SIM68AT Hardware Design

GNSS Module

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Version History

Date	Version	Description of change	Author
2021-10-26	V1.00	Origin	Yanping Yang Hang Qu

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1 Introduction

This document describes the hardware interface of the SIMCom module SIM68AT, SIM68AT is a GNSS All-in-one solution, which can be used as a Stand-alone or A-GPS(Assisted Global Positioning System),GLONASS and QZSS receiver. All functional components of SIM68AT are described in great detail, and SIM68AT supports L1+L5.

SIM68AT is a GNSS All-in-one module with stand-alone GPS (A-GPS supported) /GLONASS/GALILEO/BEIDOU receiver, with built-in LNA, SIM68AT can relax antenna requirement and don't need external LNA. SIM68AT supports various location and navigation applications, including autonomous GPS, GLONASS, BEIDOU, SBAS ranging (WAAS, EGNOS, GAGAN and MSAS), QZSS, DGPS (RTCM), and A-GPS.

Key Features

The module provides complete signal processing from antenna input to host port in NMEA messages. The module requires 2.8V to 4.3V power supply, which gives customers plenty of choices for the application circuit. The host port is configurable to UART. Host data and I/O signal levels are 2.8V CMOS compatible.

- GPS/GLONASS//GALILEO/BEIDOU receiver, supports multi-GNSS include QZSS, RTCM, SBAS ranging, supports WAAS/EGNOS/MSAS/GAGAN
- 33tracking/99 acquisition-channel GNSS receiver
- Small footprint: 16 x 12.2 x 2.4mm, 24-pin LCC package
- 12 multi-tone active interference cancellers and jamming elimination[1]
- Indoor and outdoor multi-path detection and compensation
- Max fixed update rate up to 1HZ
- Advanced software features
    1. Always locate advanced location awareness technology
    2. EPO/HotStill orbit prediction
    3. EASY self-generated orbit prediction
- Pulse-per-second (PPS) GPS time reference
    1. Adjustable duty cycle
    2. typical accuracy: +/- 10ns
- Interface
    1. UART[2]
    2. I2C
- Operating temperature: -40 ~ +85ºC
- Accuracy 1m CEP
- RoHS compliant

NOTE

1. AIC is default open and can be controlled by PAIR command, see *document [1]* for details；
2. UART0 for output NMEA and download，UART1 for system LOG，UART2 for RTCM function.

1.1 SIM68AT Functional Diagram

The following figure shows a functional diagram of the SIM68AT and illustrates the mainly functional parts:

- The main chip
- SAW filter
- Low noise amplifier
- The antenna interface
- The communication interface
- The control signals

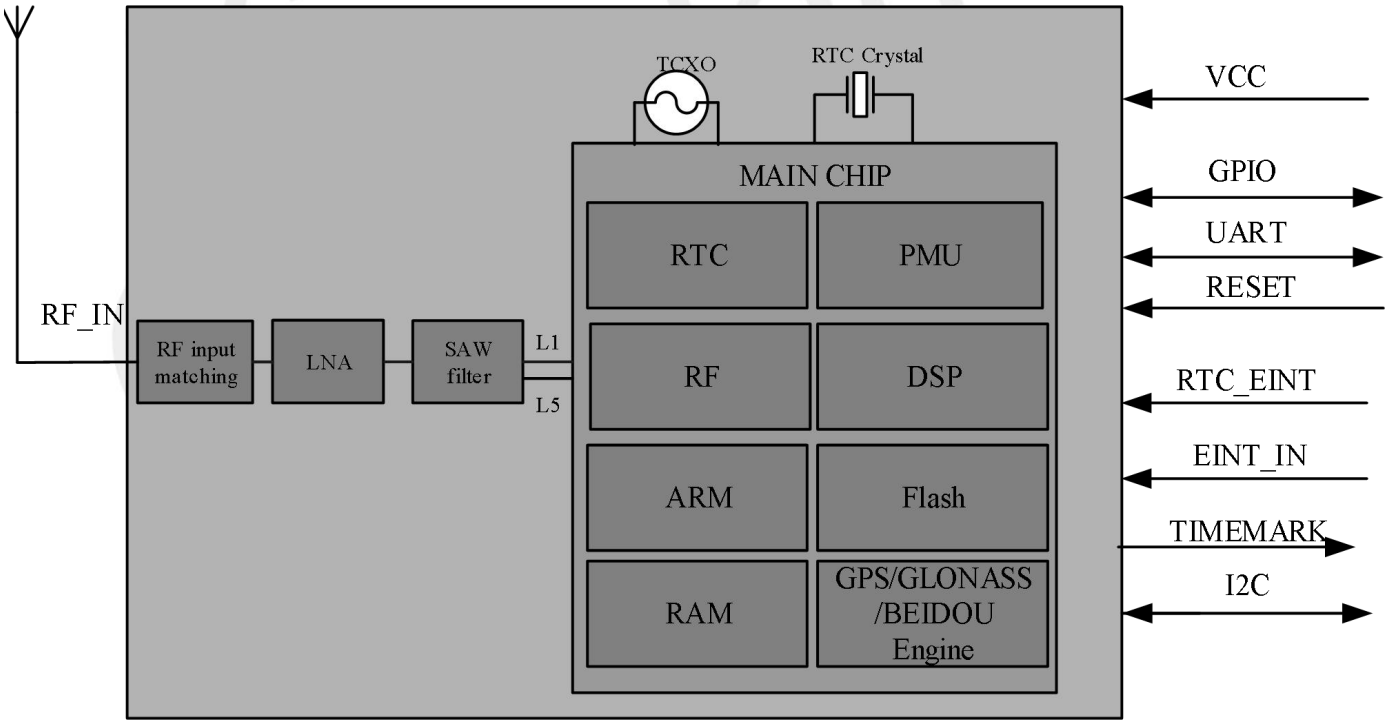

Figure 1: SIM68AT functional diagram

1.1.1 GNSS Performance

Table 1: GNSS Performance

Parameter	Description	Performance			
		Min	Type	Max	Unit
Horizontal Position Accuracy[1]	Automatic position		<1.5		m
Velocity Accuracy[2]	Without Aid		0.1		m/s
	DGPS		0.05		m/s
Timing Accuracy			10		nS
Dynamic Performance	Maximum Altitude			18000	m
	Maximum Velocity			500	m/s
	Maximum Acceleration			4	G
TTFF with GPS（L1+L5） and GALILEO[3]	Hot start		0.4		S
	Warm start		18.8		S
	Cold start		20.6		S
A-GPS TTFF(EPO in flash mode)	Hot start		TBD		S
	Warm start		TBD		S
	Cold start		TBD		S
Sensitivity with GPS（L1+L5） only mode	Autonomous acquisition(cold start)		-147		dBm
	Re-acquisition		-158		dBm
	Tracking		-167		dBm
Sensitivity with GPS（L1+L5） and GLONASS and BEIDOU mode	Autonomous acquisition(cold start)		L1:75 L5:60		dBm
	Re-acquisition		1		dBm
	Tracking		TBD		dBm
Receiver	Channels		L1:75 L5:60		
	Update rate		1		Hz
	Tracking L1, CA Code				
	Protocol support NMEA,PAIR				
Power consumption With GPS（L1+L5） and GLONASS and BEIDOU mode[4]	Acquisition		28		mA
	Continuous tracking		30		mA
	Sleep current		340		uA
	Software RTC current		60		uA

NOTE

1. 50% 24hr static, -130dBm；
2. 50% at 30m/s；
3. GPS signal level: -130dBm; GLONASS signal level: -130dBm; GALILEO signal level: -130dBm; BEIDOU signal level: -130dBm；
4. Power supply 3.3V；

1.1.2 General Features

Table 2: General features

Parameters		Value
Supply voltage VCC		+2.8V~4.3V typical:3.3V
Supply voltage ripple VCC		54 mV(RMS) max @ f = 0~3MHz 15 mV(RMS) max @ f > 3 MHz
Power consumption(acquisition)		30mA.@ VCC=3.3 V
Power consumption(sleep)		340uA.@ VCC=3.3 V
Power consumption(software RTC)		60uA.@ VCC=3.3 V
Operation temperature		-40ºC~+85ºC
Storage temperature		-45ºC~+90ºC
DVDDIO=2.8V I/O signal levels(V)	V_{IL}	-0.3~0.25* DVDDIO
	V_{IH}	0.625* DVDD ~ DVDDIO +0.3V
	V_{OL}	-0.3~0.125*DVDDIO
	V_{OH}	0.75* DVDDIO ~3.1V
DVDDIO=1.8V I/O signal levels(V)	V_{IL}	-0.3~0.35* DVDDIO
	V_{IH}	0.65* DVDD ~* DVDDIO +0.3V
	V_{OL}	-0.3~0.25* DVDDIO
	V_{OH}	0.75* DVDDIO~1.98V
I/O output sink/source capability		+/- 6mA max
I/O input leakage		+/- 16 uA max
Host port		UART0
Other port		I2C,UART1,UART2
Serial port protocol (UART)		NMEA; 8 bits, no parity, 1 stop bit; 115200 baud (configurable)
TIMEMARK output (1PPS)		3D-FIXED 1 pulse per second, synchronized at rising edge, The rising edge of the pulse is aligned with UTC

	seconds, with an accuracy of about 20nS pulse length 100ms；

1.2 Pin out Diagram

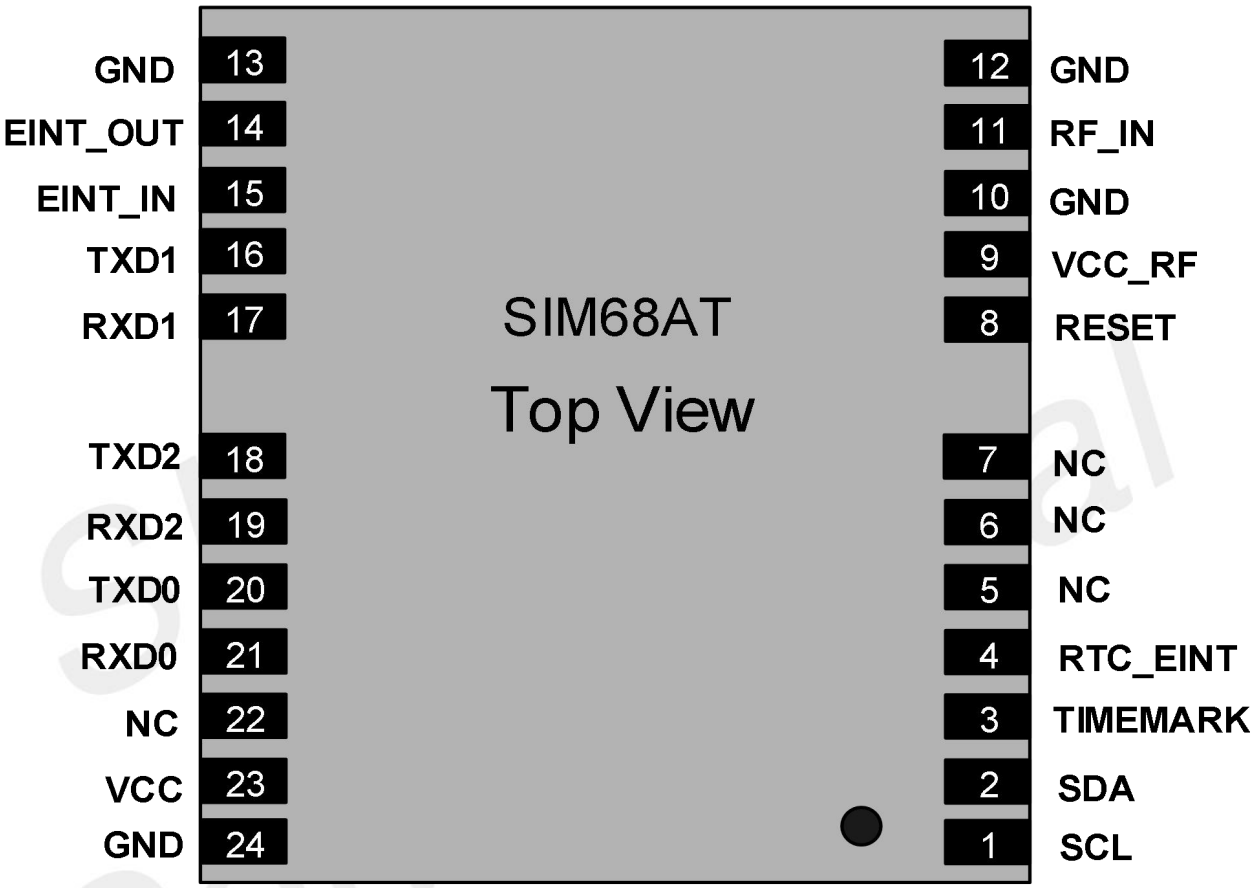

Figure 2: SIM68AT pin diagram (Top view)

1.2.1 Pin Description

Table 3: Pin description

Pin name	Pin number	I/O	Description	Comment
Power supply				
VCC	23	I	Main power input, which will be used to power the baseband and RF section internally.	Provide clean and stable power source to this pin. Add a 4.7uF capacitor to this pin for decoupling.
VCC_RF	9	O	2.8V output power supply for active antenna	If unused, keep open.
GND	10,12,13,24		Ground	GND
Host port interface				
SCL	1	I/O	Inertial navigation vehicle speed pulse	2.8V power domain, If unused, keep open.
SDA	2	I/O	Inertial navigation speed forward and backward direction	
TXD2	18	O	RTCM function and NMEA	2.8V power domain, If unused, keep open.
RXD2	19	I		
TXD0	20	O	Serial data output of NMEA	
RXD0	21	I	Serial data input for firmware upd ate	
TXD1	16	O	System LOG serial output/ input	
RXD1	17	I		
GPIOs				
RTC_EINT	4	I	RTC interrupt , Exit RTC mode	1.8V power domain, ENT0 pull high 10ms that module will exit RTC mode. Must be connected
TIMEMARK	3	O	Time Mark outputs timing pulse related to receiver time	2.8V power domain, If unused, keep open.
RESET	8	I	The module reset signal	1.8V power domain, high level default, active low.
EINT_IN	15	I	Wake up SIM68AT	1.8V power domain, pull up to 1.8V;high level default, active low. Must be connected

EINT_OUT	14	O	Wake up host notify data ready	1.8V power domain, 1.8V power domain, low level default, active high.
RF interface				
RF_IN	11	I	Radio antenna connection	Impendence must be controlled to 50Ω.
Other interface				
NC	5,6,7,22		Not Connected	Keep floating

NOTE

1. 4pin EINT0 must be connected, otherwise it may cause failure to exit RTC mode.
2. 15pin EINT_IN must be connected, otherwise it may cause failure to exit sleep mode, please refer to section 2.5 for details.
3. 14pin EINT_OUT wake up host notify data ready. If not used, the signal can be kept floating.

1.2.2 Package Dimensions

Following figure shows the Mechanical dimensions of SIM68AT (top view, side view and bottom view).

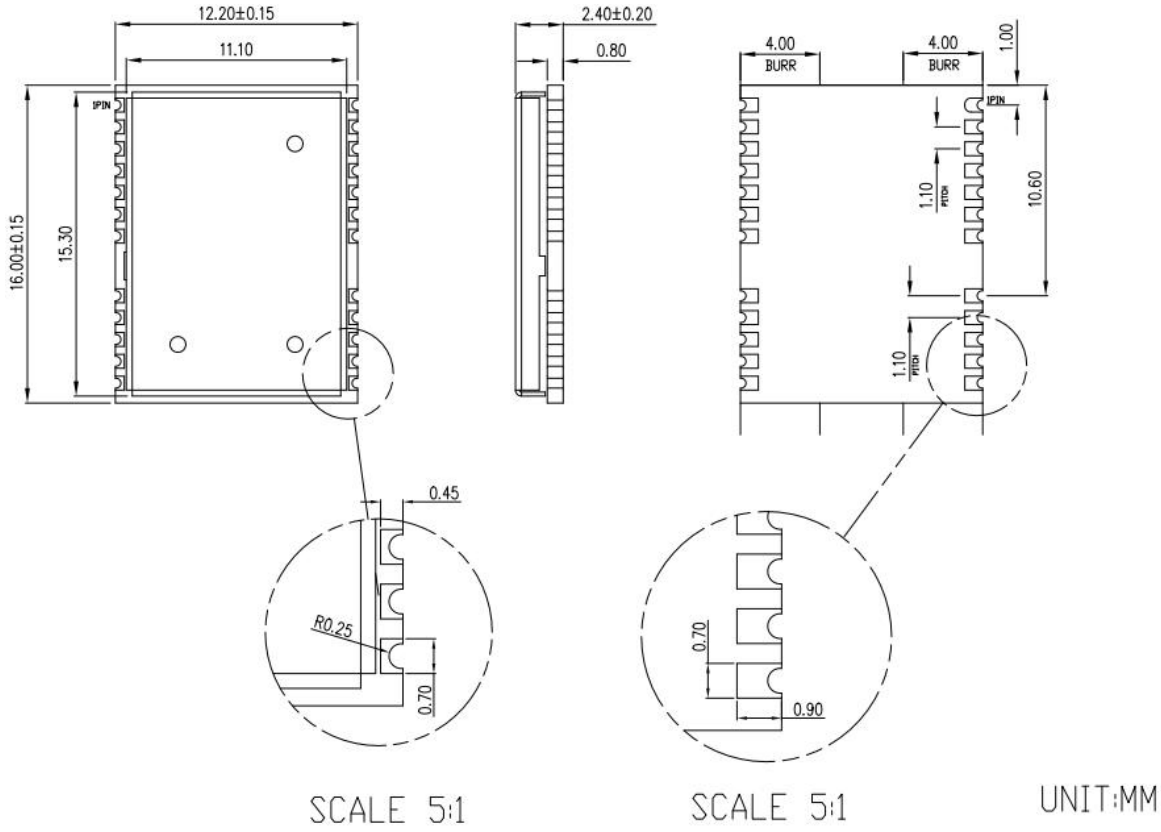

Figure 3: SIM68AT mechanical dimensions (Unit: mm)

2 Application Interface

2.1 Power Management

2.1.1 Power Input

- VCC supply requirements
  The power supply range of SIM68AT is from 2.8V to 4.3V, typical 3.3V. The power supply should be able to provide sufficient current up to 100mA. SIM68AT positioning modules require a stable power supply, consider the following points:

1. Wide power lines or even power planes are preferred.
2. VCC supply needs to add a 4.7uF and 100nF multi-layer ceramic chip (MLCC) capacitors with low ESR in high frequency band, which can be used for EMC performance .
3. The ripple of the VCC supply cannot be higher than 15mV.
4. VCC supply needs a ESD and surge protection.

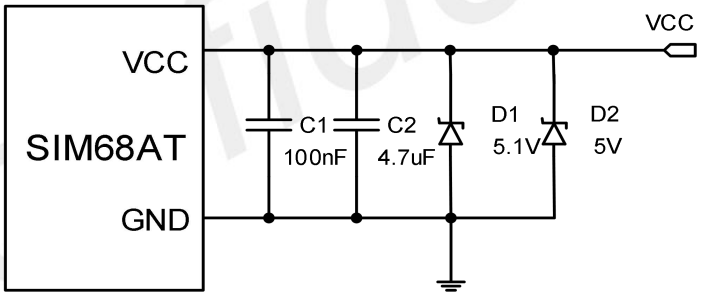

Figure 4: Power supply reference circuit

NOTE

1. C1 and C2 are multi-layer ceramic chip (MLCC) capacitors with low ESR in high frequency band, which can be used for EMC performance.
2. D2 is used for ESD protection and D1 is used for surge protection.

Table 4: Recommended D1 and D2 list

No.	Manufacturer	Part number	VRWM	Package	Ref. Designator
1	JCET	ESDBW5V0A1	5V	DFN1006-2L	D2
2	WAYON	WS05DPF-B	5V	DFN1006-2L	
3	LRC	LEDZ5.1BT1G	5.1V	SOD-523	D1
4	Prisemi	PZ5D4V2H	5.1V	SOD-523	

2.1.2 Starting SIM68AT

When power is first applied, SIM68AT goes into operation mode.

2.1.3 Verification of SIM68AT Start

System activity indication depends upon the chosen serial interface:

When it is activated, SIM68AT will output messages at the selected UART speed and message types. The default baud rate is 115200bps.

NOTE

The baud rate information can be found on the label. The last two digits of the SN number represent the baud rate, for example, 11 represents 115200.

2.1.4 Power Saving Modes

SIM68AT supports power saving modes for reducing average power consumption like sleep mode, RTC mode.

- Sleep mode: In this mode the receiver stays at full on power state. This mode can be woken up by the host by sending external interrupt.
- RTC mode: Software on host side to send the command through the communication interface to into the RTC mode, wake up by RTC_ENIT.

NOTE

The modes mentioned above are operated by PAIR commands, customs can refer to "SIM68 Series_NMEA Message_User Guide" for more information.

2.1.5 Operating Mode

Table 5: Power supply and clock state according to operation mode

Mode	VCC	Internal LDO	Main clock	RTC clock
Full on	on	on	on	on
Sleep mode	on	on	off	on
RTC mode	on	off	off	on

Full on Mode

The module will enter full on mode after first power up with factory configuration settings. Power consumption will vary depending on the amount of satellite acquisitions and number of satellites in track. This mode is also referenced as “Full on”, full power or navigation mode.

First positioning (different CN value, different positioning time), can download complete ephemeris data 15 minutes after positioning.

Navigation is available and any configuration settings are valid as long as the VCC power supply is active. When the power supply is off, settings are reset to factory configuration and receiver performs a cold start on next power up.

Sleep Mode

Sleep mode means a low quiescent (340uA type) power state, non-volatile RTC, and backup RAM block is powered on. Other internal blocks like digital baseband and RF are internally sleeping. The PMU is changed to low power mode, The power supply input VCC shall be kept active all the time, even during sleep mode.

Entering into sleep mode is controlled by UART interface, enter $PAIR003*39\r\n to enter sleep mode.Pull down “ENIT-IN” pin 10ms, in the process of pulling down EINT10ms, SIM68AT will return $PAIR012*39, and send $PAIR002*38\r\n to exit sleep mode within 100ms after returning $PAIR012*39.

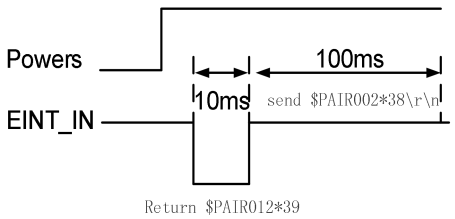

Figure 5: Exit sleep mode

NOTE

You must pull down “ENIT-IN” 10ms at least.

RTC Mode

RTC mode provides a lower current consumption than sleep mode. it is suitable for applications that remain idle for a long period. Triggering RTC mode is software configurable. The RTC timer or RTC_EINT can be used to exit RTC mode

Enter RTC mode

Entering into RTC mode is controlled by UART interface, send $PAIR650,0*25\r\n to enter sleep mode.

NOTE

For command PAIR650, please refer to SIM68 Series_NMEA Message_User Guide.

Exit RTC mode

SIM68AT module RTC_EINT pin can be used to exit RTC mode, when RTC_EINT pull high 10ms that module will exit RTC mode. For details, please refer to section 2.3

2.2 VCC_RF

VCC_RF is a 2.8V output for external antenna, for the detail usage of VCC_RF, customer can refer to document [2] for more information.

2.3 RTC_EINT Signal

SIM68AT module RTC_EINT pin can be used to exit RTC mode, when RTC_EINT pull high 10ms that module will exit RTC mode.

Case1：Using host control power source
Step1: enable external power source witch have to meeting power on sequence.
Step2: Pull up RTC_EINT 10ms.
Step3: SIM68AT module will auto exit RTC mode.

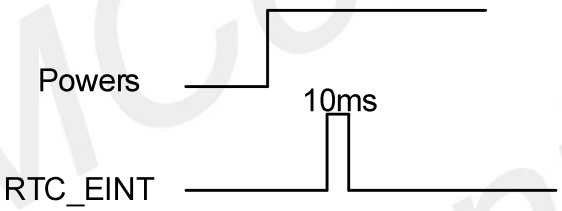

Figure 6: Exit RTC Mode

2.4 EINT_OUT Signal*

NOTE

"*" means under development.

2.5 EINT_IN Signal

When the module is successfully positioned, it will enter a short-term sleep mode to reduce power consumption. UART_RX wakes up when outputting NMEA every and sleeps at other times. If the host sends a command after the module is positioned, there is a greater chance that it cannot be executed, 15pin EINT_IN is used to wake up this sleep mode.

Pull down "ENIT-IN" pin 10ms, in the process of pulling down EINT_IN10ms, SIM68AT will return $PAIR012*39, and send $PAIR002*38\r\n to exit sleep mode within 100ms after returning $PAIR012*39.

2.6 RESET Signal

The RESET pin (active low) is used to reset the system, normally external control of RESET is not necessary. If not used the signal can be left floating.

NOTE

The RESET pin is pulled down for at least 10ms.

2.7 UART Interface

UART can provide the developers signal or message outputs.SIM68AT includes three UART interfaces.
UART0 interface for serial communication, and this UART support NMEA output and PAIR command input.
UART1 interface is System LOG.
UART2 interface is the RTCM format data input used for RTCM function.

Table 6: Host port multiplexed function pins

Pin name	Pin number	I/O	Description	Comment
TXD2	18	O	RTCM function and NMEA	2.8V power domain. If unused, keep open.
RXD2	19	I		
TXD0	20	O	Serial data output of NMEA	2.8V power domain
RXD0	21	I	Serial data input for firmware update	
TXD1	16	O	System LOG output/ input	2.8V power domain. If unused, keep open.
RXD1	17	I		

NOTE

The default baud rate is 115200, if other baud rate required please contact SIMCom.

The following figure shows the connection between module and client (DTE).

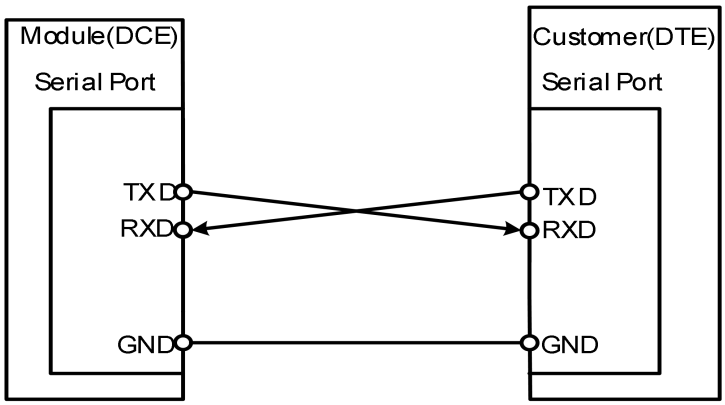

Figure 7: Connection of the serial interfaces

2.8 I2C Interface*

The SCL and SDA can be connected to an external I2C interface EEPROM up to 1 Mbits for reading and writing data into EEPROM. This can be used to store configurations permanently.

Table 7: I2C function pin

Pin name	Pin number	I/O	Description	Comment
SCL	1	I	Inertial navigation vehicle speed pulse Inertial navigation speed forward and backward direction	2.8V power domain, If unused, keep open.
SDA	2	I		

NOTE

1. “*” means under development.
2. The EEPROM and flash can’t be supported synchronously
3. The function under development, if Function required please contact SIMCom.
4. A 2.2K resistor needs to be pulled up outside the module.

2.9 Inertial Navigation Function*

NOTE

1. “*” means under development.

2.10 Timemark Output

The TIMEMARK pin outputs pulse-per-second (PPS) pulse signal for precise timing purposes after the position has been fixed. The TIMEMARK signal can be provided through designated output pin for many external applications. This pulse is not only limited to be active every second but also allowed to set the required duration, frequency, and active high/low by programming user-defined settings.

PPS GPS time reference with adjustable duty cycle and +/- 10ns accuracy, support for time service application, which is achieved by the PPS vs NMEA feature.

The following figure is the typical application of the TIMEMARK function.

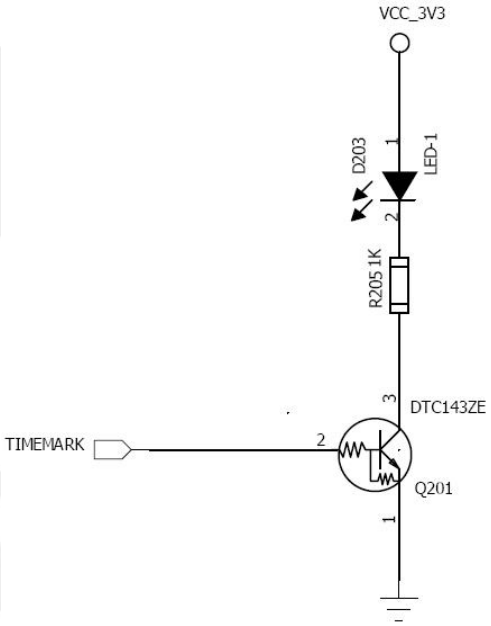

Figure 8: TIMEMARK application circuit

2.11 A-GPS

A-GPS is the meaning of assisted GPS, which is a system that can under certain conditions improve the startup performance, or time-to-first-fix (TTFF) of a GPS satellite-based positioning system. SIM68AT module supports EPO file, EASY mode, SBAS and RTCM.

2.11.1 EPO

The SIM68AT supports the EPO (Extended Prediction Orbit) data service. The EPO data service is supporting 7/14/30-day orbit predictions to customers. It needs occasional download from EPO server. Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status and an optional time synchronization signal will reduce time to first fix significantly.

The user should update the EPO files from the EPO server in the period of validity of EPO file through the internet. Then the EPO data should send to the SIM68AT by the HOST side. SIM68AT has the shorter cold TTFF and warm TTFF, when the A-GPS is used.

NOTE

For more information about EPO, please contact SIMCom.

2.11.2 EASY Mode

EASY is the abbreviation of Embedded Assist System, it works as embedded software which accelerates TTFF by predicting satellite navigation messages from received ephemeris.

No additional computing interval for EASY task. EASY is efficiently scheduled and computed in free time of every second after GPS navigation solution.

Easy function is conceptually designed to automatically engage for predicting after first receiving the broadcast ephemeris. After a while （generally tens of seconds）, 3-day extensions will be completely generated then all EASY functions will be maintained at a standby condition. EASY assistance is going to be engaged when the GPS requests in new TTFF condition or re-generates again with another new received ephemeris. Meanwhile, TTFF will be benefited by EASY assistance.

NOTE

EASY function is default open and can be closed by PAIR command.

2.11.3 SBAS and RTCM

3.7.3.1 SBAS

SBAS is the abbreviation of Satellite Based Augmentation System. The SBAS concept is based on the transmission of differential corrections and integrity messages for navigation satellites that are within sight of a network of reference stations deployed across an entire continent. SBAS messages are broadcast via geostationary satellites able to cover vast areas.

Several countries have implemented their own satellite-based augmentation system. Europe has the European Geostationary Navigation Overlay Service (EGNOS) which covers Western Europe and beyond. The USA has its Wide Area Augmentation System (WAAS). Japan is covered by its Multi-functional Satellite Augmentation System (MSAS). India has launched its own SBAS program named GPS and GEO Augmented Navigation (GAGAN) to cover the Indian subcontinent.

3.7.3.2 RTC Mode

SIM68AT module supports soft RTCM, but only one mode can be applied at one time, and SBAS is the default feature, customers who want to apply RTCM in the design can contact SIMCom for supporting.

2.12 Antenna

The antenna is the most critical item for successful GPS/GLONASS/BEIDOU reception in a weak signal environment. Proper choice and placement of the antenna will ensure that satellites at all elevations can be seen, and therefore, accurate fix measurements are obtained.

It is recommended to use an active GPS/GLONASS/BEIDOU antenna. In a typical application, SIM68AT with an active antenna can get a tracking sensitivity about 3dB better than SIM68AT with a passive antenna.

2.12.1 Antenna Interface

The SIM68AT receives L1 and L5 band signals from GPS/GLONASS/BEIDOU satellites, The RF signal is connected to the RF_IN pin. And the trace from RF_IN to antenna should be controlled to 50Ω impendence.

To suit the physical design of individual applications the RF interface pad can lead to two alternatives:

- Recommended approach: solderable RF coaxial cable assembly antenna connector, such as HRS' U.FL-R-SMT (10) connector or I-PEX's 20279-001E-01 RF connector.
- SMA connector.

2.12.2 Antenna Choice Consideration

To obtain excellent GNSS reception performance, a good antenna will always be required. Proper choice and placement of the antenna will ensure that satellites at all elevations can be seen, and therefore, accurate fix measurements are obtained.

- The total noise figure should be well below 3 dB.
- If a patch antenna is the preferred antenna, choose a patch of at least 15x15x4 mm for standalone.
- GPS/QZSS, or choose a patch of at least 25x25x4 mm for GPS + GLONASS. For smaller antennas, an LNA with a noise figure <2 dB is recommended.
- Make sure the antenna is not located close to noisy parts of the circuitry (e.g. micro-controller or High Power or display).
- To optimize performance in environments with out-of-band jamming sources, use an additional SAW filter.
- The micro strip must be 50 Ω and be routed in a section of the PCB where minimal interference from noise sources can be expected.
- In case of a multi-layer PCB, use the thickness of the dielectric between the signal and the first GND

layer (typically the 2nd layer) for the micro strip calculation.

- If the distance between the micro strip and the adjacent GND area (on the same layer) does not exceed 5 times the track width of the micro strip.
- Use an external LNA if your design does not include an active antenna when optimal performance is important.

The following table shows GNSS Operating frequencies

Table 8: GNSS Operating frequencies

Type	Frequecy
GPS L1	1575.42±1.023MHz
GLONASS G1	1601.7±6.75MHz
Galileo E1	1575.42±1.023MHz
BeiDou B1I	1561.098±2.046MHz
GPS L5	1176.45±10.23MHz
BeiDou B2a	1176.45±10.23MHz
Galileo E5a	1176.45±10.23MHz

The suggested active antenna should be chosen as following:

Table 9: Antenna Specifications

	Specification	Passive and active antenna
Active Antenna Recommendations	Frequency range L1 Frequency range L5	1560～1609MHz 1166～1187MHz
	Polarization	RHCP
	Gain	>20dB (max 50 dB)
	Noise Figure	<1.5 dB

2.12.2.1 Passive Antenna

Passive antenna contains only the radiating element, e.g. the ceramic patch, the helix structure, and chip antennas. Sometimes it also contains a passive matching network to match the electrical connection to 50 Ohms impedance.

The most common antenna type for GPS/GLONASS/BEIDOU application is the patch antenna. Patch antennas are flat, generally have a ceramic and metal body and are mounted on a metal base plate.

Figure 6 shows a minimal setup for a GPS/GLONASS/BEIDOU receiver with SIM68AT module.

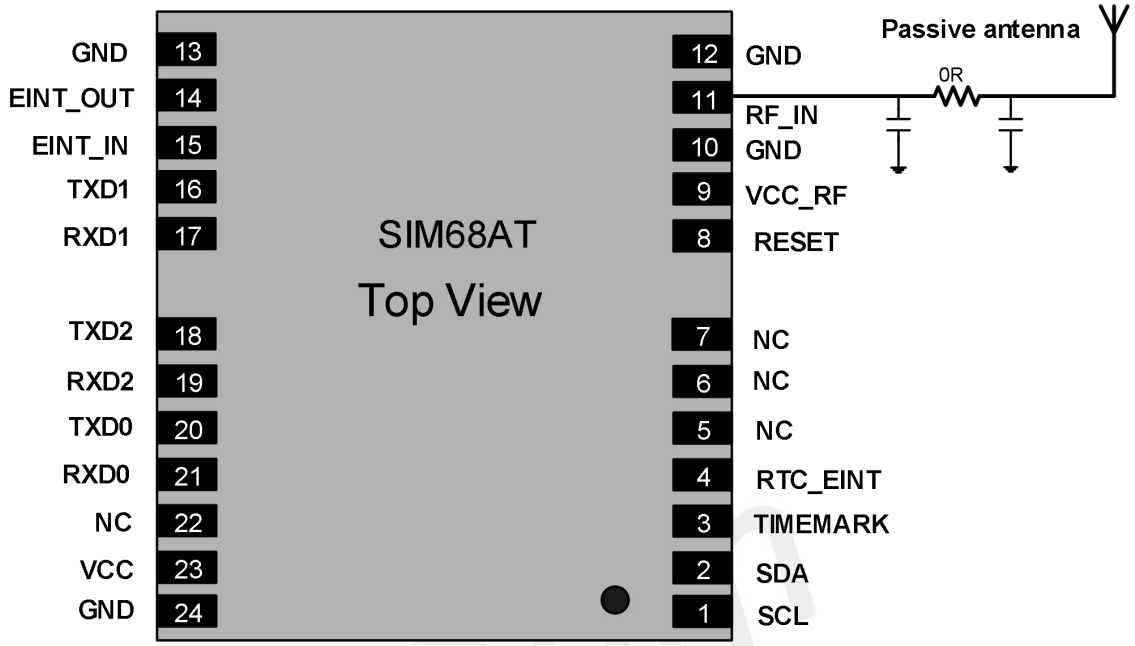

Figure 9: SIM68AT passive antenna design

For better performance with passive antenna designs user can use an external LNA to increase the sensitivity up 3~4 dB. Please see Figure 9.

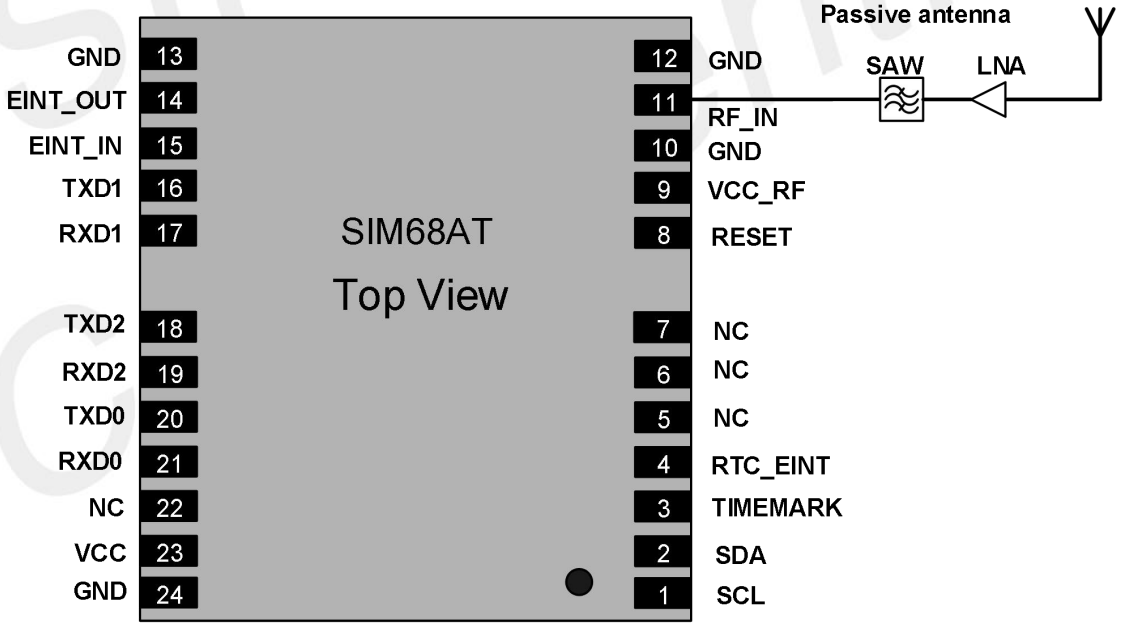

Figure 10: SIM68AT passive antenna design (with external LNA and SAW)

For best performance, user can add an external saw based on Figure10 design to avoid interference, please see Figure 11.

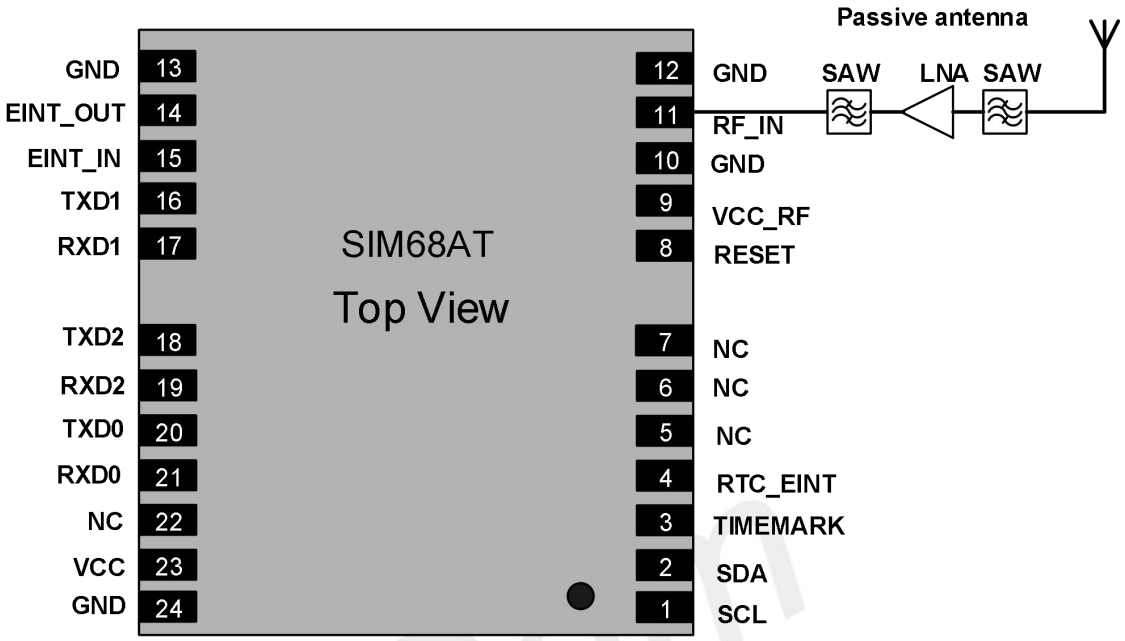

Figure 11: SIM68AT passive antenna design

2.12.2.2 Active Antenna

Active antenna has an integrated Low-Noise Amplifier (LNA). Active antenna needs a power supply that will contribute to GNSS system power consumption.

Usually, the supply voltage is fed to the antenna through the coaxial RF cable shown as Figure 10. The output voltage of PIN 9 is 2.8V. If the supply voltage of active antenna is 2.8V, PIN 9 VCC_RF can be connected to RF_IN as figure 9 shows. If the active antenna is not 2.8V, other power should be connected to RF_IN.

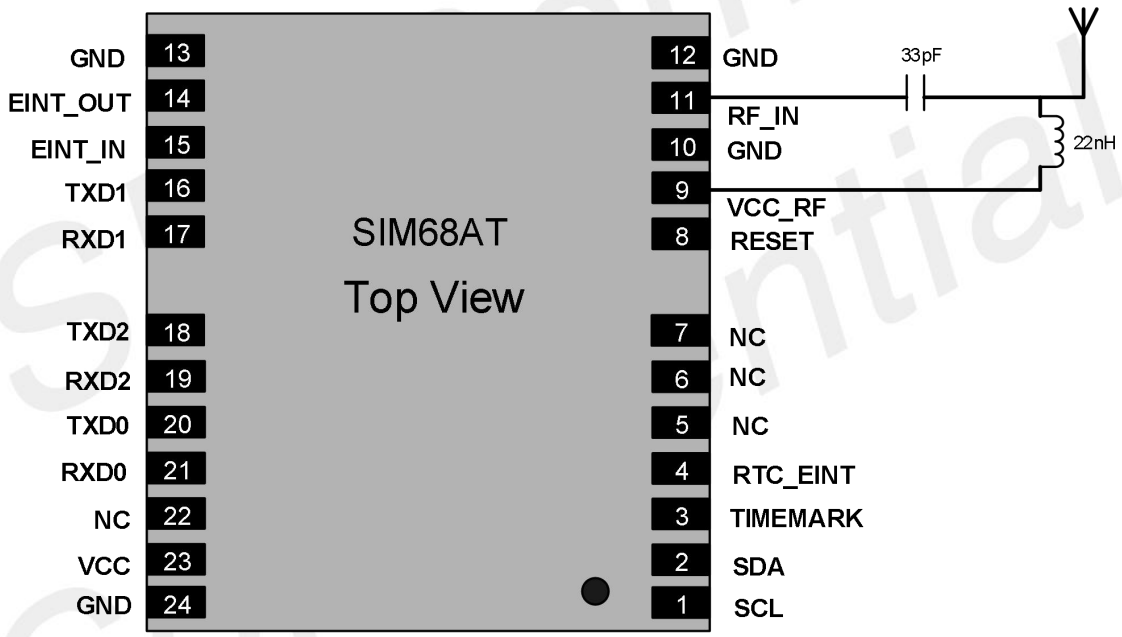

Figure 12: SIM68AT active antenna design

If the customer's design is for automotive applications, then an active antenna can be used and located on top of the car in order to guarantee the best signal quality.

GNSS antenna choice should base on the designing product and other conditions. For detailed Antenna designing consideration, please refer to related antenna vendor's design recommendation. The antenna vendor will offer further technical support and tune their antenna characteristic to achieve successful GNSS reception performance depending on the customer's design.

3 Electrical Characteristics

3.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 8 are stress ratings under non-operating conditions. Stresses beyond any of these limits will cause permanent damage to SIM68AT.

Table 10: Absolute maximum ratings

Parameter	Min	Max	Unit
VCC	-	5.5	V
RF_IN	-	3.6	V
I/O pin voltage	-	3.1	V
Operation temperature	-40	+85	℃
Storage temperature	-55	+125	℃

NOTE

The absolute maximum rating of RF_IN please reference to the active antenna datasheet

3.2 Recommended Operating Conditions

Table 11: SIM68AT operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operation temperature range		-40	+25	+85	℃
Main supply voltage	VCC	2.8	3.3	4.3	V
Active antenna supply voltage output	VCC_RF	2.7	2.8	2.9	V
	Imax		10		mA

Table 12: SIM68AT standard IO features

Parameter	Symbol	Min	Typ	Max	Unit
Low level output voltage Test conditions IOL = 2mA and 4.0mA@2.8V	V_{ol}	-0.3		0.35	V
High level output voltage Test conditions IOL = 2mA and 4.0mA@2.8V	V_{oh}	2.1		3.1	V
Low level input voltage@2.8V	V_{il}	-0.3		0.7	V
High level input voltage@2.8V	V_{ih}	1.75		3.1	V
Low level output voltage Test conditions IOL = 2mA and 4.0mA@1.8V	V_{ol}	-0.3		0.45	V
High level output voltage Test conditions IOL = 2mA and 4.0mA@1.8V	V_{oh}	1.35		1.98	V
Low level input voltage@1.8V	V_{il}	-0.3		0.63	V
High level input voltage@1.8V	V_{ih}	1.17		1.98	V
Input pull-up resistance	RPU	40	75	190	KΩ
Input pull-down resistance	RPD	40	75	190	KΩ
Input capacitance	Cin		5		pF
Load capacitance	Cload			8	pF
Tri-state leakage current	IOZ	-10		10	uA

3.3 Electro-Static Discharge

The GPS engine is not protected against Electrostatic Discharge (ESD) in general. Therefore, it is subject to ESD handing precautions that typically apply to ESD sensitive components. Proper ESD handing and packaging procedures must be applied throughout the processing, handing and operation of any application using a SIM68AT module.

Table 13: The ESD characteristics (Temperature: 25℃, Humidity: 45 %)

Pin	Contact discharge	Air discharge
VCC	± 4 kV	± 8 kV
GND	± 4 kV	± 8 kV
VCC_RF	± 4 kV	± 8 kV
RF_IN	± 4 kV	± 8 kV

NOTE

Test conditions:

1. The external of the module has surge protection diodes and ESD protection diodes.
2. The data in Table 13 were tested using SIMCom EVB.

4 Manufacturing

4.1 Top and Bottom View of SIM68AT

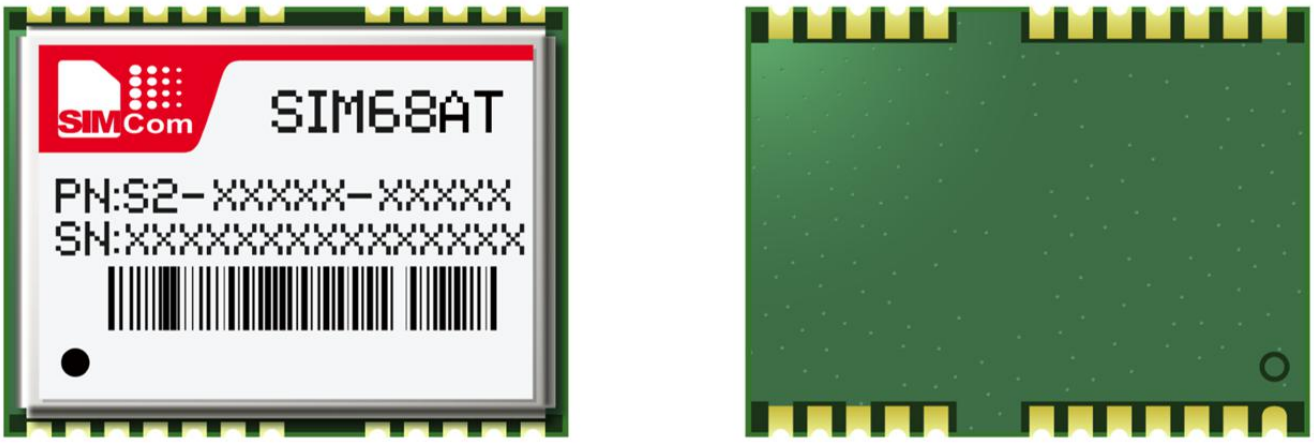

Figure 13: Top and bottom view of SIM68AT

NOTE

The above is the design effect diagram of the module for reference. The actual appearance is subject to the actual product.

4.2 Label Information

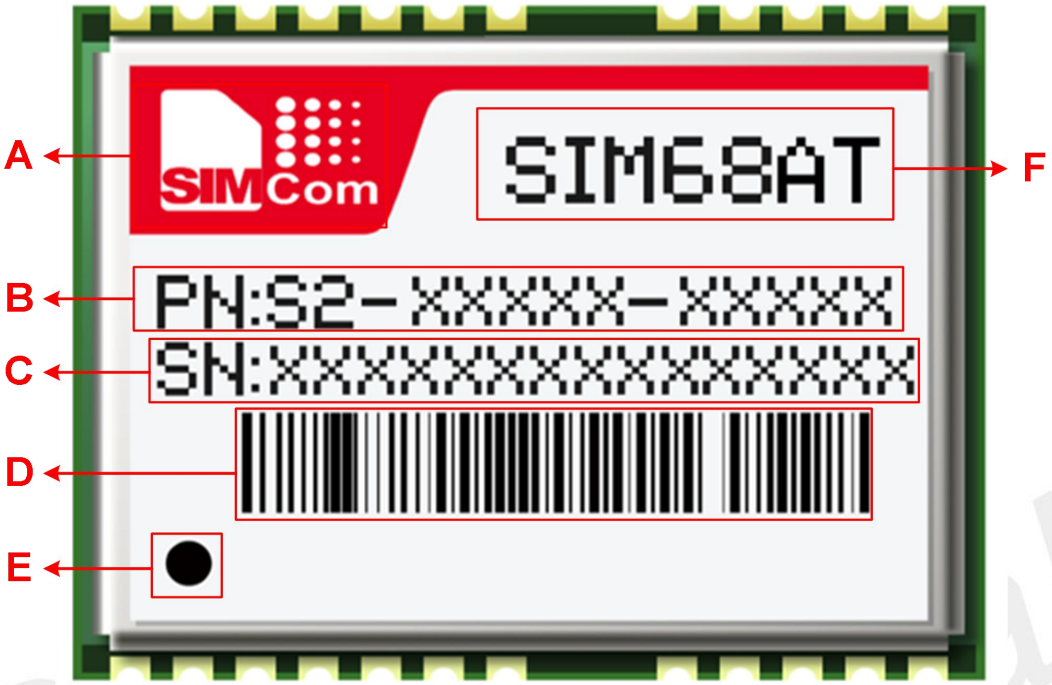

Figure 14: Label of SIM68AT

Table 14: illustration of module information

Item	Description
A	Logo of SIMCom
B	Module part number Hardware number included; ex.S2-10990 is hardware number
C	Module serial number The first number stands for factory code; The second number stands for year code; The third to eighth numbers is the SN number in hexadecimal numeric; The last two numbers stands for MNEA sentence baud rate, “11” stands for 115200, “96” stands for 9600;
D	Module bar code Stands for the first 6 numbers of SN number
E	PIN 1 Mark
F	Module name

4.3 Recommended PCB Footprint

The following figure shows the PCB footprint of SIM68AT.

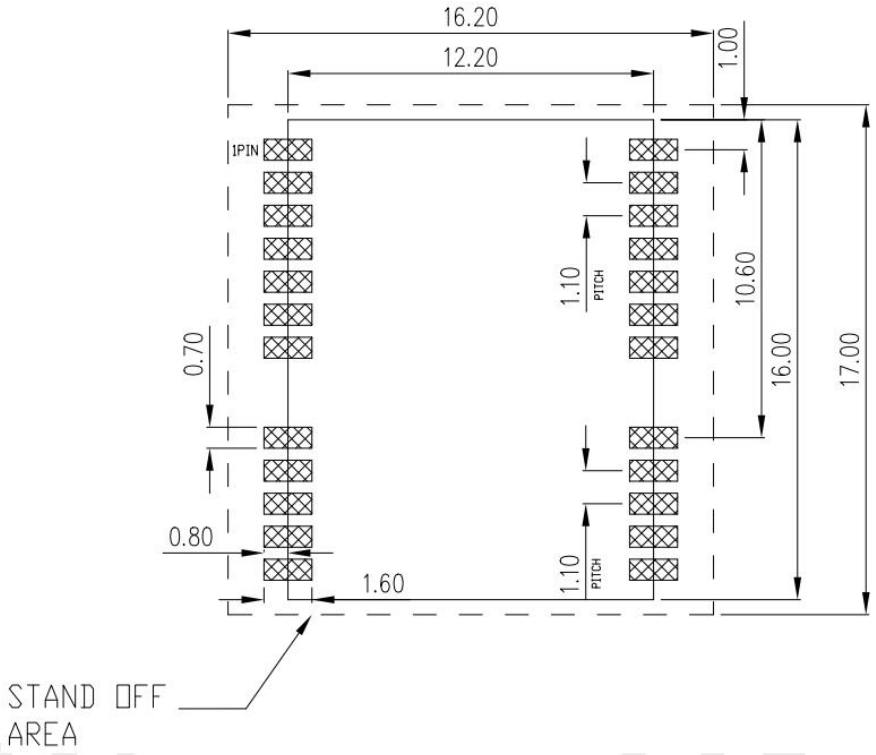

Figure 15: Recommended PCB footprint

4.4 Recommended SMT Stencil

The following figure shows the SMT stencil of SIM68AT.

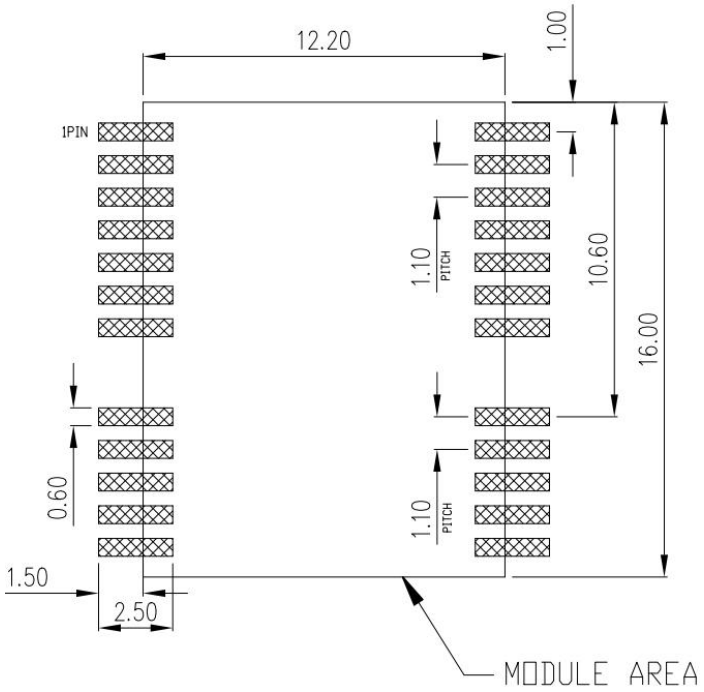

Figure 16: Recommended SMT stencil

4.5 Assembly and Soldering

The SIM68AT module is intended for SMT assembly and soldering in a Pb-free reflow process on the top side of the PCB. Suggested solder paste stencil height is 150um minimum to ensure sufficient solder volume. If required paste mask pad openings can be increased to ensure proper soldering and solder wetting over pads.

The following figure is the Ramp-Soak-Spike Reflow Profile of SIM68AT:

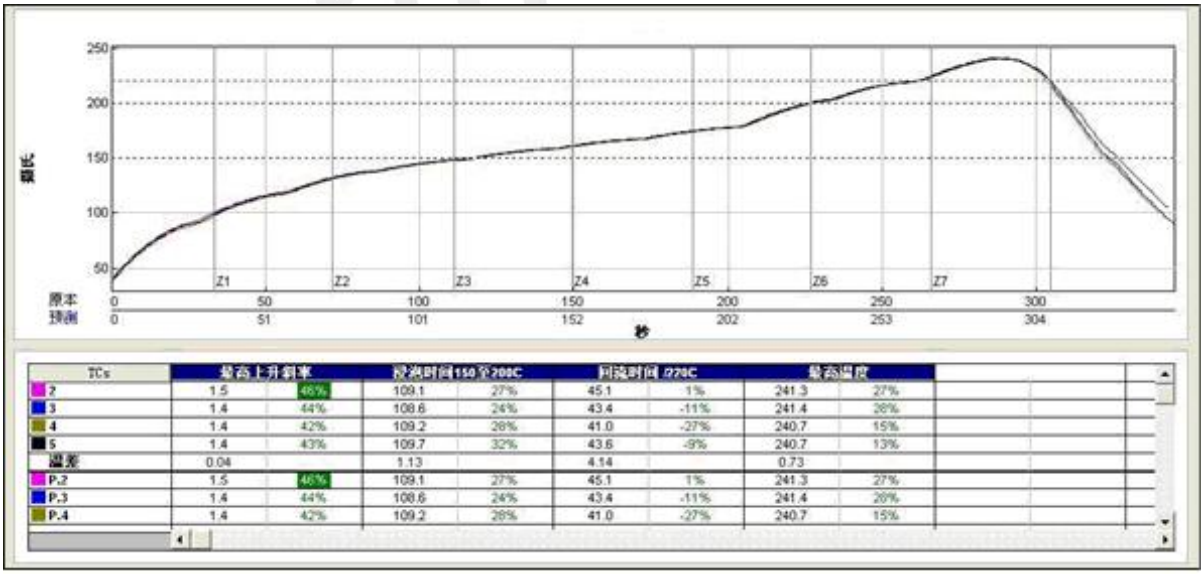

Figure 17: The Ramp-Soak-Spike reflow profile of SIM68AT

SIM68AT is Moisture Sensitive Devices (MSD), appropriate MSD handling instruction and precautions are summarized in Chapter 6.3.

SIM68AT modules are also Electrostatic Sensitive Devices (ESD), handling SIM68AT modules without proper ESD protection may destroy or damage them permanently.

Avoid ultrasonic exposure due to internal crystal and SAW components.

4.6 Moisture Sensitivity

SIM68AT module is moisture sensitive at MSL level 3, dry packed according to IPC/JEDEC specification J-STD-020C. The calculated shelf life for dry packed SMD packages is a minimum of 12 months from the bag seal date, when stored in a non condensing atmospheric environment of <40°C/90% RH.

Table 13 lists floor life for different MSL levels in the IPC/JDEC specification:

Table 15: Moisture Classification Level and Floor Life

Level	Floor Life(out of bag)at factory ambient≦+30℃/60%RH or as stated
1	Unlimited at ≦+30℃/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Mandatory bake before use. After bake, module must be reflowed within the time limit specified on the label.

Factory floor life is 1 week for MSL 3, SIM68AT must be processed and soldered within the time. If this time is exceeded, or the humidity indicator card in the sealed package indicates that they have been exposed to moisture, the devices need to be pre-baked before the reflow solder process.

Both encapsulate and substrate materials absorb moisture. IPC/JEDEC specification J-STD-020 must be observed to prevent cracking and delamination associated with the "popcorn" effect during reflow soldering. The popcorn effect can be described as miniature explosions of evaporating moisture. Baking before processing is required in the following cases:

- Humidity indicator card: At least one circular indicator is no longer blue
- Floor life or environmental requirements after opening the seal have been exceeded, e.g. exposure to excessive seasonal humidity.

Refer to Section 4 of IPC/JEDEC J-STD-033 for recommended baking procedures.

NOTE

Oxidation Risk: Baking SMD packages may cause oxidation and/or inter metallic growth of the terminations, which if excessive can result in solder ability problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solder ability considerations. The cumulative bake time at a temperature greater than 90°C and up to 125°C shall not exceed 96 hours.

4.7 ESD Handling Precautions

SIM68AT modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling!

Failure to observe these precautions can result in severe damage to the GPS receiver!

GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

Unless there is a galvanic coupling between the local GND (i.e. the work Table) and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.
Before mounting an antenna patch, connect ground of the device

When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10pF, coax cable ~50-80pF/m, soldering iron,)
To prevent electrostatic discharge through the RF input, do not touch the mounted patch antenna.

When soldering RF connectors and patch antennas to the receiver's RF pin, the user must make sure to use an ESD safe soldering iron (tip).

4.8 Shipment

SIM68AT is designed and packaged to be processed in an automatic assembly line, and it is now packaged in SIM68AT tray.

5 Packaging

SIM68AT module supports tray packaging. The packaging process is shown in the following figures.

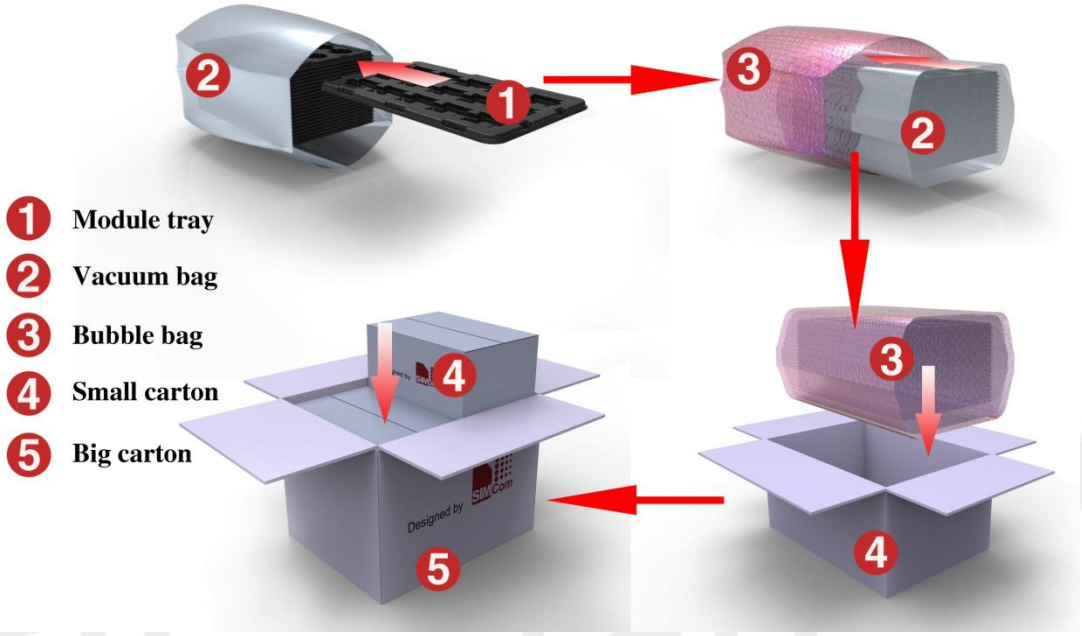

Figure 18: Packaging process

Module tray drawing:

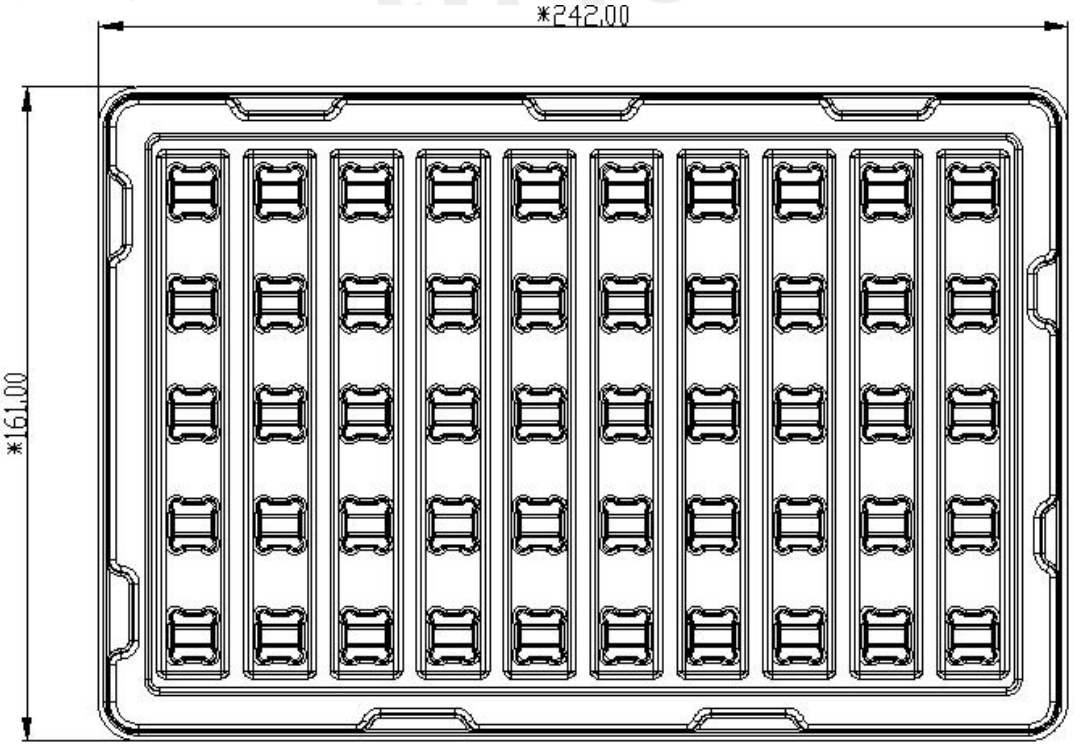

Figure 19: Module tray drawing

Table 16: Tray size

Length（±3mm）	Width（±3mm）	Number
242.0	161.0	50

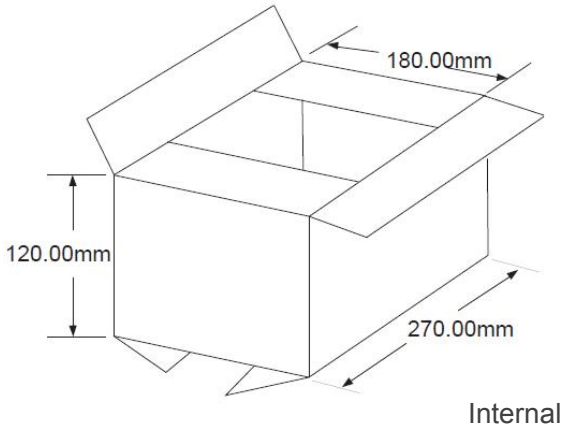

Figure 20: Small carton drawing

Table 17: Small carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Number
270	180	120	50*20=1000

Big carton drawing：

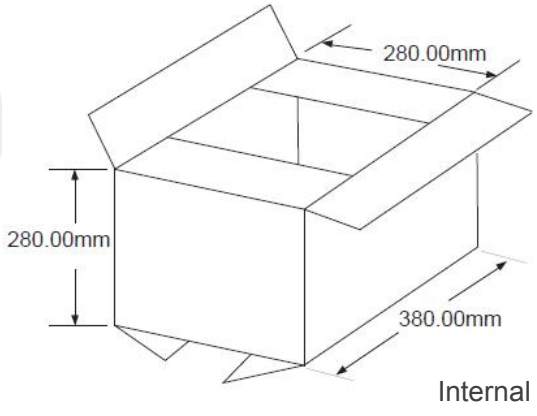

Figure 21: Big carton drawing

Table 18: Big carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Number
380	280	280	1000*4=4000

6 Reference Design

Following figure is the typical application of SIM68AT with active antenna which supplied by VCC_RF. If customer applies other kind of active antenna, keep PIN 9 floating and connect other voltage to the R8.

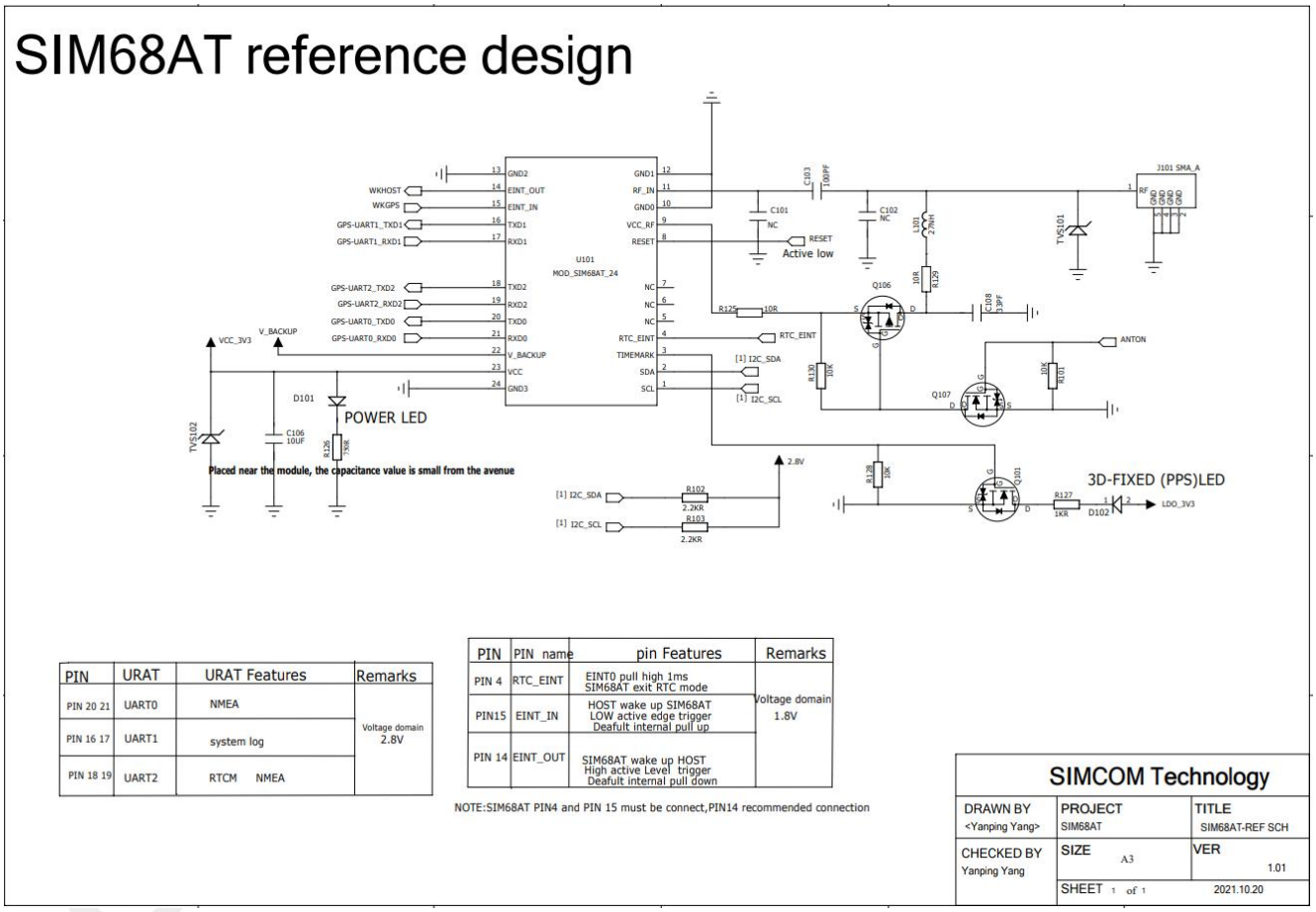

Figure 22: Refer schematic

NOTE

1、 GPIOs of SIM68AT are 2.8V and 1.8V CMOS voltage level; attentions should be paid if the voltage level of the host controller not compatible.

7 Appendix

7.1 Related Documents

Table 19: Related documents

SN	Document name	Remark
[1]	SIM68 Series_NMEA Message_User Guide	
[2]	SIM68AT REFERENCE DESIGN	

7.2 Terms and Abbreviations

Table 20: Terms and abbreviations

Abbreviation	Description
A-GPS	Assisted- Global Positioning System
CMOS	Complementary Metal Oxide Semiconductor
DGPS	Difference Global Positioning System
EASY	Embedded Assist System
EEPROM	Electrically Erasable Programmable Read Only Memory
EGNOS	Euro Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Sensitive Devices
FSM	Finite State Machine
GAGAN	The GPS Aided Geo Augmented Navigation
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
I/O	Input/Output
IC	Integrated Circuit
Inorm	Normal Current
Imax	Maximum Load Current
kbps	Kilo bits per second
LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation
MSL	moisture sensitive level
NMEA	National Marine Electronics Association

QZSS	Quasi-Zenith Satellites System
RTCM	Radio Technical Commission for Maritime Services
SBAS	Satellite Based Augmentation Systems
WAAS	Wide Area Augmentation System

7.3 Safety Caution

Table 21: Safety caution

Marks	Requirements
	When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive and not operate normally due to RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forgetting to think much of these instructions may impact the flight safety, or offend local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.
	Mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, especially with a mobile fee or an invalid (U)SIM card. While you are in this condition and need emergent help, please remember to use emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call. Also, some networks require that a valid (U)SIM card be properly inserted in the cellular terminal or mobile.