5-6 RF routing LAYOUT design schematic

◆Module wiring design guidelines in products

The reasonableness of RF routing can be directly reflected in the conduction test of the module, but in order to ensure the full play of the product's overall performance, antenna design cooperation is also required. In order to better meet the requirements of antenna design, the following requirements are hoped to be achieved in PCB design. Guidance is provided below for different layers of the overall PCB:

When the product PCB is designed as a 2-layer configuration, it is preferable for both the TOP and BOTTOM LAYER directly below the module to be GND layers. The routing lines that need to be led out by the module should avoid passing through directly below the module, and instead be led out from the outer side of the module.

When the product PCB is designed with 4 layers, it is recommended that the traces to be led out by the module should be routed on the third or fourth layer, reserving the first and second layers for the module as complete GND reference layers.

5.3 Antenna design requirements

Module terminal antenna requirements: Select an antenna that matches the operating frequency band of the module. The antenna's characteristic impedance should be 50Ω , and the insertion loss in the operating frequency band should be as small as possible. The Voltage Standing Wave Ratio (VSWR) should be ≤ 2 . The better the antenna performance, the higher the efficiency of the module and the wider the coverage range.

5.4 Recommended RF connectors.

Two common ways to connect the antenna:

- ◆Soldering of the pad: One end of the antenna is directly soldered to the antenna output port of the product using a high-frequency cable.
- ◆High-frequency head: using SMA, IPX connector, where IPX connector is recommended

to use Hirose's U.F.L-R-SMT connector, IPX connector physical picture, SMA connector physical picture

The types of antennas suitable for different NB-IoT scenarios are as follows, but not limited to:

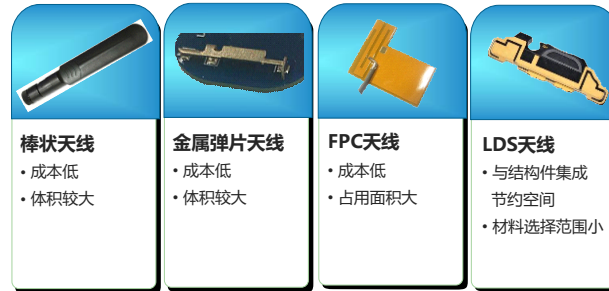


Figure 5-7 Recommended Types of Conventional Antennas for NB-IoT

6 Electrical performance and reliability

6.1 Absolute maximum rating

Table 6-1 Absolute Maximum Ratings

Parameters	Description	Minimum value	Maximum value	Unit	Note
V _{BAT}	Module power supply voltage	-0.3	4.5	V	
V _{I_{AIO}}	ADC input voltage	-0.3	3.6	V	
V _{I_{GPIO}}	GPIO input voltage	-0.3	3.6	V	
Others	Other pin input voltage	-0.3	3.6	V	

Precautions

When the operating conditions exceed the absolute maximum ratings, it may cause permanent damage to the module.

6.2 Rated power value

Table 6-2 Power Interface Electrical Characteristics

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
V _{BAT}	Module normal power supply voltage (1)	2.2	3.6	4.5	V
USIM_VDD	USIM card power supply output	-	1.8/3.0	-	V
VDD_EXT	Reference power output (2)	-	3.3	-	V

Notes

(1) When the module operates within this voltage range, the module's relevant performance meets the 3GPP standard requirements.

The specific description of the VDD_EXT voltage is shown in Table 2-4.

6.3 Power consumption

Table 6-3 Module Current Consumption

Pattern	Description	Frequency band	Typical value	Unit
PSM	Sleep mode @3.6V		1.5	uA
Idle	Idle state DRX (1.28s), ECL0@3.6V		229	uA
	Idle state DRX (2.56s), ECL0@3.6V		122	uA
Active Launch	RF transmission status Single-tone(15 kHz) (23dBm)@3.6V	B3	299	mA
		B5	271	mA
		B8	275	mA
		B20	268	mA
		B28	248	mA
	RF transmission status Single-tone(15 kHz) (12dBm)@3.6V	B3	109	mA
		B5	71	mA
		B8	72	mA
		B20	106	mA
		B28	64	mA
	Radio frequency transmission status Single-tone(15 kHz) (0dBm)@3.6V	B3	38	mA
		B5	38	mA
		B8	29	mA
		B20	31	mA
		B28	28	mA
Active Receive	RF reception status ECL0 @3.6V	B3	4.2	mA
		B5	4.3	mA
		B8	4.1	mA

		B20	4.6	mA
		B28	4.1	mA

6.4 Digital logic voltage characteristics

Table 6-4 1.8V I/O Logic Level Characteristics

Parameters	Description	Minimum value	Maximum value	Unit
VIH	Input high level	$0.7 \times V_{DDIO}$	-	V
VIL	Low level input	-	$0.2 \times V_{DDIO}$	V
VOH	Output high level	$0.8 \times V_{DDIO}$	-	V
VOL	Low level output	-	$0.15 \times V_{DDIO}$	V

Table 6-5 USIM card 1.8V logic level characteristics

Parameters	Description	Minimum value	Maximum value	Unit
USIM_VDD	Power supply	1.7	1.9	V
VIH	High level	$0.7 \times USIM_VDD$	-	V
VIL	Low level input	-	$0.2 \times USIM_VDD$	V
VOH	Output high level	$0.8 \times USIM_VDD$	-	V
VOL	Output low level	-	$0.15 \times USIM_VDD$	V

Table 6-6 USIM card 3.0V logic level characteristics

Parameters	Description	Minimum value	Maximum value	Unit
USIM_VDD	Power supply	2.85	3.15	V

VIH	Input high level	$0.7 \times \text{USIM_VDD}$	-	V
VIL	Low level input	-	$0.2 \times \text{USIM_VDD}$	V
VOH	Output high level	$0.8 \times \text{USIM_VDD}$	-	V
VOL	Low level output	-	$0.15 \times \text{USIM_VDD}$	V

6.5 Static electricity protection

Static electricity protection instructions:

In module applications, static electricity generated by human static electricity, electrostatic friction between microelectronics, etc., discharged to the module through various means may cause certain damage to the module. Therefore, ESD protection should be emphasized. In the processes of research and development, production assembly, testing, etc., especially in product design, ESD protection measures should be taken. For example, anti-static protection should be added at interfaces in circuit design and points susceptible to electrostatic discharge damage or interference; testing equipment should ensure good grounding; anti-static gloves should be worn during production.

Table 6-7 ESD performance parameters (Temperature: 25°C, Humidity: 45%)

Pin name	Corona discharge	Unit
VBAT,GND	± 8	kV
Antenna interface	± 8	kV
Other interfaces	± 0.5	kV

6.6 Working and storage temperature

Table 6-8 Working Temperature Range

Parameters	Minimum value	Typical value	Maximum value	Unit	Note
------------	---------------	---------------	---------------	------	------

Operating temperature ⁽¹⁾	-40	+25	+85	°C	
Storage environment temperature ⁽²⁾	-40	+25	+90	°C	

Points to note

(1) When the module operates within this temperature range, its relevant performance meets the 3GPP standard requirements.

(2) This storage temperature range does not include packaging materials, please pay attention to the highest temperature tolerance of the tape packaging.

6.7 Precautions

During the production and use of modules, there are some points to note:

◆When spraying the module, please try to avoid the spraying material flowing into the interior of the module.

◆When cleaning the module, do not use ultrasonic cleaning on the module, as it may cause damage to the internal crystals of the module.

◆When producing and using modules, please avoid applying them in environments or enclosures containing any amount of mercury or mercury vapor, as this may lead to the risk of product malfunction or failure.

7 Mechanical dimensions

7.1 Mechanical dimensions

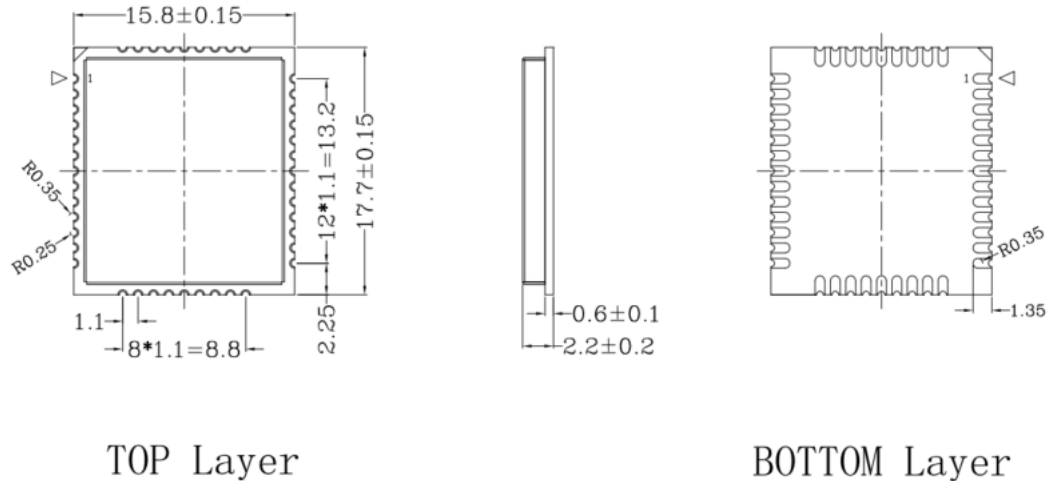


Figure 7-1 Module Mechanical Dimension Diagram

7.2 Module top view / bottom view

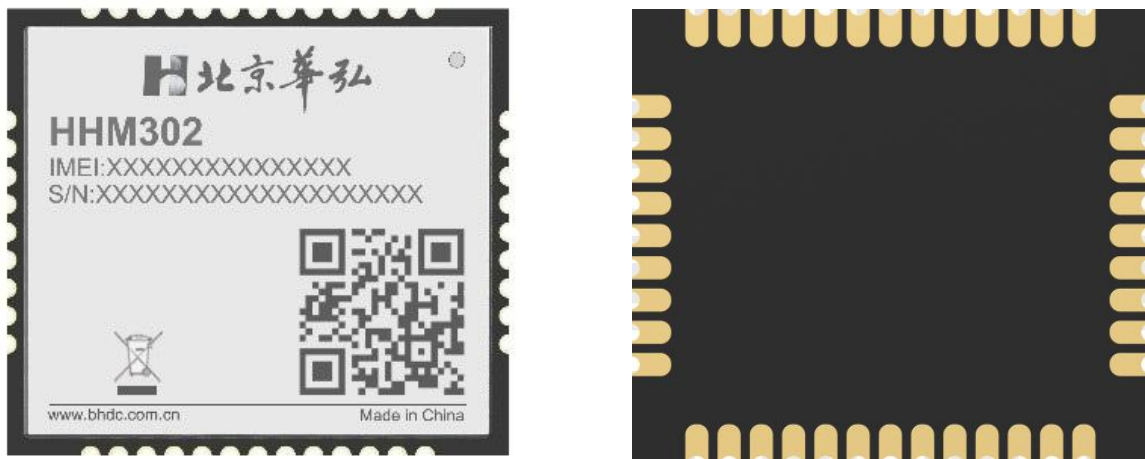


Figure 7-2 Module Top/Bottom View

The above is the design rendering of the module. Please refer to the actual module for accuracy, especially the label content is for illustration purposes only. For more

information, such as module packaging recommendations, production guidelines, and packaging methods, please refer to our production guide document.

7.3 Recommendation for packaging

The module recommends solder pads as shown in the following figure, and users can make minor adjustments according to their own production processes.

- ◆ The pins around the module are designed at right angles. When designing the bottom board for soldering, please consider using rounded corners for transition. The square solder pads at the bottom of the module can be designed using the module pin dimensions. Please refer to the design diagram of a single solder pad below.
- ◆ To facilitate the opening of the ladder steel mesh, it is recommended not to layout other components within the 2.0mm range outside the solder pad of the module. Users can refer to the requirements of their own steel mesh manufacturer to determine this distance.

Note: The module solder pads are symmetrically distributed around the module center point.

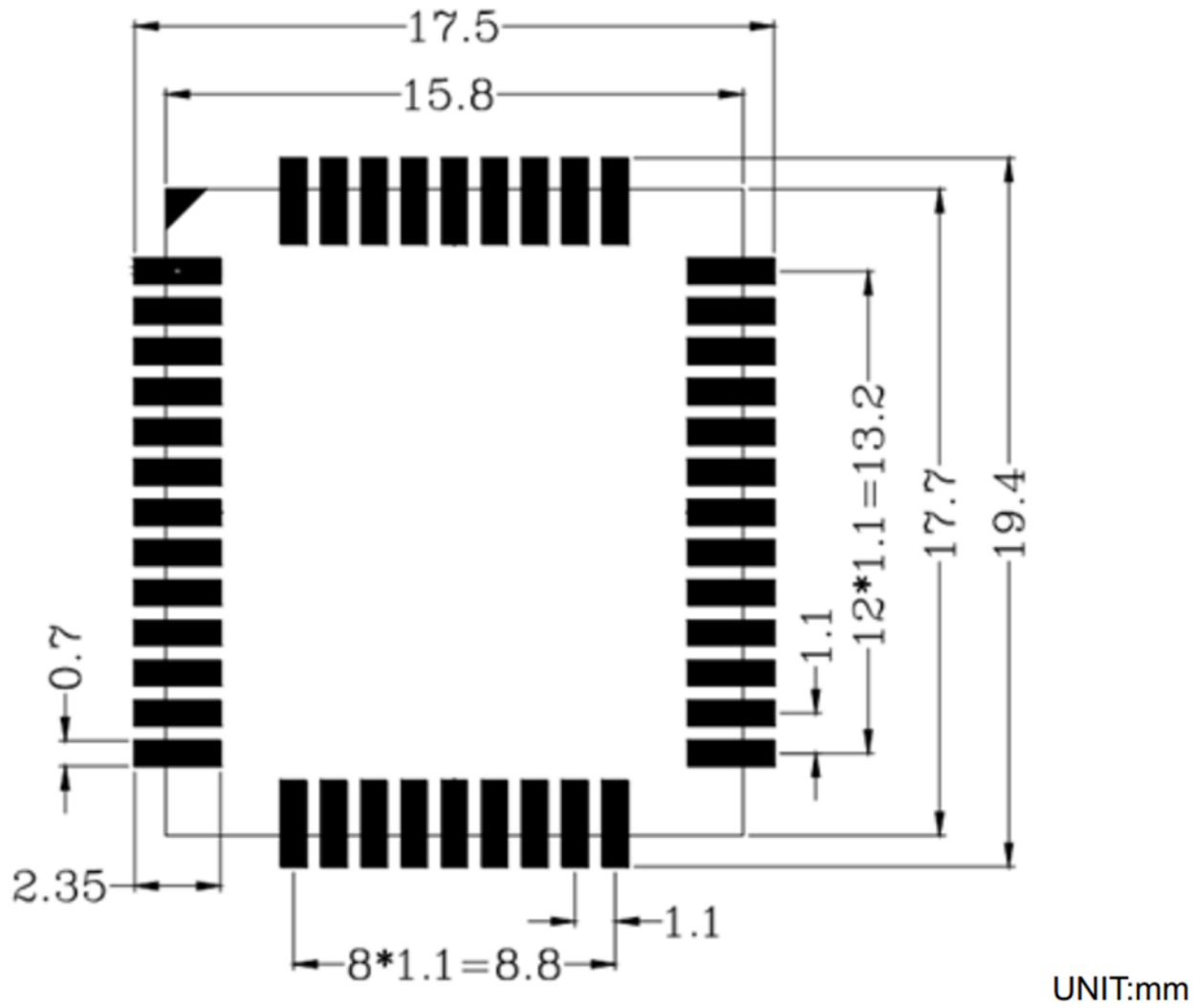


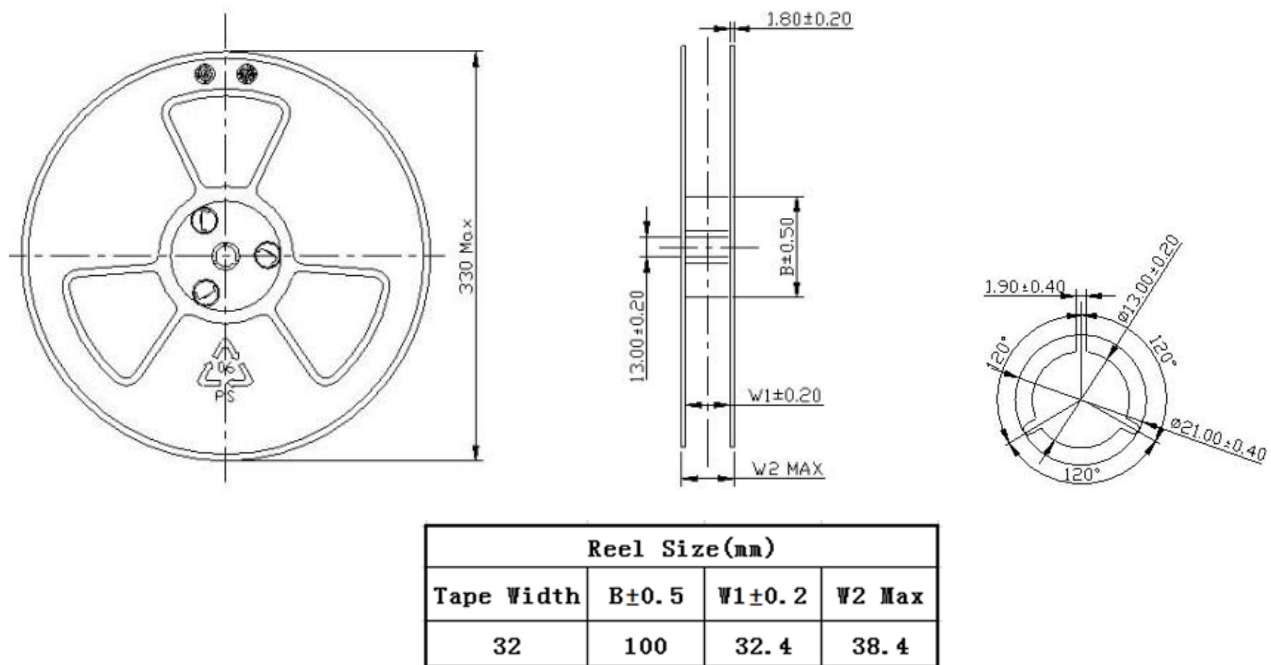
Figure 7-3 Module Recommended Solder Pads

8 Packaging and production information

This chapter describes guidance information on the packaging, storage, production, maintenance, etc. of modules, which is applicable to the assembly process guidance of modules.

8.1 Packaging specifications

The factory packaging of this module is done using a rubber wheel carrying method, the reference dimensions of the rubber wheel are as follows:



The loading direction is as follows: (refer to the diagram, actual content may vary, pay attention to the position of module PIN1)

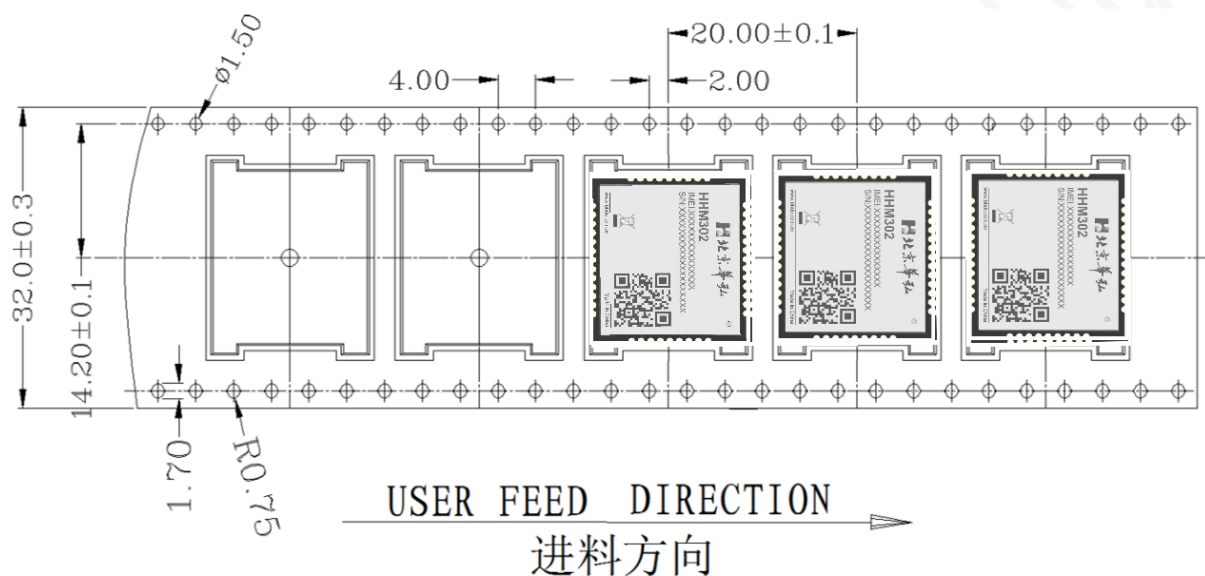


Figure 8-1 Packaging Specifications and Dimensions

8.2 Storage conditions

The module is shipped in the form of vacuum reel sealed bags, with a humidity sensitivity level of MSL 3.

Storage conditions:

1) When the temperature is below 40°C and the humidity is below 90% (RH), the solderability can be guaranteed for 12 months in well-sealed packaging.

After unpacking, ensure that SMT assembly is carried out within 168 hours under the condition of ambient temperature less than 30°C and relative humidity less than 60% (RH).

If the above conditions are not met, baking is required:

1) Coiled tape packaging, baked at 60°C ± 5°C for 24-48 hours,

If acceleration of baking is needed, the module should be taken out from the tape and placed on a high-temperature resistant container (such as a tray) for baking (ESD protection should be taken into consideration during the removal process), and baked at 125°C ± 5°C for 8 hours.

3) The cumulative baking time should not exceed 96 hours.

For more detailed guidance, please refer to the IPC/JEDEC J-STD-033 standard.

8.3 Manufacturing welding

8.3.1 Furnace charging method

If the customer uses a double-sided board as the baseboard of the module, it is recommended to place the module in the second reflow soldering. It is best for the customer's baseboard to go through the reflow oven on the carrier tape during the first reflow soldering. For the second reflow soldering, it is also recommended to put it on the carrier tape through the reflow oven as much as possible. If for special reasons it cannot go through the reflow oven on the carrier tape, consider using a fixture to go through the oven on the track or place a flat and high-temperature resistant flat board under the PCBA to support it through the oven, to prevent PCB deformation during reflow soldering leading to virtual soldering of the module.

8.3.2 Reflow soldering operation guidance

PCBA reflow soldering temperature curve is related to the use of solder paste and needs to be adjusted according to the actual solder paste. The data is only suitable for lead-free operation, refer to Figure 8-2 for lead-free reflow soldering operation guidelines.

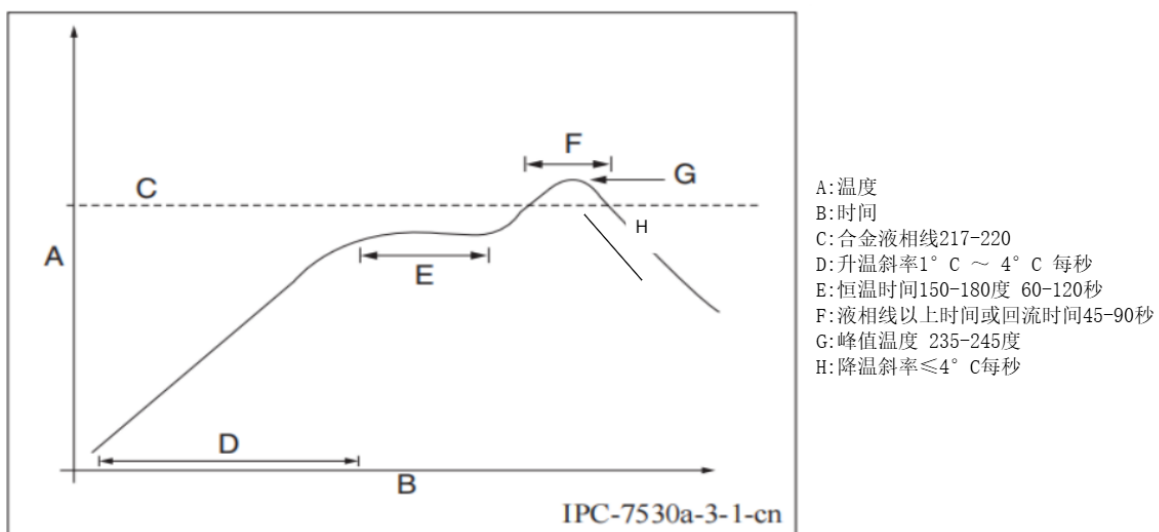


Figure 8-2 Lead-Free Reflow Soldering Operation Guide

8.3.3 Production process

During the production of welding or any process that may directly contact the module, no organic solvents (such as alcohol, isopropanol, acetone, trichloroethylene, etc.) shall be used to wipe the module shielding cover; otherwise, it may cause the shielding cover to rust.

If spraying or potting is needed for the module, please ensure that the spraying or potting materials used will not chemically react with the module shield or PCB, and also ensure that the spraying or potting materials will not flow into the interior of the module.

When producing and using modules, please avoid applying them in environments or enclosures containing any amount of mercury or mercury vapor, as this may lead to the risk of product malfunction or failure.

8.3.4 Maintenance

If the module has poor soldering, short circuits, or other defects that require repair, please follow the parameters below:

Lead-free process: Soldering iron temperature $380\pm 10^{\circ}\text{C}$, soldering iron contact time $\leq 5\text{S}$;

Lead process: soldering iron temperature $350\pm 10^{\circ}\text{C}$, soldering iron contact time $\leq 5\text{S}$;

Modules are not recommended to be blown with a hot air gun to avoid affecting the performance of the modules.

9 Related documents and terminology abbreviations

9.1 Related documents

The following related documents provide the document name, please refer to the latest released version.

Table 9-1 Related Documents

Serial number	Document Name	Annotation
[1]	IPC/JEDEC J-STD-033 specification	

9.2 Abbreviation of terms

Table 9-2 Term Abbreviations

Abbreviation	Full English name	Full name in Chinese
3GPP	3rd Generation Partnership Project	Third Generation Partner Program
ADC	Analog-to-Digital Converter	Analog-to-Digital Conversion
ANT	Antenna	Antenna
DAC	Digital -to- Analog Converter	Analog-to-Digital Conversion
DBG-	Debug	Debugging
DC-DC	Direct Current - Direct Current	DC Converter
DCXO	Digitally Controlled Crystal Oscillator	Digital Controlled Crystal Oscillator
DRX	Discontinuous Reception	Non-continuous reception
DTE	Data Terminal Equipment	Data terminal equipment
ECL	Equivalent Class Level	Network coverage level
ESD	Electro-Static discharge	Electrostatic discharge

EOS	Electrical Overtress	Electrical super stress (surge)
ESR	Equivalent Series Resistance	Equivalent series resistance
EVK	Evaluation Kit	Evaluation toolkit
H-FDD	Half Frequency Division Duplexing	Frequency Division Half Duplex
FOTA	Firmware Over-The-Air	Remote firmware upgrade
GPIO	General-purpose input/output	Universal input and output
I/O	Input/Output	Input Output Interface
I _{max}	Maximum Load Current	Maximum current
I _{norm}	Normal Current	Normal (typical) current
bps	Bits Per Second	Units of speed
LCC	Leadless Chip Carriers	N/A leadframe chip carrier packaging
LDO	Low Dropout Regulator	Low dropout linear regulator
LGA	Land Grid Array	Grid Array Package
LwM2M	Lightweight Machine-To-Machine	Lightweight M2M protocol
MCU	Mirco Controller Unit	Microcontrol unit
MSL	Moisture Senvitivity levels	Wet sensitivity level
NB-IoT	Narrow Band Internet of Things	Narrowband Internet of Things
PCB	Printed Circuit Board	Printed Circuit Board
PCBA	Printed Circuit Board Assembly	Printed circuit board components
PMU	Power Management Unit	Power Management Unit
PSM	Power Saving Mode	Energy saving mode
RF	Radio Frequency	Radio frequency
RoHS	Restriction of Hazardous Substances	Limitation of harmful substances
RXD	Receive external Data	Receive
TAU	Tracking Area Update	Track area update
TCP/IP	Transmission Control Protocol/Internet Protocol	Transmission Control

		Protocol/Internet Protocol
TVS	Transient Voltage Suppressor	Transient Voltage Suppression Diode
TXD	Transmit external Data	Send
UART	Universal Asynchronous Receiver & Transmitter	General asynchronous receiver and transmitter
UDP/IP	User Datagram Protocol - Internet Protocol	User Datagram Protocol
USIM	Universal Subscriber Identification Module	Universal User Identification Module
VSWR	Voltage Standing Wave Ratio	Voltage Standing Wave Ratio
Vmax	Maximum Voltage Value	Maximum voltage
Vnorm	Normal Voltage Value	Normal (typical) voltage
Vmin	Minimum Voltage Value	Minimum voltage
VIHmax	Maximum Input High Level Voltage Value	Maximum input high level
VIHmin	Minimum Input High Level Voltage Value	Minimum input high level
VILmax	Maximum Input Low Level Voltage Value	Maximum input low level
VILmin	Minimum Input Low Level Voltage Value	Minimum input low level
VImax	Absolute Maximum Input Voltage Value	Maximum input level
VImin	Absolute Minimum Input Voltage Value	Minimum input level
VOHmax	Maximum Output High Level Voltage Value	Maximum output high level
VOHmin	Minimum Output High Level Voltage Value	Minimum output high level
VOLmax	Maximum Output Low Level Voltage Value	Maximum output low level
VOLmin	Minimum Output Low Level Voltage Value	Minimum output low level

FCC Warning

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

2.2 List of applicable FCC rules

FCC Part 22 Subpart H

2.3 Specific operational use conditions

This transmitter/module and its antenna(s) must not be co-located or operating in conjunction with any transmitter. This information also extends to the host manufacturer's instruction manual.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

It is “not applicable” as trace antenna which is not used on the module.

2.6 RF exposure considerations

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This compliance to FCC radiation exposure limits for an uncontrolled environment, and minimum of 20cm separation between antenna and body.

The host product manufacturer would provide the above information to end users in their end-product manuals.

2.7 Antennas

External Antenna; 3.72dBi; 824 MHz -849MHz

2.8 Label and compliance information

The end product must carry a physical label or shall use e-labeling followed KDB784748D01 and KDB 784748 stating “Contains Transmitter Module FCC ID: 2BWXC-HHM302”.

2.9 Information on test modes and additional testing requirements

For more information on testing, please contact the manufacturer.

2.10 Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (FCC Part 22) listed on the grant, and 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. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed when contains digital circuitry.

FCC Statements

(OEM) Integrator has to assure compliance of the entire end-product incl. the integrated RF Module. For 15 B (§15.107 and if applicable §15.109) compliance, the host manufacturer is required to show compliance with 15 while the module is installed and operating.

Furthermore the module should be transmitting and the evaluation should confirm that the module's intentional emissions (15C) are compliant (fundamental / out-of-band). Finally the integrator has to apply the appropriate equipment authorization (e.g. Verification) for the new host device per definition in §15.101.

Integrator is reminded to assure that these installation instructions will not be made available to the end-user of the final host device.

The final host device, into which this RF Module is integrated has to be labeled with an auxiliary label stating the FCC ID of the RF Module, such as "Contains FCC ID:2BWXC-HHM302".

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.

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

The Integrator will be responsible to satisfy SAR/ RF Exposure requirements, when the module is integrated into the host device.

Module statement

The single-modular transmitter is a self-contained, physically delineated, component for which compliance can be demonstrated independent of the host operating conditions, and which complies with all eight requirements of § 15.212(a)(1) as summarized below.

- 1) The radio elements have the radio frequency circuitry shielded.
- 2) The module has buffered modulation/data inputs to ensure that the device will comply with Part 15 requirements with any type of input signal.
- 3) The module contains power supply regulation on the module.
- 4) The module contains a permanently attached antenna.
- 5) The module demonstrates compliance in a stand-alone configuration.

- 6) The module is labeled with its permanently affixed FCC ID label.
- 7) The module complies with all specific rules applicable to the transmitter, including all the conditions provided in the integration instructions by the grantee.
- 8) The module complies with RF exposure requirements.

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

CE Warning

Hereby, (Beijing Huahong IC Design Co., Ltd.) declares that the radio equipment type [NB-IoT Module] is compliance with Directive 2014/53/EU.

This product allowed to be used in all EU member states.

This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body.

Technology	Frequency		RF Power	
	From	To	Max	Type
LTE Band 3	1710 MHz	1785 MHz	24.38 dBm	Conducted
LTE Band 8	880 MHz	915 MHz	23.4 dBm	Conducted
LTE Band 20	832 MHz	862 MHz	23.36 dBm	Conducted
LTE Band 28	703 MHz	748 MHz	23.41 dBm	Conducted

EU Declaration of Conformity

We, hereby declare that the essential requirements set out in the RED Directive 2014/53/EU, have been fully fulfilled on our product with indication as below:

Product Name NB-IoT Module

Brand Name / Model N/A / HHM302

The following standards have been applied for the investigation of compliance:

☒ Article 3.1a (Safety)	EN IEC 62368-1:2024+A11:2024
☒ Article 3.1a (Health)	EN IEC 62311: 2020
☒ Article 3.1b(EMC)	ETSI EN 301 489-1 V2.2.3 (2019-11) ETSI EN 301 489-52 V1.3.1 (2024-11)
	EN 55032:2015/A11:2020 EN 55035:2017/A11:2020 EN IEC 61000-3-2:2019/A2:2024 EN 61000-3-3:2013/A2:2021/AC:2022
☒ Article 3.2 (Radio)	ETSI EN 301 908-1 V15.2.1 (2023-01) ETSI EN 301 908-13 V13.3.1 (2024-10)

Hardware version number: HHM302V1.0

Software version number: HHM302B041R00S02M010

The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

2280 MiCOM Labs Inc.

and issued the EU-type examination certificate.

Furthermore, the ISO requirement for the in-process quality control procedure as well as the manufacturing process has been reached. The technical document as well as the test reports will be kept for a period at least 10 years after the last product has been manufactured at the disposal of the relevant national authorities of any Member State for inspection.

Detail contact information for this declaration has been listed below as the window of any issues relevant for this declaration.

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Sun Shuo

Signature / stamp Date: 2026-08-24