SIM66D
Hardware Design

GNSS Module

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Version History

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1 Introduction

This document describes the hardware interface of the module, which can help customers quickly understand the interface definition, electrical performance and structure size of the module. With this document and other application documents, customers can understand and use SIM66D module to quickly design and develop applications.

SIMCom provides a set of evaluation boards to facilitate module testing and use. The evaluation board tools include an EVB board, a USB cable, an antenna, and other peripherals

1.1 Documentation Overview

Technical information for the module is primarily covered by the documents listed in Table 1. All documents must be studied for a thorough understanding of the device and its applications.

Table 1: Documentation Overview

SN	Document Name	Remark
[1]	SIM66D_Hardware_Design_V1.00(this document)	It mainly introduces hardware components such as interface functions, recommended circuits, PCB layout guides, packaging, and software instructions
[2]	8AE000-SIM66D_V1.01_REFDL	SIM66D reference design
[3]	SIM68D_EVB_User Guide	SIM66D and SIM68D are compatible with one EVB and can be used in the same way
[4]	SIM68D_EVB SCH&PCB	SIM68D-EVB schematic and PCB PDF document
[5]	MOD_SIM66D_24 SCH&PCB	SIM66D module reference package
[6]	SIM66D Series_NMEA Message_User Guide_V1.00	The SIM66D series software instruction pole usage method is introduced in detail
[7]	Module Secondary SMT Process User Guide_V1.01	This paper mainly introduces the SMT p rocess of module production, the requir ements of steel mesh production, reflow welding, welding and repair

NOTE

This current revision is an early release to support initial product developers. The content is subject to change without advance notice.

1.2 Overview

SIM66D is a BDS/GPS/GLONASS/Galileo/QZSS dual-band multi-system centimeter-level RTK positioning module, which can simultaneously track BDS B1I/B1C*/B2a/B2b*, GPS L1/L5, GLONASS L1, Galileo E1/E5a, QZSS L1/L5 and other signal frequencies. Integrated double-precision floating-point processor and RTK-specific coprocessor, using advanced low-power process, can achieve 1Hz RTK positioning result output, providing more powerful satellite navigation signal processing capabilities. The module supports communication interfaces such as UART and I2C, which can meet the needs of users in different scenarios.

1.3 Key Features

SIM66D provides the following services:

- Supports simultaneous tracking of BDS B1I/B1C*/B2a/B2b*, GPS L1/L5,GLONASS L1, Galileo E1/E5a, QZSS L1/L5 signal frequencies
- Support dual-band multi-system on-chip RTK positioning solution, positioning accuracy up to 1cm+1ppm
- Ultra-low power, dual-band RTK module tracking power consumption as low as 40mW
- Small footprint: 16.0 x 12.2 x 2.4mm, 24-pin LCC package
- Support Jamming Removing (AIC)
- Independent tracking of satellite frequency and 60 dB narrowband anti-jamming technology
- Low-noise amplifier has been integrated (LNA)
- Max fixed update rate up to 10 HZ[1]
- Support AGNSS assisted positioning
- Pulse-per-second (PPS) GPS time reference
  1. Adjustable duty cycle
  2. Typical accuracy: +/- 20ns
- Interface
  1. One UART (UART0)
  2. One I2C
- Operating temperature: -40 ~ +85ºC

NOTE

Fixed update rate default is 1 HZ.

1.4 SIM66D Functional Diagram

The following figure shows a functional diagram of the SIM66D and illustrates the mainly functional parts:

- The main chip
- SAW filter
- Integrated LNA
- The antenna interface
- The communication interface
- The control signals

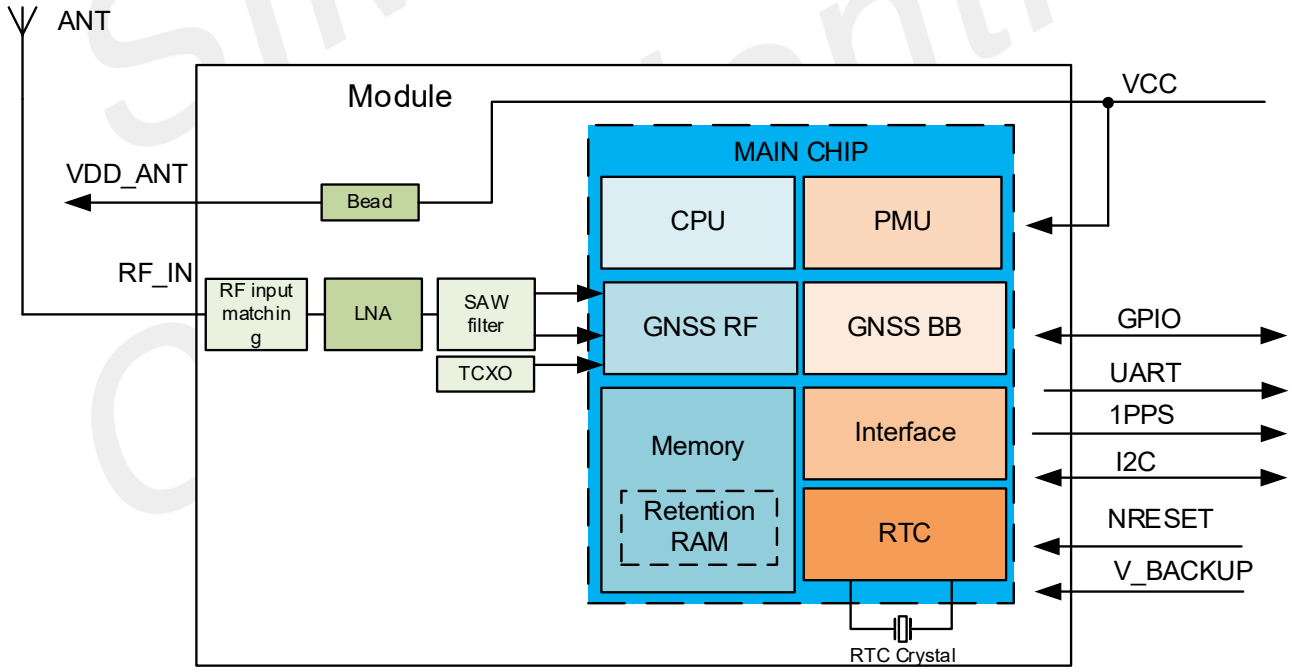


Figure 1: SIM66D functional diagram

1.5 GNSS Performance

Table 2: GNSS Performance

Parameter	Description	Performance			
		Min	Type	Max	Unit
Horizontal Position Accuracy	Automatic position[1]		1		m
	RTK Accuracy[2]		1		cm
Velocity Accuracy[3]			0.1		m/s
Timing Accuracy			20		nS
Dynamic Performance	Maximum Altitude			18000	m
	Maximum Velocity			500	m/s
	Maximum Acceleration			4	G
CN0[3](Carrier-to-Noise Density Ratio)	L1		41		dB
	L5		43		dB
TTFF with GPS（L1）and GLONASS and BEIDOU mode[3]	Hot start		1		S
	Warm start		23		S
	Cold start		24		S
A-GPS TTFF(EPO in flash mode)[3]	Cold start		3		S
Sensitivity with GPS（L1）and GLONASS and BEIDOU mode	Cold start		-149		dBm
	Re-acquisition		-157		dBm
	Tracking		-162		dBm
Receiver	Channels		96		
	Update rate	1		10	Hz
	Protocol	Support NMEA,ICOE			

NOTE

1. CEP50, 24hr static, -130dBm;
2. CEP50 at 33m/s;
3. GNSS signal level: -130dBm.

1.6 General features

Table 3: General features

Parameters	Value
Supply voltage VCC	+2.8V~+4.3V typical:3.3V
Supply voltage ripple VCC	50 mV(RMS) max @ f = 0~3MHz 15 mV(RMS) max @ f > 3 MHz
Storage temperature	-40ºC~+85ºC
Operating temperature	-40ºC~+85ºC
Host port	UART0
Other port	I2C
Serial port protocol (UART)	NMEA; 8 bits, no parity, 1 stop bit; 115200 baud (configurable)
TM 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

Table 4: General features

Pin voltage domain	Parameter	Description	Min	Typ	Max	Unit
DVDIO=3.3V I/O (V)	V_{IL}	Active low-level input	0	-	0.2*VCC	V
	V_{IH}	Active high-level input	0.7*VCC	-	VCC+0.2	V
	V_{OL}	Low-level output range	0	-	0.45	V
	V_{OH}	High-level output range	VCC-0.45	-	VCC	V
	R_{PU}	Internal pull-up resistor		10		kΩ
	R_{PD}	Internal pull-down resistor		-		
	I_{OL}	Low level output current V_{OL} = 0.45 V	4	-	-	mA
	I_{OH}	High level output current V_{OH} = 2.85 V	4	-	-	mA

1.7 Power consumption

Table 5: Consumption data (typical value)

Parameter	Description	Acquisition	Tracking	Unit
GPS+GLO+GAL+BD	@VCC=3.3V Passive ant under real network	12.5	11.1	mA
GPS+GLO+BD		12.2	10.9	mA
GPS+GAL+BD		11.3	10.2	mA
GPS+BD		10.4	9.9	mA
GPS		10.8	9	mA
BD		13.1	11.5	mA
GLO		9.3	8.6	mA

Table 6: Consumption data in PSM mode (typical value)

Mode	Description	Consumption	Unit
Idle	@VCC=3.3V, V_BACKUP=2.8V Passive ant under real network	2.8	mA
Sleep[1]		400	mA
Sleep[2]		880	mA
HD RTC		1.2	uA
SW RTC		Not support	mA

NOTE

For more information on how to enter PSM mode, please refer to Section 3.3.

1.8 GNSS operating frequency

SIM66D is a dual-band, multi-galaxy GNSS positioning module, which can receive and track multi-galaxy GNSS signals. The GNSS operating frequencies are shown in the following table:

Table 7: GNSS Operating frequencies

Type	Frequecy			
	Min	Typ	Max	Unit
GPS L1	1574.397	1575.42	1576.443	MHz
GPS L5	1166.22	1176.45	1186.68	MHz
GLONASS L1[1]	1594.95	1601.7	1608.45	MHz
Galileo E1	1574.397	1575.42	1576.443	MHz
Galileo E5a	1166.22	1176.45	1186.68	MHz
BeiDou B1I	1559.052	1561.098	1563.144	MHz
BeiDou B2a	1166.22	1176.45	1186.68	MHz

NOTE

GLONASS is not enabled by default, and GLONASS can be opened by command. Please refer to the SIM66D Series_NMEA Message_User Guide for specific instructions

1.9 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.

1.10 Firmware update

The module is shipped with firmware pre-installed. SIMCom may release firmware versions that contain bug fixes or performance optimizations, so it is important to implement a firmware upgrade mechanism in the client's system. A firmware upgrade is the process of transferring a binary image file to a receiver and storing it in flash. For details on firmware upgrades, refer to the firmware upgrade manual.

2 Package Information

2.1 Pin out Diagram

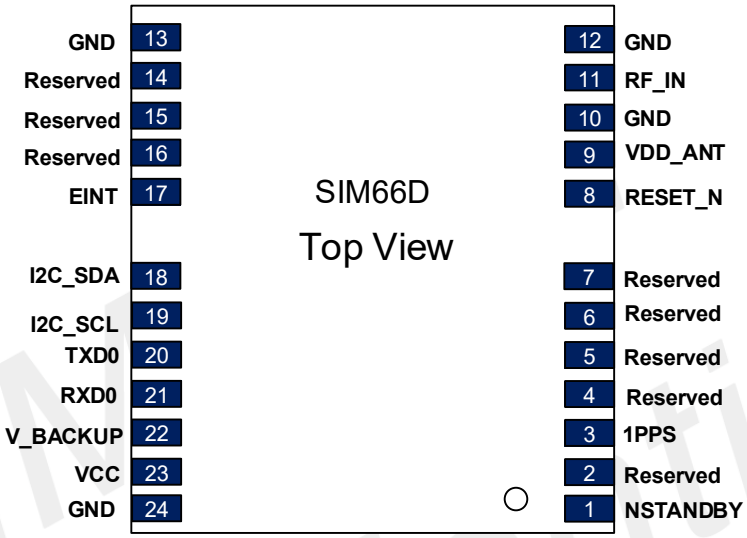


Figure 2: SIM66D Series pin diagram (Top view)

2.2 Pin Description

Table 8: I/O parameter definition

Type	Description
AI	Analog Input
AO	Analog Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
PI	Power Input
PO	Power Output
OD	Open-drain

Table 9: Pin description

Pin name	Pin No	I/O	Power Domain	Description	Comment
Power supply					
VCC	23	PI	2.8V~4.3V	Main power input, which will be used to power the baseband and RF section internally. Input voltage typical value is 3.3V The supply current requirement can reach 100mA.	Provide clean and stable power source to this pin. Add a 4.7uF capacitor to this pin for decoupling.
VDD_ANT	9	PO	-	Internal power output to power the active antenna The voltage is the same as the VCC pin of the module.	If unused, keep it open.
V_BACKUP	22	PI	1.7V~4.3V	The backup battery input power supply for RTC, the typical value is 3.3V	If a hot start and RTC are not required, then they can be connected to VCC.
GND	10, 12, 13, 24	-	-	Ground	GND
Communication interface					
TXD0	20	DO	3.3V	NMEA serial output/ input	If unused, keep it open.
RXD0	21	DI	3.3V		
I2C_SDA	18	OD	3.3V	I2C data input/output, slave mode, used for firmware loading and communication with the master	
I2C_SCL	19	OD	3.3V	I2C clock signal, slave mode, used for firmware loading and communication with the master	
System control					
RESET_N	8	DI, PU		Reset pin, active low, connected to the master GPIO or NC	Internal default pulls up. Support 3.3V input
NSTANDBY	1	PU	3.3V	Sleep control pin, default pull up	If unused, keep it open.
GPIOs					
1PPS	3	DO	3.3V	Outputs timing pulse related to receiver time	After successful positioning, the default output is 1Hz pulse. domain If unused, keep open.

EINT*	17	DI	3.3V	External interrupt input.	If unused, keep open.
Reserved	2, 4, 5, 6, 7, 14, 15, 16	-	-	Reserved pins	Keep the pins open. Do not connect to power supply or GND
RF interface					
RF_IN	11	AI	-	Radio antenna connection	Impendence must be controlled to 50Ω.

NOTE

‘ * ’ identifiers in this article indicate that the feature is under development and is not supported yet.

2.3 Machine Dimensions

Following figure shows the Mechanical dimensions of SIM66D Series (top view, side view and bottom view).

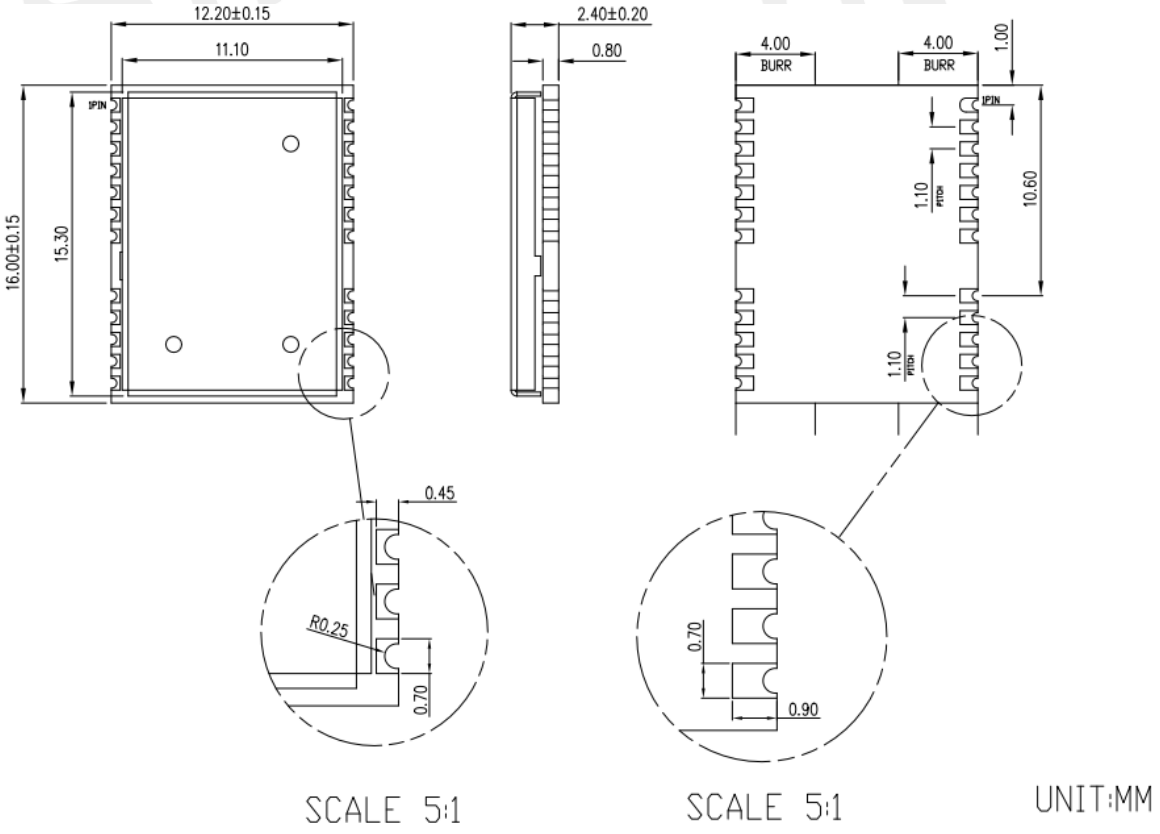


Figure 3: SIM66D mechanical dimensions (Unit: mm)

NOTE

Outline dimensional tolerances do not include burr areas.

3 Power Management

3.1 Power Input

3.1.1 VCC supply requirements

VCC is the power supply pin of the module, SIM66D power supply range: 2.8V~4.3V, typical value: 3.3V. The power supply should be able to provide sufficient current up to 100mA[1]. SIM66D positioning modules require a stable power supply, consider the following points:

- Wide power lines or even power planes are preferred.
- VCC supply needs to add a 4.7uF and 100nF multi-layer ceramic chip (MLCC) capacitors with low ESR in high frequency band.
- The ripple of the VCC supply cannot be higher than 50mV.
- VCC supply needs a TVS for ESD and surge protection.

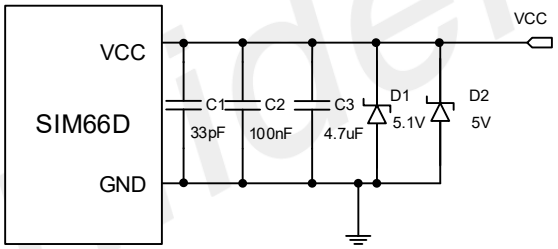


Figure 4: Power supply reference circuit

NOTE

Operating current: Due to the capacitor installed inside the product, a maximum of 80mA inrush current will be generated at the time of power-up. In the actual application scenario, it is necessary to evaluate and confirm the impact of voltage dips caused by inrush current on the system.

Table 10: 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	

3.1.2 Backup supply requirements

The V_BACKUP pin is backup power, and the power supply range is 1.7V~4.3V[1]. By using valid time and GNSS track data at start-up, the module enables hot start-up. When the module is turned on, the V_BACKUP should be connected to the power supply and maintain the power supply all the time; If RTC entry is required, disconnect the VCC power supply and keep the V_BACKUP backup power pin powered at all times.

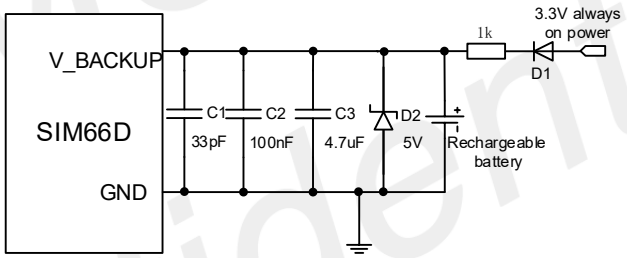


Figure 5: V_BACKUP input reference circuit

NOTE

1. The V_BACKUP voltage must not be lower than the minimum recommended operating voltage, otherwise the module may operate abnormally.
2. If a battery is connected, it is recommended to use a rechargeable battery, and please select the current limiting resistor according to the charging current requirements of the rechargeable battery.
3. If you don't need a hot start and RTC, you can connect the V_BACKUP with the VCC pin.

3.1.3 Power on

When power is first applied, SIM66D goes into operation mode. VCC should power up quickly within 50ms, and to ensure proper power-up sequencing, backup power should be started no later than VCC, so

V_BACKUP must be powered up before or at the same time as VCC. The module power-up and disconnection timing diagram is shown in Figure 6.

3.1.4 Power off

When the power supply of the module VCC is disconnected, the voltage should be guaranteed to drop rapidly within 50ms. In order to ensure that the power-on sequence is abnormal when the module is powered on next time it is powered on and restarted, ensure that the module VCC is powered down to less than 1V and maintained for at least 5s, and then perform power-on restart.

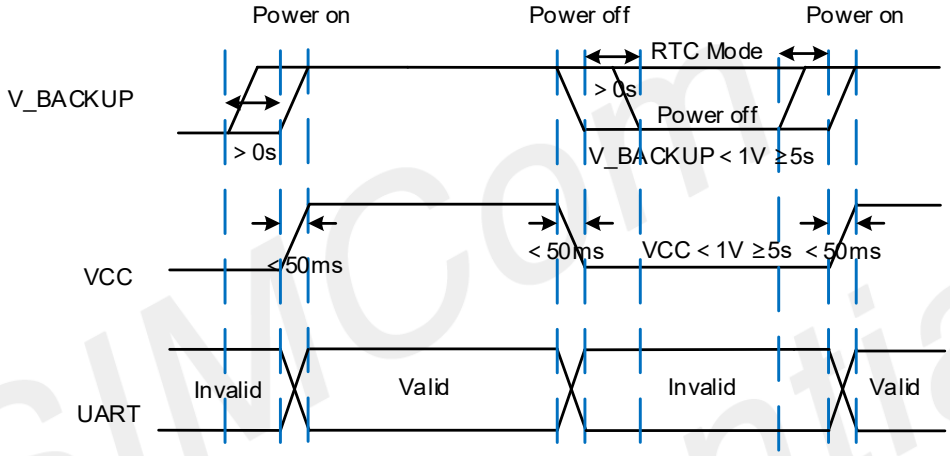


Figure 6: Timing sequence of module power-on and power-off

3.1.5 Verification of SIM66D Series Start

System activity indication depends upon the chosen serial interface:

When it is activated, SIM66D will output messages at the selected UART speed, and message types. The default baud rate is 115200bps.

3.2 Power output

VDD_ANT is a Power output pin for powering an active antenna. The output voltage is the same as the VCC pin voltage. For the detail usage of VDD_ANT, customer can refer to section 10 for details.

NOTE

VDD_ANT must be connected in series with a current limiting resistor of 10 ohm.

3.3 Operating Mode

Table 11: Power supply and clock state according to operation mode

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

3.3.1 Full on Mode

The power supply of each power supply of the model is normal, the model is operating normally, and the power supply of each power domain is configured by the firmware. All events, including external outages, communication requests, timing, and other events, can be handled normally. 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.

3.3.2 Idle Mode

The internal clock of the model is clock gating, and the model enters the low-power mode. The model can be exited via an internal RTC timing timeout or a peripheral interrupt input.

- Enter idle mode:
  Send ***$RESET,3,0 ; $CFGPOWER,2***;
- Exit idle mode
  Send ***$CFGPOWER,1 ; $RESET,0,0***

3.3.3 Sleep Mode

Sleep mode means a low quiescent 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. There

are two ways to get the module into and out of sleep mode.

- The first way
  1) Entering into sleep mode
  When the NSTANDBY pin is high (default high), send the command: ***$CFGPOWER,3,time*** (time is the wake-up time, the unit is seconds), the module will enter the sleep mode immediately after the command is entered.
  2) Exiting sleep mode
  Automatically exit the sleep mode when the time is up.

- The second way
  1) Entering into sleep mode
  When the NSTANDBY pin is pulled down, the command is sent: ***$CFGPOWER,5*** to enter sleep mode.
  2) Exiting sleep mode
  Pull up the NSTANDBY pin, and the module exits sleep mode.

NOTE

If you enter sleep mode in the second way, the current consumption will be twice as high as that of the first method.

3.3.4 RTC mode

The module provides lower power consumption than sleep mode and is suitable for applications that are idle for long periods of time or where power consumption is sensitive. In RTC mode, the module stops capturing and tracking satellite signals, and only the backup domain remains active, continuing to record time.

- Enter hardware RTC mode
  Disconnect the VCC separately and keep the V_BACKUP powered.
- Exit hardware RTC Mode
  Reconnect the VCC and module will exit RTC mode automaticly.

4 Application Interface

4.1 NSTANDBY Signal

NSTANDBY pin is used in conjunction with software commands to control the module to enter and exit sleep mode, this pin is pulled up to 3.3V by default.

4.2 1PPS

The 1PPS pin outputs pulse-per-second (PPS) pulse signal for precise timing purposes after the position has been fixed. The 1PPS 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 +/- 20ns accuracy, support for time service application, which is achieved by the PPS vs NMEA feature.

The following figure is the typical application of the 1PPS function.

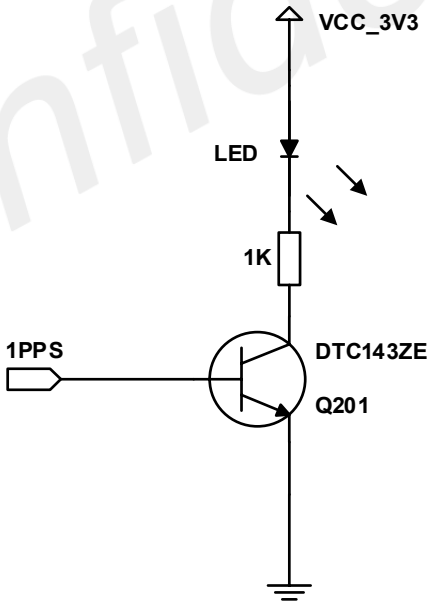


Figure 7: 1PPS application circuit

4.3 UART Interface

The module supports a UART interface. The default baud rate is 115,200bps, with a maximum support of 921,600bps, with adaptive baud rate or user configuration.

UART interface for serial communication, and this UART support NMEA output and PAIR command input. To support the firmware upgrade function, make sure the UART0 is connected to a PC or external processor.

Table 12: List of baud rate information

UART Interface	Supported baud rates(bps)	Default baud rates(bps)	Function Description
UART0	9600、115200、230400、460800、921600	115200	NMEA data, command input and output, and firmware updates

Table 13: UART interface definition

Pin name	Pin number	I/O	Description	Comment
TXD0	20	DO	Serial data output of NMEA	
RXD0	21	DI	Serial data input for firmware update	

NOTE

1. The default baud rate is 115200, if other baud rate required please contact SIMCom.
2. If the IO voltage of the MCU does not match the module, a level shifting circuit must be added.

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

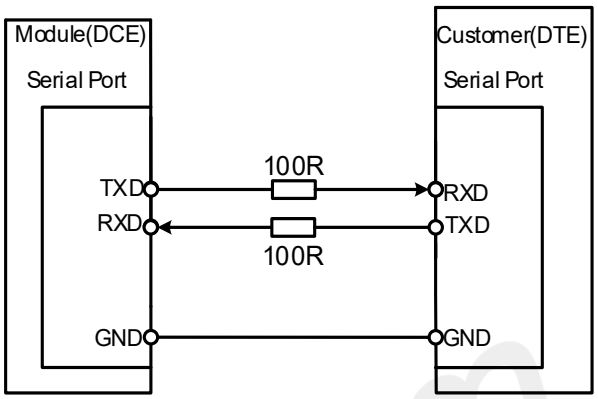


Figure 8: Connection of the serial interfaces

The following figure shows the use of triode for level shifter circuits, and attention shall be paid to the direction of the signal. The recommended triode model is MMBT3904.

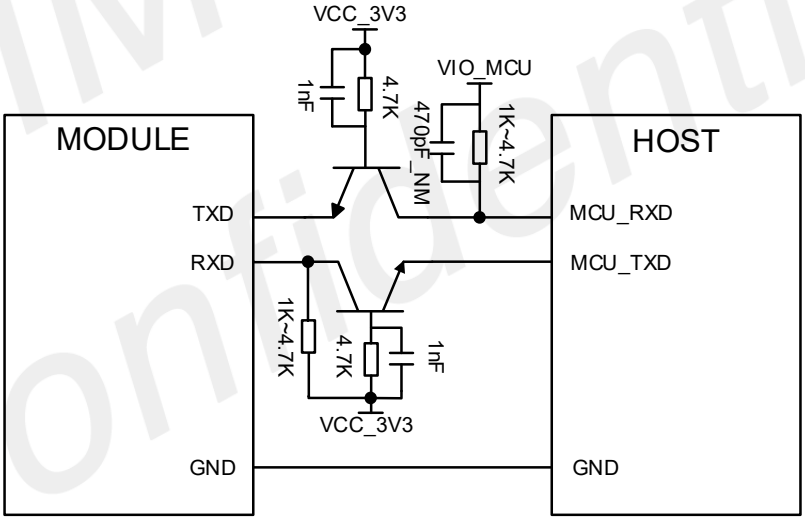


Figure 9: Triode level conversion circui

NOTE

The parasitic capacitance of the transistor will affect the edge of the high-speed digital signal. It is not recommended to use this circuit when the signal speed is higher than 115200bps.

4.4 I2C Interface*

SIM66D supports one I2C interface. It can be used for firmware loading and upgrading, as well as external devices. The protocol and electrical interface are compatible with 100kbps, 400kbps and 3.4Mbps

Table 14: I2C interface definition

Pin name	Pin number	I/O	Description	Comment
I2C_SDA	18	OD	I2C data input/output, slave mode, used for firmware loading and communication with the master	If unused, keep it open.
I2C_SCL	19	OD	I2C clock signal, slave mode, used for firmware loading and communication with the master	

The reference circuit is shown in the figure below:

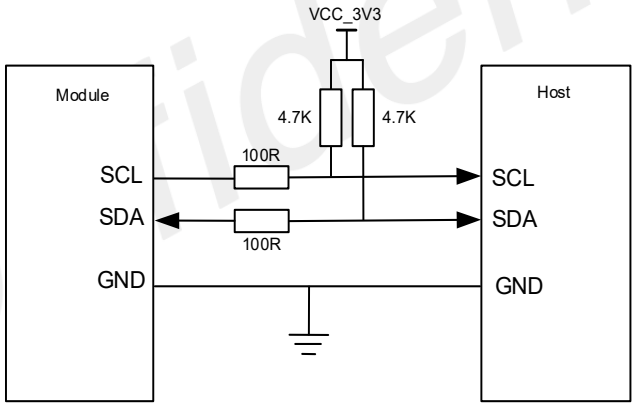


Figure 10: Connection of the i2c interfaces

NOTE

1. 4.7K resistor needs to be pulled up outside the module.
2. If the IO voltage of the MCU does not match the module, a level shifting circuit must be added.
3. ‘ * ’ identifiers in this article indicate that the feature is under development and is not supported yet.

4.5 RESET_N

Table 15: RESET_N interface definition

Pin name	Pin number	I/O	Description	Comment
RESET_N	8	DI	Module reset, low active	If unused, keep it open.

Input enable pin, pull this pin low for 10ms and then release it. This pin has been pulled up 10k resistors to 3.3V inside the module, eliminating the need to add pull-up resistors outside the module. The recommended circuit is as follows:

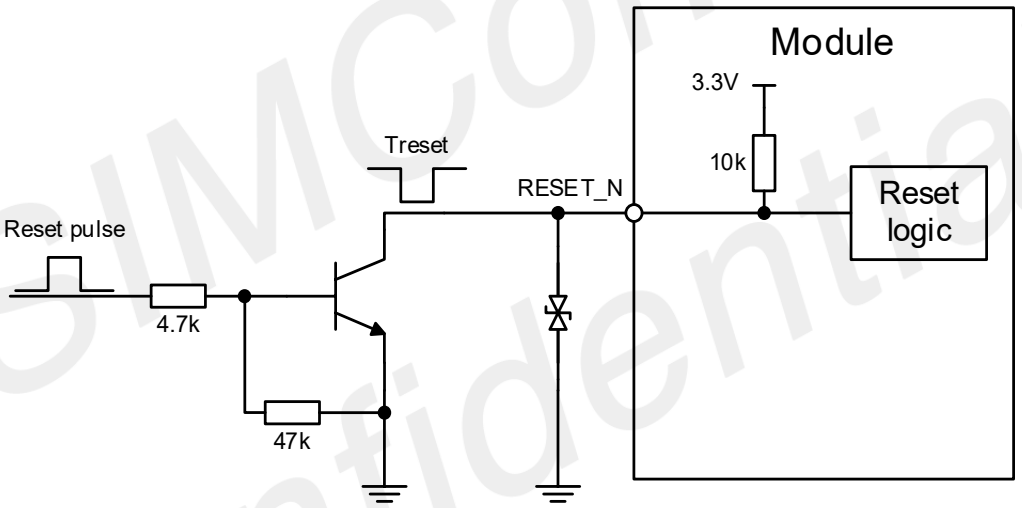


Figure 11: RESET_N recommended circuit

Table 16: RESET_N pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset}	Restart low pulse width	5	10	-	ms
V_{IH}	RESET pin input high level voltage	2.4	-	3.6	V
V_{IL}	RESET pin input low level voltage	0	0	0.9	V

5 Antenna

The antenna is the most critical item for successful GPS/GLONASS/BEIDOU/Galileo 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/Galileo antenna.

5.1 Antenna Interface

The SIM66D receives dual-band signals from GPS/BEIDOU/Galileo satellites, GLONASS is not enabled by default, and can be configured to all-satellite mode by commanding ***$CFGSYS, h15155***. 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.

5.2 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 suggested active antenna should be chosen as following:

Table 17: Antenna Specifications

Parameter	Specification	Passive and active antenna
Active Antenna Recommendations	Frequency range	L1: 1560～1609MHz L5: 1166～1187MHz
	Polarization	RHCP
	Gain	15~30dB
	Noise Figure	<1.5 dB

5.2.1 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/Galileo 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 12 shows a minimal setup for a GPS/GLONASS/BEIDOU/Galileo receiver with module.

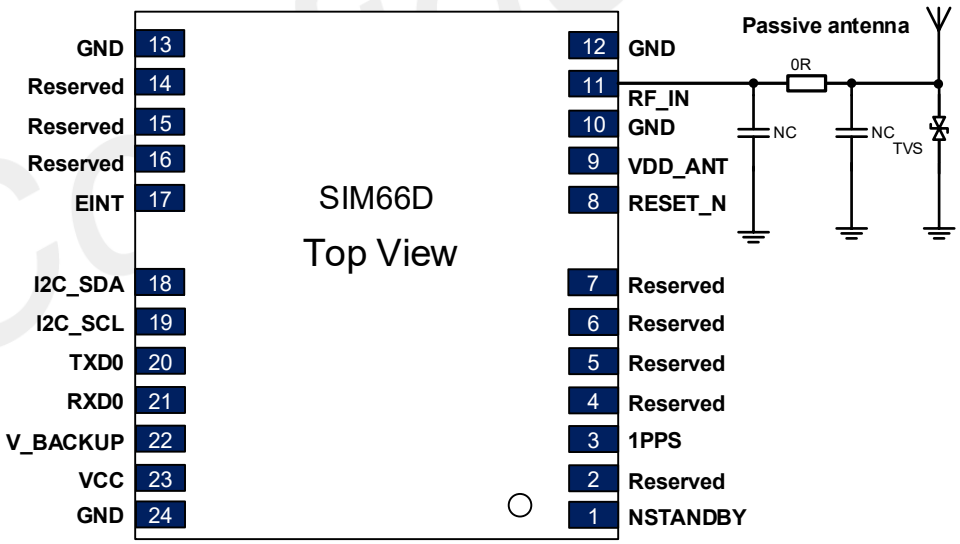


Figure 12: SIM66D passive antenna design

NOTE

TVS requires ultra-low junction capacitance, less than 0.3 pF is recommended.

Table 18: TVS recommended list

No	Vendor	Device	Clamping Voltage	Junction Capacitance	Package
1	Prisemi	PESDEC2XD5VBF	15V	0.15pF	DFN0603-2L
2	WAYON	WE05DGCF-B	20V	0.18pF	DFN0603-2L
3	WAYON	WE05DGCMS-BH	20V	0.15pF	DFN0603-2L
4	INPAQ	TVC5VB1SD-DFN0603-2L	4.7V	0.18pF	DFN0603-2L

For better performance with passive antenna designs user can use an antive antenna to increase the sensitivity up 3~4 dB. Please see Figure 13.

5.2.2 Active Antenna

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

Usually, the supply voltage is fed to the antenna through the coaxial RF cable shown as Figure 13. The output voltage of PIN9 is the same as the VCC output voltage of the module. If the output voltage of PIN9 meets the supply voltage of the active antenna, PIN 9 VDD_ANT can be connected to RF_IN as figure 16 shows. If the requirements are not met, other power should be connected to RF_IN.

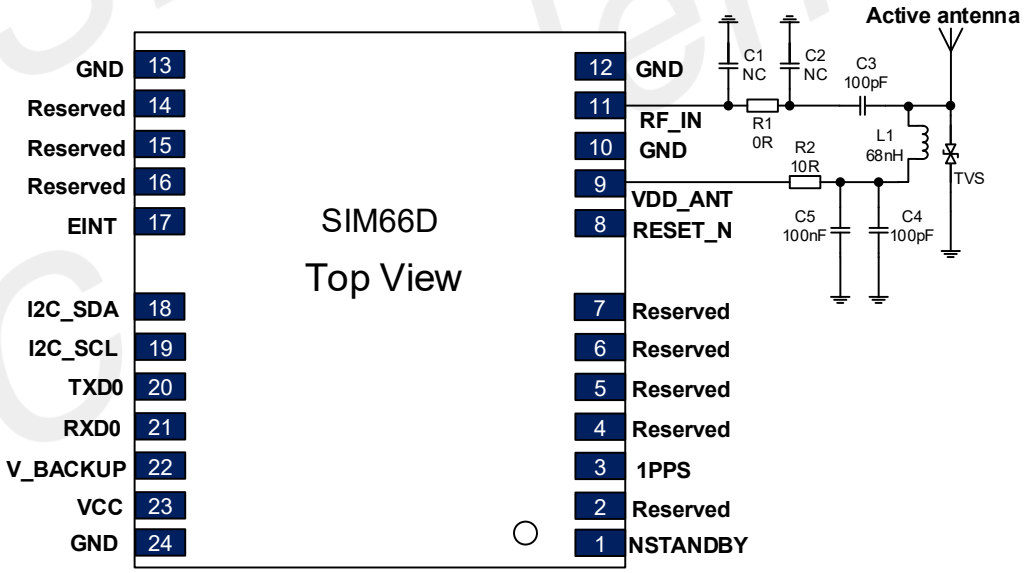


Figure 13: active antenna design

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.

6 Anti-Jamming applications

GNSS receivers typically receive signals below -130dBm and are susceptible to noise sources in the environment. The 3GPP protocol specifies that the maximum transmission power of LTE and NR PC3 is about 23dBm, and the maximum transmission power of NR PC2 is about 26dBm, when the GNSS receiver and wireless communication module coexist, the system needs to be optimized to avoid GNSS signal interference.

In the system where GNSS receivers and wireless communication modules coexist, both in-band and out-of-band jamming signals can occur, and this section will introduce the sources and effects of jamming signals, and propose anti-jamming design schemes.

6.1 In-band jamming

When the frequency of an interfering signal is within the GNSS operating band, it is called in-band jamming. In-band jamming is often generated by adjacent RF transceivers, such as in vehicle tracking and connected car solutions, where cellular communication modules used in combination with GNSS receivers are prone to jamming signals.

Because RF jamming reduces the quality of the GNSS signal and prolongs the search time, it will take longer for the GNSS receiver to achieve the first position. Because the power consumption for the first fix is significantly greater than the power consumption required for tracking after the first position, RF jamming can lead to increased power consumption, ultimately reducing battery life. Therefore, reducing RF jamming is especially important in power-constrained applications, such as battery-powered GNSS location trackers.

In some cases, RF jamming can cause GNSS signal loss, and while newer GNSS receivers can track multiple satellites in multiple GNSS constellations simultaneously, the loss of some useful signals can still lead to reduced positioning accuracy, or in the worst case, complete loss of positioning.

In the case of GPS L1, the band has a center frequency of 1575.42 MHz and a bandwidth of 2.046 MHz. When the 4G/5G communication module in the system is operating, it may generate jamming signals with frequencies between 1574.4MHz ~ 1576.4MHz, and the jamming signal power will be higher than the actual received GPS signal.

Common types of RF jamming are high-order harmonics and intermodulation distortion, which refers to the combination of frequencies of several signals of different frequencies that are the same or similar to the frequency of the useful signal when they pass through a nonlinear circuit, thereby causing jamming to the GNSS receiver. The second harmonic of LTE Band 14 and the in-band jamming caused by the intermodulation distortion of the two different signals are listed in the table below.

Table 19: Absolute maximum ratings

Signal S1	Signal S2	IM	Intermodulation distortion products
LTE Band 14	N/A	2 × S1 (788 MHz)	2nd harmonic = 1576 MHz
Wi-Fi 2.4 GHz	LTE Band 5	S1 (2412 MHz) - S2 (836.5 MHz)	2nd order intermodulation = 1575.5MHz
LTE Band 3	LTE Band 2	2 × S1 (1727.5 MHz) - S2 (1880 MHz)	3rd order intermodulation = 1575 MHz
Wi-Fi 5 GHz	LTE Band 2	S1 (5295 MHz) - 2 × S2 (1860 MHz)	3rd order intermodulation = 1575 MHz

6.2 Out-of-band jamming

When the frequency of an interfering signal is outside the GNSS operating band, it is called out-of-band jamming. Out-of-band jamming can leak into the GNSS receiver's spectrum. When the out-of-band signal is strong, it is important to suppress the out-of-band signal in advance, because the GNSS module's low-noise amplifier (LNA) has a maximum output limit, and the strong signal flow transmitted by other communication systems may cause the LNA to saturate, reduce the gain, pre-filter the out-of-band signal, and the useful signal can obtain better gain. Therefore, band-pass filters can be used to reject signals outside the frequency band used.

In practical applications, common strong jamming signals usually come from wireless communication modules, such as LTE, NR, Wi-Fi signals, etc.

6.3 Anti-Jamming design

In order to reduce the influence of interference signals on GNSS reception performance, the following anti-interference design scheme is proposed:

- The receiving antenna of the GNSS module should be as far away as possible from the transmitting antenna of the cellular communication module, and it is recommended that the isolation between the antennas be greater than 15dB.
- When the GNSS module and the wireless communication module coexist, the interference source usually has RF power amplifier, single-chip microcomputer, crystal, etc., in the PCB ornament and layout, the interference source should be far away from the GNSS module, the use of shielding frame and shielding cover to ensure sufficient grounding, can effectively prevent strong signal interference.
- Using a narrowband antenna, tuning the antenna to only receive the working band of GNSS can filter out a part of the out-of-band noise and interference signals;

7 Electrical Characteristics

7.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 20 are stress ratings under non-operating conditions. Stresses beyond any of these limits will cause permanent damage to the module.

Table 20: Absolute maximum ratings

Parameter	Min	Max	Unit
VCC	-	5	V
V_BACKUP	-	5	V
I/O pin voltage	-	3.6	V
Storage temperature	-40	+85	℃
Operating temperature	-40	+85	℃

7.2 Recommended Operating Conditions

Table 21: Operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operating temperature range	T_{opr}	-40	+25	+85	℃
Main supply voltage	VCC	2.8	3.3	4.3	V
VCC maximum ripple	V_{rpp}	-	-	50	mV
VCC operating current	I_{opr} @VCC=3.3V	-	13	80	mA
Backup battery voltage	V_BACKUP	1.7	-	4.3	V

NOTE

VCC operating current: Because the capacitor is installed inside the product, an inrush current will be generated at the time of power-up. In the actual application scenario, it is necessary to evaluate and confirm the impact of voltage dips caused by inrush current on the system.

7.3 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 SIM66D module.

Table 22: The ESD characteristics (Temperature: 25℃, Humidity: 45 %)

Pin	Contact discharge	Air discharge
VCC	± 5 kV	± 10 kV
GND	± 6 kV	± 12 kV
VDD_ANT	± 5 kV	± 10 kV
RF_IN	± 5 kV	± 10 kV

NOTE

Test conditions:
1. The external of the module has surge protection diodes and ESD protection diodes.
2. The data in Table 22 were tested using SIMCom EVB.

8 Manufacturing

8.1 Top and bottom View of SIM66D

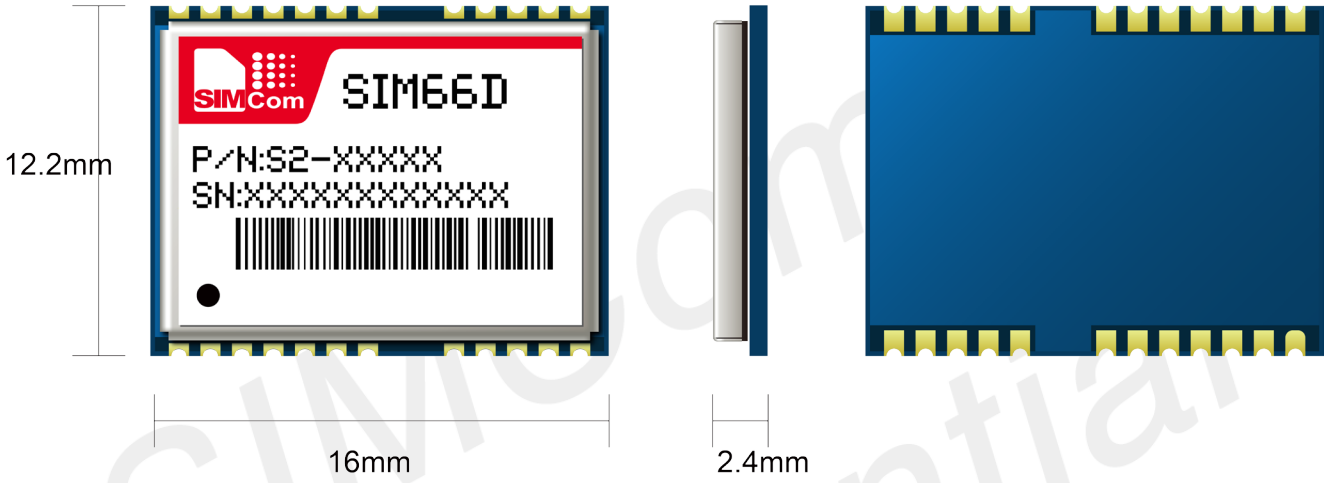


Figure 14: Top and bottom view of SIM66D

8.2 Label Description Information

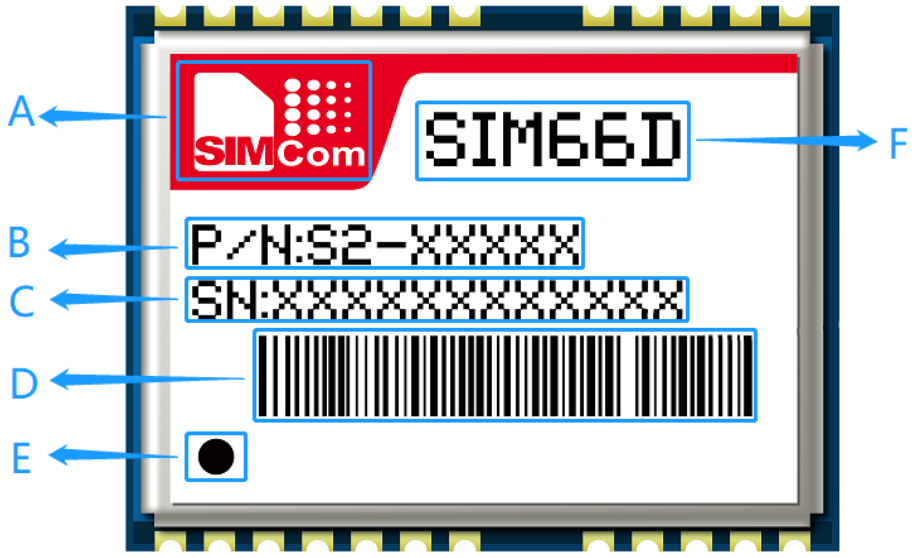


Figure 15: Label description of module information

Table 23: Label description of module information

No.	Description
A	Logo
B	Module part number 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

NOTE

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

8.3 Recommended PCB Footprint

The following figure shows the PCB footprint of the module:

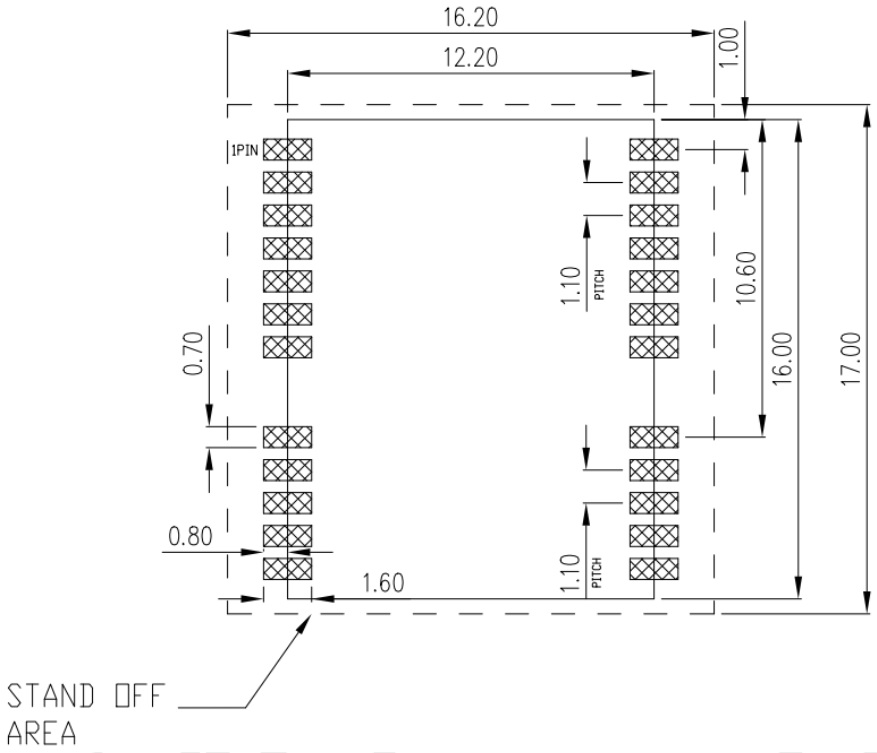


Figure 16: Recommended PCB footprint (top view) (Unit: mm)

8.4 Recommended SMT Stencil

The following figure shows the SMT stencil of SIM66D:

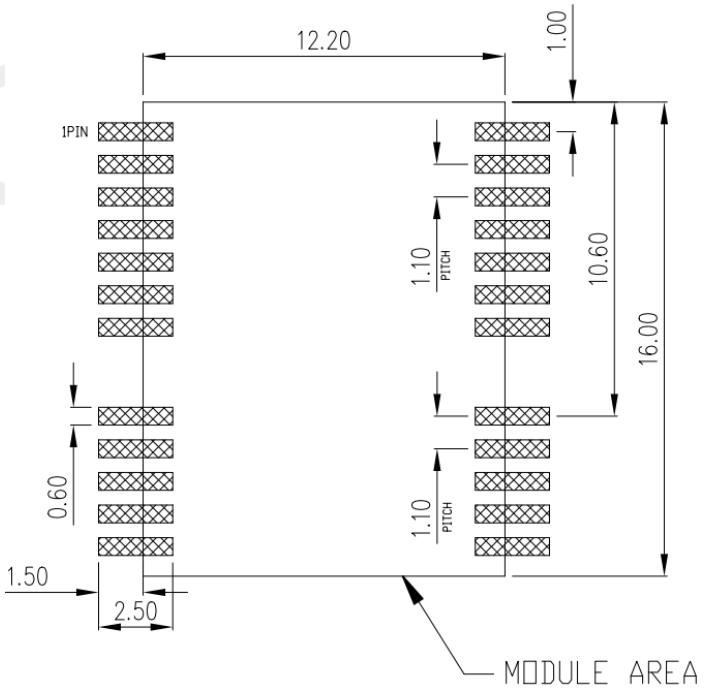


Figure 17: Recommended SMT stencil(top view)

8.5 Recommended reflow furnace temperature curve

The following figure is the Ramp-Soak-Spike Reflow Profile of SIM66D:

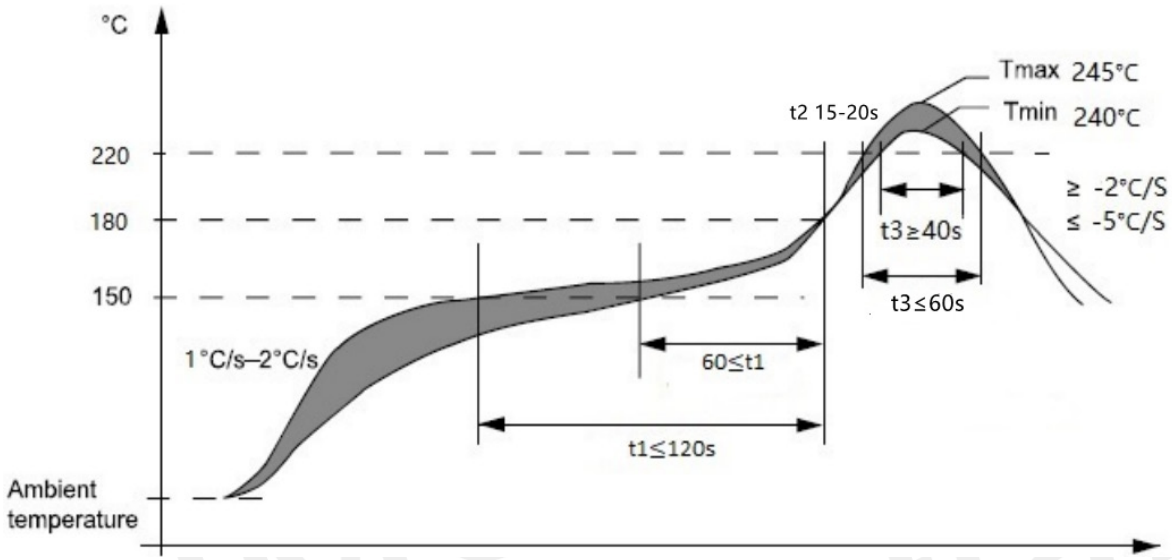


Figure 18: Recommended reflow furnace temperature curve (lead-free)

Table 24: The main board reflux temperature curve requirements (lead-free)

Zone	Time	Parameter
Preheat Zone (Room temperature~150℃)	NA	Heating rate: 1~2℃/s
T1 (150~180℃)	60~120s	/
T2 (180~220℃)	15~20s	/
T3 (≥220℃)	40~60s	Peak temperature: 240~245℃
Cooling Zone	NA	Cooling rate: -2~-5℃/s

NOTE

- Recommended lead-free process.
- In the table above, the temperature testing location includes the solder mask of the module MCU pins, bottom LGA pins, and external LCC pins.
- The actual welding temperature is affected by other external factors, such as the presence of furnace carriers, solder paste, size and thickness of the substrate, and component resistance. Thermal requirements and panel design, etc. Please confirm with our engineering and technical personnel in time if the recommended parameters cannot be reached. Otherwise, the module may be damaged.
- For boards with thickness less than 1.2mm, it is recommended to use board supported by furnace carrier or high Tg to prevent warping and PCB when heated. Deformation, thus affecting module welding. Due to the difference of Tg value of block, the phenomenon of unbalanced thermal stress appears in the process of high temperature welding reflow, resulting in the defect rate of virtual welding and little tin.
- After the module is welded, X-ray and optical inspection methods shall be used to check the welding quality. For specific standards, please refer to relevant standards of IPC-A-610H.
- For more information about shipping and manufacturing, please refer to “Module Secondary SMT Process User Guide”.
- Due to the complexity of the SMT process, in case of uncertainty or processes not mentioned in this document (such as selective wave soldering, ultrasonic welding), please contact SIMCom support team before SMT process starts.

8.6 Moisture Sensitivity Level and Storage conditions

Modules are shipped in vacuum-sealed aluminum foil bag bags, vacuum packaging according to IPC/JEDEC standard J-STD-020C specification.

- Recommended storage conditions: temperature 23℃± 5℃, and relative humidity 35%~60%.
- Storage period: 12 months (Under recommended storage conditions and in sealed vacuum packaging).

The module meets the humidity sensitivity level 3 (MSL-3), and the storage period after unpacking is shown in table below.

The out-of-bag floor life of the module with MSL-3 is 168 hours. If the workshop temperature is 23℃ ±5℃ and the relative humidity is less than 60%, the module needs to be unpacked within 168 hours of reflux production or other high temperature operations. Otherwise, the module shall be stored in an environment with relative humidity less than 10% (for example, a moisture-proof cabinet) to keep the product dry.

Table 25: MSL levels

MSL	Out-of-bag floor life	Comment
1	Unlimited	≤+30℃/85% RH
2	1 year	≤+30℃/60% RH
2a	4 weeks	
3	168 hours	
4	72 hours	
5	48 hours	
5a	24 hours	
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.	

Before use, it is necessary to confirm whether the package is in good condition; after unpacking, check the status of humidity indicator card in vacuum bag (Figure 19). The module needs to be baked before use if any of the following conditions occur.

- Explanation Humidity indicator card: 30%, 40%, and 50% of any indicator circle has discolouring
- The module has been un-packed and the module exceeds the humidity sensitivity level corresponding to the exposed workshop time. For example, MSL=3 is 168.
- Packed，but the Shelf Life exceeds 12 months；
- Exceeds the Floor Life；
- Unable to track and determine the status of the module.

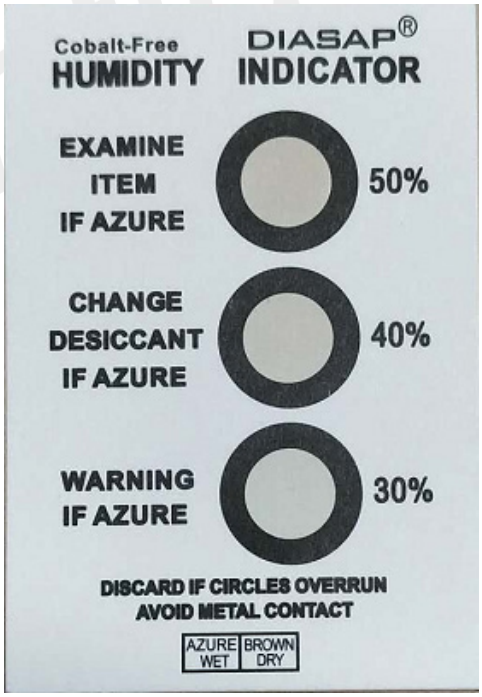


Figure 19: Humidity card

The following conditions also need to be pre-baked.

- The storage temperature and humidity do not meet the recommended storage conditions.
- Vacuum sealed bag leak, bulk materials
- Before repairing the module.
- After unpacking, the module failed to complete production or storage under the control of humidity sensitive level 3.

8.7 Baking Requirements

If baking is required, proceed according to the requirements in the table below. Preferentially choose a nitrogen-filled oven.

Table 26: Baking requirements

Baking conditions	Baking time	Comment
120°C±5°C, <5% RH	8 hours	Not applicable to original packaging pallets

NOTE

- In order to prevent and reduce the occurrence of poor welding caused by moisture, such as foaming and delamination, the module should be strictly controlled. It is not recommended to expose the module to air for a long time after unpacking the vacuum package。
- Before baking, it is necessary to remove the module from the package and place the bare module on the high temperature resistant device to avoid high temperature damage to the plastic tray or coil; The modules for secondary baking must be welded within 24 hours after baking, otherwise they need to be stored in vacuum packaging or in a drying oven.
- Please pay attention to ESD protection when unpacking and placing modules, such as wearing anti-static gloves.

9 Packaging

Module support tray and reel packaging. The module is packaged in trays by default, select REEL if reel packaging is required.

9.1 Tray packaging

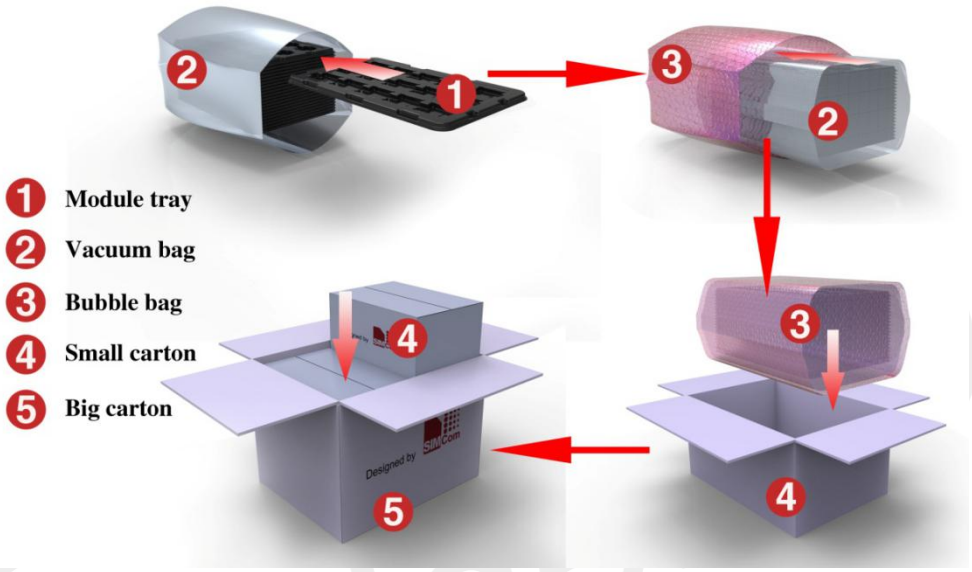


Figure 20: packaging diagram

Module tray drawing：

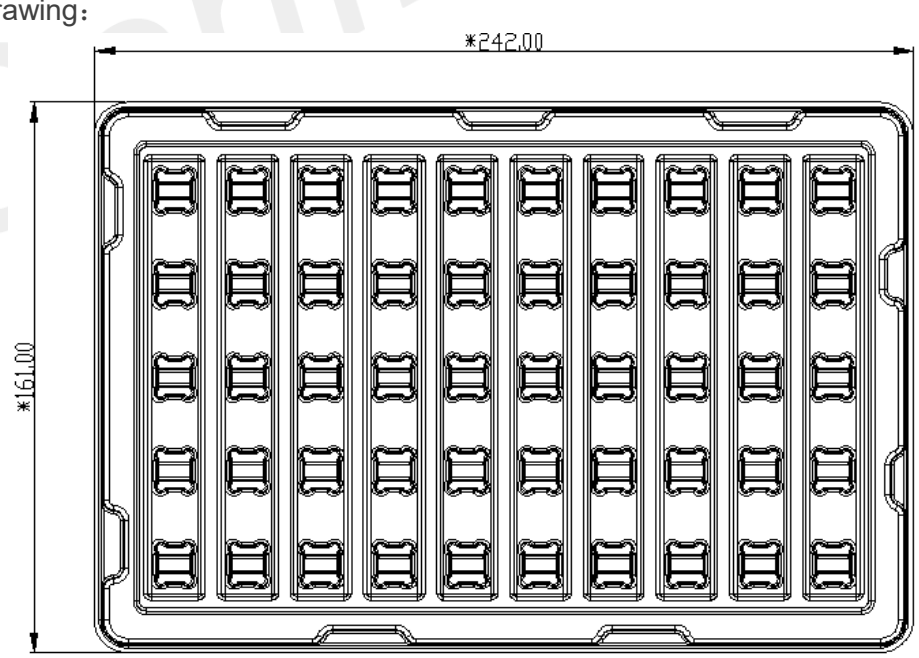


Figure 21: Tray drawing

Table 27: Tray size

Length（±3mm）	Width（±3mm）	Module number
242.0	161.0	50

Small carton drawing：

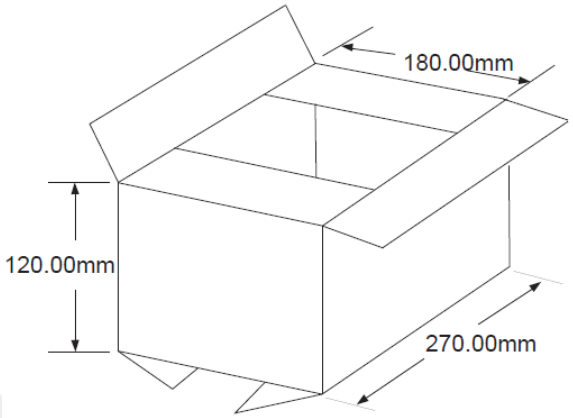


Figure 22: Small carton drawing

Table 28: Small Carton size

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

Big carton drawing：

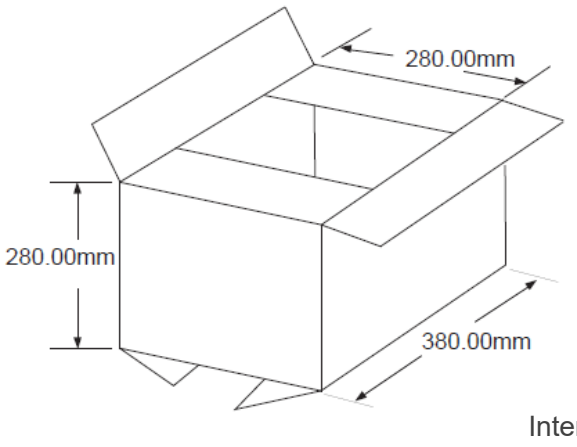


Figure 23: Big carton drawing

Table 29: Big Carton size

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

9.2 Reel packaging

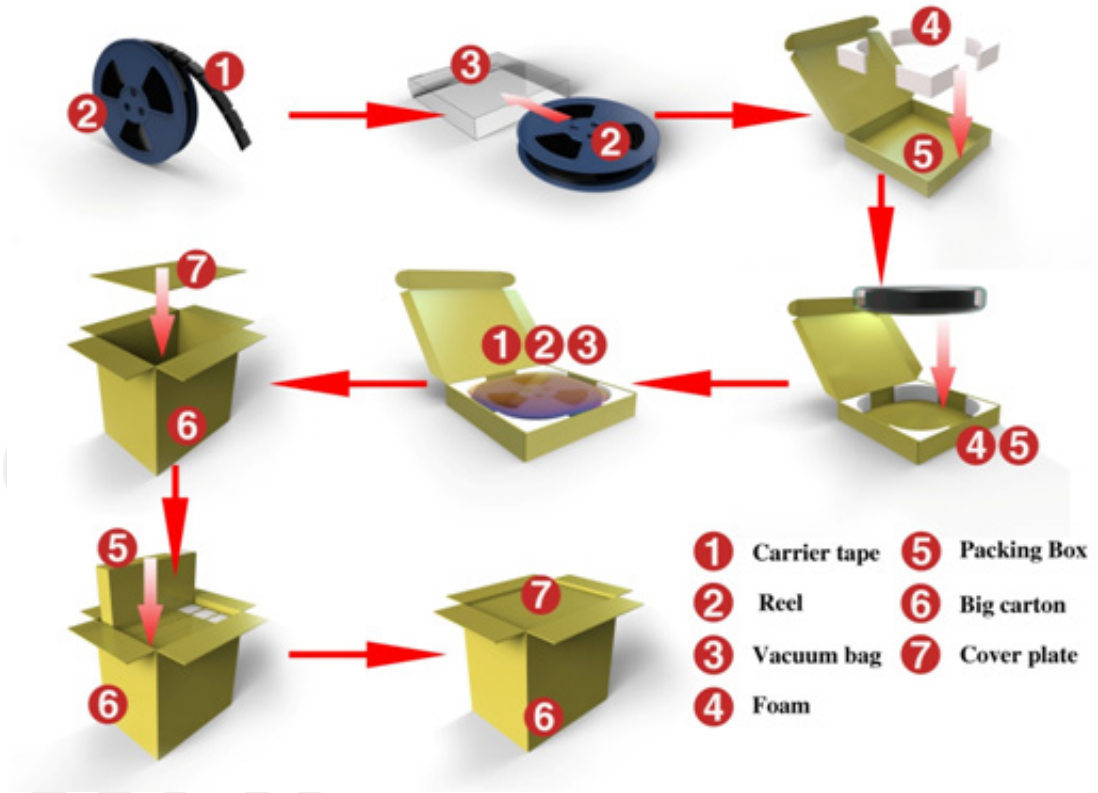
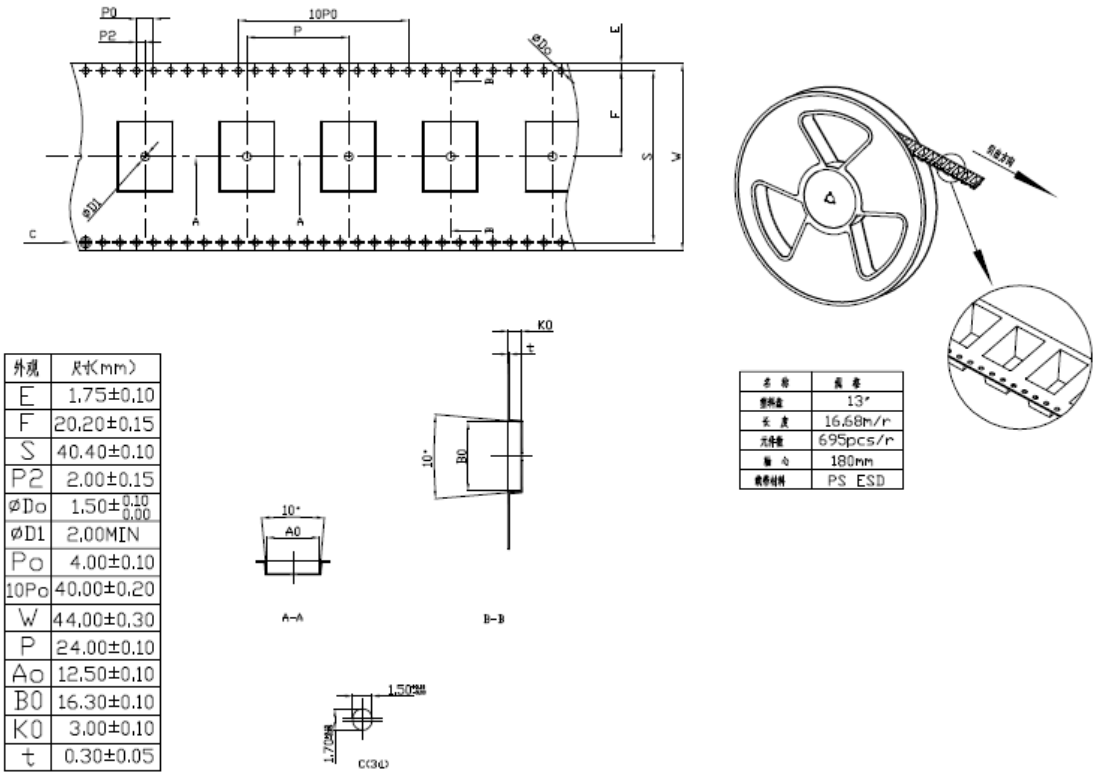


Figure 24: Packaging introduce

Carrier tape drawing：



外观	尺寸(mm)
E	1.75±0.10
F	20.20±0.15
S	40.40±0.10
P2	2.00±0.15
øDo	1.50±0.10/0.00
øD1	2.00MIN
Po	4.00±0.10
10Po	40.00±0.20
W	44.00±0.30
P	24.00±0.10
Ao	12.50±0.10
B0	16.30±0.10
K0	3.00±0.10
t	0.30±0.05

	13"
	16.68m/r
	695pcs/r
	180mm
	PS ESD

Figure 25: Carrier tape drawing introduce

Table 30: Reel size

External Diameter（mm）	Width（mm）	Inside Diameter（mm）	Module number
330.0	44.0	180.0	500

Packing box drawing：

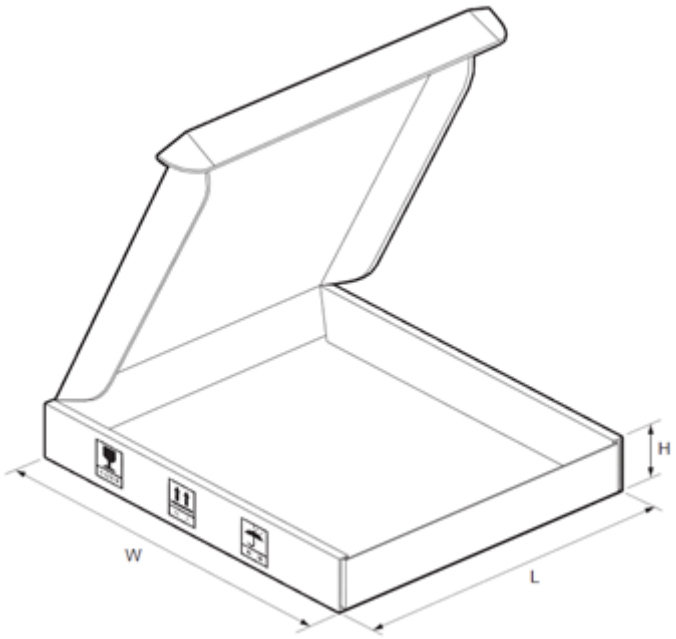


Figure 26: Packing box drawing introduce

Table 31: Packing box size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Module number
345	340	60	500

Big carton drawing：

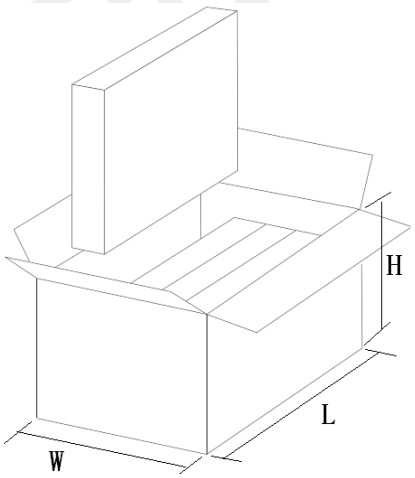


Figure 27: Big carton drawing introduce

Table 32: Big carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Module number
380	275	380	500*4=2000

10 Reference Design

Following figure is the typical application of SIM66D with active antenna which supplied by VDD_ANT. If customer applies other kind of active antenna, keep PIN 9 floating and connect other voltage to the R125.

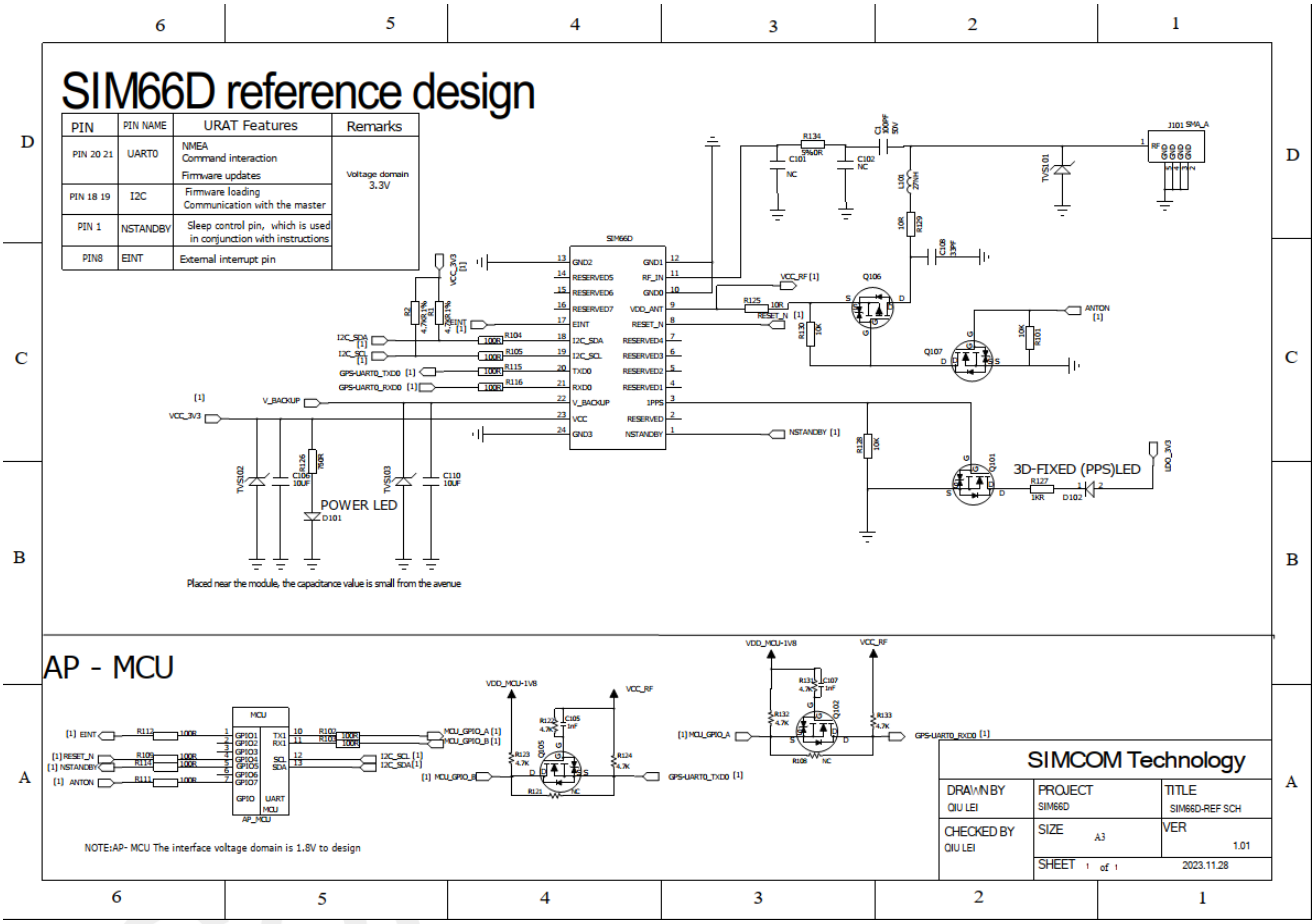


Figure 28: Refer schematic

NOTE

The IO levels of SIM66D are different; attentions should be paid if the voltage level of the host controller not compatible.

11 Appendix

11.1 Related Documents

Table 33: Related documents

SN	Document name	Remark
[1]	SIM68D_EVB_User Guide	SIM66D and SIM68D are compatible with one EVB and can be used in the same way
[2]	SIM66D Series_NMEA Message_User Guide_V1.00	
[3]	8AE000-SIM66D_V1.01_REFDL	
[4]	SIMCom GNSS Hardware Design Manual_V1.00	
[5]	Module Secondary SMT Process User Guide_V1.01	
[6]	SIMCom Standard module ESD surge protection design manual_V1.00	

11.2 Terms and Abbreviations

Table 34: 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
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
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

11.3 Safety Caution

Table 35: 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.