SIM68E_Hardware Design_V1.01

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Date	Version	Description of change	Author
2014-05-07	V1.01	Origin	Chengbing.wu Xuegang.Wang

1 Introduction

This document describes the hardware interface of the SIMCom module SIM68E which can be used as a stand alone or A-GPS（Assisted Global Positioning System） receiver. As a wide range of applications can be integrated in SIM68E, all functional components of SIM68E are described in great detail.

2 SIM68E Overview

SIM68E is a stand-alone or A-GPS receiver. With built-in LNA, SIM68E can relax antenna requirement and don't need for external LNA. SIM68E can track as low as -165dBm signal even without network assistance. The SIM68E has excellent low power consumption characteristic (acquisition 25mA, tracking 18mA). SIM68E supports various location and navigation applications, including autonomous GPS,GLONASS,QZSS, SBAS ranging (WAAS, EGNOS, GAGAN, MSAS), DGPS and A-GPS.

Key Features

- GPS/ GLONASS/Galileo receiver, supports QZSS, SBAS ranging, supports WAAS/EGNOS/MSAS/GAGAN
- 33 tracking/99 acquisition-channel, up to 210 PRN channels
- Small footprint: 15x 13 x 2.3mm, 22-pin LCC package
- 12 multi-tone active interference cancellers and jamming elimination
- Indoor and outdoor multi-path detection and compensation
- Max NMEA update rate up to 10 HZ
- Advanced software features
    1. EASY self-generated orbit prediction
    2. EPO/HotStill orbit prediction
    3. AlwaysLocate advanced location awareness technology
    4. supports logger function
    5. supports active interference cancellation (AIC)
- Pulse-per-second (PPS) GPS time reference
    1. Adjustable duty cycle
    2. typical accuracy: ±10ns
- Interface
    UART0/UART1
- Operating temperature: -40 ~ +85ºC
- Accuracy <2.5m CEP
- RoHS compliant

The module provides complete signal processing from antenna input to host port in either NMEA messages. The module requires 2.8V~4.3V power supply. The host port is configurable to UART. Host data and I/O signal levels are 2.85V CMOS compatible.

2.1 SIM68E Functional Diagram

The following figure shows a functional diagram of the SIM68E and illustrates the mainly functional parts:
- The GNSS chip

- SAW filter
- LNA
- The antenna interface
- The communication interface
- The control signals
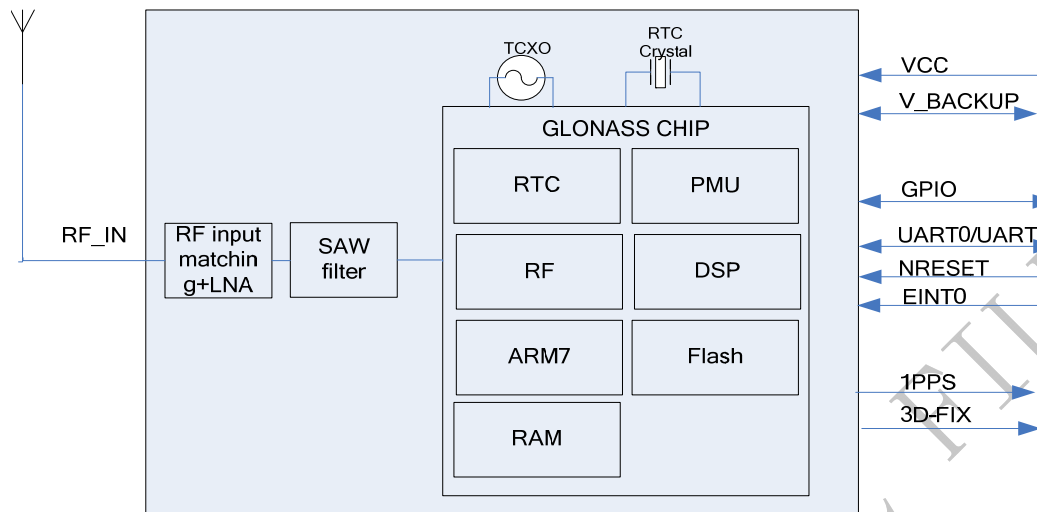
Figure 1: SIM68E functional diagram

2.2   GPS Performance

Table 1: GPS performance

Parameter	Description	Performance			
		Min	**Type**	**Max**	**Unit**
Horizontal Position Accuracy[1]	Autonomous		<2.5		m
Velocity Accuracy[2]	Without Aid		0.1		m/s
	DGPS		0.05		m/s
Acceleration Accuracy	Without Aid		0.1		m/s²
	DGPS		0.05		m/s²
Timing Accuracy			10		nS
Dynamic Performance	Maximum Altitude			18000	m
	Maximum Velocity			515	m/s
	Maximum Acceleration			4	G
Time To First Fix[3]	Hot start		<1		s
	Warm start		20.4		s
	Cold start		25.8		s
A-GPS TTFF(EASY mode)	Hot start		0.6		s
	Warm start		1.8		s
	Cold start		13.3		s
Sensitivity[7]	Autonomous acquisition(cold start)		-147		dBm

	Re-acquisition		-160		dBm
	Tracking		-165		dBm
Receiver	Channels		132		
	Update rate		1	10	Hz
	Tracking L1, CA Code				
	Protocol support NMEA,PMTK				
Power consumption[4]	Acquisition		25		mA
	Continuous tracking		22		mA
	Sleep current		350		uA
	Backup current		14		uA
Power consumption[5]	Acquisition		20		mA
	Continuous tracking		NC		mA
	Sleep current		350		uA
	Backup current		14		uA
Power consumption[6]	Acquisition		20		mA
	Continuous tracking		NC		mA
	Sleep current		350		uA
	Backup current		14		uA

(1) 50% 24hr static, -130dBm

(2) 50% at 30m/s

(3) −130 dBm, GPS&GLONASS mode

(4) Single Power supply 3.3V under GPS+GLONASS signal@-130dBm

(5) Single Power supply 3.3V under GPS signal@-130dBm

(6) Single Power supply 3.3V under GLONASS signal@-130dBm

(7) Single Power supply 3.3V under GPS+GLONASS signal

2.3 General features

Table 2: General features

Parameters		Value
Supply voltage VCC		+2.8V~4.3V
Supply voltage ripple VCC		54 mV(RMS) max @ f = 0~3MHz 15 mV(RMS) max @ f > 3 MHz
Power consumption(acquisition)		25mA type. @ VCC=3.3 V
Power consumption(sleep)		350uA type. @ VCC=3.3 V
Storage temperature		-40ºC~+85ºC
Operating temperature		-40ºC~+85ºC (note 1)
I/O signal levels	VIL	-0.3V~0.8V
	VIH	2.0V~3.3V
	VOL	-0.3V~0.4V

	VOH	2.4V~3.1V
I/O output sink/source capability		+/- 3mA max
I/O input leakage		+/- 10 uA max
Host port		UART0
Serial port protocol (UART)		NMEA; 8 bits, no parity, 1 stop bit; 115200 baud (configurable)
1PPS output		1 pulse per second, synchronized at rising edge, pulse length 100ms

Note 1: Operation in the temperature range –40°C~ –30°C is allowed but Time-to-First-Fix performance and tracking sensitivity may be degraded.

3 Package Information

3.1 Pin out Diagram
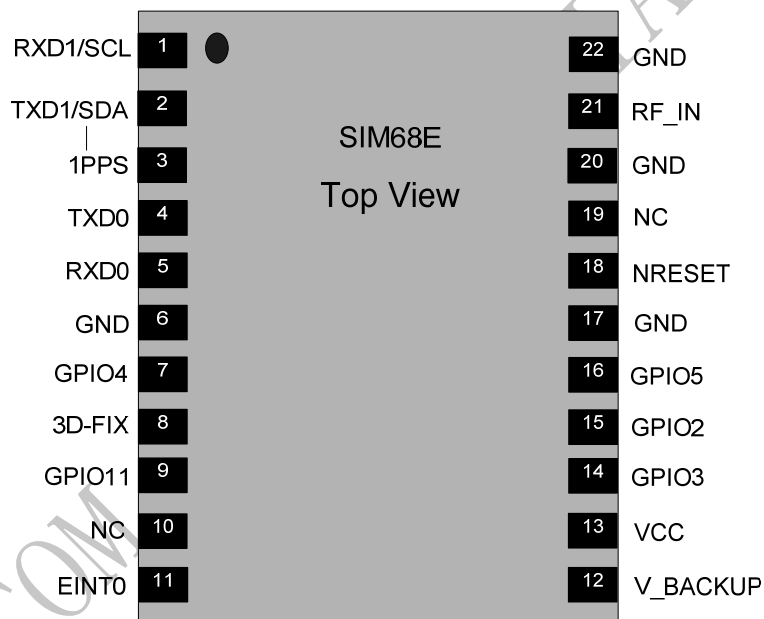
Figure 2: SIM68E pin out diagram (Top view)

3.2 Pin Description

Table 3: Pin description

Pin name	Pin number	I/O	Description	Comment
Power supply				
VCC	13	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 and 0.1uF capacitor to this pin for

			decoupling.	
V_BACKUP	12	I/O	The backup battery input power supply for RTC	If unused, keep open.
GND	6,17,20,22		Ground	GND
Host port interface				
TXD0	4	O	NMEA serial output	
RXD0	5	I	MMEA serial input	
TXD1/SDA	2	O	Serial output as RTCM	I2C communicate not supported yet
RXD1/SCL	1	I	Serial input as RTCM	
GPIOs				
1PPS	3	O	Time Mark outputs timing pulse related to receiver time	If unused, keep open.
3D-FIX	8	O	3D-fix indicator	If unused, keep open.
NRESET	18	I	Reset input, active low，default pull-up	If unused, keep open.
EINT0	11	I	This interrupt source could control the module come into or wake up from sleep mode. Low=come into sleep mode High=wake up from sleep mode.	If unused, keep open. Default High level.
GPIO	7,9,14,15,16	I/O	Reserved	Keep open
RF interface				
RF_IN	21	I	Radio antenna connection	Impendence must be controlled to 50Ω.
Other interface				
NC	10,19		Not Connected	Keep open

3.3   Package Dimensions

Following figure shows the Mechanical dimensions of SIM68E (top view, side view and bottom view).

Figure 3: SIM68E mechanical dimensions (Unit: mm)

3.4 SIM68E Recommended PCB Decal

Figure 4: Recommended PCB decal (top view) (Unit: mm)

4 Application Interface

4.1 Power Management
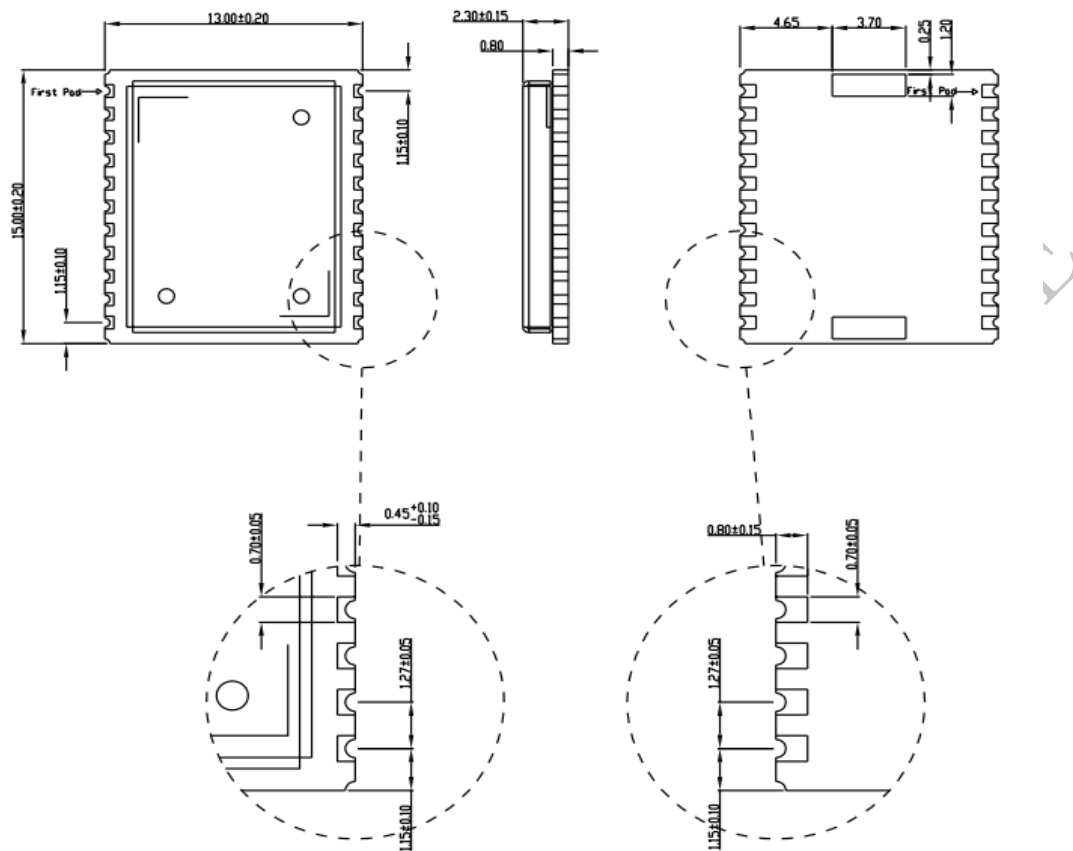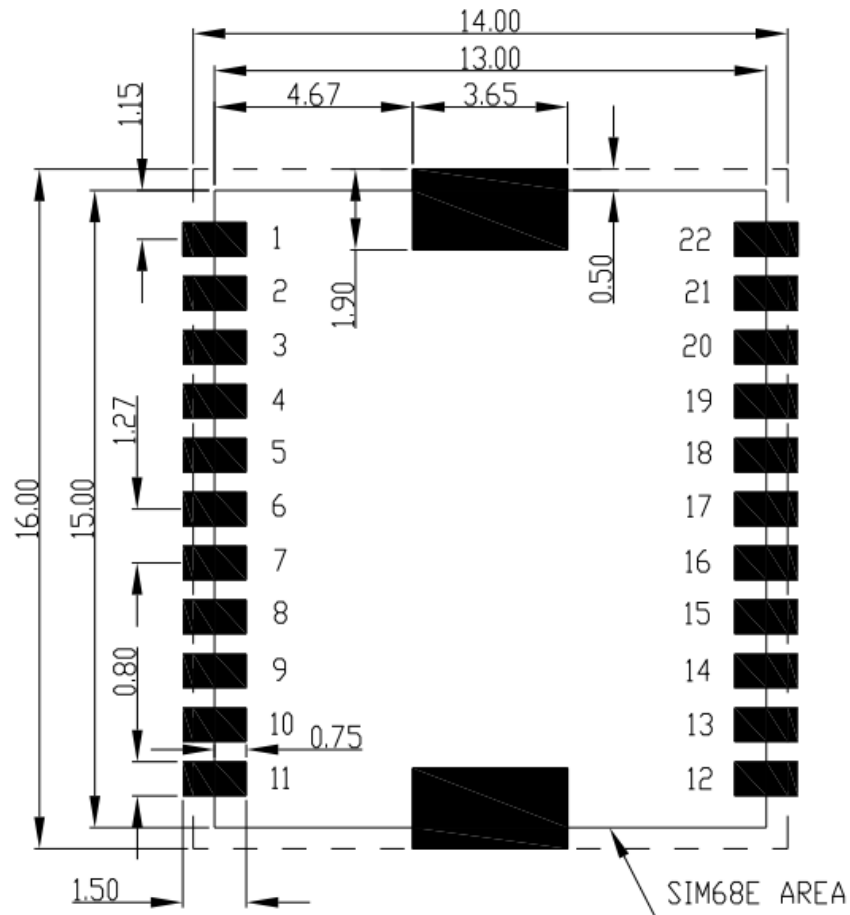
4.1.1 Power Input

The power supply range of SIM68E is from 2.8V to 4.3V. The power supply should be able to provide sufficient current up to 100mA.

The power supply range of V_BACKUP is from 2V to 4.3V, typical 3.0V, suggest customer keep the V_BACKUP supply active all the time, the module will perform a quick start every time it is power-on.

4.1.2 Starting SIM68E

When power is first applied, SIM68E goes into operation mode.

4.1.3 Verification of SIM68E Start

System activity indication depends upon the chosen serial interface:
- When it is activated, SIM68E will output messages at the selected UART speed and message types.

4.1.4 Power Saving Modes

SIM68E supports operating modes for reduced average power consumption like standby mode, backup mode, periodic mode, and AlwaysLocate^{TM} mode.
- Sleep mode: In this mode the receiver stays at full on power state. When this mode that can be wake up by the host sends the command through the communication interface.
- Backup mode: In this mode the SIM68E must be supplied by the backup and it can help to count down the time for backup mode. Software on host side to send the command through the communication interface into the backup mode.
- Periodic mode: In this mode the SIM68E enters tracking and sleep or Backup mode according to the interval configured.
- AlwaysLocate^{TM} mode: AlwaysLocate^{TM} is an intelligent controller of SIM68E periodic mode. Depending on the environment and motion conditions, SIM68E can adaptive adjust the on/off time to achieve balance of positioning accuracy and power consumption.

Note: the modes mentioned above are operated by PMTK commands, users can refer to document [1] for more information.

SIM68E provides very low leakage battery back up memory, which contains all the necessary GPS information for quick start up and a small amount of user configuration variables. It needs a 3V power supply for V_BACKUP pin.

4.1.5 Operating Mode

Table 4: 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
Sleep	on	on	on	off	on
Backup	on	on	off	off	on

4.1.5.1   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.

4.1.5.2   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 powered off. The power supply input VCC shall be kept active all the time, even during sleep mode.

Entering into sleep mode is sent PMTK command through the communication interface by host side or pull down EINT1.

Waking up from sleep mode is sent any byte through the communication interface by host side or pull high EINT1.

4.1.5.3   Backup Mode

This connects to the backup power of the module. Power source (such as battery or cap) connected to V_BACKUP pin will help the chipset in keeping its internal RTC running when the VCC power source is turned off. The voltage should be kept between 2.0~4.3V, Typical 3.0V.
The V_BACKUP power should be kept active all the time, the module will perform a quick start every time it is power-on.

4.1.5.4   Periodic Mode

In this mode the SIM68E enters tracking and sleep or Backup mode according to the interval configured by users in the commands.
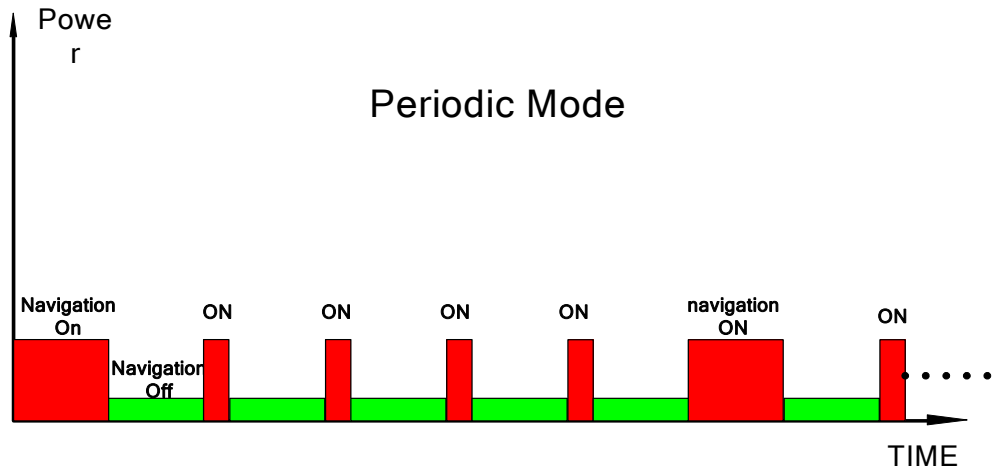
Figure 5: Periodic Mode

4.1.6 3D-FIX Output

The 3D-FIX is assigned as a fix flag output. This pin will output high after successful positioning.

4.1.7   Interrupt input EINT0

This interrupt source could control the module come into or wake up from sleep mode.
Low=come into sleep mode
High (default) =wake up from sleep mode.

4.2   UART Interface

SIM68E includes two UART (UART0 and UART1) interface for serial communication. The UART0 is as NEMA output and PMTK command input. The receiver (RXD0) and transmitter (TXD0) side of every port contains a 16-byte FIFO and has 256 bytes URAM. UART can provide the developers signal or message outputs. The baud rates are selectable and ranging from 4.8 to 921.6kbps through PMTK commands, see the following table for details. UART1 is as RTCM input.
Note: the UART1 can also used to be as I2C port for NMEA communication, this function is not supported yet.

Table 5: PSIMIPR NMEA port data rate

PSIMIPR	NMEA port data rate
Example: $PSIMIPR,W,115200*1C	
Test Command **PSIMIPR,T**	Response PSIMIPR,T,(0,4800,9600,14400,19200,38400,57600,115200)
	Parameters See Write Command

Write Command
PSIMIPR,W,<baud rate>
	Response
	  If success, return :
	    PSIMIPR,W,Ok

	If error, return :
	PSIMIPR,W,Error
	Parameters
	\<baud rate> support default baud rate(<u>0</u>) or
	4800,9600,14400,19200,38400,57600,115200
Read Command	Response
PSIMIPR,R	TA returns the current debug information output control
	PSIMIPR,R,Ok,
	\< baud rate>
	Parameters
	See Write Command

Note:

1. 0 refer to firmware default baud rate.

2. Need module reset or Cold/Warm/Hot/Full cold restart to take effect.

4.3 NRESET Input

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

When NRESET signal is used, it will force volatile RAM data loss. Note that Non-Volatile backup RAM content is not cleared and thus fast TTFF is possible. The input has internal pull up.

4.4 1PPS Output

The 1PPS pin outputs one pulse-per-second (1PPS) pulse signal for precise timing purposes. 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.

4.5 A-GPS and DGPS

A-GPS is the meaning of Assisted GPS, which is a system that can improve the startup performance, and time-to-first-fix (TTFF) of a GPS satellite-based positioning under certain conditions . SIM68E module supports EPO file, EASY MODE.

4.5.1 EPO

The SIM68E 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 and improve the acquisition sensitivity.

The user should update the EPO files from the EPO server daily through the internet. Then the EPO data should send to the SIM68E by the HOST side. SIM68E has the short cold TTFF and warm TTFF, when the A-GPS is used.

Note: For more information about EPO, please contact SIMCom sales. users can refer to document [2] for more information

4.5.2 EASY MODE

EASY is the abbreviation of Embedded Assist System, it works as embedded firmware 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 sleep 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 PMTK command.

4.5.3 DGPS

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.

SIM68E module supports SBAS and 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 sales for supporting

4.6 GNSS Antenna

The antenna is a critical item for successful GNSS reception in a weak signal environment. Proper choice of the antenna will ensure that satellites at all elevations can be seen. Therefore, accurate fix measurements could be obtained.

It is recommended to use an active GNSS antenna. In typical application, module can get a tracking sensitivity about 3dB increased with an active antenna better than a passive antenna.

It is suggested the antenna should be chosen as followed.

Table 6: Antenna Specifications

Parameter	Specification	
Passive Antenna Recommendations	Frequency range	1560—1616MHz
	Polarization	RHCP & Linear
	Gain	> 0dBi
	VSWR	< 2
Active Antenna Recommendations	Frequency range	1560—1616MHz
	Polarization	RHCP & Linear
	VSWR	< 2
	Noise Figure	< 1.5dB
	Gain	> 20dBi (max 50 dB)

4.6.1 Antenna Interface

The RF signal is connected to the RF_IN pin. And the trace from RF_IN to antenna should be 50Ω controlled.

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.

4.6.2 Antenna Choice and RF Design Consideration

To obtain excellent GNSS reception performance, a good antenna will always be required. The RF circuits should also be designed properly based on the type of antenna.

4.6.2.1 Passive Antenna

Passive antenna contains only the radiating element, e.g. the ceramic patch, the helix structure, and chip antenna.

Sometimes it also contains a passive matching network to match the electrical connection to 50 Ohms impedance.

The most common antenna type for GNSS application is the patch antenna. Patch antenna is flat, generally has a ceramic and metal body and is mounted on a metal base plate.

There are two modes for module with using passive antenna.

● Module + passive antenna

● Module + LNA+ SAW+ passive antenna

A minimal setup for a GNSS receiver with SIM68E module is shown in Figure 6. RF_IN pin has been connected with internal 2.8V power supply, so the cap C3 is for DC blocking with 22pF default.
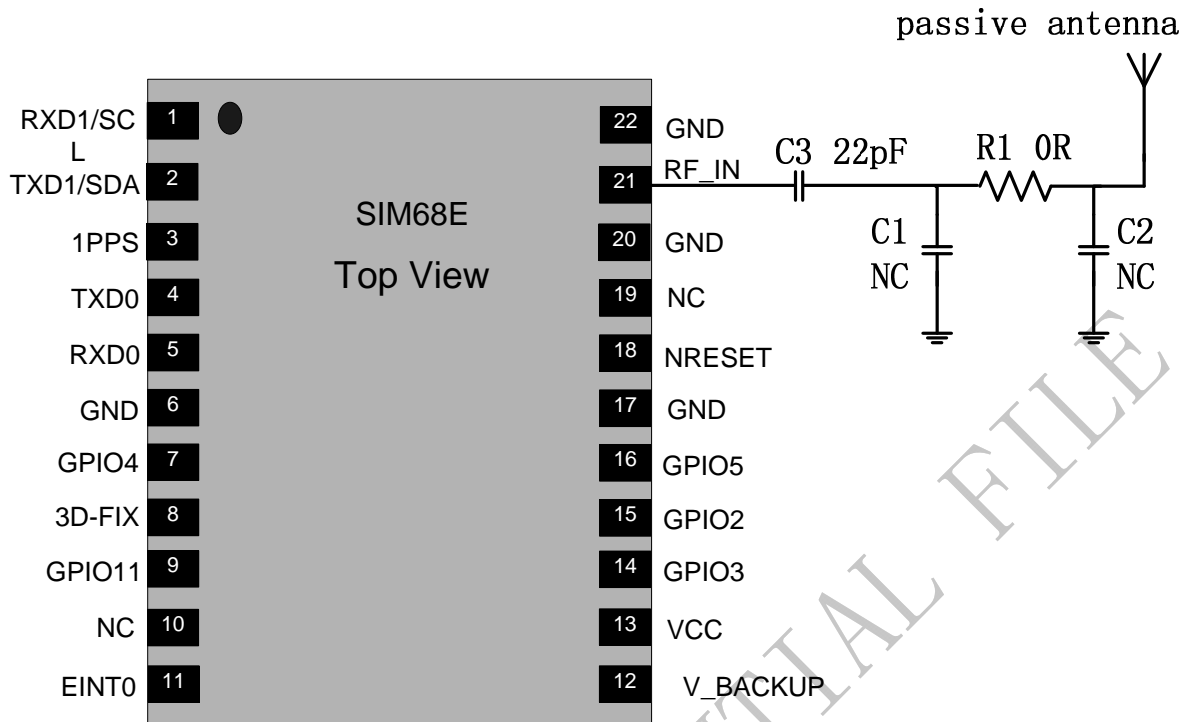
Figure 6: only passive antenna design

As shown in Figure 7, for better performance customer can use an external LNA to increase the sensitivity about 3~4 dB. The inductor L3 is used to prevent the RF signal from leaking into the Vcc and route the bias supply to LNA, the recommended value of L3 is no less than 27nH. The cap C4 is used for DC blocking. L2 is used for LNA input matching.
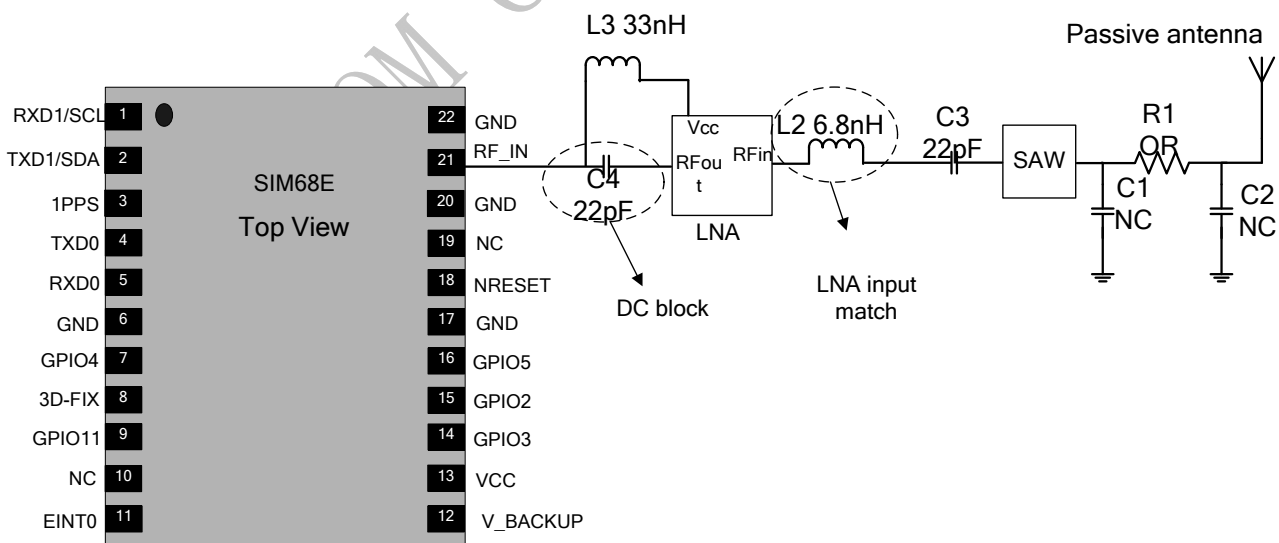

Figure 7: passive antenna desgin (with external LNA and SAW)

4.6.2.2 Active Antenna

Active antennas have an integrated Low-Noise Amplifier (LNA). And it could be connected directly because RF_IN pin has been connected with internal 2.8V power supply.
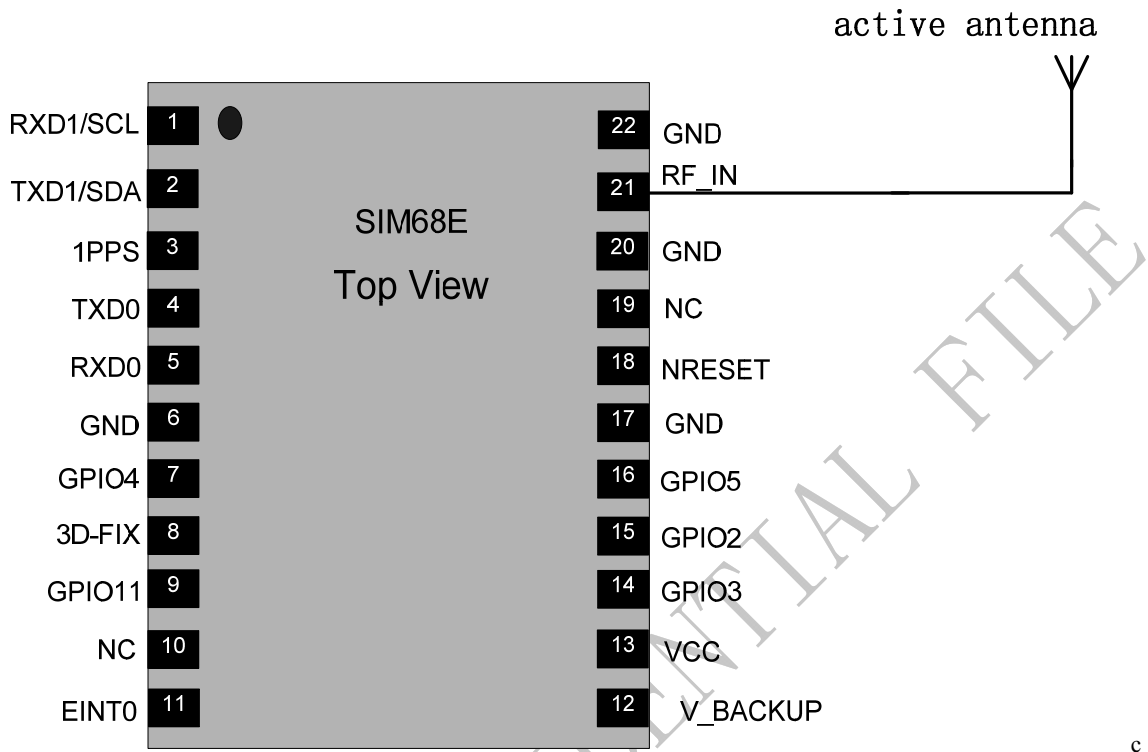
Figure 8: Active antenna simplified design

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.

5   Electrical, Reliability and Radio Characteristics

5.1   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 SIM68E.

Table 7: Absolute maximum ratings

Parameter	Min	Max	Unit
VCC	-	4.3	V
Input Power at RF_IN	-	-12	dBm
V_BACKUP	-	4.3	V
I/O pin voltage	-	3.6	V
Storage temperature	-45	+125	℃
Operating Temperature	-40	+85	℃

5.2   Recommended Operating Conditions

Table 8: SIM68E operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operating temperature range		-40	+25	+85	℃
Main supply voltage	VCC	2.8	3.3	4.3	V
Backup battery voltage	V_BACKUP	2	3	4.3	V

Table 9: SIM68E standard IO features

Parameter	Symbol	Min	Typ	Max	Unit
Low level output voltage Test conditions IOL = 2mA and 4.0mA	V_{OL}	-0.3		0.40	V
High level output voltage Test conditions IOL = 2mA and 4.0mA	V_{OH}	2.4		3.1	V
Low level input voltage	V_{IL}	-0.3		0.8	V
High level input voltage	V_{IH}	2.0		3.6	V
Input Pull-up resistance	R_{PU}	40		190	KΩ
Input Pull-dowm resistance	R_{PD}	40		190	KΩ
Input capacitance	C_{IN}		5		pF
Load capacitance	C_{load}			8	pF
Tri-state leakage current	I_{OZ}	-10		10	uA

5.3   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 SIM68E module. The ESD test results are shown in the following table.

Table 10: The ESD characteristics (Temperature: 25℃, Humidity: 45 %)

Pin	Contact discharge	Air discharge
VCC	±5KV	±10KV
RF_IN	±5KV	±10KV
V_BACKUP	±5KV	±10KV
GND	±5KV	±10KV
UART0/UART1	±4KV	±8KV
NRESET	±4KV	±8KV
1PPS	±4KV	±8KV
3D-FIX	±4KV	±8KV
EINT0	±4KV	±8KV

6 Manufacturing

6.1 Top and Bottom View of SIM68E

Figure 9: Top and bottom view of SIM68E

6.2 Assembly and Soldering

The SIM68E 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.

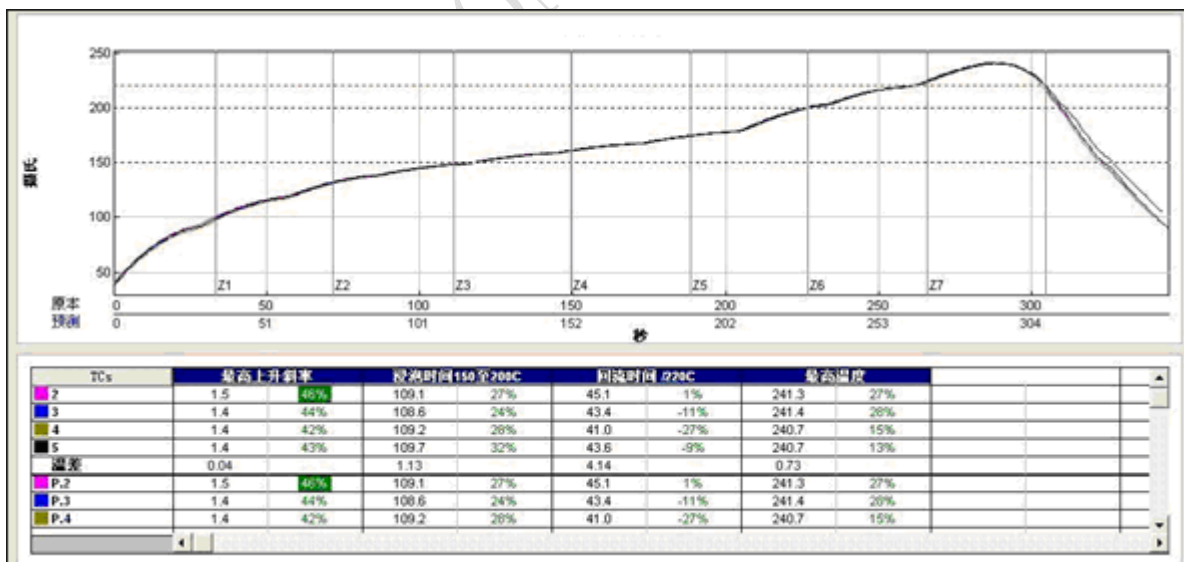The following figure is the Ramp-Soak-Spike Reflow Profile of SIM68E:

Figure 10: The Ramp-Soak-Spike reflow profile of SIM68E

SIM68E is Moisture Sensitive Devices (MSD), appropriate MSD handling instruction and precautions are summarized in Chapter 6.3.

SIM68E modules are also Electrostatic Sensitive Devices (ESD), handling SIM68E modules without proper ESD

protection may destroy or damage them permanently.

Avoid ultrasonic exposure due to internal crystal and SAW components.

6.3 Moisture sensitivity

SIM68E 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 6 months from the bag seal date, when stored in a non condensing atmospheric environment of <40°C/90% RH.

Table 12 lists floor life for different MSL levels in the IPC/JDEC specification:

Table 11: 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, SIM68E must be processed and soldered within the time. If this time is exceeded, 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 case:

● 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.

Notes: 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.

6.4 ESD handling precautions

SIM68E 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).

6.5   Shipment

SIM68E is designed and packaged to be processed in an automatic assembly line, and it is now packaged tray and reel.
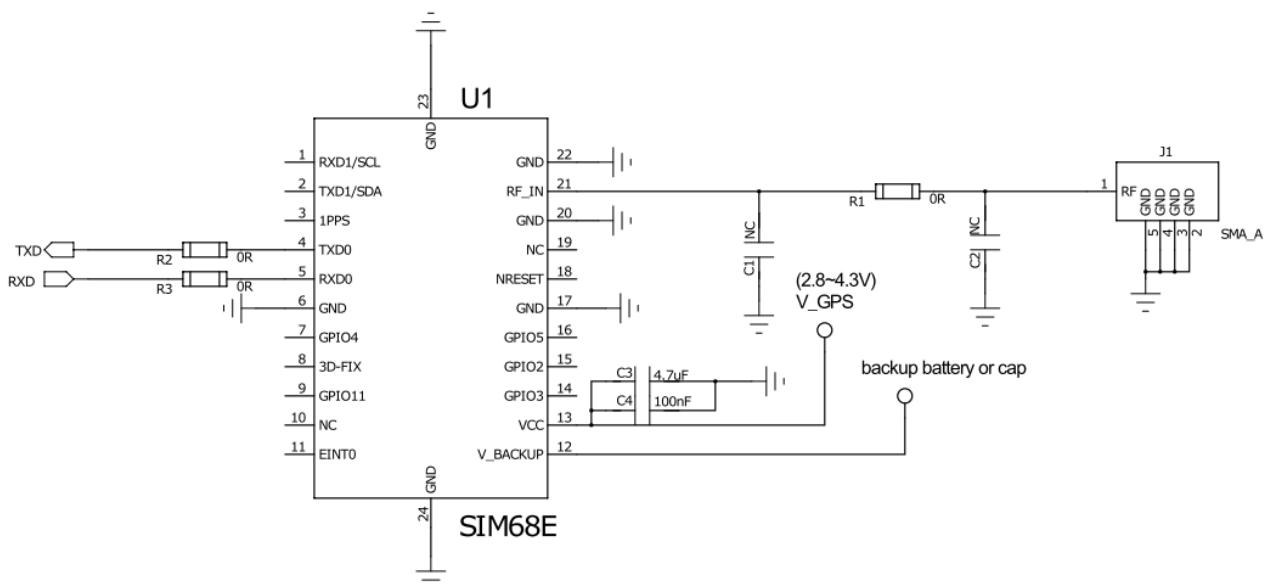
7   Reference Design

Figure 11: Application schematics

Appendix

A. Related Documents

Table 12: Related documents

SN	Document name	Remark
[1]	MT3333 Platform NMEA Message Specification For GPS+GLONASS_V1.00	
[2]	EPO-II Protocol for SIMCOM GNSS Platform V1.00	EPO-II_Format and Protocol

B. Terms and Abbreviations

Table 13: Terms and abbreviations

Abbreviation	Description
A-GPS	Assisted Global Positioning System
CMOS	Complementary Metal Oxide Semiconductor
CEP	Circular Error Probable
DGPS	Difference Global Positioning System
EEPROM	Electrically Erasable Programmable Read Only Memory
EPO	Extended Prediction Orbit
ESD	Electrostatic Sensitive Devices
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
GPS	Global Positioning System
GAGAN	The GPS Aided Geo Augmented Navigation
I/O	Input/Output
IC	Integrated Circuit
Inorm	Normal Current
Imax	Maximum Load Current
kbps	Kilo bits per second
MSL	moisture sensitive level
MSAS	Multi-Functional Satellite Augmentation System
NMEA	National Marine Electronics Association
PRN	Pseudo Random Noise Code
QZSS	Quasi-Zenith Satellites System
SBAS	Satellite Based Augmentation Systems

| WAAS | Wide Area Augmentation System |

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