

TRI-020 NB_IOT Module Hardware Design Manual

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Revision history

Version number	Time	Reason for revision
V1.0	2025-03-28	Initial establishment
V1.01	2025-05-15	Update the packaging and size information; Add the power consumption current data of the PSM for the baseline test; Improve the pin definition and description
V1.02	2025-06-16	Supplement and improve the power consumption information and RF indicators of the module.
V1.03	2025-07-10	Update packaging information.
V1.04	2025-09-15	Remove the BLE function and improve the description of WiFiscan

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1 Module Introduction

TRI-020 is a high-performance, low-power NB-IoT wireless communication module, with a highly integrated design scheme, integrating RF and baseband in an LCC package, supporting baseband signal processing, wireless transmission and reception and other functions, in addition to integrating GNSS and Wifiscan for auxiliary positioning, It supports indoor and outdoor positioning information acquisition functions to meet the design needs of IoT customers for small-sized terminals, helping customers reduce product size and optimize costs.

The module is designed with a single-sided cloth board and a structure size of 19.9mm*23.6mm*2.2mm, which can meet the application needs of most IoT products, including smart smoke detectors, wireless meter reading, bicycle sharing, smart parking, smart cities, security, asset tracking, smart home appliances, wearable devices, agriculture and environmental monitoring, and many other industries.

2 Performance parameters

The following table details the main features of the TRI-020 module

Table 2.1 TRI-020 Key Performance Parameters

NBIOT Module	TRI-020
Module size	23.6mm*19.9mm*2.2mm
encapsulation	54 Pin LCC 40 Pin LGA
Temperature range	
Normal operating temperature	-30° ~ +75°
Limited operating temperature	-40° ~ +85°
Storage temperature	-40° ~ +90°
Channel information	
LTE FDD	Default :B2/B4/B5/B12/B13/B26/B66/B71 Optional:B1/B3/B5/B8/B18/B20/B26/B28
GNSS	1561.098MHz, 1575.42MHz; Support GPS, Beidou, QZSS
Wifiscan (RX)	802.11b/g/n
Transmission rate	
LTE FDD transmission rate (R13).	Single Tone DL 25.2Kbps(Max) , UL 16.7Kbps(Max) Multi Tone DL 127Kbps(Max) , UL 159Kbps(Max)

Interface information	
Power connector	In the tank
Reset interface	In the tank
Wake up the interface	In the tank
SIM interface	1.8V/3.0V
UART interface	*3
ADC interface	In the tank
GPIO interface	In the tank
Antenna interface	Support NB, GNSS, Wifiscan, BLE
BOOT interface	In the tank
Electrical characteristics	
Supply voltage	VBAT Supply voltage range:2.9V ~ 4.5V
power consumption	PSM Minimum current consumption in mode:5uA(GNSS coldstart) 20uA(GNSS warmstart)
RoHS	accord with EU RoHS standard
Ambient humidity	5%~95%

3 Functional description

The TRI-020 module adopts the Xinyi platform, which integrates the power module, baseband module, storage module and RF module, as well as positioning module into one chip, which greatly simplifies the peripheral circuit. In order to assist indoor positioning, a Wifiscan chip is used to communicate with the Xinyi chip, so that the application scenarios of the module are more extensive.

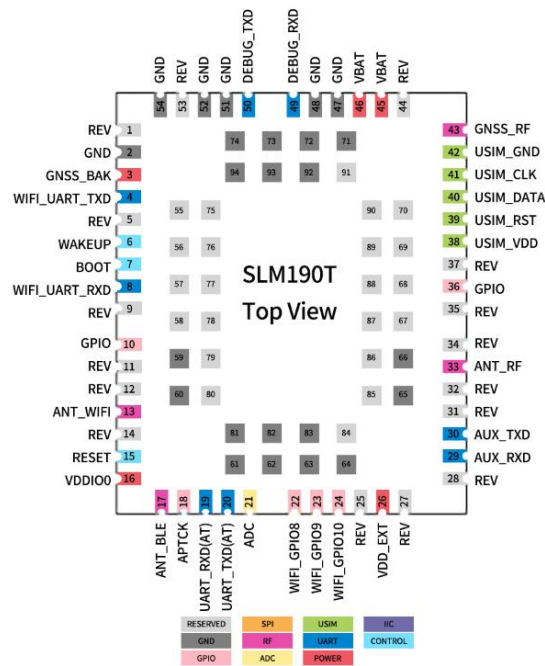
4 Application Interfaces

Basic description

TRI-020 has a total of 54 LCC pins and provides the following functional interfaces:

- power supply
- BOOT
- RESET
- DBG interface
- ADC interface
- USIM interface (supports 3.0V, 1.8V).
- UART interface
- The GPIO interface is configurable
- Wakeup interface
- Antenna interface*4

4.1 Interface definition



4.2 Pin Description

Table 4.1 IO Parameter Definitions

type	description
IO	Input and output
DI	Digital inputs
PI	Power input
PO	Power output
AI	Analog inputs
AO	Analog output
OD	Open drain

Table 4.2 TRI-020 Pin Definition Parameters

Functions dot	Pin name	Pin number	I/O	description	DC characteristics	other
power supply	VBAT	45,46	PI	Module power supply	V _{max} =4.5V V _{min} =2.9V V _{norm} =3.3V	Greater than or equal to 500mA power supply
	VDD_EXT	16,26	PO	The module outputs a power supply	V _{norm} =1.8V I _{max} =80mA	1.8/3V, power supply to internal and external circuits, maximum output current 100mA, external 100uF capacitor
	GND	2,32,34,42,44,47,48,51,52,54		earthing	0	Ensure that the GND signal is reliably grounded
Power on and off	RESET	15	DI	Module reset signal		Internal pull-up, low level Effective, not in the air
SIM	USIM_DATA	40	IO	USIM card data card	1.8V USIM: V _{ILmax} =0.6V V _{IHmin} =1.2V V _{OLmax} =0.45V V _{OHmin} =1.35V 3.0V USIM: V _{ILmax} =1.0V V _{IHmin} =1.95V V _{OLmax} =0.45V V _{OHmin} =2.55V	Connect a 10K pull-up resistor to USIM_VDD
	USIM_CLK	41	DO	USIM Card Clock Line	1.8V USIM: V _{OLmax} =0.45V V _{OHmin} =1.35V 3.0V USIM: V _{OLmax} =0.45V	

					VOHmin =2.55V	
	USIM_RST	39	DO	USIM card reset line	1.8V USIM: VOLmax =0.45V	
					VOHmin =1.35V 3.0V USIM: VOLmax =0.45V VOHmin =2.55V	
	USIM_VDD	38	PO	USIM card power supply	1.8V USIM: Vmax=1.9V Vmin=1.7V 3.0V USIM: Vmax=3.05V Vmin=2.7V IoMax=50mA	1.8V or 3.0V USIM Card adaptive
	USIM_GND	42		earthing	0	Guaranteed GND signal can By grounding
UART0	DBG_TXD	50	DO	Module data sending		1.8/2.8V/3.3V voltage The domain is configurable, or it is left blank when not in use
	DBG_RXD	49	DI	Module data reception		1.8/2.8V/3.3V voltage Domains are configurable, not required dangling
UART1	RXD	19	DI	The module receives the data		1.8/2.8V/3.3V voltage The domain is configurable, and if not used, it will have WAKEUP in the air function
	TXD	20	DO	The module sends data		1.8/2.8V/3.3V voltage The domain is configurable, or it is left blank when not in use
UART2	AUX_TXD	29	DO	The module sends data		GPIO can be configured, and other functions can be configured
	AUX_RXD	30	DI	The module receives the data		GPIO can be configured, and other functions can be configured
Wifiscan UART	UART_TXD	4	DO	The module sends data		Wifiscan chip interactive interface, suspended
	UART_RXD	8	DI	The module receives the data		Wifiscan chip interactive interface, suspended

RF connection mouth	RF_ANT	33	IO	Main antenna interface	50 ohm characteristic impedance	
	GNSS_ANT	43	IO	Locate the antenna interface	50 ohms characteristic impedance	
	Wifi_ANT	13	IO	Wifi antenna interface	50 ohms characteristic impedance	
	BLE_ANT(NA)	17	IO	Bluetooth antenna interface	50 ohms characteristic impedance	
ADC interface	ADC	21	AI	General digital-to-analog conversion		If not, it will be suspended
GPIO	GPIO_6	10	IO	Configurable (Internal connection with GNSS_BAK for power supply has been established.)		1.8/2.8V/3.3V voltage The domain is configurable, or it is left blank when not in use
	GPIO_13	36	IO	Configurable		1.8/2.8V/3.3V voltage The domain is configurable, or it is left blank when not in use
GPIO_WKP	GPIO_WKP3	9	IO	Power the TCXO inside the module		
	GPIO_WKP2	11	IO	Wake up the system in PSM mode		The wake-up is triggered by the rising edge or falling edge, and the software can be configured
Retain the pins	RESERVED	5,14,22,23,24,27,28		Preserve the interface		If not, it will be suspended; Part leads to the GPIO
	BOOT	7	DI	Download mode		Valid high, no then suspended
	WAKEUP	6	DI	awaken		Pull down to wake up, and hang in the air when not

Note: The GPIO level is 1.8V by default, which can be changed to 3.3V through software configuration, and the VBAT power supply is always $\geq 3.3V$ to avoid GPIO level changes (especially for VBAT battery-powered circuits, consider whether this condition is met when the battery is lost)

4.3 Working mode

The module supports three working modes, corresponding to different business scenarios and requirements, to achieve the best performance;

The default parameters for switching between specific modes are delivered by the carrier's network configuration.

Table 4.3 List of module operating modes

mode	function	
Normal working mode	Active	The module is active; All functions are normally available, and data can be sent and received; In this mode, the module can be switched to either idle mode or PSM mode.
	Standby	The module is in light sleep and the network is in DRX/eDRX and can receive paging messages. In this mode, the module can be switched to Active or PSM mode.
	PSM	Only the RTC works inside the module, the network is in a non-connected state, cannot receive downstream data, and can be woken up by the AT command. At this time, the module can enter a deep sleep state; T3412 (related to periodic network updates) timeout or WAKEUP (or UART1_RXD) pin The lower edge can wake up the module, and when the Bluetooth low energy broadcast is turned on, the module can be woken up by the Bluetooth connection signal.

4.4 Power supply design

4.4.1 Pin introduction

TRI-020 has 2 VBAT pins for connecting to an external power supply. The following table describes the VBAT and ground pins of the module.

Table 4.4 Module VBAT and GND Pins

Pin name	Pin number	description	minimum	Typical	maximum	unit
VBAT	45,46	Module power input	2.9	3.3	4.5	V
GND	2,32,34,42,44,47,48,51,52,54	earth				

Note: When the GPIO level is configured to be 3.3V, the VBAT power supply needs to $\geq 3.3V$

4.4.2 Power supply reference circuit

The power design of a module is critical to its performance. It can use LDO or DC-DC with low quiescent current and output current capability of more than 0.5A as power supply, and can also support Li-MnO₂/2S battery power supply; The power supply drop needs to be according to the following requirements: the power supply input voltage range is 2.9V ~ 4.5V, and the module must ensure that the power drop is not lower than the minimum working voltage of the module 2.9V, otherwise the module will work abnormally.

In order to ensure better power supply performance, it is recommended to connect a 100uF tantalum capacitor with low ESR (ESR=0.7Ω) in parallel close to the VBAT input of the module, as well as 100nF and

100pF(0402 package) and 22pF (0402 package). At the same time, it is recommended to add a TVS tube close to the VBAT input to increase the surge voltage tolerance of the module. In principle, the longer the VBAT trace, the wider the line width

Wide.

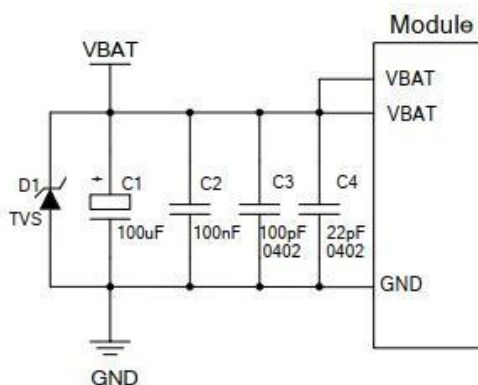


Figure 4.2 VBAT input reference circuit

4.4.3 Shutdown

Shutdown can be achieved in the following ways:

- The module can be powered off by disconnecting the VBAT power supply;
- When the power supply of the module is less than the minimum supply voltage, it will automatic

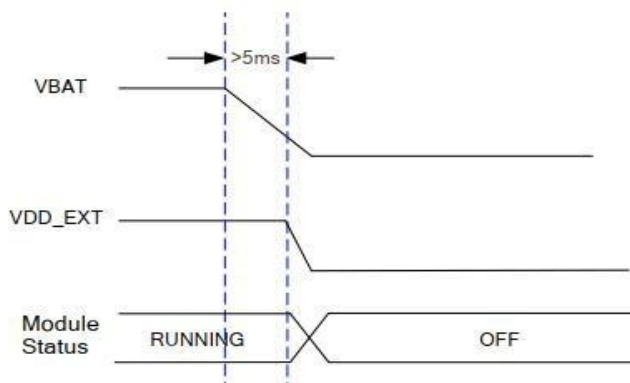


Figure 4.3 Shutdown Timings

4.4.4 Reset module

The module can be reset by pulling the RESET pin down for at least 1 second.

Pin name	Pin number	description	Reset pin pull-down time
RESET	15	Reset module; Valid low	$\geq 1S$

The hardware reset reference circuit is shown in the figure below. It is recommended to use an open-set drive circuit to control the RESET pin.

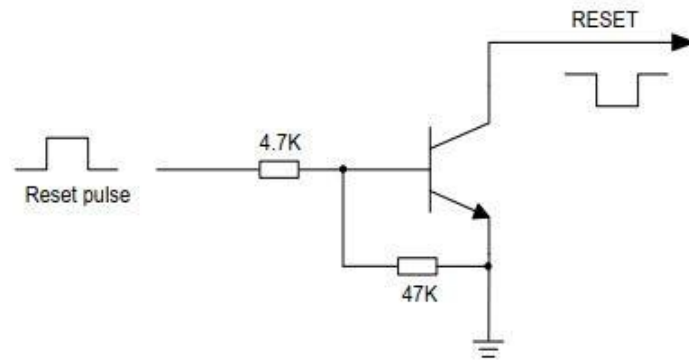


Figure 4.4 Boot Drive Reset Reference Circuit

You can also use the key to control the RESET pin:

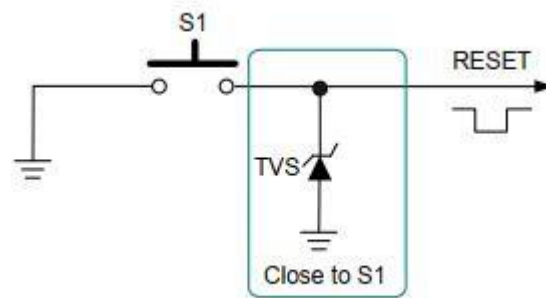


Figure 4.5 Key Reset Reference Circuit

The reset timing diagram looks like this:

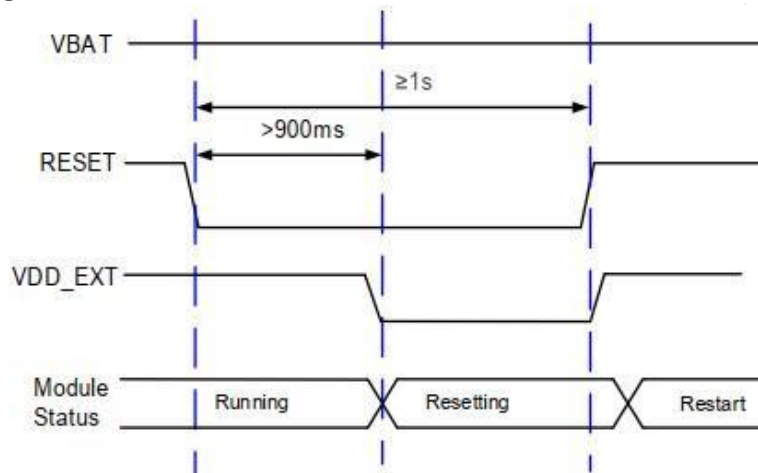


Figure 4.6 Reset Timings

4.5 Serial

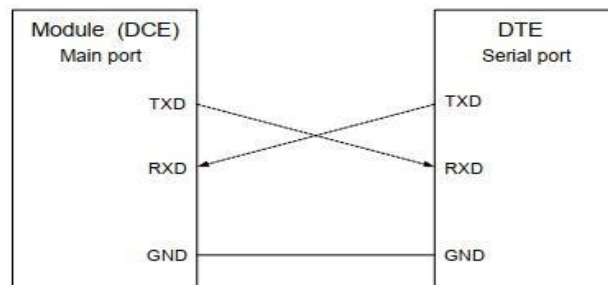
The module is equipped with three serial ports: the main serial port, the debug serial port and the auxiliary serial port. The module acts as a DCE (Data Communication Equipment) and connect in the traditional DCE-DTE (Data Terminal Equipment) manner.

Table 4.5 Module Serial Pin Definitions

interface	Pin name	Pin number	description	remark
Main serial port	UART1_TXD	20	The main serial port sends data to the RXD side of the DTE device	1.8V/2.8V/3.3V The voltage domain is configurable See VIO_SEL definition
	UART1_RXD	19	The main serial port receives data from the TXD side of the DTE device	
Debug the serial port	DBG_RXD	49	The debug serial port is received from the TXD side of the DTE device data	
	DBG_TXD	50	Debug the serial port to send data to the DTE device RXD side	

4.5.1 Main serial port

The main serial port can be used for AT command communication, data transfer, and software upgrades. When used for AT command communication and data transmission, it supports a variety of baud rates, with a default of 9600 bps. The main serial port can work in both Active and Idle modes.



4.5.2 Debug the serial port

Figure 4.7 Schematic diagram of the connection between DCE and DTE:

Through the log viewing tool, the debug serial port can be used to view the underlying log information for software debugging, and its supported baud rate is 3Mbps. The debug serial port can also be used for software upgrades, which support 921600bps baud rate. The reference design for debugging a serial port is shown in the following figure:

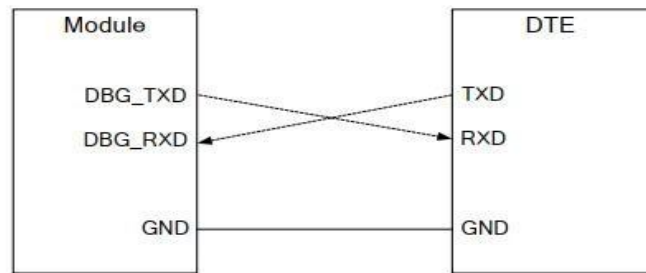


Figure 4.8 Debugs the serial port reference design

4.5.3 Serial port application

The module has a serial voltage domain of 1.8V. If the voltage domain of the customer's application system is 3.3V, a level translator needs to be added to the serial connection between the module and the customer's application. Texas Instruments (more information on <http://www.ti.com>) TXS0108EPWR is recommended. The design of the reference circuit using the level-shifting chip is shown in the figure below

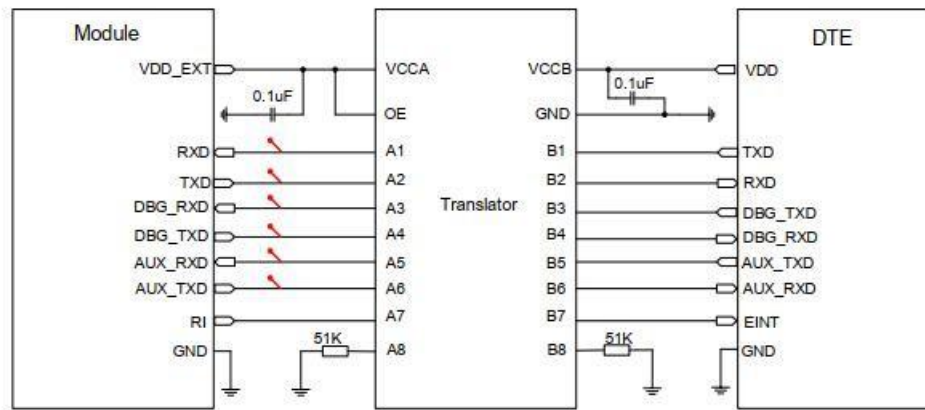


Figure 4.9 Level Shifting Reference Circuit (Level Shifting Chip).

Another level-shifting circuit is shown in the figure below. The input and output circuits of the dotted line section below can be designed with reference to the solid line part, but the connection direction should be noted, and the transistor level translation reference circuit is not suitable for applications with baud rates exceeding 460kbps .

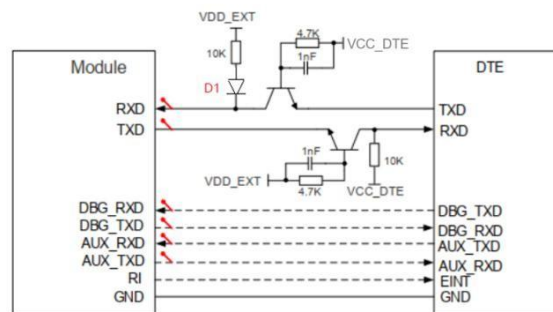


Figure 4.10 Level Translation Reference Circuit (Transistor).

The serial port level translation circuit needs to follow the reference circuit in Figure 4.12, module PIN17 (RXD), this pin has a sleep wake-up function in PSM mode, and PIN17 (RXD) will keep 1.3V high in PSM mode; When using the internal power supply VDD_EXT of the module (OV in PSM mode) as the PULL-UP power supply, a D1 Schottky diode must be added to prevent false wake-up caused by current backfill (VDD_EXT in PSM mode is OV, which will pull down PIN10 (RXD) to cause false wake-ups) and reduce leakage; D1 Select a device with low reverse leakage (IR) and low VF characteristics; D1 Reference Model: PSBD2FD30V01(PRISEMI); If you use an external power supply instead of VDD_EXT to do PULL-UP, D1 should not be omitted.

Important Note - For circuits where the UART level of the module is consistent with the level of the microcontroller: If the standby current (PSM) requirements are very strict, a level translation circuit with a D1 device (as shown in the figure above) needs to be added between the module RXD (PIN17) and the microcontroller TXD to avoid the possibility of current backflow in the circuit in PSM mode to achieve the lowest current consumption; If the module is powered off to reduce the power consumption of the device, the level translation circuit can also be omitted, and it is recommended that the serial port level corresponding to the single-chip microcomputer is configured to 0V to save unnecessary leakage;

The diagram below is a schematic diagram of the connection between the standard RS-232 interface and the module. The customer needs to make sure that the level shifting chip is connected to the module

The I/O voltage is 1.8V.

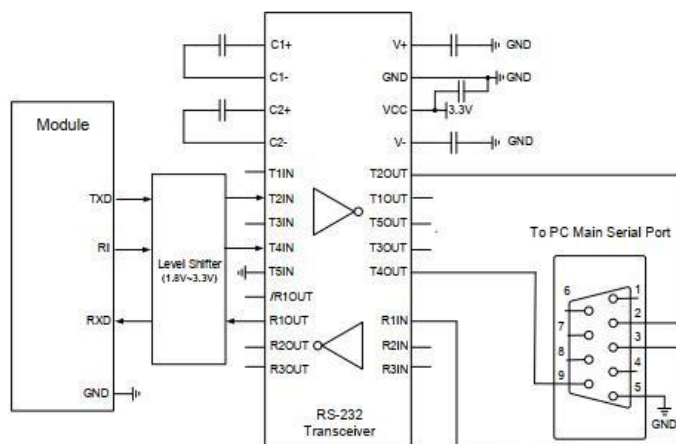


Figure 4.11 Schematic diagram of RS232 interface matching

4.6 USIM interface

The TRI-020 module's USIM interface is ISO /IEC 7816-3 compliant and supports 1.8V/3.0V external USIM cards. External

The USIM card is powered by a power supply inside the module.

Table 4.7 Module USIM Pins

Pin name	Pin number	description	remark
USIM_VDD	38	External USIM card power supply	Voltage: 1.8V/3.0V The module automatically recognizes the USIM card voltage
USIM_CLK	41	External USIM card clock signal	
USIM_DATA	40	External USIM card data signal	A pull-up 10K resistor is required to USIM_VDD
USIM_RST	39	External USIM card reset signal	
USIM_GND	42	The external USIM card is grounded	

The following diagram is a reference design for a 6-pin external USIM deck:

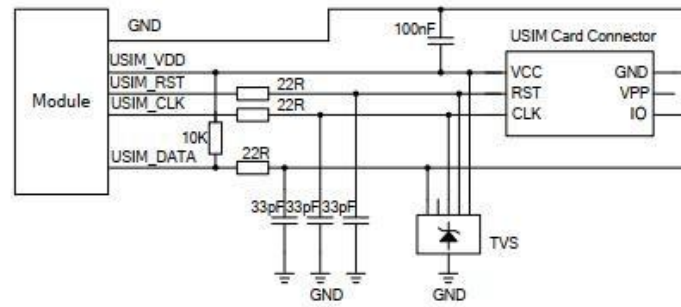


Figure 4.14 Reference circuit diagram of a 6-pin external USIM deck

In the circuit design of the USIM interface, in order to ensure the good performance of the external USIM card and prevent the external USIM card from being damaged, the following design principles are recommended in the circuit design:

- The external USIM deck is placed close to the module, and the wiring length of the external USIM deck signal cable is not exceeded as much as possible

- 200mm。
- USIM_VDD 3.0V is high for a period of time before the card is identified, and the external USIM deck signal line is routed away from the RF traces and VBAT power lines.
 - The GND wiring of the ground and module of the external USIM deck should be short and thick. In order to guarantee the same potential, it is necessary to ensure that the wiring width is not less than 0.5mm. The USIM_VDD has a decoupling capacitance of 1uF or less, and the capacitor should be placed close to the external USIM deck.
 - In order to prevent crosstalk between USIM_CLK and USIM_DATA signals, the wiring should not be too close to each other, and additional shielding should be required between the two traces. In addition, USIM_RST signals need to be protected.
 - To ensure good ESD protection, it is recommended to add a TVS tube to the pins of the external USIM deck. The parasitic capacitance of the selected TVS tube should be no greater than 50pF, and the <http://www.onsemi.com> can be accessed to select the appropriate TVS device. The ESD protection device should be placed as close to the external USIM deck as possible, and the external USIM deck signal traces should be connected from the external USIM deck to the ESD protection device and then from The ESD protection device is connected to the module. A 22Ω resistor is required in series between the module and the external USIM card to suppress stray EMI and enhance ESD protection. The peripherals of the external USIM card should be placed as close to the external USIM card holder as possible.
 - 33pF capacitors in parallel on USIM_DATA, USIM_CLK, and USIM_RST lines are used to filter out RF interference.

4.7 ADC interface

The module provides a 12-bit analog-to-digital conversion input interface to measure voltage values.

Table 4.8 Module ADC Pins

Pin name	Pin number	description
ADC	21	The reference voltage is 1.5V/2.2V configurable, the sampling accuracy is 10bit, and the maximum sampling frequency is 10MHz. At 1.5V level, the detection range of ADC is 0~1.5V in low-voltage mode and 0~VBAT in high-voltage mode, and the maximum withstand voltage value is 5.5V At 2.2V, the detection range of ADC low-voltage mode is 0~2.2V, and the maximum withstand voltage value is 5.5V

When using an external voltage divider resistor, the total resistance of the ADC sampling resistor needs to be less than 500K, otherwise the sampling accuracy will be reduced. If you have strict requirements on power consumption, you can refer to the following circuit, sample when the module is working, and disconnect the sampling when the module is asleep.

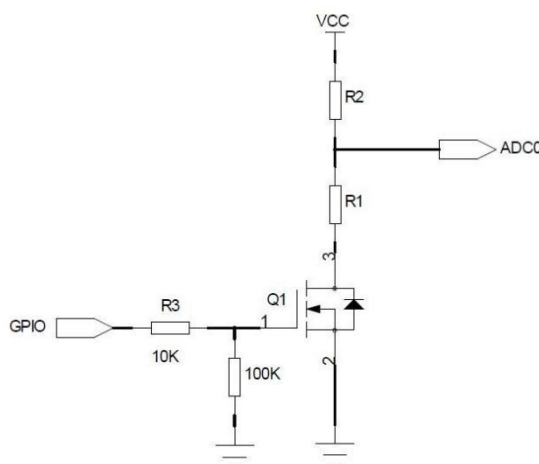


Figure 4.17 ADC Sampling Reference Circuit

5 Antenna interface

5.1 NB-IoT antennas

TRI-020 provides 1 antenna pin RF_ANT.

It is recommended that the user use an antenna with a 50Ω impedance that matches the RF connector on the module side.

Table 5.1 Module RF Pins

Pin name	Pin number	description
RF_ANT	33	NB_IoT Antenna interface
GNSS_ANT	43	GNSS antenna interface
Wifiscan_ANT	13	Wifi antenna interface
BLE_ANT(NA)	17	Bluetooth Low Energy interface

It is recommended that the application side carefully select the RF adapter cable. RF adapter cables with the lowest possible losses need to be selected. It is recommended to use RF adapter cables for the following RF loss requirements:

TDD-LTE<1.5dB

FDD-LTE<1.5dB

5.1.1 NB-IoT antenna reference circuit

For the peripheral circuit design of the antenna interface, in order to better adjust the RF performance, it is recommended to reserve a π matching circuit, and the π matching circuit components should be placed as close to the antenna as possible, and need to be selected and pasted according to the actual situation. RF_ANT connect TRI-020 module, by default, L102, L100 do not stick, only stick 100pF-50V capacitors on C160. In addition, TVS tubes can be connected in parallel at L100 (TVS device selection junction capacitance cannot exceed 0.1PF) to absorb static electricity. The impedance of the RF traces should be controlled at around 50Ω, and the shorter the traces, the better

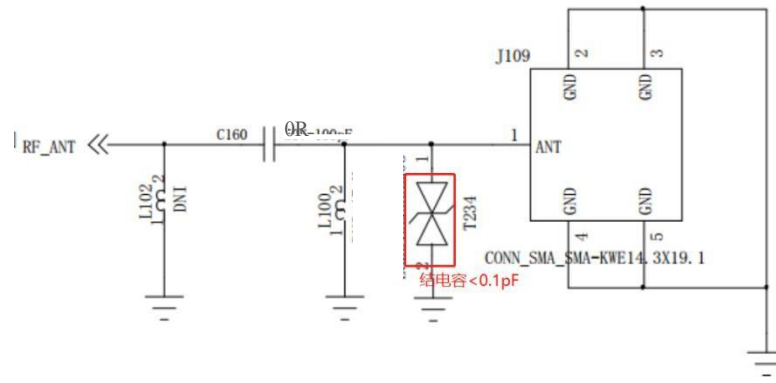


Figure 5.1 NB-IoT antenna reference circuit

5.1.2 NB-IoT antenna parameter requirements

Table 5.2 Module NB-IoT antenna parameter requirements

parameter	request
Band	699MHz~960MHz
VSWR	<1.5
efficiency	>30%
Maximum input power (W).	50
Input Impedance (Ω).	50

5.1.3 GNSS antenna parameter requirements

Table 5.2 Module GNSS Antenna Parameter Requirements

parameter	request
Band	1.55905~1.60589GHz
VSWR	<2
gain	$\geq 1\text{dBi}$
Maximum input power (W).	2
Input Impedance (Ω).	50

5.1.4 Wifi antenna parameter requirements

Table 5.2 Module Wifi Antenna Parameter Requirements

parameter	request
Band	2.4GHz-2.485GHZ
VSWR	<1.5
gain	$\geq 2\text{dBi}$
Maximum input power (W).	1
Input Impedance (Ω).	50

5.1.5 Output power

Table 55 Module conduction power

Band	maximum	minimum
B2	26.5dBm	< -40dBm
B4	26dBm	< -40dBm
B12	24.5dBm	< -40dBm
B13	24.5dBm	< -40dBm
B66	26dBm	< -40dBm
B5	24.5dBm	< -40dBm
B26	24.5dBm	< -40dBm
B71	24.5dBm	< -40dBm

Table 5.4 Modules can support frequency bands

5.2 Operating frequency band

Band	Transmit frequency/MHz	Receive frequency/MHz
Band2	1850-1910	1930-1990
Band4	1710-1755	2110-2155
Band5	824-849	869-894
Band12	699-716	729-746
Band13	777-787	746-756
Band26	1710-1780	2110-2220
Band66	1710-1785	2110-2155
Band71	663-698	617-652

Different frequency bands can be customized according to customer needs, and specific sub-models are distinguished;

5.3 RF signal line layout reference design

For the user's PCB, the characteristic impedance of all RF signal lines should be controlled to 50Ω. In general, the RF signal line

The impedance is determined by the dielectric constant of the material, the width of the trace (W), the clearance to ground (S), and the height of the reference ground plane (H). The characteristic impedance of the PCB is usually controlled by two methods: microstrip lines and coplanar waveguides. To illustrate the design principles, the following diagrams illustrate the structural design of a microstrip line and a coplanar waveguide with an impedance line controlled at 50 Ω.

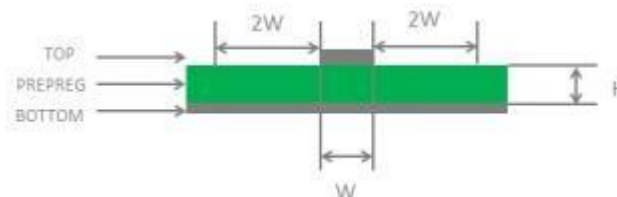


Figure 5.2 Microstrip line structure of a two-layer PCB

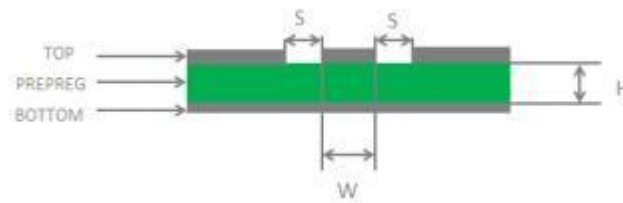


Figure 5.3 Coplanar waveguide structure of a two-layer PCB board

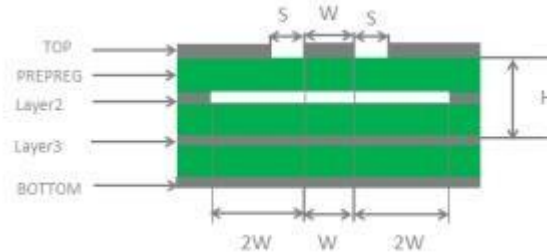


Figure 5.4 Coplanar waveguide structure of a four-layer PCB (reference ground is the third layer).

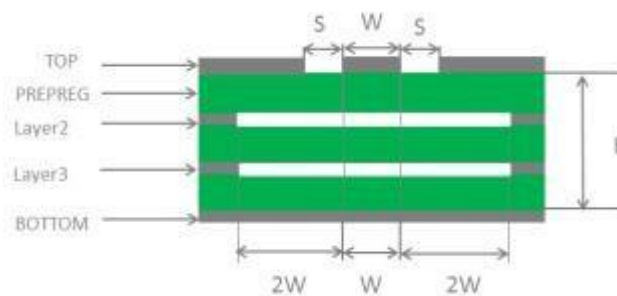


Figure 5.5 Coplanar waveguide structure of a four-layer PCB (reference ground is the fourth layer).

In the circuit design of RF antenna interface, in order to ensure the good performance and reliability of RF signals, the following design principles are recommended in the circuit design:

- Impedance simulation calculation tools should be used for accurate 50Ω impedance control of RF signal lines.
- The GND pin adjacent to the RF pin should not be a hot pad, but should be in full contact with the ground.
- The distance between the RF pins and the RF connector should be kept as short as possible; Also avoid right-angle traces, which are recommended to have an angle of 135 Degree.
- When the connection device package is established, it should be noted that the signal pins should be kept at a certain distance from the ground.
- The ground plane referenced by the RF signal line should be intact; Adding a certain amount of ground holes around the signal line and reference ground can help improve RF performance; The distance between the ground hole and the signal line should be at least 2 times the line width ($2*W$).
- RF signal lines must be kept away from the source of interference and avoid crossing or parallel to any signal lines in adjacent layers.

6 Electrical characteristics

6.1 Operating and storage temperature

parameter	least	typical	utmost	unit
Normal operating temperature	-30	25	75	°C
Extended operating temperature	-40		85	°C
Storage temperature	-40		90	°C

Table 6.2 TRI-020 Current Status (3.6V voltage at room temperature, platform test data for reference.)

6.2 Flow consumption

参数	模式	描述	平均值	最大值
I (VBAT)	PSM	睡眠状态	4.575uA(GNSS Coldstart)、 17.811uA(GNSS Hotstart)	5.17uA(GNSS冷启动)、 20.054uA(GNSS Hotstart)
	Idle	空闲状态	1.2218mA	1.76mA
	Active @Single-tone (3.75kHz/15kHz)	射频发射状态, 23dBm	B2	394.48mA
			B4	291.55mA
			B5	365.32mA
			B12	289.13mA
			B13	323.78mA
			B26	361.66mA
			B66	291.43mA
			B71	301.75mA
		射频接收状态	B2	22.49mA
			B4	21.19mA
			B5	20.03mA
			B12	23.14mA
			B13	23.09mA
			B26	20.01mA
			B66	21.26mA
			B71	23.27mA
	Active @Multi-tone (15kHz)	射频发射状态, 23dBm	B2	276.39mA
			B4	277.06mA
			B5	353.04mA
			B12	279.91mA
			B13	304.46mA
			B26	346.58mA
			B66	277.18mA
			B71	288.38mA

6.3 ESD protection

In module applications, static electricity generated by human static electricity and live friction between

microelectronics will be discharged to the module through various ways, and the mold may be reversed blocks cause some damage, so ESD protection should be taken seriously. ESD protection should be taken during R&D, production, assembly, and testing, especially in product design . For example, anti-static protection should be added at the interface of the circuit design and at the point where it is susceptible to electrostatic discharge damage or influence; Anti-static gloves should be worn during production. The ESD withstand voltage of the module pins is $\geq 2\text{KV}$ under unprotected conditions;

6.4 Receive sensitivity

Table 6.4 Module Reception Sensitivity

Band	Main set	NBLoT Receive Sensitivity/3GPP	unit
B2	-115.75	-107.5	dBm
B4	-115.53	-107.5	dBm
B5	-116.85	-107.5	dBm
B12	-117.52	-107.5	dBm
B13	-117.35	-107.5	dBm
B26	-116.82	-107.5	dBm
B66	-115.62	-107.5	dBm
B71	-118.02	-107.5	dBm

7 Mechanical characteristics

7.1 Top and bottom views of the module



Figure 7.1 TRI-020 Top view

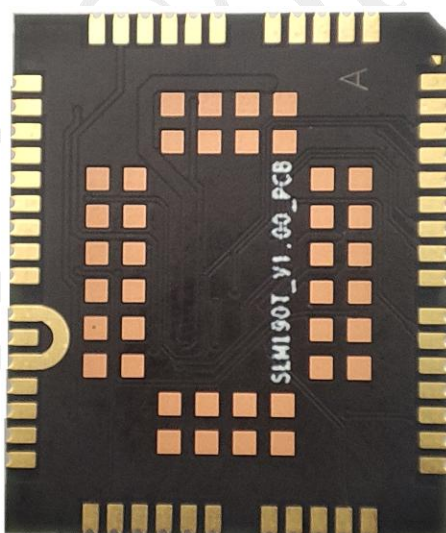


Figure 7.2 TRI-020 Bottom view

7.2 Module mechanical dimensions

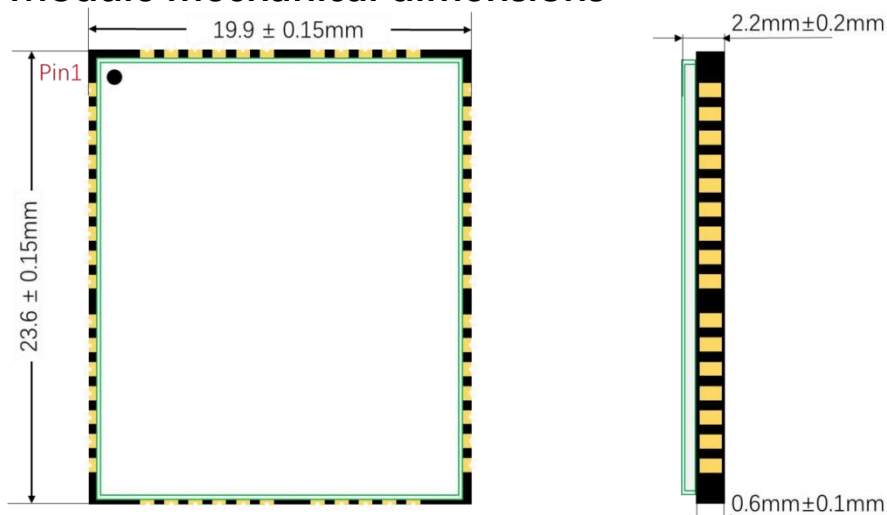


Figure 7.3 TRI-020 Top and side view dimensions (mm).

7.3 Recommended PCB package size

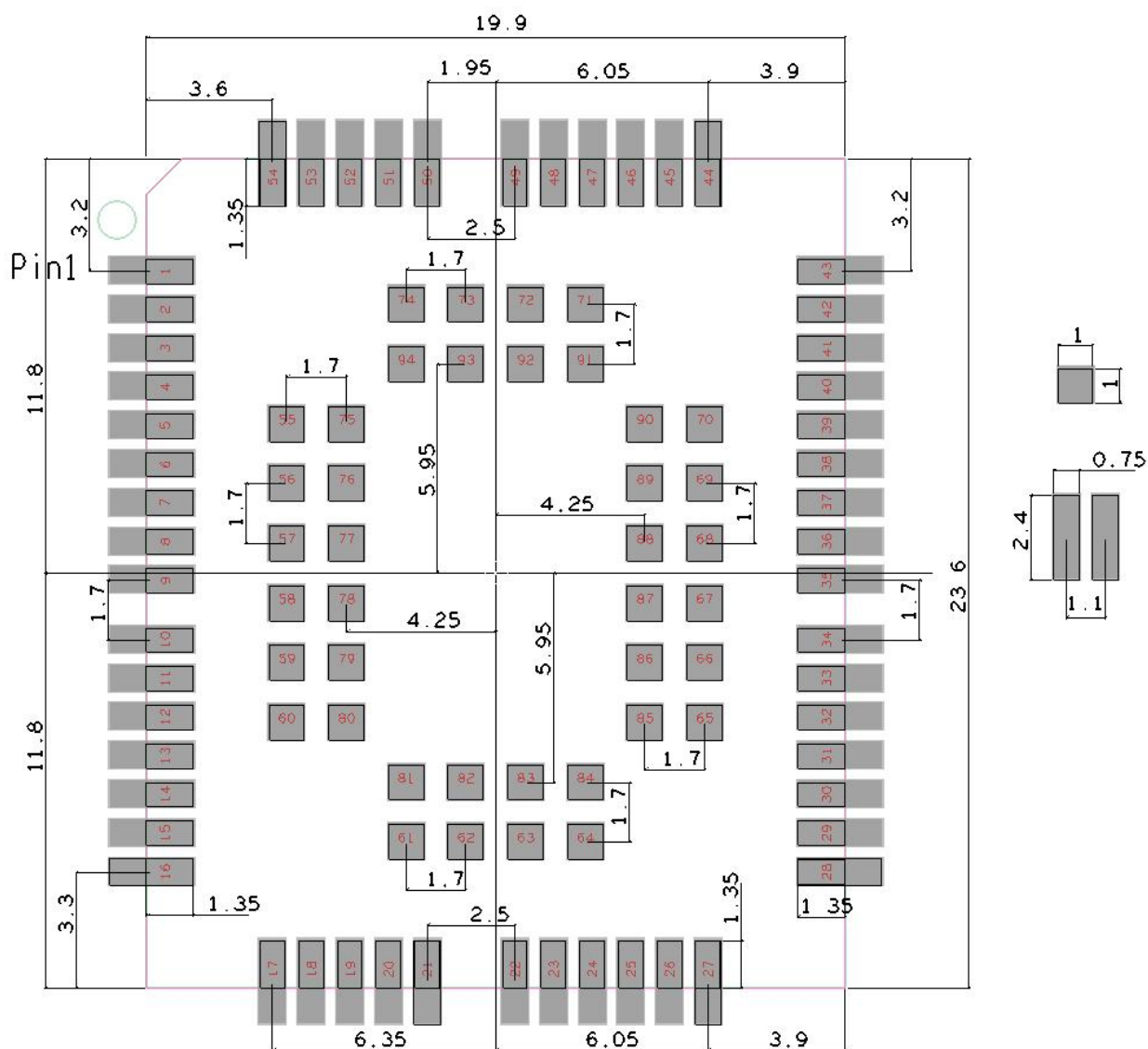


Figure 7.4 Recommended Package Top View (mm).

8 Storage and production

8.1 storage

TRI-020 Vacuum sealing treatment before shipment, storage should follow the following conditions:

Form 8.1 Storage Environment Requirements

Precautions	description
Ambient temperature	The ambient temperature is below 40 degrees Celsius and the air humidity is less than 60%. In 90% of cases, the modules can be stored in vacuum-sealed bags for 12 months.
Requirement to return to the furnace after unsealing	When the vacuum-sealed bag is opened, the module can be directly reflowed or other high-temperature processes if the following conditions are met: - The module stores air humidity of less than 10%. - The ambient temperature of the module is lower than 30 degrees Celsius, and the air humidity is less than 60%. The factory completed the placement within 72 hours.
Baking conditions before patching	- When the ambient temperature is 23 degrees Celsius (5 degrees Celsius up and down is allowed). The humidity indicator card shows that the humidity is greater than 10%.
	- After unsealing, the ambient temperature of the module is lower than 30 degrees Celsius, the air humidity is less than 60%, but the factory failed to complete the placement within 72 hours. - After unsealing, the module stores high humidity in the air at 10%.
Baking precautions	If the module requires baking, bake at 125°C (+/-5) for 48 hours. Note: The module packaging must be removed before the module is baked.

8.2 Furnace temperature curve

The recommended temperature for reflow soldering is 235~245°C and cannot exceed 260°C. In order to avoid repeated heat damage to the module, it is recommended that the first side of the customer's PCB board be reflowed before attaching the module. The recommended furnace temperature curve is shown in the figure below:

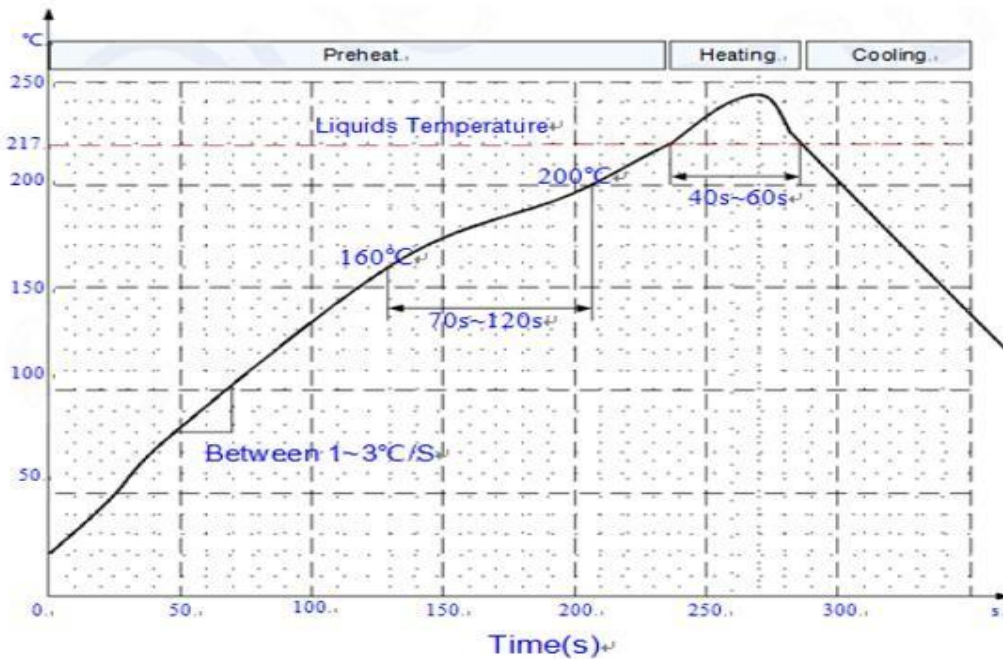


Figure 8.1 Furnace temperature curve reference

9 appendix

9.1 Abbreviations

Form 9.1 Abbreviations

abbreviation	Description in English	Description in Chinese
IO	Input and output	
DI	Digital inputs	
PI	Power input	
abbreviation	Description in English	Description in Chinese
AMR	Adaptive Multi-rate	Adaptive multi-rate
BER	Bit Error Rate	Ber
BTS	Base Transceiver Station	Base station transceiver station
PCI	Peripheral Component Interconnect	Peripheral components are interconnected
CS	Circuit Switched (CS) domain	Circuit domain
CSD	Circuit Switched Data	Circuit-switched data
DCE	Data communication equipment	Data circuit terminal equipment
DTE	Data terminal equipment	Data terminal equipment
DTR	Data Terminal Ready	The data terminal is ready
EFR	Enhanced Full Rate	Enhanced Full Rate
EMC	Electromagnetic Compatibility	Electromagnetic compatibility
ESD	Electrostatic Discharge	Electrostatic discharge
FR	Frame Relay	Frame Relay
GMSK	Gaussian Minimum Shift Keying	Gaussian minimum frequency-shift keying
GPIO	General Purpose Input Output	Universal inputs/outputs
HR	Half Rate	Half speed
HSDPA	High Speed Downlink Packet Access	High-speed downlink packet access
HSUPA	High Speed Uplink Packet Access	High-speed uplink packet access
HSPA	HSPA High-Speed Packet Access	High-speed packet access
HSPA+	HSPA High-Speed Packet Access+	Enhanced high-speed packet access
IEC	International Electro-technical Commission	International Electrotechnical Commission
IMEI	International Mobile Equipment Identity	International Mobile Equipment Identification
MEID	Mobile Equipment Identifier	The identification number of the CDMA terminal
I/O	Input/Output	Inputs/Outputs

ISO	International Standard s Organization	International Organization for Standardization
ITU	International Telecommunications Union	International Telecommunication Union
bps	bits per second	bits per second
LED	Light Emitting Diode	Light-emitting diodes
M2M	Machine to machine	Machine-to-machine
MO	Mobile Originated	Initiated by the mobile station
MT	Mobile Terminated	The mobile station is terminated
NTC	Negative Temperatur e Coefficient	Negative temperature coefficient
PC	Personal Computer	PC
PCB	Printed Circuit Board	Printed circuit boards
PDU	Packet Data Unit	Grouping data units
PPP	Point-to-point protocol	Point-to-point protocol
PS	Packet Switched	packet switching
QPSK	Quadrature Phase Shift Keying	Quadrature phase-shift frequency keying
SIM	Subscriber Identity Module	User Identification Module
TCP/IP	Transmission Contro l Protocol/ Internet Protocol	Transmission Control Protocol/Internet Protocol
UART	Universal asynchronou s receiver-transmitter	General-purpose asynchronous transceiver (machine).
USIM	Universal Subscriber Identity Module	Universal User Identification Module
UMTS	Universal Mobil e Telecommunications System	Universal mobile communication system
USB	Universal Serial Bus	Universal Serial Bus
WCDMA	Wideband Code Division Multiple Access	Wideband code division multiple access
TD-SCDMA	Time Division- Synchronous Code Division Multiple Access	Time division synchronization code division multiple access
TDD LTE	Time Division Long Term Evolution	Time and time are long-term evolution
FDD LTE	Frequency Division Duplexing Long Term Evolution	Long-term evolution of frequency divisions
Vmax	Maximum Voltage Value	Maximum voltage value
Vnorm	Normal Voltage Value	Typical voltage values
Vmin	Minimum Voltage Value	Minimum voltage value
VIHmax	Maximum Input High Level Voltage Value	The maximum voltage that is input high

VIHmin	Minimum Input High Level Voltage Value	Enter the minimum voltage at a high level
VILmax	Maximum Input Low Level Voltage Value	The maximum voltage that is input low
VILmin	Minimum Input Low Level Voltage Value	The minimum voltage at the input level
VOHmax	Maximum Output High Level Voltage Value	The maximum voltage at the output high level
VOHmin	Minimum Output High Level	The minimum voltage at which the output is high
	Voltage Value	
VOLmax	Maximum Output Low Level Voltage Value	The maximum voltage that outputs low
VOLmin	Minimum Output Low Level Voltage Value	The minimum voltage at the output level

FCC Statement

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.

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

2.2

This module has been assessed against the following FCC rule parts: CFR 47 FCC Part 2,22H,24E,27,90S. It is applicable to the modular transmitter

2.3

This radio transmitter 2BR82-TRI020 has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

The concrete contents to check are the following three points.

- 1) Maximum antenna gains are shown in item 2.7 below.
- 2) Should be installed so that the end user cannot modify the antenna
- 3) Feed line should be designed in 50ohm

Fine-tuning of return loss etc. can be performed using a matching network.

The antenna shall not be accessible for modification or change by the end user.

2.4

The module complies with CFR 47 FCC Part 2,22H,24E,27,90S and apply for Single module approval.

2.5

Trace antenna designs: Not applicable, the antenna connector for this module are integrated into the module. Use of external antennas or antennas integrated into the host circuit board are not an option.

2.6

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

2.7

The following antennas have been certified for use with this module.

Only antennas of the same type with equal or lower gain may also be used with this module.

Other types of antennas and/or higher gain antennas may require the additional authorization for operation. The installer should use unique antenna connector and Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device. The manufacturer of module will inform installer to meet with the FCC part 15.203 in the warning part.

Antenna Specification list below:

Antenna type:
Blade Shape Rubber Rod
Antenna

Band	MAX Antenna Gain (dBi)
NB-IoT Band 2	2.19
NB-IoT Band 4	3.35
NB-IoT Band 5	1.35
NB-IoT Band 12	1.62
NB-IoT Band 13	1.35
NB-IoT Band 26(part 90S)	1.46
NB-IoT Band 26(part 22)	1.35
NB-IoT Band 66	3.35
NB-IoT Band 71	1.62

2.8

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as “Contains FCC ID: 2BR82-TRI020” ; any similar wording that expresses the same meaning may be used.

2.9

Testing of the host product with all the transmitters installed – referred to as the composite investigation test- is recommended, to verify that the host product meets all the applicable FCC rules. The radio spectrum is to be investigated with all the transmitters in the final host product functioning to determine that no emissions exceed the highest limit permitted for any one individual transmitter as required by Section 2.947(f). The host manufacturer is responsible to ensure that when their product operates as intended it does not have any emissions present that are out of compliance that were not present when the transmitters were tested individually.

If the modular transmitter has been fully tested by the module grantee on the required number of channels, modulation types, and modes, it should not be necessary for the host installer to re-test all the available transmitter modes or settings. It is recommended that the host product manufacturer, installing the modular transmitter, perform some investigative measurements to confirm that the resulting composite system does not exceed the spurious emissions limits or band edge limits (e.g., where a different antenna may be causing additional emissions).

The testing should check for emissions that may occur due to the intermixing of emissions with the other transmitters, digital circuitry, or due to physical properties of the host product (enclosure). This investigation is especially important when integrating multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration.

2.10

Any company of the host device which install this modular should perform the test of radiated & conducted emission and spurious emission etc. according to CFR 47 FCC Part 2,22H,24E,27,90S,15B class B requirement, only if the test result comply with FCC part 15C: 15.247 and 15.209 & 15.207, part 15 E 15.407,15B class B requirement. Then the host can be sold legally.

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.

2.11

The host manufacturer is recommended to use FCC KDB 996369 D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

Canada Statement

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
 - (2) This device must accept any interference, including interference that may cause undesired operation of the device.
- Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
- (1) l'appareil ne doit pas produire de brouillage;
 - (2) l'utilisateur de l'appareil doit accepter tout brouillage radio électrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Please notice that if the ISED certification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains IC: 34598-TRI020" any similar wording that expresses the same meaning may be used.

L'appareil hôte doit porter une étiquette donnant le numéro de certification du module d'Industrie Canada, précédé des mots « Contient un module d'expédition », du mot « IC: 34598-TRI020 » ou d'une formulation similaire exprimant le même sens, comme suit

The device meets the exemption from the routine evaluation limits in section 6.6 of RSS 102 and compliance with RSS-102 RF exposure, users can obtain Canadian information on RF exposure and compliance.

Le dispositif rencontre l'exemption des limites courantes d'évaluation dans la section 6.6 de RSS 102 et la conformité à l'exposition de RSS-102 RF, utilisateurs peut obtenir l'information canadienne sur l'exposition et la conformité de rf.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

Cet émetteur ne doit pas être Co-placé ou ne fonctionnant en même temps qu'aucune autre antenne ou émetteur. Cet équipement devrait être installé et actionné avec une distance minimum de 20 centimètres entre le radiateur et votre corps.

Notice to OEM integrator

Must use the device only in host devices that meet the FCC/ISED RF exposure category of mobile, which means the device is installed and used at distances of at least 20cm from persons.

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

The end user manual shall include PFCC art 2,22H,24E,27,90S /ISED RSS GEN compliance statements related to the transmitter as show in this manual(FCC/Canada statement).

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B, ICES 003.

Host manufacturer is strongly recommended to confirm compliance with FCC/ISED requirements for the transmitter when the module is installed in the host.

The use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual.

Host manufacturer is strongly recommended to confirm compliance with FCC/ISED requirements for the transmitter when the module is installed in the host.

Must have on the host device a label showing Contains FCC ID: 2BR82-TRI020 or IC: 34598-TRI020

Both FCC ID and IC ID are not to be placed on the host at the same time and only hosts going into the US can use the FCC ID and only hosts going into Canada can use the IC ID.

Installer should put it in the manual:

l'hôte doit utiliser l'instrument uniquement dans des dispositifs qui r é pondent à la fcc / (cat é gorie d'exposition rf mobile, ce qui signifie le dispositif est install é et utilis é à une distance d'au moins 20 cm de personnes.

le manuel de l'utilisateur final doit inclure la partie 15 / (fac rss gen d é clarations de conformit é relatives à l' é metteur que de montrer dans ce manuel.

le fabricant est responsable de la conformit é de l'hôte, le syst è me d'accueil avec le module install é avec toutes les autres exigences applicables du syst è me comme la partie 15 b, ices - 003.

accueillir le fabricant est fortement recommand é de confirmer la conformit é avec les exigences de la fcc / (é metteur lorsque le module est install é dans l'hôte.

le dispositif d'accueil doivent avoir une étiquette indiquant contient FCC ID: 2BR82-TRI020, IC: 34598-TRI020

Doit avoir sur l'appareil hôte une étiquette indiquant Contient l'ID FCC 2BR82-TRI020 ou IC : 34598-TRI020

L'ID FCC et l'ID IC ne doivent pas ê tre plac é s sur l'hôte en m ê me temps et seuls les hôtes se rendant aux tats-Unis peuvent utiliser l'ID FCC et seuls les hôtes se rendant au Canada peuvent utiliser l'ID IC.

Professional Installation Instructions

The device must be professionally installed. Installation must be controlled and requires special training.

The intended use is generally not for the general public. It is generally for industry/commercial use.

The connector is within the transmitter enclosure and can only be accessed by disassembly of the transmitter that is not normally required. The user has no access to the connector.

Must use the same type of antenna with lower or equal gain to the listing antenna as follows: