RC10EM-NA Module Hardware Manual

Introduction

The IOT Division is an independent operating department affiliated to Huizhou Boshijie Technology Co. , Ltd. The IOT Division is committed to providing high-quality modules and product solutions for the Internet of Things industry, mainly including GSM module product lines, GNSS module product lines, WiFi module product lines, Bluetooth module product lines, NB-IOT module product lines, etc. See the table below for details:

product line	model	Standard sizes
Communication	RC20	20.0*14.0*3.0mm

module	BC25	17.6*15.7*3.0mm
	BC26	17.7*15.8*3.0mm
	BC28	22.2*20.2*3.0mm
Communication + positioning module	BC20	18.7*16.0*3.0mm
	RC10EM-NA	15.0*24.0*3.0mm
	RC30	17.6*15.7*3.0mm
Positioning module	B1612-U	16.0*12.2*2.4mm
	B1612-M	16.0*12.2*2.4mm
	B1612-Z	16.0*12.2*2.4mm
WiFi Module	BC30	24.0*16.0*3.0mm
	BC31	21.2*18.0*2.6mm
WIFI+Bluetooth	BC33	25.5*18.0*3.0mm
NB-IOT module	BC60	18.0*16.0*3.0mm

Notice

Due to product version upgrades or other reasons, the content of this document will be updated from time to time. Unless otherwise agreed, this document is only used as a guide, and all

statements, information and suggestions in this document do not constitute any express or implied warranty.

Version History

Document Version	Updated	illustrate
V1.0.0	2024 -12 -15	initial version

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1 Introduction

This document defines the RC10 EM-NA module and its hardware interface specifications, electrical characteristics and mechanical specifications. With the help of this document, combined with our application manual and user guide, customers can quickly apply the RC10 EM-NA module to wireless applications.

1.1. Safety Instructions

By following the safety guidelines below, you can ensure your personal safety and help protect the product and work environment from potential damage.

Road safety comes first! When you are driving, please do not use handheld mobile devices.

Even if it has a hands-free function. Please stop the car before calling!

Please turn off your mobile device before boarding. The wireless function of your mobile device is not allowed to be turned on on the aircraft.

This is to prevent interference with the aircraft's communication system. Ignoring this prompt may result in flight safety or even

To violate the law.

pay attention to any restrictions on the use of mobile devices .

Interference may cause medical equipment to malfunction and the mobile terminal device may need to be switched off.

Mobile terminal devices do not guarantee effective connection in all situations, such as

the terminal device has no credit or the SIM card is invalid. If you encounter the above situation in an emergency, please remember

Always use emergency calling and make sure your device is turned on and in an area with sufficient signal strength.

Your mobile device will receive and transmit radio frequency signals when it is turned on.

Radio frequency interference may occur when using a mobile phone, computer or other electronic equipment.

Please keep your mobile terminal device away from flammable gases.

Please turn off the mobile terminal device when working in any place with potential explosion hazard.

Electronic devices have safety risks.

2 Product Concept

2.1. Overview

RC10EM-NA is a 4G CAT1 wireless communication module that supports FDD-LTE and TDD-LTE network data connections. The standards and frequency bands supported by the RC10EM-NA module are shown in the following table:

Table 1: RC10EM-NA module supported standards and frequency bands

Network Standard	illustrate
FDD-LTE	B2/B4/B5/B12/B17/B66
TDD-LTE	B34/B38/B39/B40/B41

The GNSS receiver integrates BD and GPS systems. It supports multiple

positioning and navigation systems including GPS, BD, SBAS (including WAAS, EGNOS, MSAS and GAGAN) and QZSS. It can achieve industrial-grade receiving sensitivity, high accuracy and fast first positioning at minimum power consumption. At the same time, users can use embedded flash memory to store specific configuration and software update information.

RC10 EM-NA is a SMD module with 57 LCC pads, which can be easily embedded in product applications. RC10 EM-NA has an ultra-small size of 15.0*24.0* 3.0mm , and its application areas include shared bicycles , cars, personal tracking services, wearable devices, security systems, wireless POS machines, industrial PDAs , smart meters, wireless remote controls, etc.

CAT1 part of RC10 EM-NA embeds data transmission protocols such as TCP/UDP , HTTP and FTP . The embedded extended AT commands enable users to use these Internet protocols more easily.

2.2. Main features

Table 2**: Some main features of LTE**

feature	illustrate
powered by	VBAT supply voltage range: 4 V Typical supply voltage: 4V
Transmit power	TDD-LTE: 23dBm±2dBm FDD-LTE: 23dBm±2dBm
LTE Features	● Maximum support for 3GPP R13 CAT 1 FDD and TDD ● Supports 1.4/3/5/10/15/20MHz downlink and uplink bandwidth ● FDD-LTE: Maximum downlink rate 10Mbps, maximum uplink rate 5Mbps ● TDD-LTE: Maximum downlink rate 7.5Mbps, maximum uplink rate 2Mbps
Network protocol characteristics	● TCP /UDP/PPP/FTP/HTTP/NITZ/CMUX/MDIS/NTP/HTTPS/PING/ FTPS/MQTT/SMS/DTMF
Short Message Service (SMS)	● Text and PDU modes ● Point-to-point SMS

	● SMS storage: default storage module
(U)SIM interface	● Support USIM/SIM card: 1.8V and 3.0V
USB interface	● Compatible with USB2.0 (only supports slave mode), data transfer rate up to 480Mbps ● Yongyu AT command transmission, data transmission, software debugging, software upgrade ● USB virtual serial port driver: supports USB drivers under Windows7/8.1/10, Linux2.6.x/3.x/4.1, Android 4.x/5.x/6.x/7.x and other operating systems
Serial Port	UART0: ● Used to output debugging information UART1: ● Used to download firmware, transmit AT commands and data, and connect other peripherals , universal serial port UART2: ● Internal GNSS module connected , GNSS data can be monitored externally
Physical properties	● Size: 15.0*24.0*3.0mm
temperature range	● Working temperature: -40℃~+85℃ ● Storage temperature: -40℃~+125℃
software upgrade	● Upgradeable via USB and serial port
RoHS	● All devices are fully RoHS compliant

Table 3: Main features of some GNSS

feature	illustrate
GNSS	● GPS+BD
Current consumption	● Capture: 25mA @-130dBm ● Tracking: 22 mA @-130dBm ● Sleep : 6m A ● Backup: 5 uA
Receiver Type	● GPS L1 1575.42mHz C/A Code ● BD B1 1561.098MHz C/A Code
Receiving sensitivity	● Capture: -148dBm ● Recapture: -160dBm

GPS+BD	● Tracking: -163dBm,
TTFF (EASY ™ Disabled)	● Cold start (autonomous): <15s average@-130dBm ● Warm start (autonomous): <5 s average@-130dBm ● Hot start (autonomous): 1s@-130dBm
Horizontal position accuracy (autonomous)	● <2.5 m CEP @-130 Bm
Update rate	● Maximum 10Hz, default 1Hz
1PPS signal accuracy	● Typical accuracy <10ns ● Time pulse width: 100ms
Speed accuracy	● Without assistance: 0.1m/s
Acceleration accuracy	● Without assistance: 0.1m/ s^2
Dynamic performance	● Maximum altitude: 18,000m ● Maximum speed: 515m/s ● Maximum acceleration: 4G
GNSS serial port	● GNSS serial port: UART2 _TXD and UART2 _RXD ● Baud rate: 4800bps to 115200bps, default 115200bps ● Communicates with CAT1 parts in an integrated control mode solution ● Communicate with MCU in standalone control mode

Table 4: Protocols supported by the module

protocol	type
NMEA	Output, ASCII
Unicore Protocol	Input/output, Unicore proprietary protocol

2.3. Evaluation Board

BSJ provides a complete set of evaluation boards to facilitate the testing and use of the RC10EM-NA module.

3 Application Features

RC10EM-NA is an SMD package module. The functions of the RC10EM-NA pins will be described in detail in the following chapters.

- Module Pinout
- Power supply
- Operating mode
- Power on/off
- Power saving technology
- Serial Port
- SIM card interface
- ADC Interface
- RI interface
- Network status indication interface
- LTE RF
- EASY autonomos AGPS technology
- EPO offline AGPS technology
- FastFix Online Technology
- Multi-tone AIC
- PPS VS. NMEA

3.1. Pin Description

3.1.1. Pin Assignment

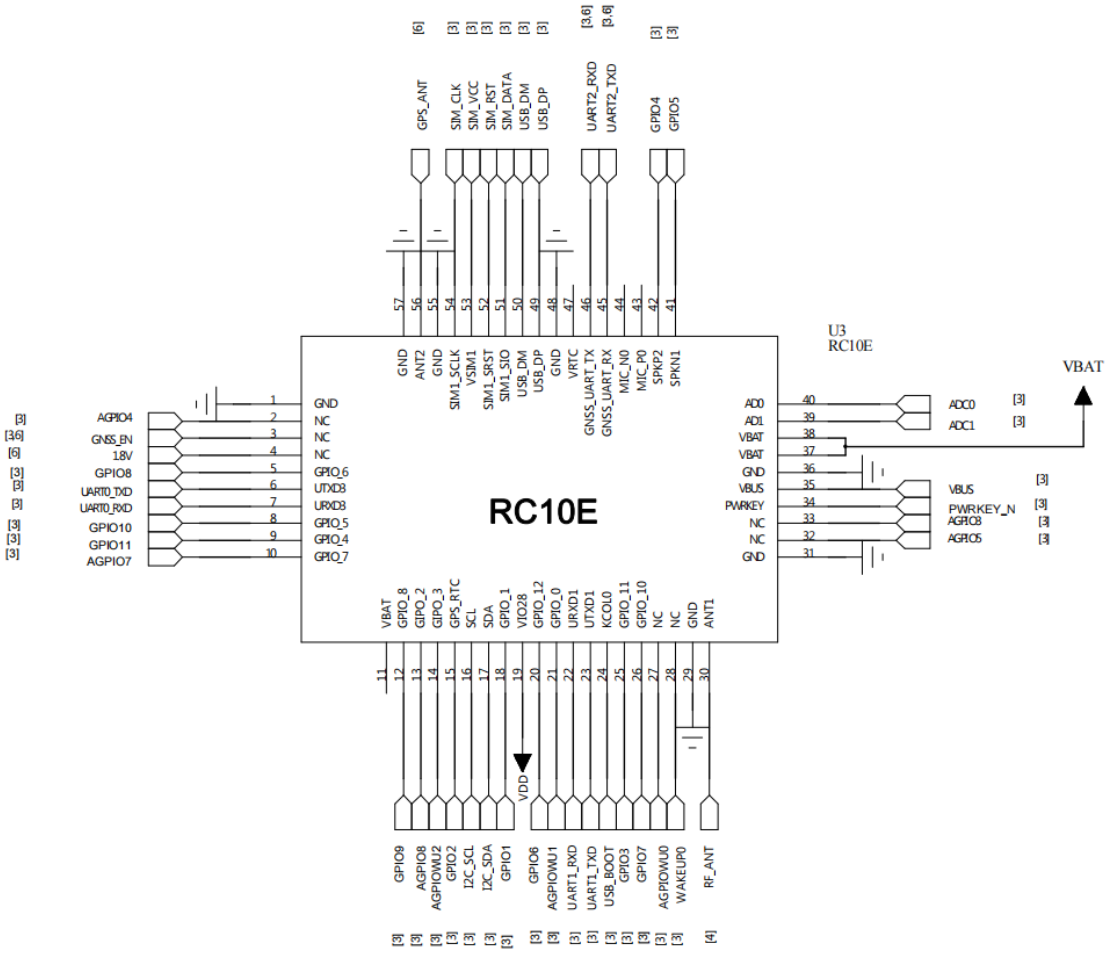


Figure 1: Pinout

3.1.2. Pin Description

Table 5: I/O parameter definition

type	describe
IO	input Output
DI	Digital Input
DO	Digital Output
PI	power input

PO	Power Output
AI	Analog Input
AO	Analog Output

Table 6: Pin Description

Pin Name	Pin Number	I/O	describe	Remark
power supply				
VBAT	37,38	P I	LTE part power supply: 4V	
VDD	19	P O	Output 1.8V/ 2.8V /3.3V for external power supply	If not in use, leave it unconnected , and power off in Sleep1 , Sleep2, or Hibernate mode.
1.8V	4	PO	Output 1.8V power supply	GNSS Power Supply
GND	1,2 9 ,31, 36 ,48, 55,57	P	land	
Power on/off				
PWRKEY	34	D I	Pull down PWRKEY for a specified period of time to turn on or off the device.	
Main Serial Port				
UART1_RXD	twenty two	D I	Receive data	If only RXD, TXD and GND are used for communication , it is recommended to leave other pins
UART1_TXD	twenty three	D O	send data	

				floating .
Auxiliary serial port				
UART0_TXD	6	D I	Receive data	Print debug information
UART0_RXD	7	D O	send data	
GNSS serial port				
UART2_TXD	46	DO	send data	Connecting to the internal GNSS module
UART2_RXD	45	DI	Receive data	
SIM card interface				
SIM_VDD	53	P O	SIM card supply voltage	The module automatically selects 1.8 V or 3.0 V
SIM_CLK	54	D O	SIM card clock line	TVS tube for ESD protection on the SIM card interface , and the wiring should not exceed 2 cm
SIM_DATA	51	IO	SIM card data cable	
SIM_RST	52	D O	SIM card reset cable	
Analog-to-digital conversion interface				
ADC0	40	AI	Analog-to-digital converter interface	Input range 0 ~2.8V
ADC1	39	AI	Analog-to-digital converter interface	Input range 0 ~2.8V
I2C Interface				
I2C_SCL	16	DO	I2C clock line	
I2C_SDA	17	IO	I2C Data Line	
A GPIO interface				
A GPIO 4	2	IO	General Purpose IO	Drive current ≤ 5mA
A GPIO 7	10	IO	General Purpose IO	
A GPIO 8	13	IO	General Purpose IO	

AGPIO 5	32	IO	General Purpose IO	
AGPIO3	33	IO	General Purpose IO	
AGPIOWU interface				
AGPIOWU2	14	IO	General Purpose IO	Wake up in low power mode, driving current ≤ 30uA
AGPIOWU 1	twenty one	IO	General Purpose IO	
AGPIOWU 0	27	IO	General Purpose IO	
GPIO interface				
GPIO 8	5	I	ME	
GPIO10	8	I	ME	
GPIO11	9	I	ME	
GPIO 9	12	I	ME	
GPIO2	15	I	ME	
GPIO1	18	I	ME	
GPIO6	20	I	ME	
GPIO3	25	I	General Purpose IO	
GPIO7	26	IO	General Purpose IO	
GPIO5	41	IO	General Purpose IO	
GPIO4	42	IO	General Purpose IO	
Antenna interface				
RF_ANT	30	IO	GSM antenna interface	
GNSS_ANT	56	I	GNSS antenna interface	
USB interface				
VBUS	35	PI	USB Power	
USB_DP	49	IO	Differential signal positive	
USB_DM	50	IO	Differential signal negative	
USB_BOOT	twenty four	I	Download mode control pin	Internally, the VBUS voltage is divided.
Other interfaces				
GNSS_EN	3	I		There is a connection in the module

RESERVED	11 ,43,44,47	Reserve

3.2 . Power supply

3.2.1.Power supply characteristics

In the module application design, power supply design is a very important part. Because there will be a burst pulse with a large current in a short time during RF transmission. During the burst pulse stage, the power supply must be able to provide a high peak current, otherwise it may cause the power supply voltage to drop.

3.2.2 . Reduce voltage drop

3.3.2.1. Reduce VBAT voltage drop

The VBAT voltage input range is 4 V. To ensure that the VBAT voltage does not drop below 4V , it is recommended to connect a 100uF tantalum capacitor with low ESR (ESR=0.7 Ω) and 100nF , 33pF (0603 package) and 10pF (0603 package) filter capacitors in parallel near the module VBAT input terminal. The reference circuit of the VBAT input terminal is shown in the figure below.

It is also recommended that the VBAT PCB trace be as short as possible and wide enough to reduce the equivalent impedance of the VBAT trace and ensure that there is no large voltage drop under high current at maximum transmission power. It is recommended that the VBAT trace width be no less than 2mm. In principle, the longer the trace, the wider the trace.

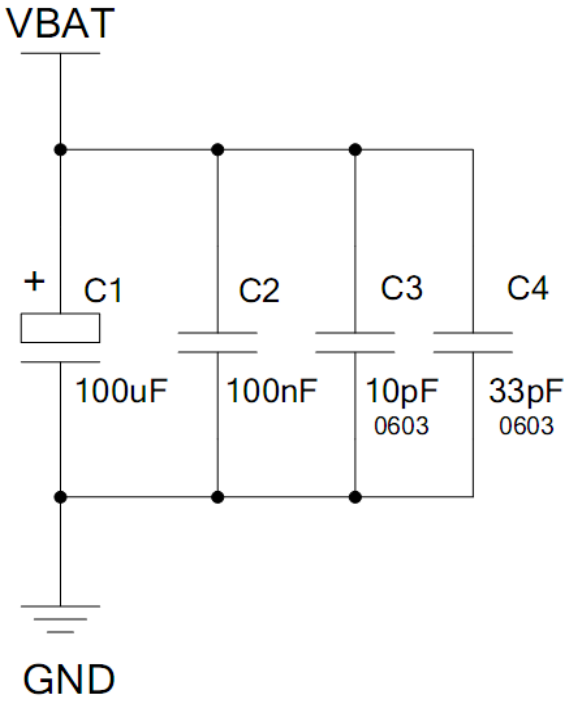


Figure 2: VBAT input reference circuit

3.2.3.Power supply reference circuit

3.2.3.1.Module power supply reference circuit

RC10EM-NA module should provide at least 1 A of current. If the voltage difference between the input voltage and the output voltage is not large, it is recommended to choose LDO as the power supply. If there is a large voltage difference between the input and output, it is recommended to use a switching power converter.

The figure below is a reference design for a +5V power supply circuit. In this reference design, the power supply output voltage is 4.0V and the load current peak is 1A . To ensure the stability of the output voltage, it is recommended to reserve a voltage regulator at the output end and place it close to the module VBAT pin. It is recommended to select a voltage regulator with a reverse breakdown voltage of 5.1V and a power dissipation of more than 1W .

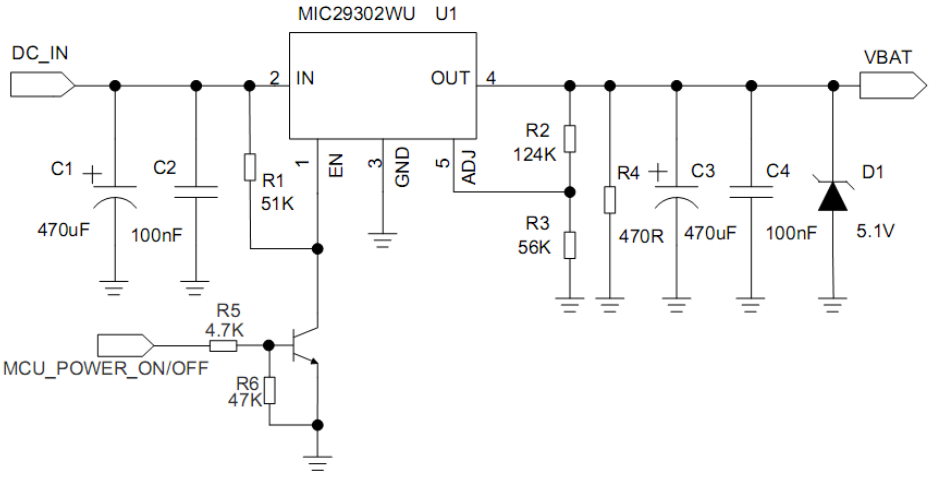


Figure 3: RC10EM-NA module power supply reference circuit

3.3 . Working mode

3.3.1 . CAT1 working mode

The following table briefly describes the various operating modes of module CAT1 .

Table 7: CAT1 working mode list

model	Function	
Operating mode	ACTIVE state	The PMU module is turned off, and the MCU is still waiting for the cycle even if there is nothing to do. The power consumption is the maximum.
	IDLE state	In this state, the MCU will turn off the core clock when there is no task, and all system interrupts can wake up the system and restart the core clock.
	SLEEP1 state	In this state, the MCU will turn off the core clock when there is no task, and all system interrupts can wake up the system and restart the core clock.
	SLEEP2 state	The main SRAM (MSMB) is turned off according to the SLEEP1 state, and the 64KB SRAM (ASMB) is kept in retention mode.
	HIBERNATE	The main SRAM (MSMB) is turned off

	state	according to the SLEEP1 state, and the 64KB SRAM (ASMB) is kept in retention mode.
Shutdown Mode	The main SRAM (MSMB) is turned off according to the SLEEP1 state, and the 64KB SRAM (ASMB) is kept in retention mode.	

The CAT1 software runs as a multi-tasking system. All tasks equally determine the depth of sleep. The depth of the final sleep state is affected by many factors, and will eventually enter the deepest sleep mode that can be entered.

3.3.1.1 . Idle mode

When all tasks are suspended, the software tries to enter the idle state automatically. After waking up from the idle state, the program (PC value) starts executing from the same location before the idle occurred.

AT+ECPMUCFG=1,1, sets the maximum sleep depth to idle.

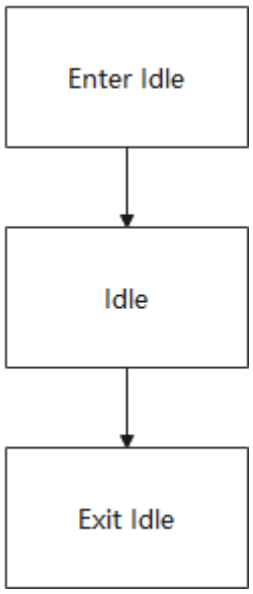


Figure 4: Idle Mode Block Diagram

3.3.1.2 . Sleep mode 1

In the sleep 1 state, since the power of all peripherals is turned off, it is necessary to execute a pre-sleep callback function before actually entering sleep 1 to prepare for sleep, and execute a post-sleep callback function after waking up to restore to the pre-sleep state.

Users can use the API to register callback functions. The callback function registered by the user should be as short as possible because it is called in the critical section (all

tasks are suspended and interrupts are blocked). Do not use operations that suspend the system (such as sending and receiving operating system messages, waiting for task queues or calling FreeRTOS OsDelay, etc.), time-consuming operations (such as flash operations, waiting for external interrupts, waiting for serial data, etc.). In order to ensure the efficiency of PMU and the normal operation of the PMU module, the sleep process registered by the user, all pre-sleep callback functions, and all post-sleep callback functions should not exceed 3 ms. The storage and recovery of driver-level registers are done by the SDK driver, which does not need to be considered by the user.

AT+ECPMUCFG=1,2, sets the maximum sleep depth to sleep mode 1.

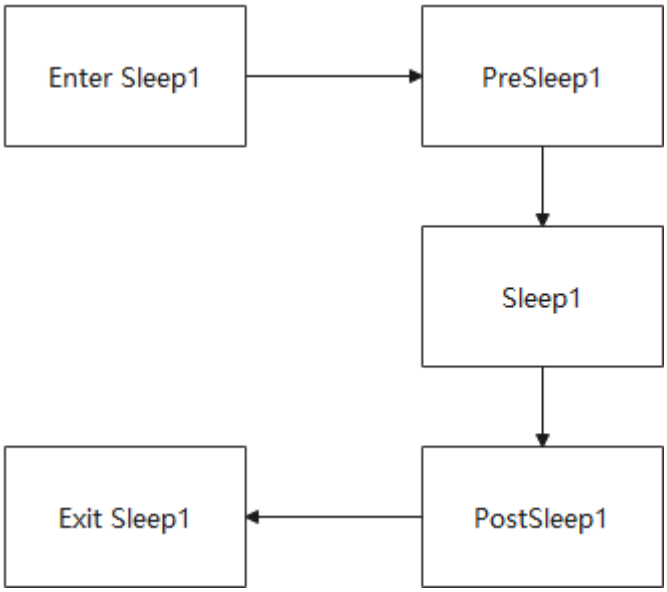


Figure 5: Sleep Mode 1 Block Diagram

3.3.1.3 . Sleep mode 2

In sleep 2 state, 1.25MB of SRAM will be turned off and 64KB of SRAM will remain reserved. If sleep 2 entry is successful, the program will run from the beginning after the system wakes up.

After a tiny CAT1 process (closed source process) is completed, the user will get control in the Main_Entry function. The user can query the status through API functions (described later), check whether the program is running for the first time after power-on, or wake up from sleep process, and select different application flows.

If Sleep2 fails, the program will be executed in order (as if no sleep occurred), and the PostSleep2 callback will be executed before we exit Sleep2. Before we actually fall asleep, we cannot know whether Sleep2 will succeed. Therefore, users need to be prepared for sleep failure, that is, register the corresponding callback function with PostSleep2. Similarly, the execution time of the callback functions before Sleep2 and after Sleep2 also needs to be strictly controlled.

AT+ECPMUCFG=1, 3 , set the maximum sleep depth to sleep 2.

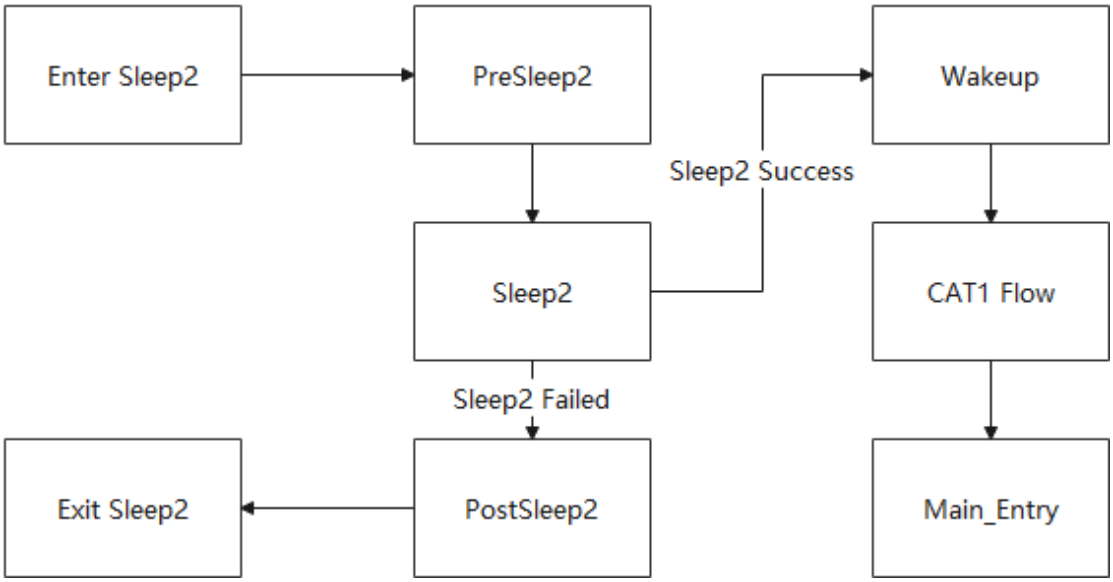


Figure 6: Sleep Mode 2 Block Diagram

3.3.1.4 . Sleep mode

In the sleep state, 64KB of SRAM will also be powered off. The software process is basically the same as Sleep2. Similarly, users can also register a PostHib callback function to prepare for sleep failure.

AT+ECPMUCFG=1,4 , sets the maximum sleep depth to hibernate.

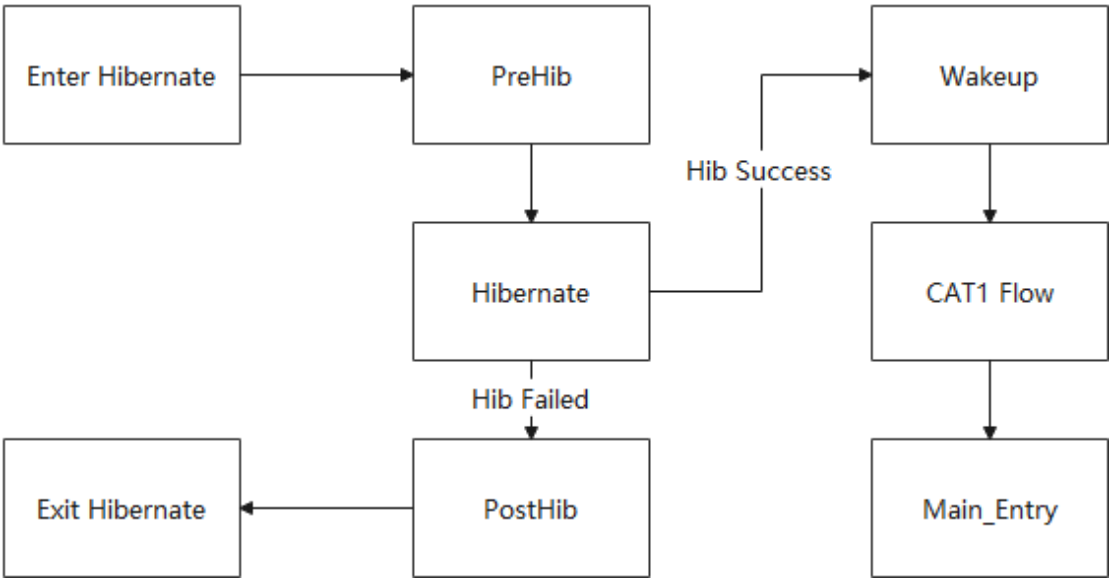


Figure 7: Sleep mode block diagram

3.3.2.GNSS operating mode

3.3.2.1. Full on mode

Full on mode includes tracking and acquisition mode. In acquisition mode, the GNSS receiver starts searching and determining
visible satellites, and roughly determines the carrier frequency and pseudo code phase of the satellite signal. When the acquisition is completed, the module
automatically switches to tracking mode. In tracking mode, the GNSS receiver accurately tracks
the changes in the carrier frequency and pseudo code phase of the signal, and completes satellite signal despreading and demodulation. The GNSS power supply is controlled by CAT1, and CAT1 entering sleep mode will not affect the power supply of GNSS.

The following table describes the default settings for Full on mode.

Table 8: GNSS Full on mode default settings

project	Configuration	Notes
Baud rate	115200bps	
protocol	NMEA	RMC, VTG, CGA, GSA, GSV and GLL
Update rate	1Hz	
SBAS	Available	
AIC	Available	
LOCUS ™	unavailable	
Easy ™	Available	When the update rate exceeds 1Hz, Easy ™ technology will be disabled.
GNSS	GPS+BD	

In Full on mode, when the GNSS part is powered on, its average current consumption will rise to about 40mA and last for a few seconds, then drop to the value shown in Table 3 ; this process is the capture process. After the capture process lasts for a few minutes, it will automatically switch to the tracking state. The current consumption in the tracking state is less than that in the capture state, see Table 3 for details .

3.3.2.2. Standby mode

Standby is a low power mode. In Standby mode, the core and I/O power domains are still operational, while the RF and TXCO are turned off; at the same time, the GNSS engine stops searching for satellites. Commands can be used to put the GNSS part of the module into or out of Standby mode.

When the GNSS part exits Standby mode, it will use internal assistance information, such as GNSS time, ephemeris, last position, etc., to ensure the shortest TTFF during hot start or warm start. In Standby mode, the typical current consumption of the GNSS part is about 300uA@ GNSS_VCC= 3.3V.

3.3.3. Combination of CAT1 and GNSS partial working modes

Table 9: List of CAT1 and GNSS working modes

CAT1 Partial Working Mode	GNSS partial working mode	
	Full on	Standby
normal	✓	✓
idle	✓	✓
Sleep 1	✓	✓
Sleep 2	✓	✓
Hibernation	✓	✓

Note : 1. ✓Indicates that the module supports this mode.

2, When the GNSS part is powered on and the main serial port is accessible, all PMTK commands related to the GNSS part can be sent through the main serial port.

3. When the CAT1 part is in sleep mode, the GNSS part can still Works in Standby or Full on mode.

3. 4. Power on / off

3. 4 .1. Power on

The normal way to start the module is to pull down the PWRKEY pin. It is

recommended to use an open collector drive circuit to control the PWRKEY pin. The following figure is a reference circuit:

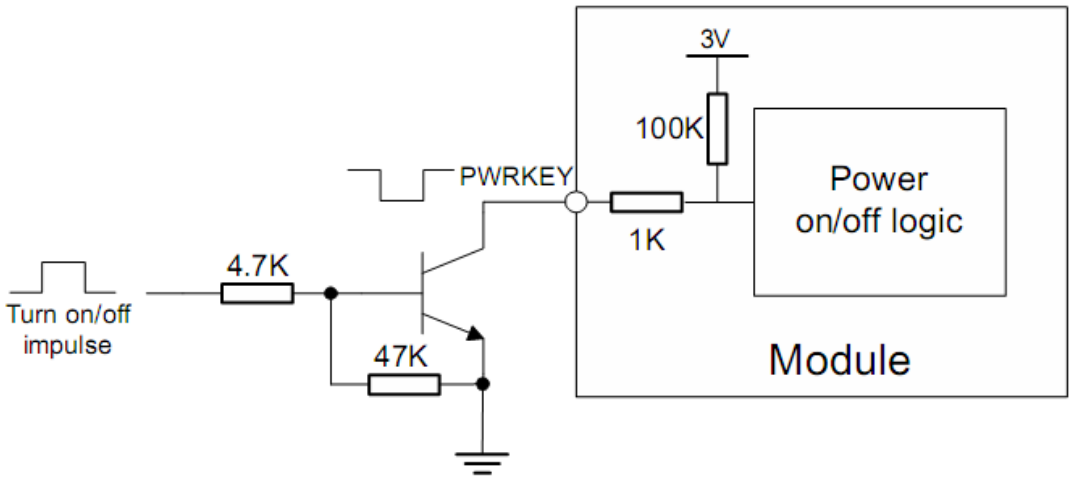


Figure 8**: Power-on driver reference circuit**

Note: When the AT command can respond normally, it indicates that the module has been powered on successfully; at this time, the PWRKEY pin can be released.

Otherwise, the module fails to start up.

Another way to control the PWRKEY pin is to use a push button switch directly. Fingers may generate static electricity when pressing keys;

TVS component should be placed near the button for ESD protection. To achieve the best ESD protection performance, TVS

The components must be placed near the button. The reference circuit is as follows:

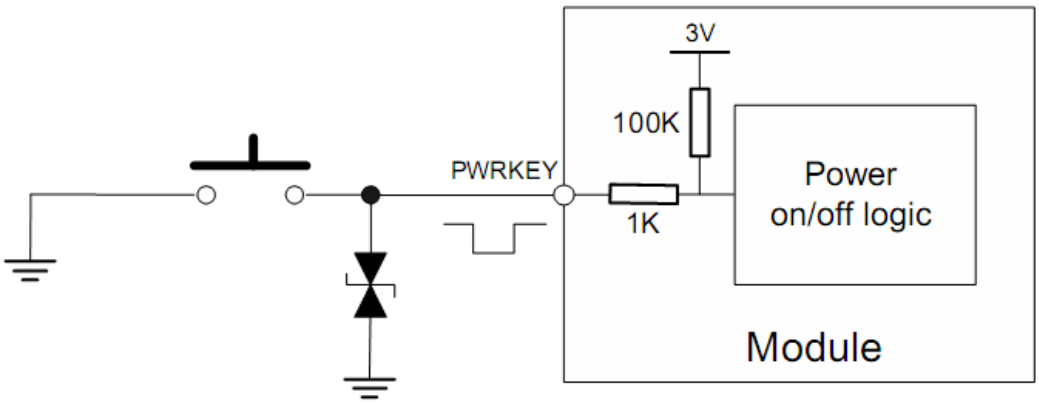


Figure 9**: Button start reference circuit**

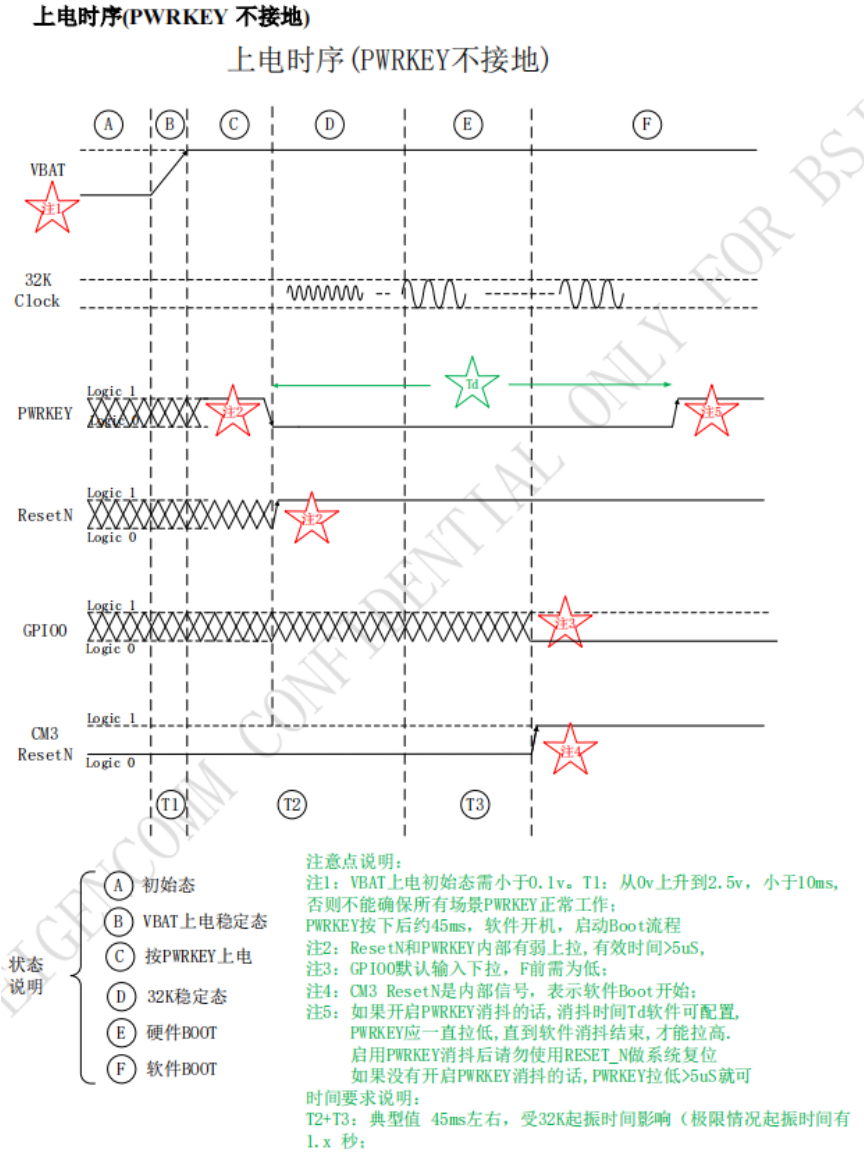


Figure 10**: Power-on timing diagram**

PWRKEY function is not used , directly connect a 3.3K resistor to the ground from the PWRKEY pin, and the device will automatically start up when powered on.

3.4.2 . Shutdown

The module can be shut down by :

- Normal shutdown: The module is shut down by controlling the PWRKEY pin.
- Normal shutdown: Shut down via AT+QPOWD command
- Automatic shutdown at low voltage: When the module detects low voltage at VBAT , it will automatically shut down.

3. 4 .2. 1 . PWRKEY pin shutdown

If the PWRKEY pin is pulled low for more than 2.5s, the module will execute the shutdown action. During the shutdown process, the module needs to log off the network. The logoff time is related to the current network status. It is measured to take about 2s to 12s. Therefore, it is recommended to extend the power off or restart after 12s to ensure that the software saves important data before the power is completely off .

by executing the **AT+ Q POWD** command. This command logs the module off the network, allowing the software to save important data before completely shutting down the power.

For more information about the **AT+ Q POWD** command, see **document [1].**

3.4.2.2 . Low voltage automatic shutdown

a voltage range of 3.1 V to 4.5 V. If the module voltage is lower than 3.1 V , the module will automatically shut down.

3.4.2.3 . Low voltage automatic shutdown AT command turns off the GNSS part

The GNSS part can be turned off by the AT+QGNSS=0 command.

3. 5. Serial port

The module has three serial ports (Universal Asynchronous Receiver/Transmitter): main serial port, auxiliary serial port and GNSS serial port .

Configurable baud rate: 4.9Kbps, 9.6Kbps, 115.2Kbps, 9216Kbps, up to 3MBps. Supports DMA and hardware flow control.

Main serial port:

U ART1_TXD : Sends data to the RXD terminal of the DTE device .
UART1_RXD : Receives data from the TXD port of the DTE device .

Auxiliary serial port :

UART0_TXD : print debug information
UART0_ RXD: receive debug command

GNSS Serial Port:

In Integrated Control Mode:

UART2_ TXD : Send data to the GSM part.
UART2 _RXD: Receive data from GSM part.

In standalone control mode:
UART2_ TXD : Send data to the peripheral COM port.
UART2 _RXD: Receive data from the peripheral COM port.

The serial port logic levels are shown in the following table:

Table 10: Serial port logic levels

parameter	Minimum	Maximum	unit
VIL	0	0.2×VDD	V
VIH	0.7×VD D	3.6	V
VOL	0	0.15×VDD	V
VOH	0. 8 × VDD	VDD	V

Table 11: Serial port pin definition

interface	name	Pinout	effect
Main Serial Port	UART1_TXD	twenty two	send data
	U ART1_R XD	twenty three	Receive data
Auxiliary serial port	UART0_TXD	6	Receive data
	U ART 0 _ R XD	7	send data
GNSS serial port	UART2_TXD	4 6	Receive data
	UART2_TXD	4 5	send data

3. 5.1 . Main Serial Port

3. 5 .1.1. Main serial port features

- Two-wire UART interface
- Including data lines TXD and RXD .
- Used for downloading, AT command transmission, etc. Support baud rates as follows: 4.9Kbps, 9.6Kbps, 115.2Kbps, 9216Kbps, 3MBps.
- Support LPUART.

3. 5 .1.2. Main UART reference design

The connection method of the main serial port is relatively flexible. The following are

the commonly used connection methods.

For the main serial port three-wire wiring method, please refer to the figure below:

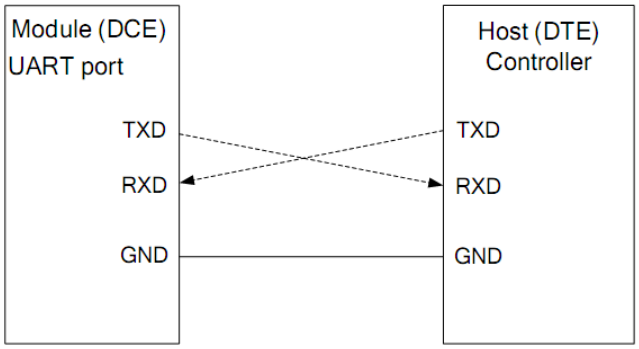


Figure 11**: Serial port three-wire connection diagram**

3.5.1.3. Software Download

The module downloads software via UART1 .

Use the serial download tool to connect to serial port 1 to directly download the firmware.

3.5.2. Auxiliary Serial Port

Used for logging in bootstrap and bootloader modes. Used for outputting debugging information when the system is operating normally .

3.5.2.GNSS Serial Port

A set of serial ports inside the module has been interconnected with the GNSS serial port to complete the communication between the CAT1 part and the GNSS part.

Note: The GNSS part of the RC10 EM-NA module can output more data information in the same period of time than a module with only GNSS function. At a baud rate of 4800bps and a data update rate of 1Hz, some of the default output NMEA data may be lost. To avoid this, it is recommended to use the default baud rate of 115200bps.

3.5.3.Serial port application

The serial port level can be configured as needed. If the serial port level does not match the peripheral serial port level, it is necessary to add a level conversion circuit - a transistor level conversion circuit or a dedicated level conversion chip.

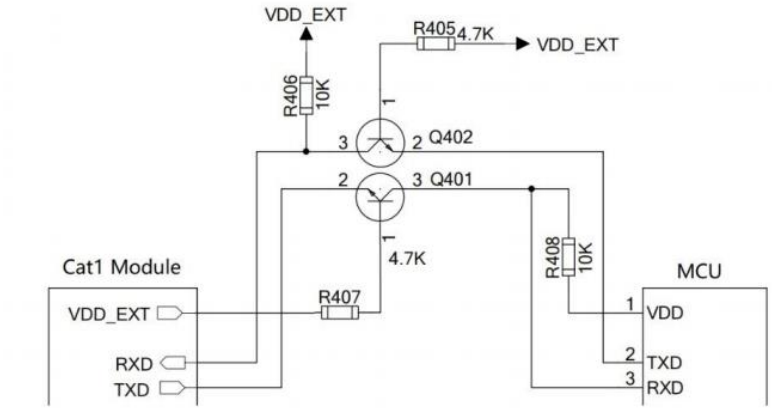


Figure 12: Transistor level conversion circuit

VDD will be turned off in sleep mode, if RXD is pulled to VDD in the level shift circuit, the system will wake up when VDD is turned off in sleep mode (LPUART function), in this case, the customer should replace the transistor with a series resistor, the TXD circuit does not need to be changed .

communicates with the PC , since the serial port of the module is a CMOS level at the VDD level , an RS232 level conversion circuit needs to be added between them . The following figure is a schematic diagram of the connection between the standard RS-232 interface and the module. Customers need to ensure that the IO voltage of the level conversion chip connected to the module is VDD .

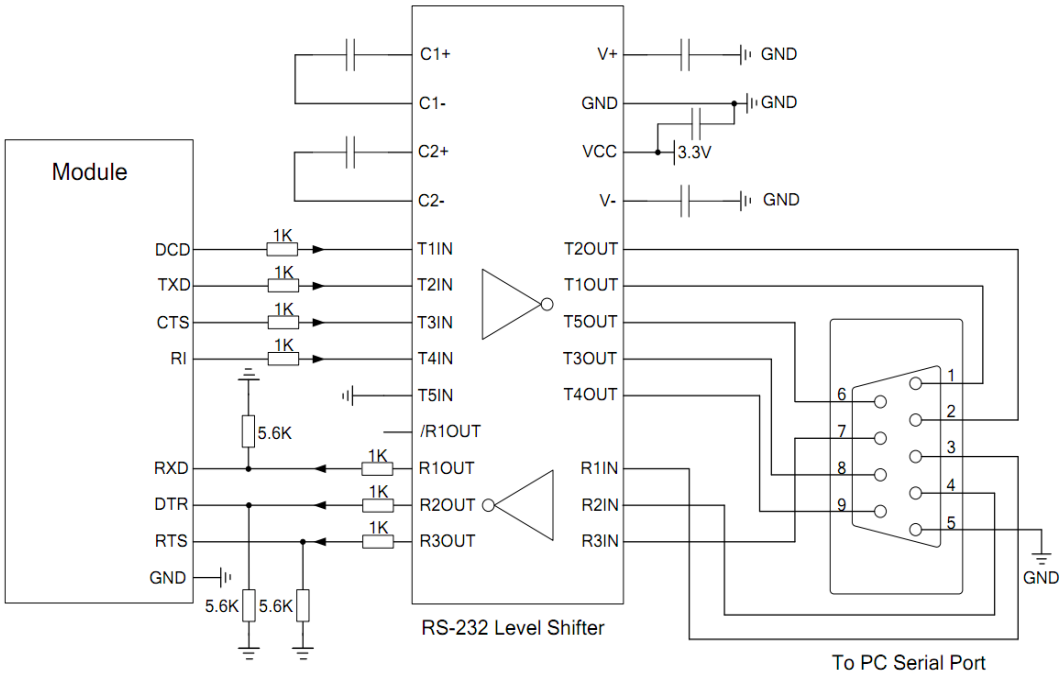


Figure 13**: RS-232 interface matching diagram**

3.6. USB interface

The module supports customers to download firmware via USB. Before powering on, connect the four USB lines. USB_BOOT will be pulled high by default, and the module will enter USB download mode after powering on. If you need to use USB virtual serial port debugging, do not connect USB before powering on, and connect USB debugging after powering on.

3.7. SIM card interface

U SIM card interface , supports eSIM .

The module supports single-card single-standby function. The SIM card is powered by the power supply inside the module and supports 1.8V and 3.0V operating voltages.

Table 12: SIM card interface pin definition

Pin Name	Pin number	describe	Other functions
SIM_VDD	53	SIM card power supply. Automatically detects SIM card operating voltage. Accuracy 3.0V±5% and 1.8V±5%. Maximum supply current 10mA.	
SIM_CLK	54	SIM clock pin	
SIM_DATA	51	SIM data I/O pin	
SIM_RST	52	SIMRESET pin	
GND	55	SIM ground pin	

The following figure is a reference circuit diagram of a 6-pin SIM card holder:

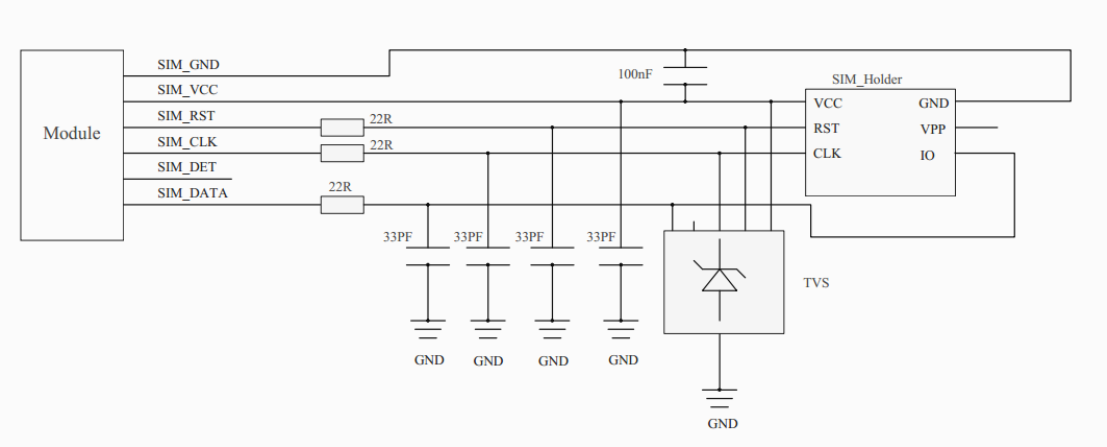


Figure 14**: 6-pin SIM card reference circuit diagram**

In the circuit design of the SIM card interface, in order to ensure the good performance of the SIM card and prevent it from being damaged, it is recommended to follow the following design principles in the circuit design:

- SIM card holder close to the module and try to ensure that the SIM card signal line wiring does not exceed 200mm .
- The SIM card signal line should be routed away from the RF line and VBAT power line.
- between the SIM card holder ground and the module SIM_GND should be short and thick. The wiring between SIM_VDD and SIM_GND should be no less than 0.5mm , and the bypass capacitor between SIM_VDD and GND should not exceed 1uF, and should be placed close to the SIM card holder .
- To prevent the SIM_CLK signal and the SIM_DATA signal from crosstalking, the two should not be routed too close to each other, and a ground shield should be added between the two traces. In addition, the SIM_RST signal also requires ground protection.
- To ensure good ESD performance, it is recommended to add TVS tubes to the pins of the SIM card. The parasitic capacitance of the selected TVS tube should not exceed 50pF ; the ESD protection device should be placed as close to the SIM card holder as possible, and the SIM card signal routing should first be connected from the SIM card holder to the ESD protection device and then from the ESD protection device to the module. A 22 ohm resistor needs to be connected in series between the module and the SIM card to suppress stray EMI and enhance ESD protection. The peripheral devices of the SIM card should be placed as close to the SIM card holder as possible.
- Connect 33pF capacitors in parallel on the SIM_DATA, SIM_VDD, SIM_CLK and SIM_RST lines to filter out RF interference.

3.8.ADC analog-to-digital conversion

RC10EM-NA module provides two external ADC interfaces. You can use the

AT+CADC command to read the voltage value of the analog input on the ADC channel . To ensure the accuracy of the collected data and prevent interference from power supply and other RF signals, it is recommended to surround the ADC with ground planes , and place 0.1uF filter capacitors close to the pins . For more information about this AT command, please refer to the document.

Table 13: ADC pin definition

Pin Name	Pin number	describe
ADC0	40	Analog-to-digital converter interface
ADC1	39	Analog-to-digital converter interface

Table 14: ADC characteristics

project	Minimum	typical	maximum	unit
voltage range	0		VDD	V
ADC resolution		10		bits
ADC Accuracy		10		mV

3.11. Seconds

Based on the EPO ™ function, the second-position function adds real-time and reference-location information (latitude and longitude of the reference location). It can help the GNSS part of the module to achieve fast positioning and reduce its positioning time in cold start mode. After downloading the EPO data to the GNSS, the reference location information will be downloaded to the GNSS immediately. For more details, please refer to document [15].

3.13. PPS VS. NMEA (1PPS function)

PPS VS.NMEA can be used for timing. The rising edge of the PPS signal is the time synchronization point, and the first frame of serial port message information is delayed by 465~485ms from the rising edge of the PPS signal.

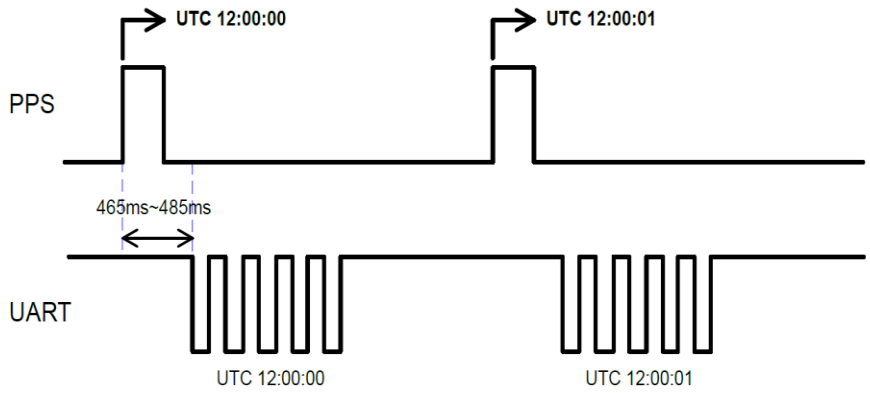


Figure 15**: PPS VS. NMEA Timing Diagram**

RC10EM-NA module supports timing via PPS VS.NMEA. The frequency of NMEA sentence output is 1Hz, and the supported baud rate range is 14400~115200bps. When the baud rate is too low, if there are too many NMEA sentences in one second, they cannot be fully transmitted. For example, when the baud rate is 9600 or 4800bps, only RMCNMEA sentence output is supported.

Note: The default baud rate of the GNSS serial port is fixed, the default is 115200bps

4 antenna interfaces

RC10EM-NA contains two antenna interfaces: LTE and GNSS antenna interfaces. Pin 32 is the LTE antenna input terminal, and pin 20 is the GNSS antenna input terminal. Both LTE and GNSS antenna interfaces have a 50 ohm characteristic impedance.

4.1. LTE Antenna Interface

RC10EM-NA module provides the LTE antenna interface pin RF_ANT.

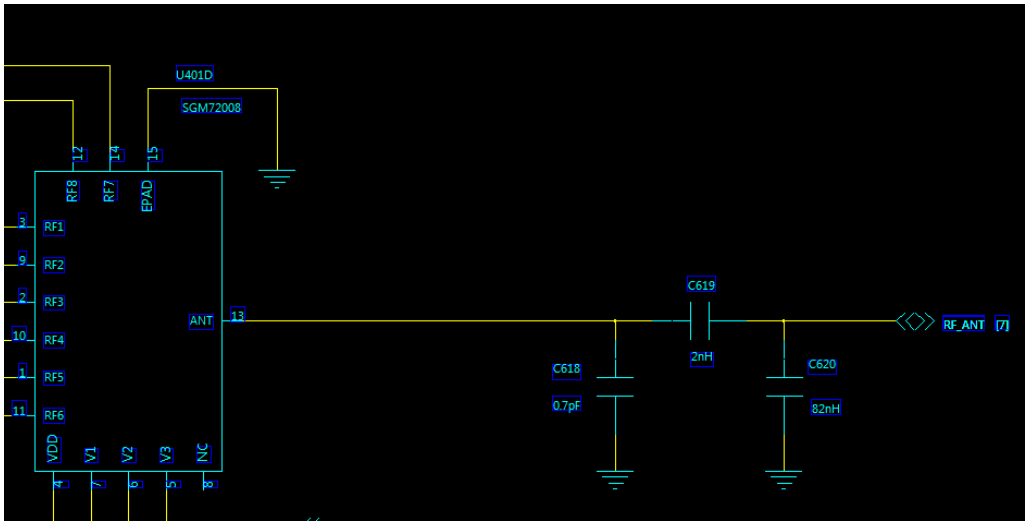
Table 15: LTE antenna pin definition

name	Pinout	effect
GND	29	land
RF_ANT	30	GSM antenna interface
GND	31	land

4.1.1. Reference Design

For the peripheral circuit design of the antenna interface, in order to better adjust the RF performance, it is recommended to reserve a matching circuit. The antenna

connection reference circuit is shown in the figure below.



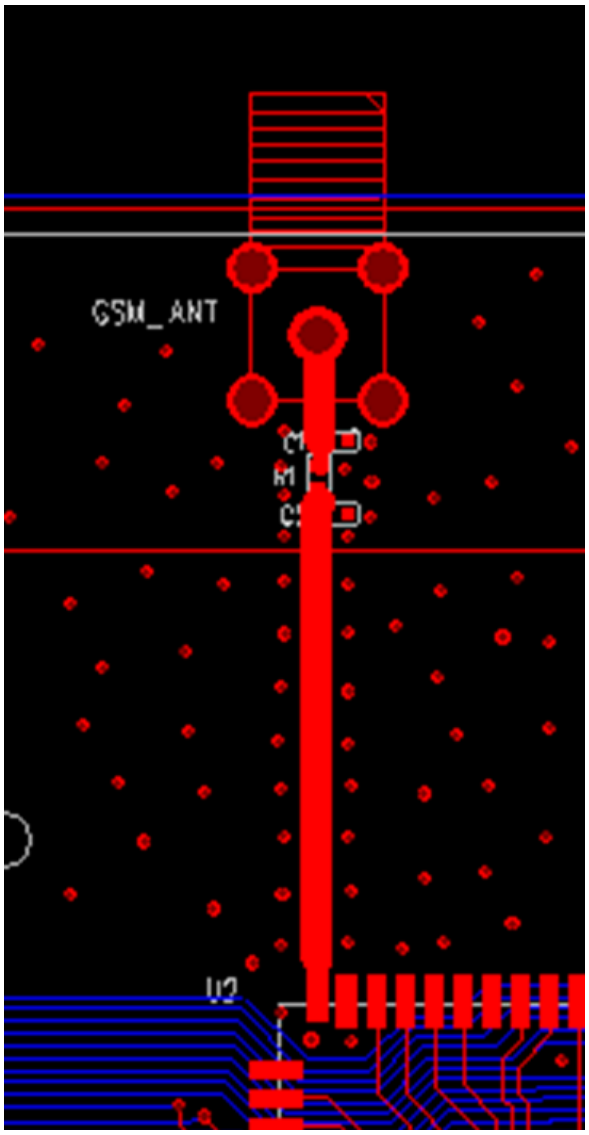
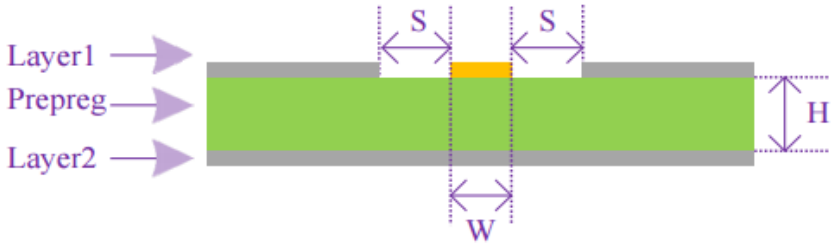
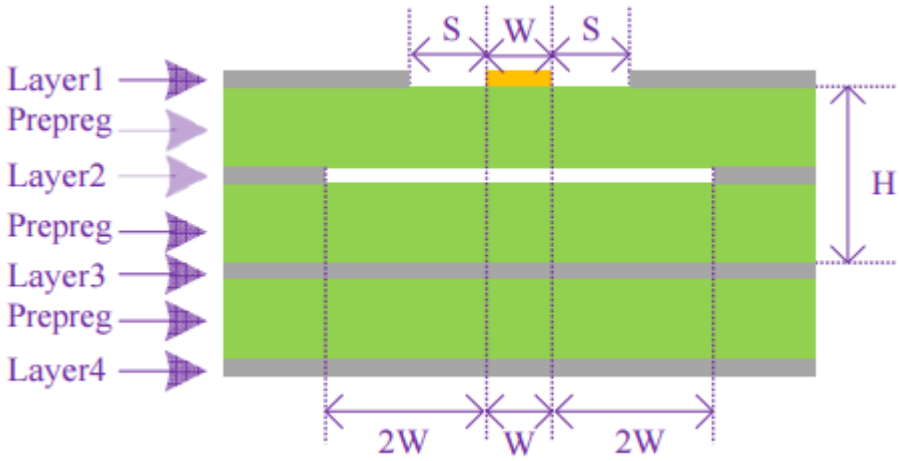


Figure 16: **RF reference circuit**

Two Layers PCB Coplanar Waveguide-slot Line Structure :



Four Layers PCB Coplanar Waveguide-slot Line Structure (Reference Layer Three) :



RC10EM-NA module provides an RF pad interface for connecting an external antenna. The RF trace from the pad to the antenna connector should be a coplanar waveguide or microstrip line, and its characteristic impedance should be controlled at around 50 ohms. There are two ground pads on each side of the RC10 module RF interface to obtain better grounding performance. In addition, in order to better adjust the RF performance, it is recommended to reserve a π matching circuit.

In the circuit design of the RF antenna interface, in order to ensure good performance and reliability of the RF signal, it is recommended to follow the following design principles:

- Impedance simulation tools should be used to accurately control the 50Ω impedance of RF signal lines.
- The GND pin adjacent to the RF pin does not have a thermal pad and must be in full contact with the ground.
- The distance between the RF pin and the RF connector should be as short as possible; avoid right-angle routing. The recommended routing angle is 135 degrees.
- When establishing the connector package, be sure to keep the signal pin at a certain distance from the ground.

- The ground plane referenced by the RF signal line should be complete; adding a certain number of ground holes around the signal line and the 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).

Table 16: LTE antenna requirements

project	Require
VSWR	<2
Gain (dBi)	9
Maximum input power (W)	50
Input impedance (Ω)	50
Polarization type	Vertical polarization
Cable Insertion Loss	<1dB (LTE B5/B12/B17) <1.5dB (LTE B2/B4/B39/B66) <2dB (LTE B34/B38/B40/B41)

RF output power

Table 17: RF conducted power

frequency	maximum	Minimum
FDD-LTE B2/B5	23dBm±1dBm	<-39dBm
FDD-LTE B4/B66	23.5dBm±1dBm	<-39dBm
FDD-LTE B12/B17	22.5dBm±1dBm	<-39dBm
TDD-LTE B34/B38/B39/B40/B41	23.5dBm±1dBm	<-39dBm

RF receiving sensitivity

Table 18: RF Conducted Susceptibility

frequency	Receiving sensitivity
FDD-LTE B 2 (10M)	<- 99dBm
FDD-LTE B 4 (10M)	<- 99dBm
FDD-LTE B5 (10M)	<-99dBm
FDD-LTE B12 (10M)	<-98dBm
FDD-LTE B17 (10M)	<-99dBm

FDD-LTE B66 (10M)	<-99dBm
TDD-LTE B34 (10M)	<-99dBm
TDD-LTE B38 (10M)	<-99dBm
T DD-LTE B 39 (10M)	<- 98dBm
T DD-LTE B 40 (10M)	<- 99dBm
T DD-LTE B 41 (10M)	<- 99dBm

4.1.4. Operating frequency

Table 19: Module operating frequency

3GPP frequency bands	send	take over	unit
FDD-LTE B2	1850~1909.9	1930~1989.9	MHz
FDD-LTE B4	1710~1754.9	2110~2154.9	MHz
FDD-LTE B5	824~849	869~894	MHz
FDD-LTE B12	699~715.9	729~745.9	MHz
FDD-LTE B17	704~715.9	734~745.9	MHz
FDD-LTE B66	1710~1779.9	2110 ~ 2179.9	MHz
TDD-LTE B34	2010~2025	2010~2025	MHz
TDD-LTE B38	2570~2620	2570~2620	MHz
TDD-LTE B39	1880~1920	1880~1920	MHz
TDD-LTE B40	2300~2400	2300~2400	MHz
TDD-LTE B41	2555~2655	2555~2655	MHz

4.2. GNSS antenna interface

RC10EM-NA module has GPS and BD antenna interfaces. The RF signal is input from the GNSS_ANT pin. The impedance of the RF trace should be controlled to 50 ohms and the trace should be as short as possible.

4.2.1. Antenna specifications

The module can use active or passive antennas to receive GPS/BD satellite signals. The following table gives the recommended antenna specifications.

Table 20: Recommended antenna specifications

Antenna Type	specification
Passive Antenna	GPS frequency: 1575.42±2MHz BD frequency: 1561.098±2MHz Standing wave: <2 (Typ.) Polarization: right-hand circular polarization or linear polarization Gain : >0dBi
Active Antenna	GPS frequency: 1575.42±2MHz BD frequency: 1561.098±2MHz Standing wave: <2 (Typ.) Polarization: right-hand circular polarization or linear polarization Noise figure: <1.5Db Gain (antenna): >-2dBi Gain (built-in LNA): 20Db (Typ.) Total gain : >18dBi(Typ.)

4.2.2. Active Antenna

The figure below is a reference circuit using an active antenna. The active antenna is powered by VBAT .

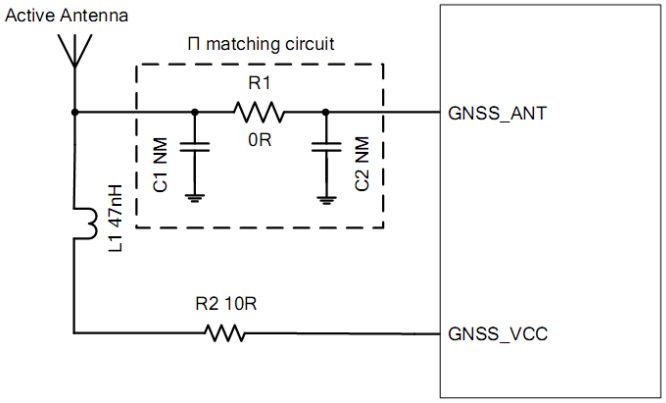


Figure 17**: Active antenna reference circuit**

C1, R1 and C2 form a matching circuit that is recommended to be reserved for adjusting the antenna impedance. By default, C1 and C2 are not attached, and only the 0 ohm R1 resistor is attached.

The external active antenna is powered by VBAT , the voltage range is from 2.8V to

4.3V, and the typical value is 3.3V. If the voltage does not meet the power supply requirements of the active antenna, an external LDO should be used for power supply.

Inductor L1 blocks the RF signal and isolates the RF signal from GNSS_VCC. It is recommended that the value of L1 should be no less than 47 Nh . R2 can protect the active antenna when it is short-circuited to the ground.

Note: In integrated control mode, GNSS_VCC power supply is controlled by CAT1 part through AT commands.

4.2.3. Passive Antenna

The figure below is a reference circuit when using a passive antenna.

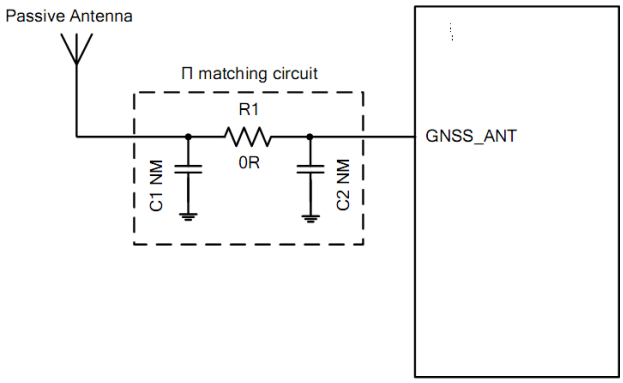


Figure 18**: Passive antenna reference circuit**

C1, R1 and C2 form a matching circuit that is recommended to be reserved for adjusting the antenna impedance. C1 and C2 are not mounted by default, and only the 0 ohm R1 resistor is mounted. The impedance of the RF trace should be controlled at about 50 ohms, and the shorter the trace, the better.

5. Electrical performance and reliability

5.1. Absolute Maximum Ratings

The following table shows the maximum tolerance values of the power supply voltage and current of the module's digital and analog pins.

Table 21: Absolute Maximum Ratings

parameter	Minimum	maximum	unit

VBAT	-0.3	+ 5	V
Power supply peak current	0	2	A
Average power supply current (TDMA one frame time)	0	0.7	A
Voltage at digital pin	-0.3	3.6	V
Voltage at analog pin	-0.3	3.6	V
Voltage at digital/analog pins in shutdown mode	-0.25	0.25	V

5.2. Operating temperature

Table 22: RC10EM-NA module operating temperature

parameter	Minimum	typical	maximum	unit
Normal operating temperature	-40	+25	+85	℃

5.3. Power supply rating

Table 23: LTE Part Power Supply Ratings

parameter	describe	condition	Minimum	typical	maximum	unit
VBAT	Supply voltage	The voltage must be within this range, including voltage drop, ripple and peak.	3. 1	4.0	4. 5	V
	Voltage drop during burst transmission	At maximum transmit power level			400	mV
I_{VBAT}	Average supply current	Normal operating current				
		Idle Mode				
		Sleep Mode 1				
		Sleep Mode 2				

		Sleep Mode			
		Shutdown Mode			
	Peak current (per transmit time slot)	At maximum power level	1.6	2	A

5.4. Current consumption

Table 24: CAT1 part current consumption (GNSS part turned off)

Case Name	Voltage (V)	Band	Channel	Freq(MHz)	Temperature = 25°		
					AvrgCurrent(mA)	MaxCurrent(mA)	txPower(dBm)
IDLE 0.64s	3.8	1	300	2140	0.4009856	97.07369	-
IDLE 1.28s	3.8	1	300	2140	0.2322558	99.87789	-
IDLE 2.56s	3.8	1	300	2140	0.1334065	102.8762	-
IDLE 0.64s	3.8	3	1575	1842.5	0.4332593	98.61486	-
IDLE 1.28s	3.8	3	1575	1842.5	0.2003251	100.0433	-
IDLE 2.56s	3.8	3	1575	1842.5	0.1063499	103.1923	-
EDRX 81.92s	3.8	3	1575	1842.5	0.02085966	108.2219	-
IDLE 0.64s	3.8	5	2525	881.5	0.3897183	98.8346	-
IDLE 1.28s	3.8	5	2525	881.5	0.2227459	98.37755	-
IDLE 2.56s	3.8	5	2525	881.5	0.124412	103.2431	-
EDRX 81.92s	3.8	5	2525	881.5	0.05594905	107.4003	-
IDLE 0.64s	3.8	8	3625	942.5	0.4013965	98.69181	-
IDLE 1.28s	3.8	8	3625	942.5	0.1985607	99.91826	-

IDLE 2.56s	3.8	8	3625	942.5	0.114295 7	102.0641	-
IDLE 0.64s	3.8	34	36275	2017.5	0.461631 6	97.39129	-
IDLE 1.28s	3.8	34	36275	2017.5	0.212204 3	99.27704	-
IDLE 2.56s	3.8	34	36275	2017.5	0.121467	102.3288	-
IDLE 0.64s	3.8	38	38000	2595	0.398953 9	98.77734	-
IDLE 1.28s	3.8	38	38000	2595	0.203372 3	97.07507	-
IDLE 2.56s	3.8	38	38000	2595	0.130095 2	100.7662	-
EDRX 81.92s	3.8	38	38000	2595	0.023575 82	108.3221	-
IDLE 0.64s	3.8	39	38450	1900	0.461517 5	98.99881	-
IDLE 1.28s	3.8	39	38450	1900	0.204457 5	99.71191	-
IDLE 2.56s	3.8	39	38450	1900	0.107668 5	102.7139	-
IDLE 0.64s	3.8	40	39150	2350	0.398956 4	99.12929	-
IDLE 1.28s	3.8	40	39150	2350	0.209686 6	100.1462	-
IDLE 2.56s	3.8	40	39150	2350	0.106272 1	103.4888	-
IDLE 0.64s	3.8	41	40620	2593	0.453435 7	96.81462	-
IDLE 1.28s	3.8	41	40620	2593	0.229719 7	100.1496	-
IDLE 2.56s	3.8	41	40620	2593	0.138662 6	103.4508	-
Connect TX -40dBm	3.8	8	3500	930	94.63671	103.1469	-38.8715
Connect TX 0dBm	3.8	8	3500	930	109.8941	118.2505	-0.15155
Connect TX 10dBm	3.8	8	3500	930	134.1044	142.587	9.98019

Connect TX 23dBm	3.8	8	3500	930	421.0037	435.4528	22.1417
Connect TX -40dBm	3.8	5	2525	881.5	95.49163	104.3511	-39.3195
Connect TX 0dBm	3.8	5	2525	881.5	108.1711	116.6706	-0.120026
Connect TX 10dBm	3.8	5	2525	881.5	132.3021	140.8863	9.81842
Connect TX 23dBm	3.8	5	2525	881.5	423.6926	436.8865	22.1115
Connect TX -40dBm	3.8	1	300	2140	101.4419	109.7603	-39.1475
Connect TX 0dBm	3.8	1	300	2140	118.5097	127.0542	-0.0535889
Connect TX 10dBm	3.8	1	300	2140	145.4966	155.0509	10.0472
Connect TX 23dBm	3.8	1	300	2140	505.1228	519.4079	22.7571
Connect TX -40dBm	3.8	3	1575	1842.5	100.3884	108.6825	-38.9273
Connect TX 0dBm	3.8	3	1575	1842.5	114.2364	122.6501	-0.162689
Connect TX 10dBm	3.8	3	1575	1842.5	138.1826	146.6408	9.81046
Connect TX 23dBm	3.8	3	1575	1842.5	477.0599	490.7061	22.6776
Connect TX -40dBm	3.8	38	38000	2595	68.93457	114.5086	-38.7734
Connect	3.8	38	38000	2595	76.42826	113.5906	-0.374298

TX 0dBm							
Connect TX 10dBm	3.8	38	38000	2595	87.51012	137.8956	9.65048
Connect TX 23dBm	3.8	38	38000	2595	237.7843	531.0421	21.8538
Connect TX 23dBm_ TDD_FU LL_TBS	3.8	38	38000	2595	237.5951	531.4604	21.9737
Connect TX 23dBm_ FDD_FU LL_TBS	3.8	3	1575	1842.5	478.2791	492.7133	22.6692
Connect TX 23dBm_ RSRP_- 114_TD D_FULL _TBS	3.8	38	38000	2595	240.0264	531.0255	21.976
Connect TX 23dBm_ RSRP_- 114_FD D_FULL _TBS	3.8	3	1575	1842.5	478.7737	493.5411	22.6642
Connect TX -40dBm	3.8	39	38450	1900	64.70332	108.2688	-38.9936
Connect TX 0dBm	3.8	39	38450	1900	69.7813	103.845	0.127228
Connect TX 10dBm	3.8	39	38450	1900	78.22313	121.7778	9.28775
Connect TX 23dBm	3.8	39	38450	1900	221.7966	488.6023	23.3149

Connect TX -40dBm	3.8	40	39150	2350	67.10934	110.3686	-39.2403
Connect TX 0dBm	3.8	40	39150	2350	73.57155	113.0219	-0.0223999
Connect TX 10dBm	3.8	40	39150	2350	100.3861	165.5801	9.91547
Connect TX 23dBm	3.8	40	39150	2350	231.4339	510.9291	22.1208
Connect TX -40dBm	3.8	41	40620	2593	68.85119	113.907	-39.4584
Connect TX 0dBm	3.8	41	40620	2593	76.45527	113.3234	-0.216431
Connect TX 10dBm	3.8	41	40620	2593	87.59305	137.5866	9.7757
Connect TX 23dBm	3.8	41	40620	2593	237.7972	531.2055	22.1003
Connect TX -40dBm	3.8	34	36275	2017.5	64.79876	108.1492	-39.6306
Connect TX 0dBm	3.8	34	36275	2017.5	70.60842	105.1386	0.267334
Connect TX 10dBm	3.8	34	36275	2017.5	80.1735	125.6326	10.0724
Connect TX 23dBm	3.8	34	36275	2017.5	206.8718	449.5487	22.4474

Table 25: Current consumption of GNSS part

project	condition	Typical Value	unit

Power consumption	capture	25	mA
	track	twenty two	mA
	Sleep mode	6	mA

5.5. Electrostatic protection

In module applications, static electricity generated by human body static electricity, charged friction between microelectronics, etc. will be discharged to the module through various channels, which may cause certain damage to the module, so ESD protection of the module is very important. Whether it is product development, production assembly, testing, or product design, ESD protection measures should be taken. For example: when designing a circuit, ESD protection should be added at the interface or ESD-prone points; wear anti-static gloves during the production process, etc.

The following table shows the ESD withstand voltage of key pins of the module.

Table 26: ESD performance parameters (temperature: 25°C, humidity: 45%)

Test Points	Contact discharge	Air discharge
VBAT, GND	±5KV	±10KV
RF_ANT	±5KV	±10KV
TXD, RXD	±2KV	±4KV
Others	±0.5KV	±1KV

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module .

6.1. Module mechanical dimensions

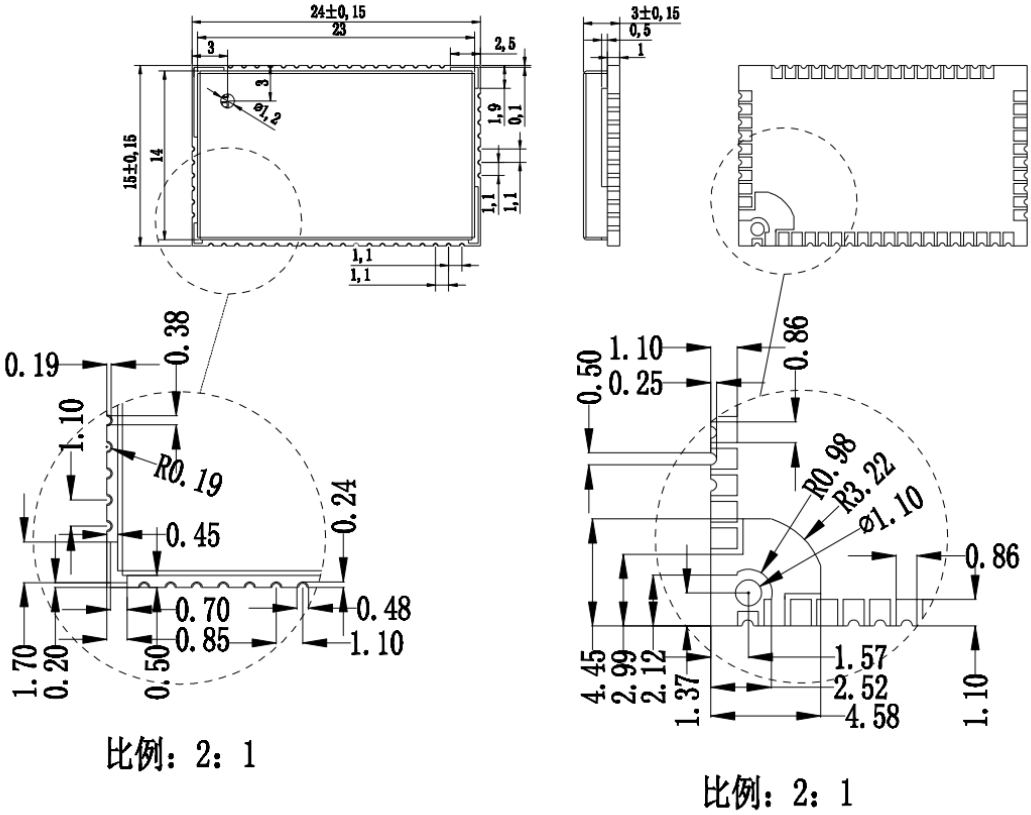


Figure 19: **RC10EM-NA dimensions (unit: mm)**

6.2. Recommended packaging

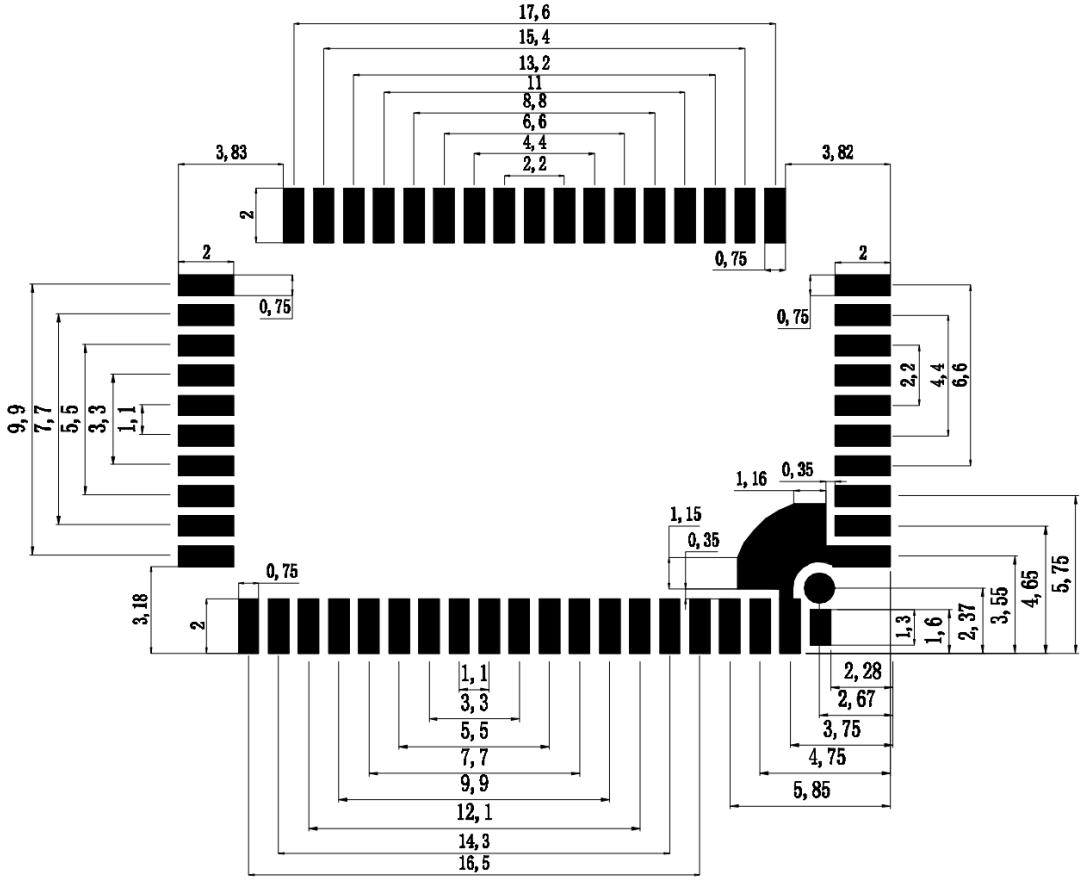


Figure 20**: RC10EM-NA recommended footprint (unit: mm)**

7 Storage, production and packaging

7.1. Storage

RC10EM-NA is packaged in vacuum sealed bags. The storage conditions of the module should be as follows:

1. When the ambient temperature is below 40 degrees Celsius and the air humidity is less than 90%, the module can be stored in a vacuum sealed bag for 12 months.

2. After the vacuum seal bag is opened, the module can be directly subjected to reflow soldering or other high temperature processes if the following conditions are met:

- The module ambient temperature is below 30 degrees Celsius, the air humidity is less than 60%, and the factory completes the patching within 72 hours.
- Air humidity is less than 10%.

3. If the module is in the following conditions, it needs to be baked before mounting:

- When the ambient temperature is 23 degrees Celsius (a fluctuation of 5 degrees Celsius is allowed), the humidity indicator card shows that the humidity is greater than 10%.
- When the vacuum sealed bag was opened, the module ambient temperature was below 30 degrees Celsius and the air humidity was less than 60%, but the factory failed to complete the patching within 72 hours.
- When the vacuum sealed bag is opened, the module storage air humidity is greater than 10%.

4. If the module needs to be baked, please bake it at 125 degrees Celsius (allowing a fluctuation of 5 degrees Celsius) for 48 hours.

Note: The module packaging cannot withstand such high temperatures (125ºC). Please remove the module packaging before baking the module. If only a short baking time is required, please refer to the IP /JEDE J-STD-033 specification.

7.2. Production welding

Use a printing scraper to print solder paste on the stencil so that the solder paste leaks through the stencil opening onto the PCB. The strength of the printing scraper needs to be adjusted appropriately. To ensure the quality of the module printing paste, the thickness of the steel mesh corresponding to the RC10 module pad should be 0.2mm. For more details, please refer to document [12].

The recommended maximum reflow temperature is 235°C to 245°C (SnAg3.0Cu0.5

alloy). The absolute maximum reflow temperature is 260ºC. To avoid repeated heating of the module and damage, it is recommended that customers attach the BSJ communication module after completing the reflow soldering of the first side of the PCB board. The recommended furnace temperature curve is shown in the figure below:

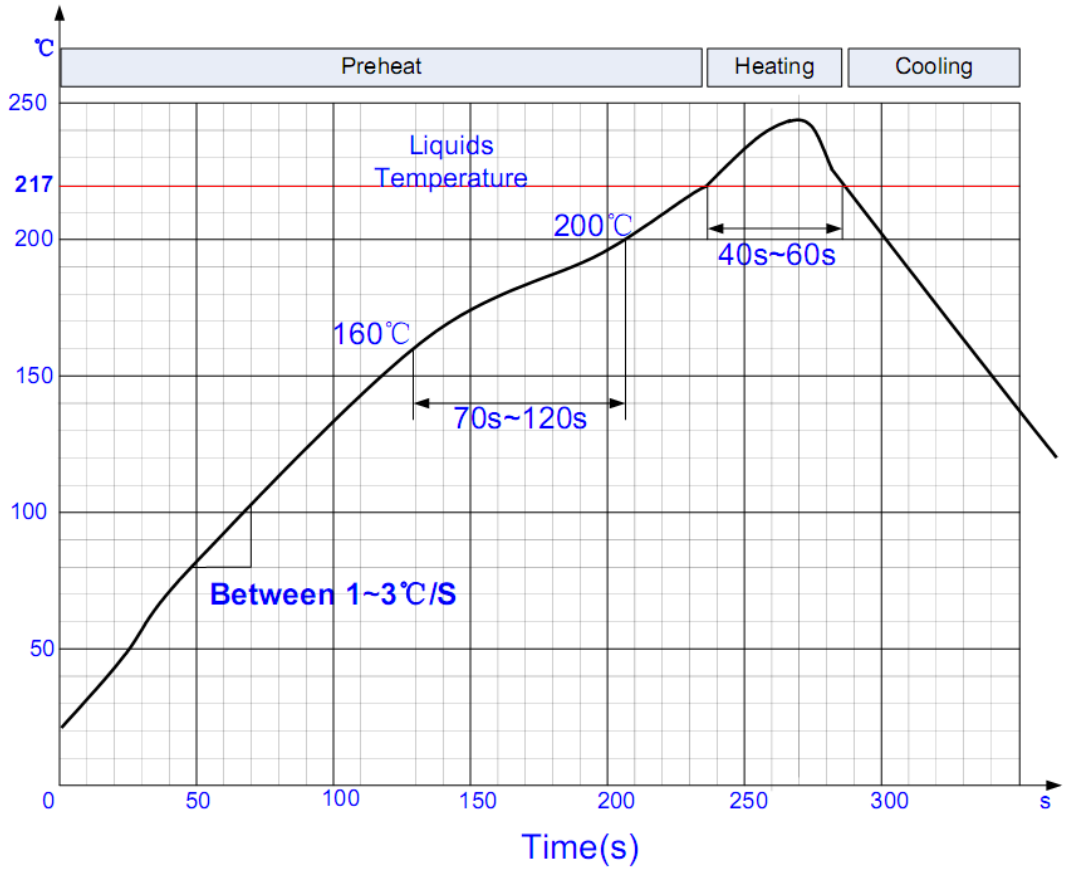


Figure 21**: Recommended furnace temperature curve**

7.3. Packaging

RC10EM-NA module is packaged in a vacuum sealed bag with static protection. The package should not be opened until the module is ready for soldering.

7.3.1. Tape and Reel Packaging

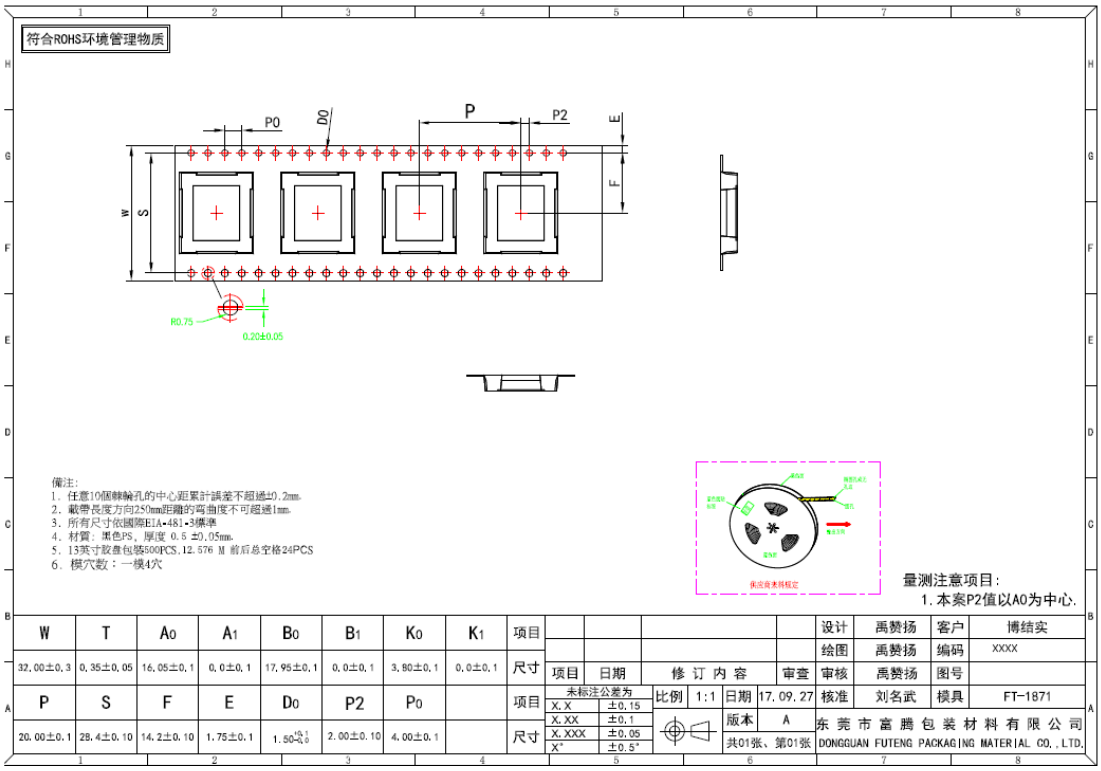


Figure 22**: Carrier tape dimensions (unit: mm)**

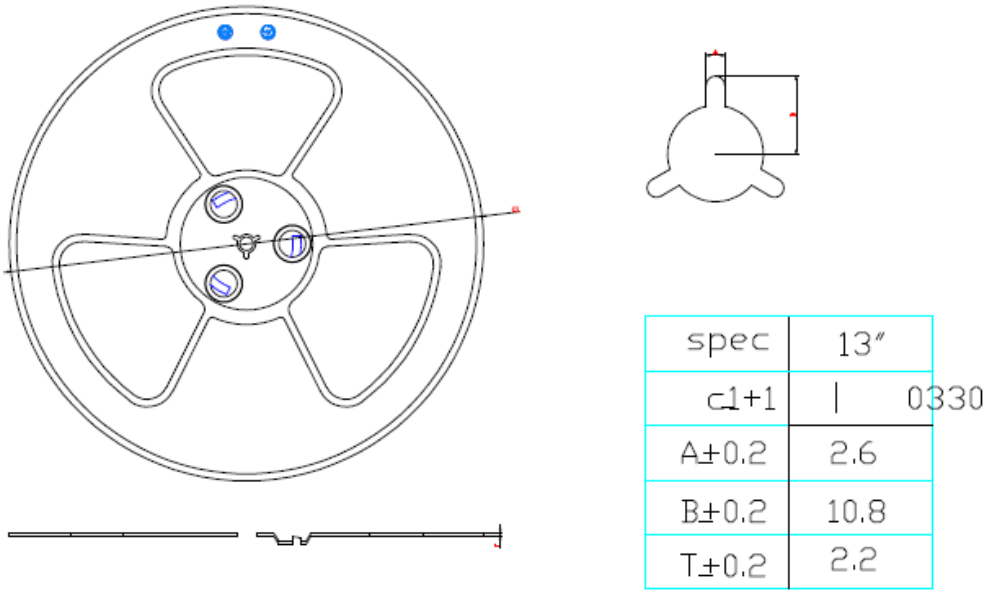


Figure 23**: Reel dimensions (unit: mm)**

8. FCC warning message

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile or fixed device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile or fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time averaging duty factor, antenna gain, and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a mobile or fixed device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3. A label with the following statements must be attached to the host end product: This device contains FCC ID: 2AQSK-RC10EM-NA . This module must not transmit simultaneously with any other antenna or transmitter

4. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093 If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations. For this device, OEM Integrator must be provided with labeling instructions of finished products.

Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs: A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required.

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: 2AQSK-RC10EM-NA: "Contains Transmitter Module FCC ID: 2AQSK-RC10EM-NA"

The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

8.1 Statement

The module is limited to OEM installation only. The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module. OEM host shall implement a Class II Permissive Change (C2PC) or a new FCC ID to demonstrate complied with FCC standard. The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

The final end product must be labeled in a visible area with the following: "Contains FCC ID: 2AQSK-RC10EM-NA" The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

8.2 Class B digital device

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

8.3 Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

8.4 Summarize the specific operational use conditions

The RC10EM-NA radio module is designed specifically for control applications in the host product intelligent lightingseries, model: RC10EM-NA. The radio module is not intended to be sold as a standalone product. RC10EM-NA is applicable to oil platforms, cars, trans, boats and aircraft. RC10EM-NA radio module must not coexist or work in conjunction with anyother antenna or transmitter.

8.5 Trace antenna designs

Please refer to Chapter 4

Typical antenna types include monopole, PIFA, dipole and PCB(Trace antenna). The modular transmitter is certified based on the conducted output power, a change in antenna gain is possible through a Class II permissive change by contacting the module grantee, or filling for a change in FCC ID.

8.6 Important Note

In the event that these conditions cannot be met (for example co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

8.7 Note EMI Considerations

KDB 996369 D04 Module Integration Guide has been considered as "best practice# for RF design engineering testing and evaluation of non-linear interactions which can generate additional non-compliant limits due to module placement to host components or properties.
For standalone mode, KDB 996369 D04 Module Integration Guide was referenced, and simultaneous mode considered for the host product to confirm compliance.

8.8 How to make changes

Only Grantees are permitted to make permissive changes, it is recommended that module manufactures provide contact information and some guidance to host providers. Each host product model will require AC Powerline Conducted Emissions, Spurious Radiated Emissions, and conducted output power/EIRP verification. A C2PC will be completed for the integration into additional host models.

8.9 Information on test modes and additional testing requirements

Data transfer module demo board can control the EUT work in RF test mode at specified conditions. This radio module must not be installed to co-locate and operating simultaneously with other radios in the host system except in accordance with FCC multi-transmitter product procedures. Additional testing and equipment authorization may be required operate simultaneously with other radio.

8.10 Additional testing, Part 15 Subpart B disclaimer

The host product manufacturer is responsible for compliance with any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.