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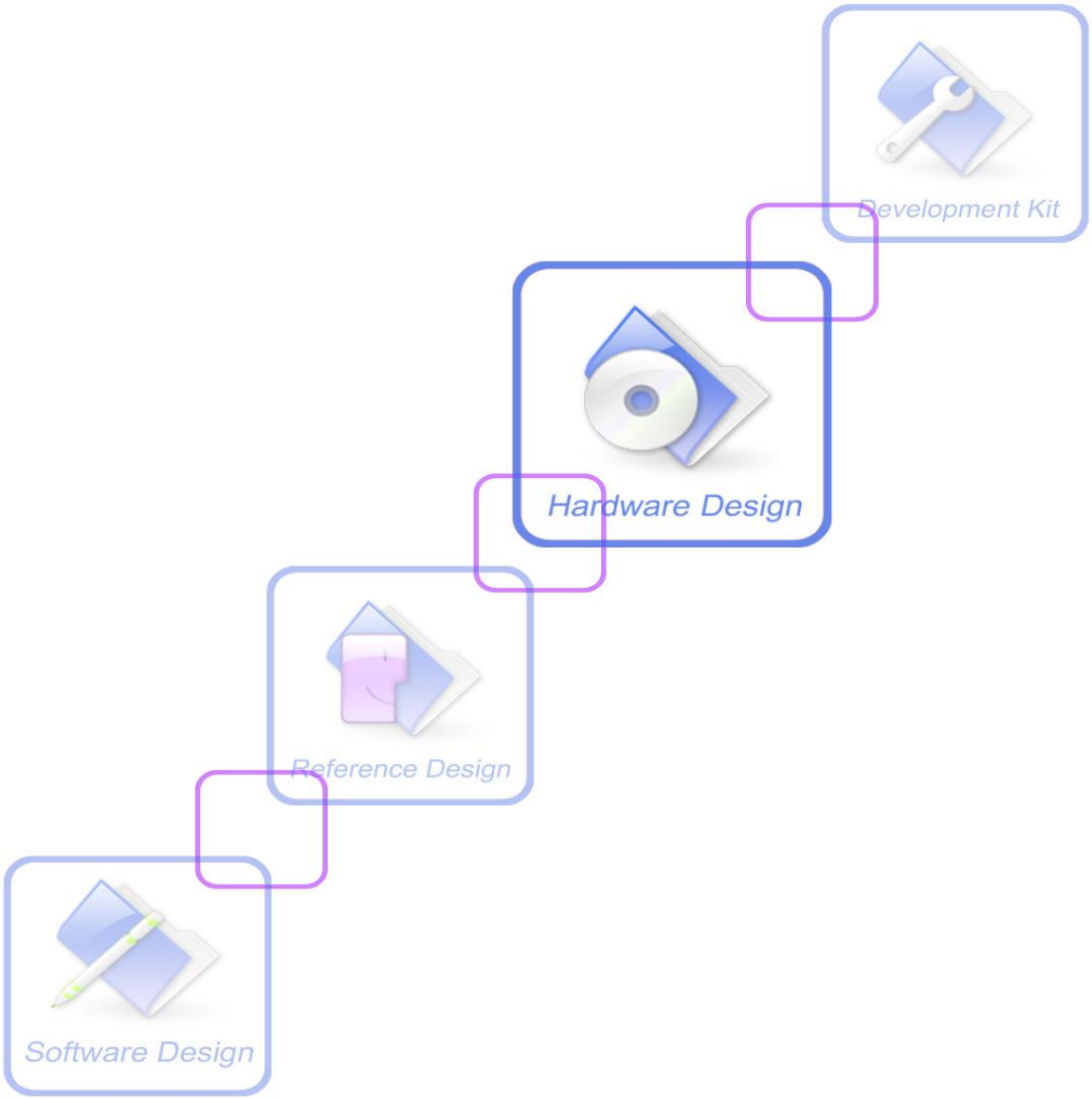
SIM808_Hardware Design_V1.03



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Version History

Date	Version	Description of change	Author
2014-03-27	1.00	Origin	ShengWu.Sun Xuegang.Wang
2014-09-09	1.01	Normalize the pin name, Add Appendix Multiplexing Function Add BT Performance	Xiujing.xiao Lili.teng
2015-04-09	1.02	Update the GPIO Multiplexing function, Add related information about the Multiplexing of SD card	Xiuyu.zhang Hailin.yang
2016-06-30	1.03	Update the GNSS AT command Delete the CSD functions Delete the automatic power off function related to temperature	Xiuyu.zhang

1 Introduction

This document describes SIM808 hardware interface in great detail. This document can help user to quickly understand SIM808 interface specifications, electrical and mechanical details. With the help of this document and other SIM808 application notes, user guide, users can use SIM808 to design various applications quickly.

2 SIM808 Overview

Designed for global market, SIM808 is integrated with a high performance GSM/GPRS engine, a GNSS engine and a BT engine. SIM808 is a quad-band GSM/GPRS module that works on frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. SIM808 features GPRS multi-slot class 12/ class 10 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. The GNSS solution offers best-in-class acquisition and tracing sensitivity, Time-To-First-Fix (TTFF) and accuracy.

With a tiny configuration of 24*24*2.6mm, SIM808 can meet almost all space requirements in users' applications, such as M2M, smart phone, PDA, tracker and other mobile devices.

SIM808 has 68 SMT pads, which provide all hardware interfaces between the module and customers' boards.

- Support 4*4keypads by default
- One full modem serial port(UART interface)
- One USB, which support debug and firmware upgrading.
- Audio channels which include a microphone input and a receiver output.
- One SIM card interface.
- Charging interface.
- Programmable general purpose input and output (GPIO).
- Support Bluetooth function.
- Support GNSS function.
- Support two PWMs and two ADCs.
- PCM interface.

SIM808 is designed with power saving technique so that the current consumption is as low as 1.2mA in sleep mode (with GNSS engine powered down).
SIM808 integrates TCP/IP protocol and extended TCP/IP AT commands which are very useful for data transfer applications. For details about TCP/IP applications, please refer to *document [2]*.

2.1 SIM808 Key Features

Table 1: SIM808 GSM/GPRS engine key features

Feature	Implementation
Power supply	3.4V ~ 4.4V
Power saving	Typical power consumption in sleep mode is 1.07 mA (BS-PA-MFRMS=9)
Charging	Supports charging control for Li-ion battery

Frequency bands	● SIM808 Quad-band: GSM 850, EGSM 900, DCS 1800, PCS 1900. SIM808 can search the 4 frequency bands automatically. The frequency bands also can be set by AT command "AT+CBAND". For details, please refer to *document [1]*. ● Compliant to GSM Phase 2/2+
Transmitting power	● Class 4 (2W) at GSM 850 and EGSM 900 ● Class 1 (1W) at DCS 1800 and PCS 1900
GPRS connectivity	● GPRS multi-slot class 12（default） ● GPRS multi-slot class 1~12 (optional)
Temperature range	● Normal operation: -40℃ ~ +85℃ ● Storage temperature -45℃~ +90℃
Data GPRS	● GPRS data downlink transfer: max. 85.6 kbps ● GPRS data uplink transfer: max. 85.6 kbps ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● PAP protocol for PPP connect ● Integrate the TCP/IP protocol. ● Support Packet Broadcast Control Channel (PBCCH)
USSD	● Unstructured Supplementary Services Data (USSD) support
SMS	● MT, MO, CB, Text and PDU mode ● SMS storage: SIM card
SIM interface	Support SIM card: 1.8V, 3V
External antenna	Antenna pad
Audio features	Speech codec modes: ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● Adaptive multi rate (AMR) ● Echo Cancellation ● Noise Suppression
Serial port and USB interface	**Serial port:** ● Full modem interface with status and control lines, unbalanced, asynchronous. ● 1200bps to 460800bps. ● Can be used for sending AT commands or transmitting data stream. ● Support RTS/CTS hardware handshake and software ON/OFF flow control. ● Multiplex ability according to GSM 07.10 Multiplexer Protocol. ● Autobauding supports baud rate from 1200 bps to 115200bps. **USB interface:** ● Can be used for debugging and firmware upgrading.
Phonebook management	Support phonebook types: SM, FD, LD, RC, ON, MC.
SIM application toolkit	GSM 11.14 Release 99
Real time clock	Support RTC
Alarm function	Can be set by AT command
Physical characteristics	Size: 24*24*2.6mm Weight: 3.3g
Firmware upgrade	Firmware upgrading by serial port or USB interface (recommend to use USB).

Table 2: GNSS engine 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/s^2
	DGPS		0.05		m/s^2
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		28		s
	Cold start		30		s
Sensitivity	Autonomous acquisition(cold start)		-148		dBm
	Re-acquisition		-159		dBm
	Tracking		-165		dBm
Receiver	Channels		22/66		
	Update rate			5	Hz
	Tracking L1, CA Code				
	Protocol support NMEA				
Power consumption(4)	Acquisition		42		mA
	Continuous tracking		24		mA

(1) 50% 24hr static, -130dBm
(2) 50% at 30m/s
(3) GNSS signal level: -130dBm
(4) Single Power supply 3.8V@-130dBm,GSM IDLE

Table 3: BT engine Performance

Parameter	Condition	Performance			
		Min	Type	Max	Unit
Frequency Range		2402		2480	MHz
Maximum Transmit Power			7		dBm
Gain Step			4		dB
Receiver Sensitivity	DH1 (BER<0.1%)		-91.4		dBm
	DH5 (BER<0.1%)		-91.4		dBm
EDR Receiver Sensitivity	2-DH5		-92		dBm
	3-DH5		-88		dBm

Table 4: Coding schemes and maximum net data rates over air interface

Coding scheme	1 timeslot	2 timeslot	4 timeslot
CS-1	9.05kbps	18.1kbps	36.2kbps
CS-2	13.4kbps	26.8kbps	53.6kbps
CS-3	15.6kbps	31.2kbps	62.4kbps
CS-4	21.4kbps	42.8kbps	85.6kbps

2.2 Operating Modes

The table below summarizes the various operating modes of SIM808.

Table 5: Overview of operating modes

Mode	Function	
Normal operation	GSM/GPRS SLEEP	Module will automatically go into sleep mode if the conditions of sleep mode are enabling and there is no on air and no hardware interrupt (such as GPIO interrupt or data on serial port). In this case, the current consumption of module will reduce to the minimal level. In sleep mode, the module can still receive paging message and SMS.
	GSM IDLE	Software is active. Module registered to the GSM network, and the module is ready to communicate.
	GSM TALK	Connection between two subscribers is in progress. In this case, the power consumption depends on network settings such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
	GPRS STANDBY	Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration.
	GPRS DATA	There is GPRS data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level); uplink/downlink data rates and GPRS configuration (e.g. used multi-slot settings).
	Charge	The mode support charge function (Default is closed).
Power off	Normal power off by sending the AT command “AT+CPOWD=1” or using the PWRKEY. The power management unit shuts down the power supply for the baseband part of the module, and only the power supply for the RTC is remained. Software is not active. The serial port is not accessible. Power supply (connected to VBAT) remains applied.	
Minimum functionality mode	AT command “AT+CFUN” can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work or the SIM card will not be accessible, or both RF part and SIM card will be closed, and the serial port is still accessible. The power consumption in this mode is lower than normal mode.	

2.3 SIM808 Functional Diagram

The following figure shows a functional diagram of SIM808:

- PMU
- The GSM baseband engine
- The GNSS engine
- The GSM Radio Frequency part
- The antenna interface
- The other interfaces

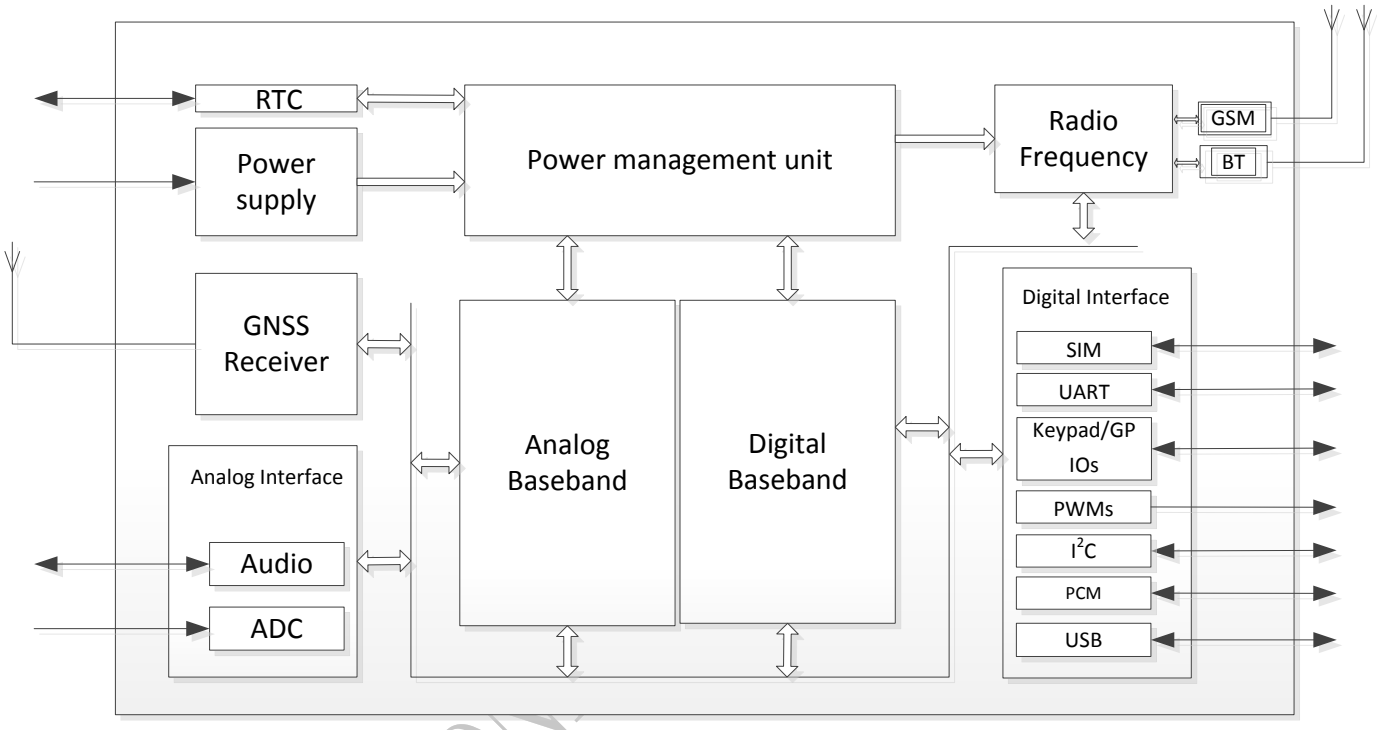

Figure 1：SIM808 functional diagram

3 Package Information

3.1 Pin out Diagram

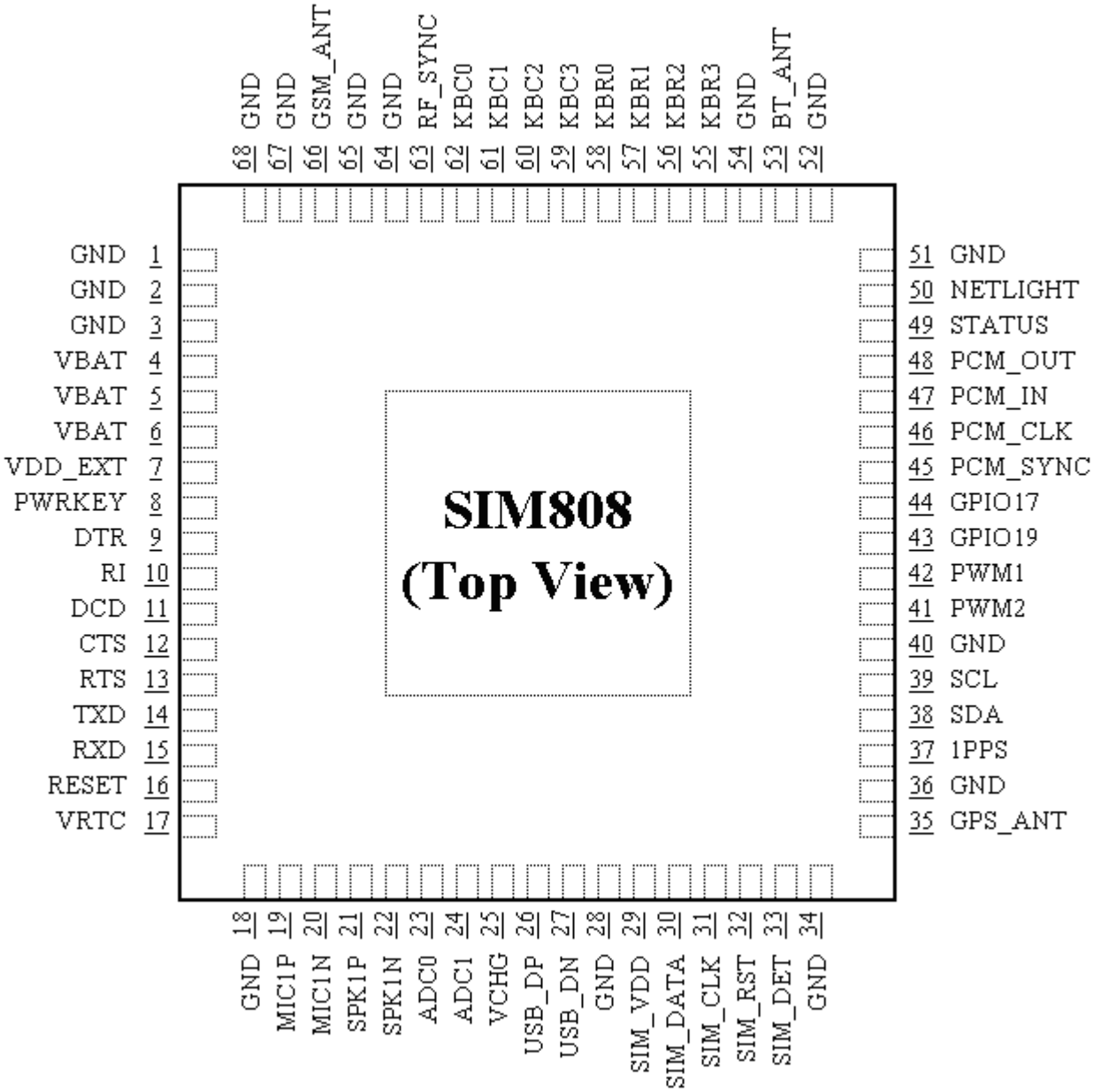

Figure 2: SIM808 pin out diagram (Top view)

3.2 Pin Description

Table 6: Pin description

Pin name	Pin number	I/O	Description	Comment
Power supply				
VBAT	4,5,6	I	SIM808 supplies 3 VBAT pins, and the power range is from 3.4V to 4.4V. Power supply should provide sufficient current so that the module can work normally; the peak current is nearly 2A.	Zener diode is Strongly recommended to anti surge on VBAT.
VRTC	17	I/O	Power supply for RTC	It is recommended to connect VRTC to a backup battery or a capacitor (e.g. 4.7uF).
VDD_EXT	7	O	2.8V power output	Keep floating if unused.
GND	1,2,3,18,28,34,36,40,51,52,54,64,65,67,68		Ground	Recommend connecting 1,2,3pin to the power GND.
Power on/off				
PWRKEY	8	I	PWRKEY should be pulled low at least 1 second and then released to power on/off the module.	Internally pulled up to 3V.
Audio interface				
MIC1P	19	I	Differential audio input	Keep floating if unused.
MIC1N	20			
SPK1P	21	O	Differential audio output	
SPK1N	22			
PCM interface				
PCM_OUT	48	O	PCM interface for audio	Keep floating if unused.
PCM_IN	47	I		
PCM_SYNC	45	O		
PCM_CLK	46	I		
Keypad interface				
KBC3	59	I	Support 16 buttons（4*4）by default	Keep floating if unused. (KBC0 can not be pulled down).
KBC2	60	I		
KBC1	61	I		
KBC0	62	I		
KBR3	55	O		
KBR2	56	O		
KBR1	57	O		
KBR0	58	O		
GPIO				

GPIO19	43	I/O	Programmable general purpose input and output.	
GPIO17	44	I/O		
Serial port				
DTR	9	I	Data terminal ready	Keep floating if unused.
RI	10	O	Ring indicator	
DCD	11	O	Data carrier detect	
CTS	12	O	Clear to send	
RTS	13	I	Request to send	
TXD	14	O	Transmit data	
RXD	15	I	Receive data	
USB interface				
VCHG	25	I	Debug and firmware upgrading	Keep floating if unused.
USB_DP	26	I/O		
USB_DN	27	I/O		
ADC				
ADC0	23	I	10 bit general analog to digital converter	Keep floating if unused.
ADC1	24			
PWM				
PWM1	42	O	Pulse-width modulation	Keep floating if unused.
PWM2	41	O	Pulse-width modulation	
I2C				
SDA	38	I/O	I2C serial bus data	Internal pulled up to 2.8V via 4.7KΩ
SCL	39	O	I2C serial bus clock	
SIM interface				
SIM_VDD	29	O	Voltage supply for SIM card. Support 1.8V or 3V for SIM card	All signals of SIM interface should be protected against ESD with a TVS diode array.
SIM_DATA	30	I/O	SIM data input/output	
SIM_CLK	31	O	SIM clock	
SIM_RST	32	O	SIM reset	
SIM_DET	33	I	SIM card detection	
Antenna				
GSM_ANT	66	I/O	Connect GSM antenna	Impendence must be controlled to 50Ω.
BT_ANT	53	I/O	Connect Bluetooth antenna	Impendence must be controlled to 50Ω.
GPS_ANT	35	I	Connect GPS antenna	Impendence must be controlled to 50Ω.
RF synchronization				
RF_SYNC	63	O	RF burst synchronous signal	Do not pull up
Other signal				
RESET	16	I	Reset input(Active low)	
1PPS	37	O	Time Mark outputs timing pulse related to receiver time	If unused, keep open.

NETLIGHT	50	O	Network status	Can not multiplex with GPIO function.
STATUS	49	O	Power on status	

3.3 Package Dimensions

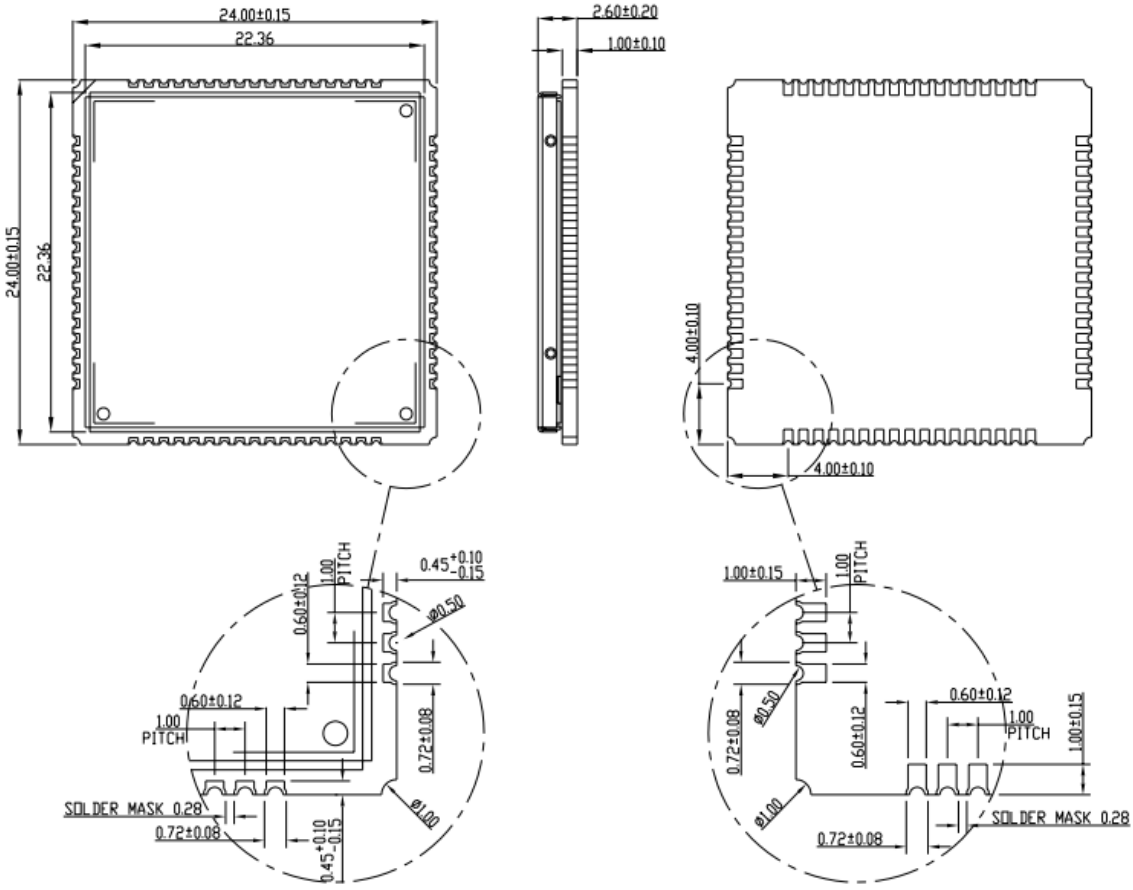

Figure 3：Dimensions of SIM808（Unit: mm）

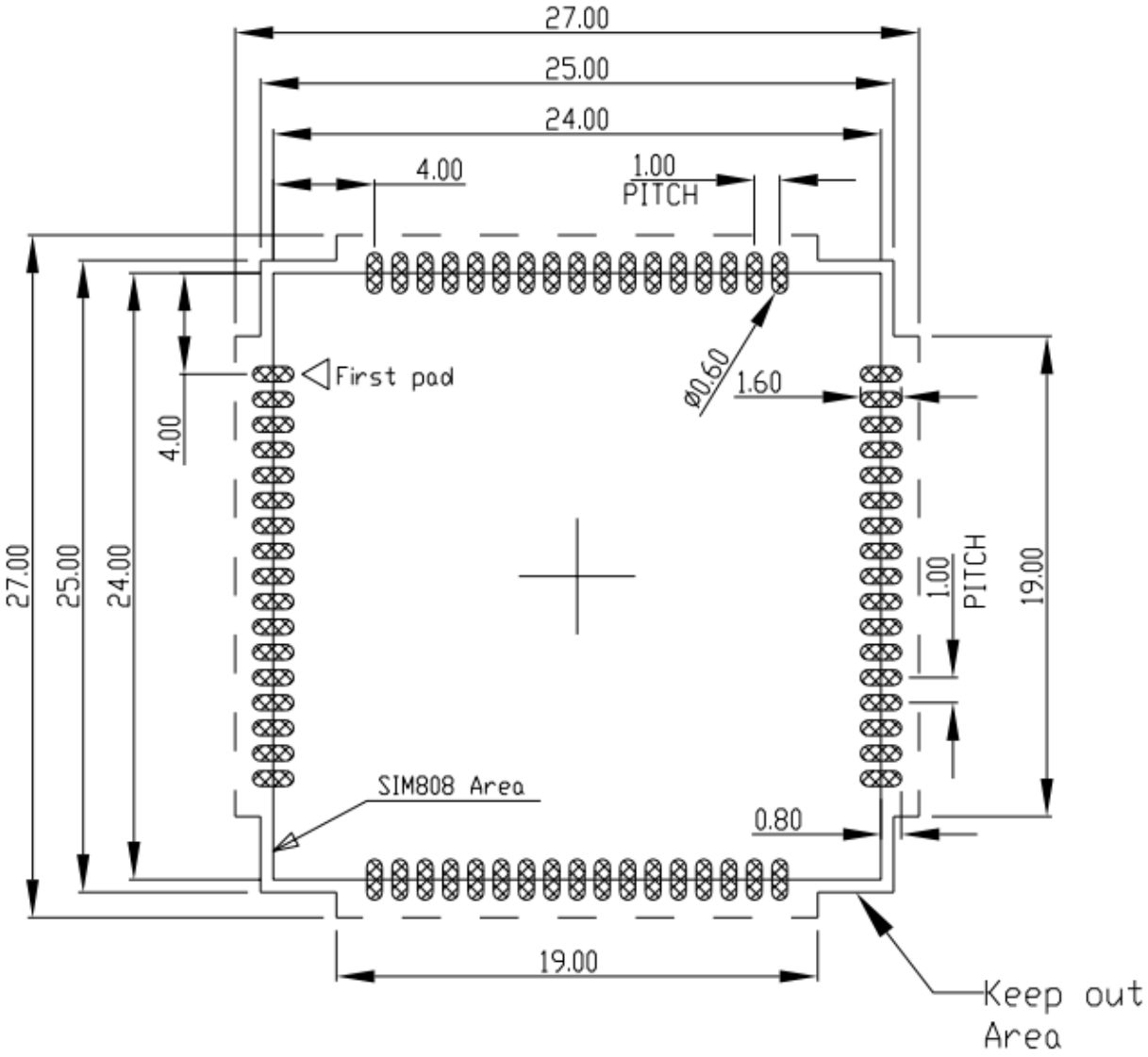

Figure 4: Recommended PCB footprint outline（Unit: mm）

4 Application Interface

4.1 Power Supply

The power supply range of SIM808 is from 3.4V to 4.4V.Recommended voltage is range from 3.8V to 4.0V.The transmitting burst will cause voltage drop and the power supply must be able to provide sufficient current up to 2A. For the VBAT input, a decoupling capacitor (low ESR) such as a 100 μF is strongly recommended.

Increase the 33PF and 10PF capacitors can effectively eliminate the high frequency interference. A 5.1V/500mW Zener diode is strongly recommended, the diode can prevent chip from damaging by the voltage surge. These capacitors and Zener diode should be placed as close as possible to SIM808 VBAT pins.

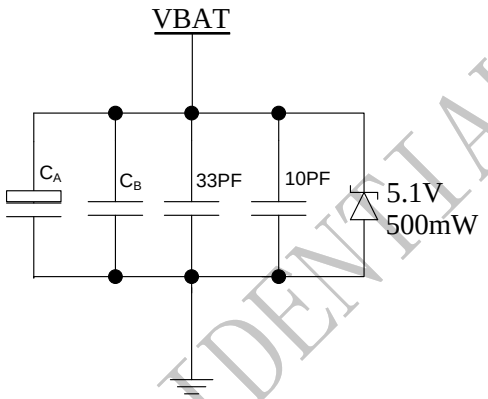

Figure 5: Reference circuit of the VBAT input

Table 7: Recommended Zener diode

	Vendor	Part number	Power(watts)	Packages
1	On semi	MMSZ5231BT1G	500mW	SOD123
2	Prisemi	PZ3D4V2H	500mW	SOD323
3	Vishay	MMSZ4689-V	500mW	SOD123
4	Crownpo	CDZ55C5V1SM	500mW	0805

The following figure is the reference design of +5V input power supply. The designed output for the power supply is about 3.9V, thus a linear regulator can be used.

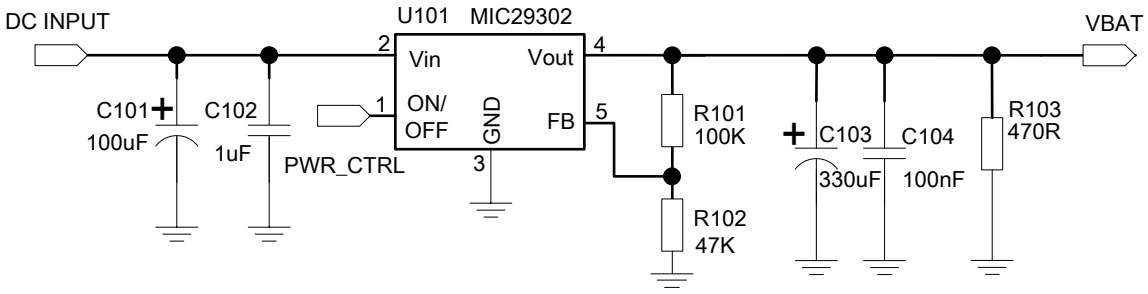

Figure 6: Reference circuit of the LDO power supply

If there is a high drop-out between the input and the desired output (VBAT), a DC-DC power supply will be preferable because of its better efficiency especially with the 2A peak current in burst mode of the module. The following figure is the reference circuit.

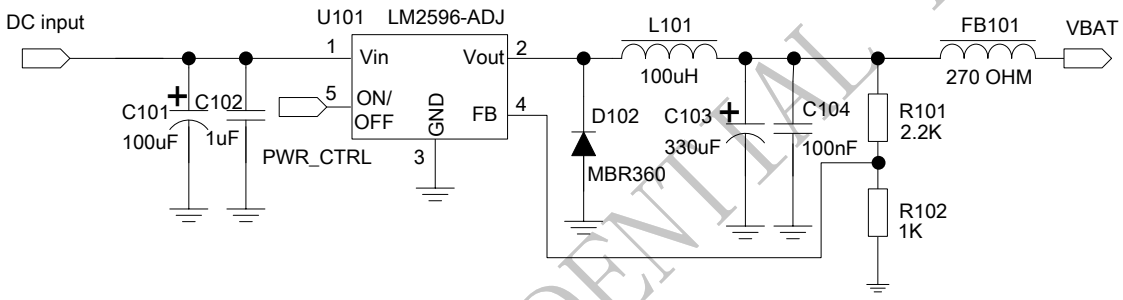

Figure 7: Reference circuit of the DC-DC power supply

The single 3.7V Li-ion cell battery can be connected to SIM808 VBAT pins directly. But the Ni-Cd or Ni-MH battery must be used carefully, since their maximum voltage can rise over the absolute maximum voltage of the module and damage it.

Notes：The module do not support for charging Ni-Cd or Ni-MH battery.

When battery is used, the total impedance between battery and VBAT pins should be less than 150mΩ.

The following figure shows the VBAT voltage drop at the maximum power transmit phase, and the test condition is as following:

VBAT=4.0V,

A VBAT bypass capacitor C_A=100μF tantalum capacitor (ESR=0.7Ω),

Another VBAT bypass capacitor C_B=1μF.

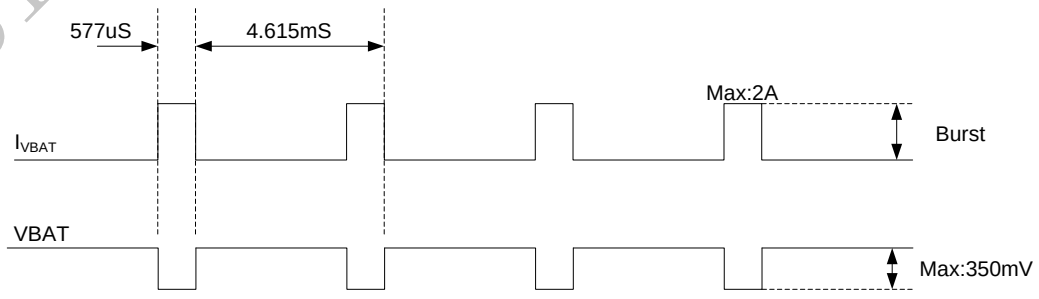

Figure 8: VBAT voltage drop during transmit burst

4.1.1 Power Supply Pin

There are 3 VBAT pins(Pin 4, 5, 6)used for power input, and Pin 1,2,3 should be connected to the power GND. VRTC pin is power supply of the RTC circuit in the module. VDD_EXT will output 2.8V when module is powered on and in normal operation.

When designing the power supply in user's application, pay special attention to power losses. Ensure that the input voltage never drop below 3.4V even when current consumption rises to 2A in the transmit burst. If the power voltage drops below 3.4V, the module may be shut down automatically. The PCB traces from the VBAT pins to the power supply must be wide enough (at least 80mil) to decrease voltage drops in the transmit burst. The power IC and the bypass capacitor should be placed to the module as close as possible.

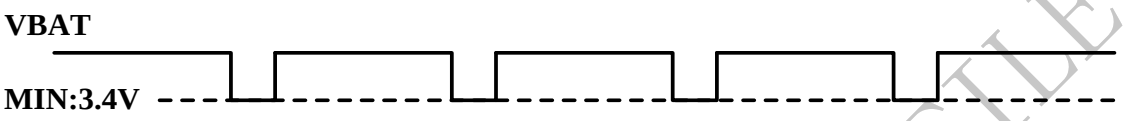

Figure 9: The minimal VBAT voltage requirement at VBAT drop

4.1.2 Monitoring Power Supply

The AT command "AT+CBC" can be used to monitor the VBAT voltage. For detail, please refer to ***document [1].***

4.2 Power on/off SIM808

4.2.1 Power on SIM808

SIM808 will be powered on in the following situations:

- Power on SIM808 using the PWRKEY pin.
- Power on SIM808 using the VCHG pin

4.2.1.1 Power on SIM808 Using the PWRKEY Pin

User can power on SIM808 by pulling down the PWRKEY pin for at least 1 second and release. This pin is already pulled up to VBAT in the module internal, so external pull up is not necessary. Reference circuit is shown as below.

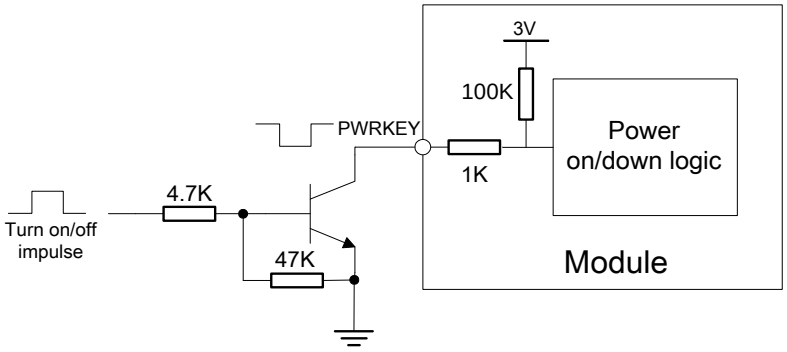

Figure 10: Powered on/down module using transistor

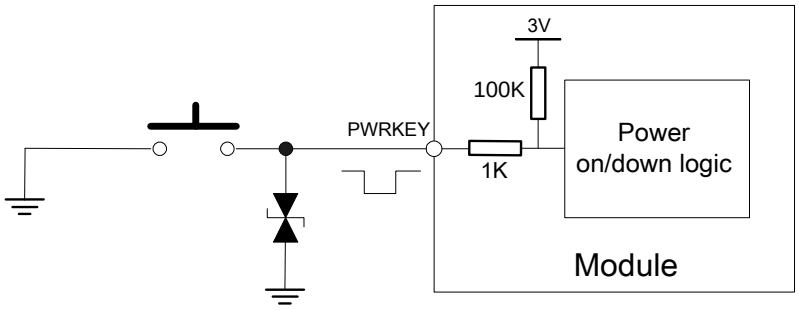

Figure 11:Powered on/down module using button

The power on scenarios is illustrated as following figure.

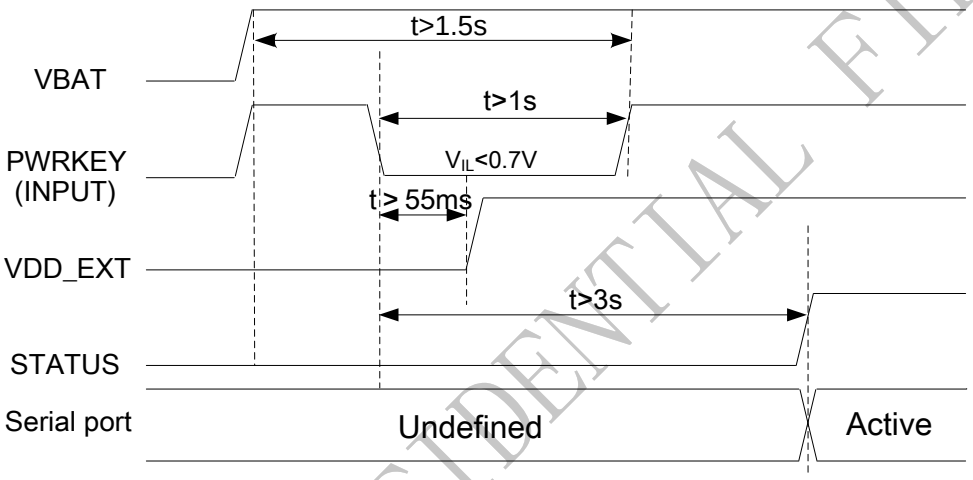

Figure 12: Timing of power on module

When power on procedure is completed, SIM808 will send following URC to indicate that the module is ready to operate at fixed baud rate.

RDY

This URC does not appear until autobauding function is active.

Note: User can use AT command "AT+IPR=x" to set a fixed baud rate and save the configuration to non-volatile flash memory. After the configuration is saved as fixed baud rate, the Code "RDY" should be received from the serial port every time when SIM808 is powered on. For details, please refer to the chapter "AT+IPR" in document [1].

4.2.1.2 Power on the SIM808 using the VCHG Signal

The switched-off SIM808, of which VBAT pin voltage is greater than 3.4V, will be automatically turned on when a charger is connected to VCHG pin.

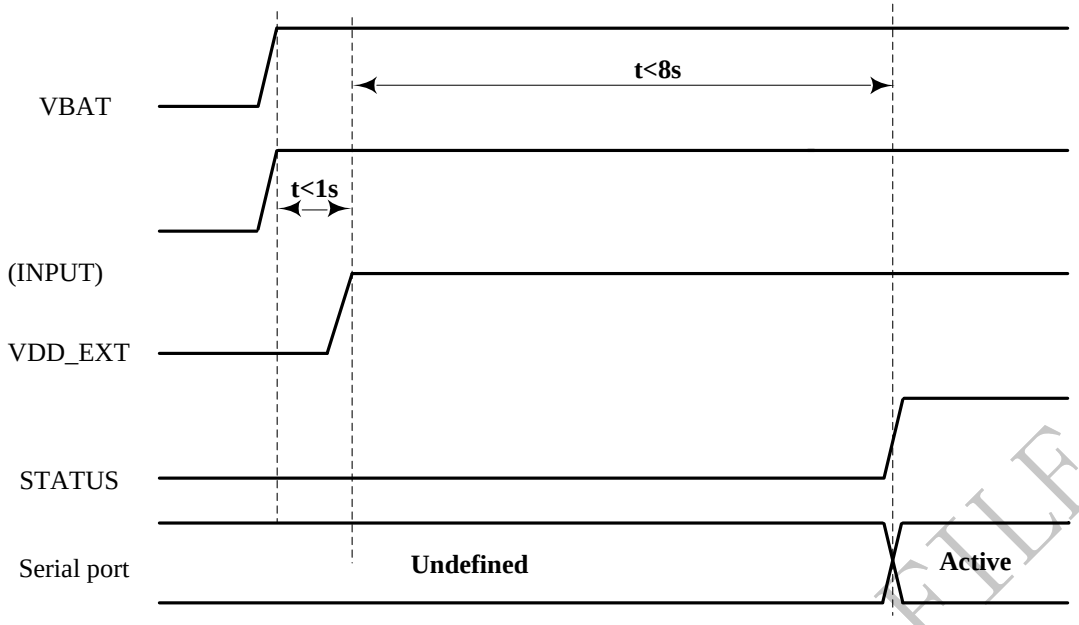

Figure 13: Timing of power on module

4.2.2 Power off SIM808

SIM808 will be powered off in the following situations:

- Normal power off procedure: power off SIM808 by the PWRKEY pin.
- Normal power off procedure: power off SIM808 by AT command "AT+CPOWD=1".
- Abnormal power off: over-voltage or under-voltage automatic power off.

Note: The VCHG pin should not be charged, otherwise, the module will not be powered off.

4.2.2.1 Power off SIM808 by the PWRKEY Pin

User can power off SIM808 by pulling down the PWRKEY pin for at least 1.5 second and release. Please refer to the power on circuit. The power off scenario is illustrated in following figure.

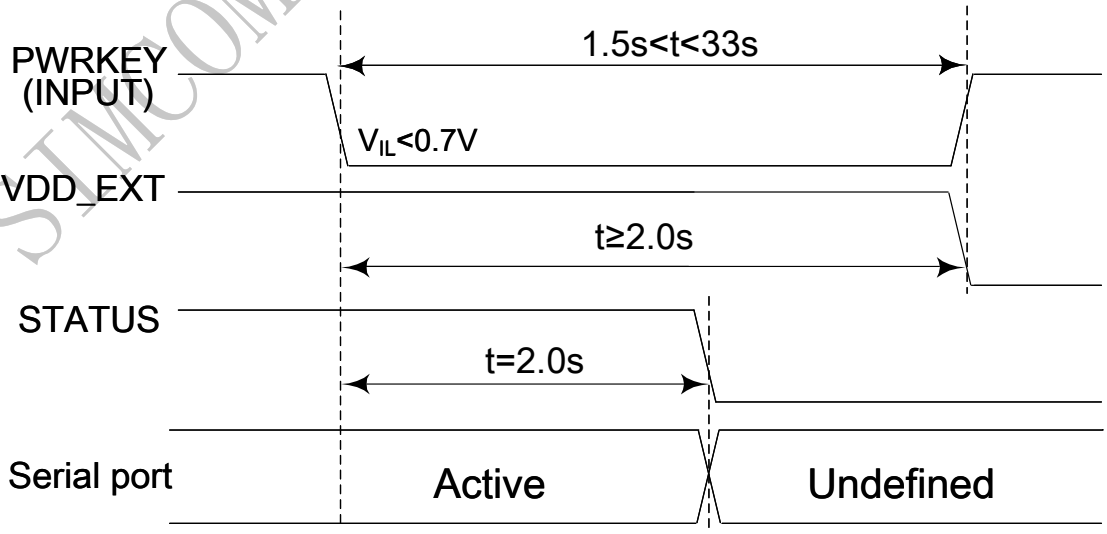

Figure 14: Timing of power off SIM808 by PWRKEY

This procedure makes the module log off from the network and allows the software to enter into a secure state to

save data before completely shut down.

Before the completion of the power off procedure, the module will send URC:

NORMAL POWER DOWN

At this moment, AT commands can not be executed any more, and only the RTC is still active. Power off mode can also be indicated by STATUS pin, which is at low level at this time.

4.2.2.2 Power off SIM808 by AT Command

SIM808 can be powered off by AT command "AT+CPOWD=1". This procedure makes the module log off from the network and allows the software to enter into a secure state to save data before completely shut down.

Before the completion of the power off procedure, the module will send URC:

NORMAL POWER DOWN

At this moment, AT commands can not be executed any more, and only the RTC is still active. Power off mode can also be indicated by STATUS pin, which is at low level at this time.

For detail about the AT command "AT+CPOWD", please refer to *document [1]*

4.2.2.3 Over-voltage or Under-voltage Power off

The module software monitors the VBAT voltage constantly.

If the voltage ≤ 3.5V, the following URC will be reported:

UNDER-VOLTAGE WARNNING

If the voltage ≥ 4.3V, the following URC will be reported:

OVER-VOLTAGE WARNNING

If the voltage < 3.4V, the following URC will be reported, and the module will be automatically powered off.

UNDER-VOLTAGE POWER DOWN

If the voltage > 4.4V, the following URC will be reported, and the module will be automatically powered off.

OVER-VOLTAGE POWER DOWN

At this moment, AT commands can not be executed any more, and only the RTC is still active. Power off mode can also be indicated by STATUS pin, which is at low level at this time.

4.2.3 Reset Function

SIM808 also has a RESET pin (pin 16) used to reset the module. This function is used as an emergency reset only when AT command "AT+CPOWD=1" and the PWRKEY pin has no effect. User can pull the RESET pin to ground, then the module will reset.

This pin is already isolated in the module, so the external isolation is not necessary. Following figure is internal circuit of the RESET pin.

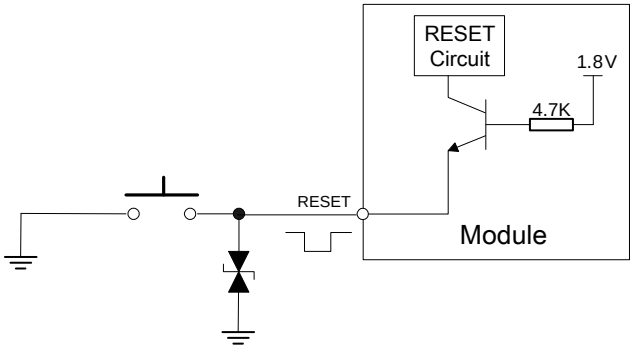

Figure 15: Reset Circuit

The typical value of RESET pin high level is 1.8V, but with the isolated circuit inside，even for the 3V or 3.3V, customer could use MCU's GPIO to driver this pin directly. Resistor in serial the RESET signal could enhance the ESD performance but the value, which should not be too high, must be less than 100Ω . Otherwise the level of RESET could not be lower than threshold value; RESET hardware parameters can refer to the following table.

Table 8: Electronic characteristic of the RESET Pin

Pin name	Symbol	Min	Typ	Max	Unit
RESET	V_{IH}	1.2	1.8	3.3	V
	V_{IL}	-	-	0.6	V
	$T_{pull\ down}$	105		-	ms

The reset scenarios are illustrated in the following figure.

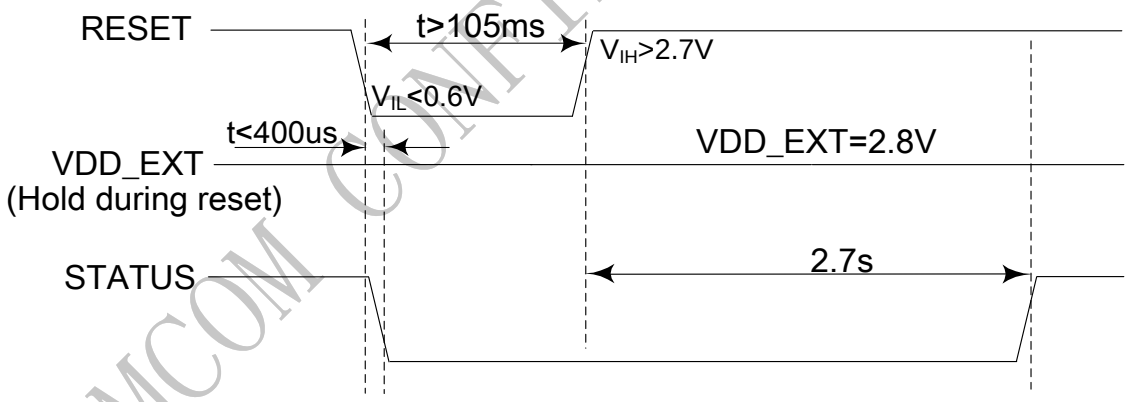

Figure 16: Reset timing sequence

4.3 Power Saving Mode

SIM808 has two power saving modes: functionality mode and sleep mode. The AT command "AT+CSCLK=1" can be used to set SIM808 into sleep mode. The AT command "AT+CFUN=<fun>" can be used to set SIM808 into minimum function. When SIM808 is in sleep mode and minimum function mode, the current of module is the lowest.

Note: Customer must shut off the power supply of GNSS, and then the AT commands about the power saving mode can be executed correctly, and the current consumption will be lower.

4.3.1 Functionality Mode

There are three functionality modes, which could be set by the AT command "AT+CFUN=<fun>". The command provides the choice of the functionality levels <fun>=0, 1, 4.

- AT+CFUN=0: minimum functionality.
- AT+CFUN=1: full functionality (default).
- AT+CFUN=4: flight mode (disable RF function).

Table 9: The current consumption of function modes (AT+CSCLK=1)

<Fun>	Current consumption(mA)
0	0.801
1	1.176 (BS-PA-MFRMS=5)
4	0.925

Minimum functionality mode minimizes the current consumption to the lowest level. If SIM808 is set to minimum functionality by "AT+CFUN=0", the RF function and SIM card function will be disabled. In this case, the serial port is still accessible, but all AT commands correlative with RF function and SIM card function will not be accessible.

For detailed information about the AT Command "AT+CFUN=<fun>", please refer to *document [1]*.

4.3.2 Sleep Mode (AT+CSCLK=1)

When the GNSS function is shut off, user can control SIM808 module to enter or exit the sleep mode (AT+CSCLK=1) by DTR signal. When DTR is in high level and without interrupt (on air and hardware such as GPIO interrupt or data in serial port), SIM808 will enter sleep mode automatically. In this mode, SIM808 can still receive paging or SMS from network but the serial port is not accessible.

Note: For SIM808, it requests to set AT command "AT+CSCLK=1" and ensure DTR at high level to enable the sleep mode; the default value is 0, which can not make the module to enter sleep mode. For more details please refer to document [1].

4.3.3 Wake Up SIM808 from Sleep Mode (AT+CSCLK=1)

When SIM808 is in sleep mode (AT+CSCLK=1), the following methods can wake up the module:

- Pull down DTR pin.
  The serial port will be active after DTR pin is pulled to low level for about 50ms.
- Receive a voice or data call from network.
- Receive a SMS from network.
- Receive external interrupt
- Charge VCHG pin

Note: After module has received incoming call or new SMS, serial port can report URC, but the serial port can not input AT command. Only after the DTR pin is pulled to low level for 50ms, the serial port can input AT command.

4.4 Charging Interface

SIM808 has integrated a charging circuit inside the module for Li-ion batteries charging control, which make it very convenient for user's applications that support battery charging. A common connection is shown in the following figure:

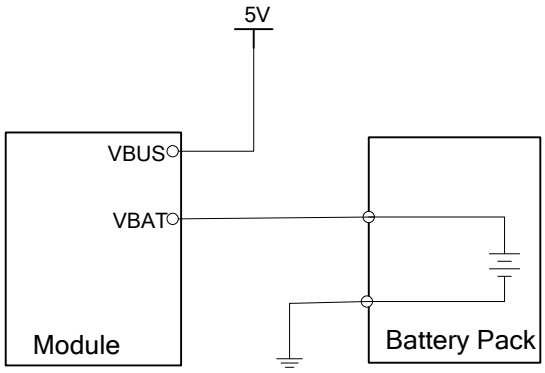

Figure 17: SIM808 with battery charger and pack connection

4.4.1 Battery Pack Characteristics

SIM808 has optimized the charging algorithm for the Li-ion battery that meets the characteristics listed below.

- The maximum charging voltage of the Li-ion battery pack is 4.2V and the recommended capacity is 1100mAh. The Battery packs with more than 1100 mAh capacity will take more time for charging.
- The battery pack should have a protection circuit to avoid overcharging, deep discharging and over-current, and the circuit should be insensitive to pulsed current.
- The internal resistance of the battery pack including protection circuit should be as low as possible. Its recommended value does not exceed 150mΩ.
- The battery pack must be protected from reverse pole connection.

On the SIM808, the build-in circuit of the power management chipset monitors the supply voltage constantly. Once the Under-voltage is detected, the SIM808 will be powered off automatically.

4.4.2 Recommended Battery Pack

Following is the specification of recommended battery pack:

Table 10: Specification of recommended battery pack

Items	Description
Battery type	Li-ion
Manufacturer	Jiade Energy Technology
Normal voltage	3.7V
Capacity	NORMAL 1100mAh
Charge Voltage	4.200±0.050V
Max Charge Current	1.0C
Charge Method	CC / CV (Constant Current / Constant Voltage)

Max Discharge Current	1.0C (for continuous discharging mode)
Discharge Cut-off Voltage	3.0V/ cell
Internal resistance	Initial≤150mΩ

4.4.3 Implemented Charging Technique

SIM808 has battery charging function, but charging function is not supported by default, the customer should input AT command（AT+echarge=1） to enable charging function. There are two pins related to the battery charging function: VCHG, VBAT. The VCHG Pin is driven by an external voltage (AC adapter or USB host).System can use this pin to detect a charger supply and the external voltage provides most charging current through SIM808 module to battery when charging is in fast charge state. VBAT pin gives charging current to external battery from SIM808 module.

It is very simple to implement charging function, user just needs to connect the charger to the VCHG Pin and connect the battery to the VBAT Pin
SIM808 battery charging happens after detecting charger supply and the presence of battery. If there is no charger supply or no battery present, charging function will not be enabled.

Normally, there are three states in the whole charging procedure.

- DDLO charge (Pull-up mode) and UVLO charge (Pre-charge mode);
- Constant current mode (CC);
- Constant voltage mode and over-voltage protection(OV)

DDLO charge and UVLO charge:
DDLO is the state of battery when its voltage is under 2.5V. And UVLO means the battery voltage is less than 3.2V and more than 2.5V. The battery is not suitable for fast charging when its condition is DDLO or UVLO. The SIM808 provides a small constant current to the battery when the battery is between DDLO and UVLO. In DDLO charging state, SIM808 gives out pu1se 70mA current to the battery. And in UVLO charging state, SIM808 provides about 200mA (AC<7V) or 70mA (USB mode) current to the battery.

DDLO charging terminates when the battery voltage reaches 2.5V. UVLO charging terminates when the battery voltage is up to 3.2V. Both DDLO and UVLO charge are controlled by the SIM808 hardware only.

Constant current mode (CC):
As the battery voltage is charged up and over 3.4V, the SIM808 will enter CC mode. The typical CC mode charging current with AC adapter is 700mA, and can be set from 70 to 800mA by the software.

Constant voltage mode (CV) and over-voltage protection (OV):
As the battery is charged up and over 4.1V, the SIM808 will enter CV mode. While the batter voltage actually reaches 4.2V, the charging current is gradually decreased step by step until stop charging.

4.4.4 Operating Modes during Charging

The battery can be charged during various operating mode. That means that charging can be in progress while SIM808 is in Normal mode (SLEEP, IDLE, TALK, GPRS IDLE or GPRS DATA mode). In this case the voltage supply should be sufficient. Here Charging in Normal mode is named as Charge mode.

If the charger is connected to the module's VCHG Pin and the valid battery is connected to the VBAT Pin while

SIM808 is in POWER DOWN mode, SIM808 will auto power up.

4.4.5 Charger Requirements

Following is the requirements of charger for SIM808:

- Simple transformer power plug
- Output voltage: 5.0V~7V
- Minimum supply current: 1.0 C
- A 10V peak voltage is allowed for maximum 1ms when charging current is switched off.
- A 1.6A peak current is allowed for maximum 1ms when charging current is switched on.

4.5 RTC Backup

Current input for RTC when the VBAT is not supplied for the system. Current output for backup battery when the VBAT power supply is in present and the backup battery is in low voltage state. The RTC power supply of module can be provided by an external capacitor or a battery (non-chargeable or rechargeable) through the VRTC. The following figures show various reference circuits for RTC back up.

- **External capacitor for RTC**

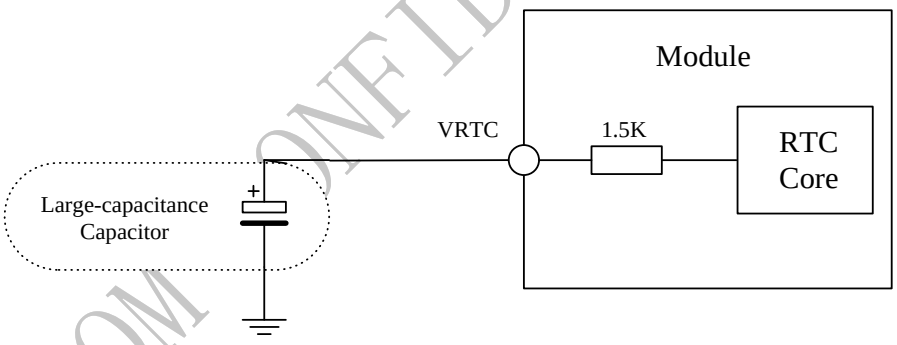

Figure 18: RTC supply from capacitor

- **Non-chargeable battery for RTC**

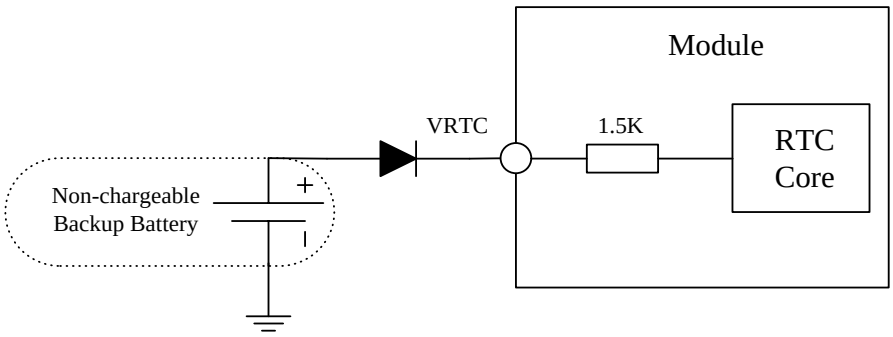

Figure 19: RTC supply from non-chargeable battery

- **Rechargeable battery for RTC**

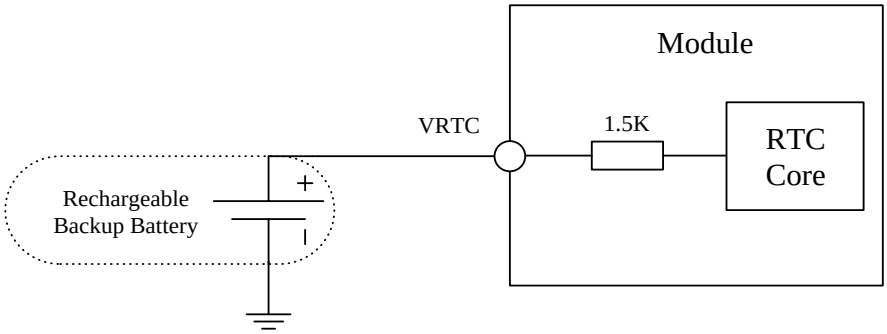

Figure 20: RTC supply from rechargeable battery

Coin-type rechargeable battery is recommended.

NOTE: When there are no sources on the VBAT or VCHG pins, which means the module is only supplies by the external VRTC, the system time will not be accurate.

4.6 Serial Port and USB Interface

Table 11: Serial port and USB pin definition

	Name	Pin number	Function
Serial port	DTR	9	Data terminal ready
	RI	10	Ring indicator
	DCD	11	Data carrier detect
	CTS	12	Clear to send
	RTS	13	Request to send
	TXD	14	Transmit data
	RXD	15	Receive data
USB interface	VCHG	25	VCHG power supply
	USB_DP	26	USB data line positive
	USB_DN	27	USB data line negative

SIM808 provides one unbalanced asynchronous serial port. The module is designed as a DCE (Data Communication Equipment). The following figure shows the connection between module and client (DTE).

Note: Hardware flow control is disabled by default. The AT command "AT+IFC=2,2" can enable hardware flow control .The AT command "AT+IFC=0,0"can disable hardware flow control. For more details, please refer to document [1].

Table 12: Serial port characteristics

Symbol	Min	Typ	Max	Unit
V_{IL}	-0.3	-	0.7	V
V_{IH}	2.1	-	3.1	V
V_{OL}	-	-	0.4	V
V_{OH}	2.4	2.8	-	V

4.6.1 Function of Serial Port

Serial port:

- Full modem device.
- Contains data lines TXD and RXD, hardware flow control lines RTS and CTS, status lines DTR, DCD and RI.
- Serial port can be used for GPRS service and AT communication..
- Serial port supports the following baud rates:
  1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 and 460800bps
- Autobauding only supports the following baud rates:
  1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200bps

- The default setting is autobauding.

Autobauding allows SIM808 to automatically detect the baud rate of the host device. Pay more attention to the following requirements:

- **Synchronization between DTE and DCE:**

  When DCE powers on with autobauding enabled, firstly, user must send character “AT” or “at” to synchronize the baud rate. It is recommended to send “AT” until DTE receives the “OK” response, which means DTE and DCE are correctly synchronized. For more information please refer to the AT command “AT+IPR”.

- **Restrictions of autobauding operation:**

  The DTE serial port must be set at 8 data bits, no parity and 1 stop bit.

  The URC such as "RDY", "+CFUN: 1" and "+CPIN: READY” will not be reported.

Note: User can use AT command “AT+IPR=x” to set a fixed baud rate and the setting will be saved to non-volatile flash memory automatically. After the configuration is set as fixed baud rate, the URC such as "RDY", "+CFUN: 1" and "+CPIN: READY” will be reported when SIM808 is powered on.

4.6.2 Serial Port

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

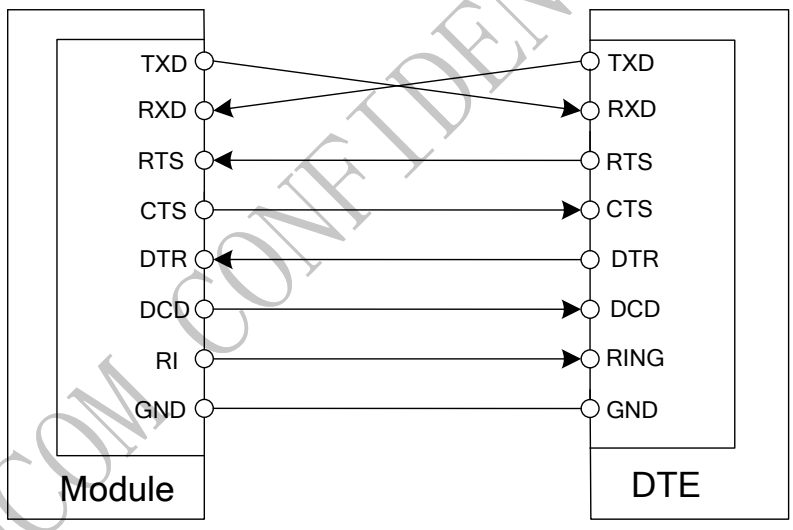

Figure 21: Connection of the serial port

If the voltage of UART on the DTE side is 3.3V, the following reference circuits are recommended. And if the voltage is 3.0V, please change the resistors in the following figure from 5.6K to 14K.

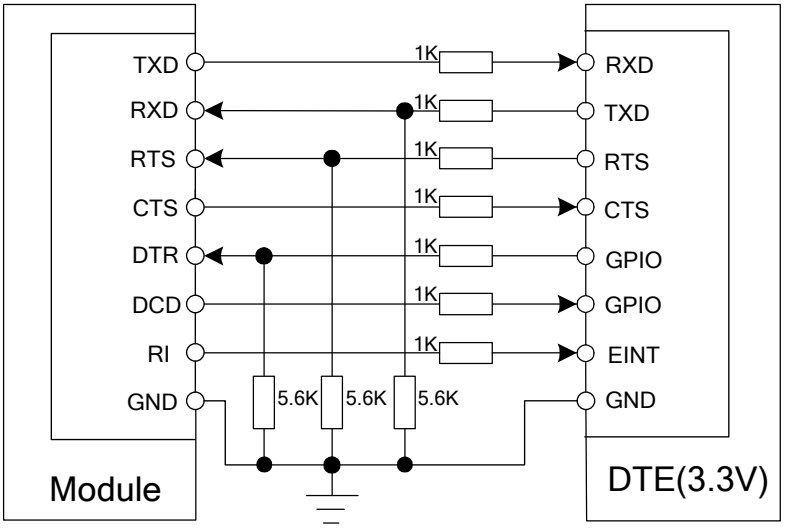

Figure 22: Level converting by resistor

If the voltage of UART is 3V or3.3V, user also can use following reference circuits:

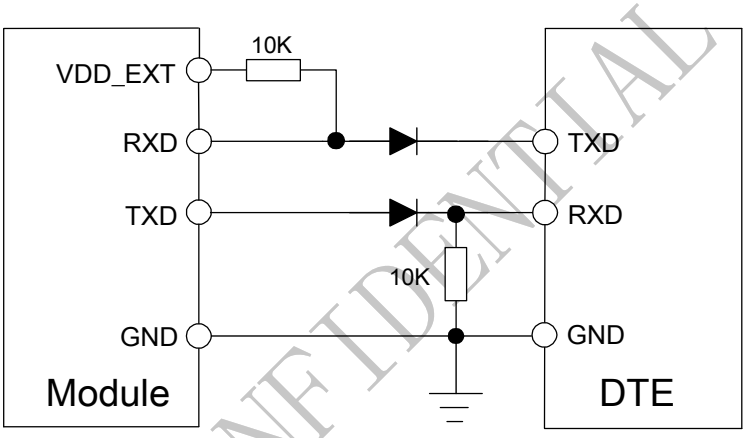

Figure 23: Isolation circuit by diodes

Note: when a diode used to isolate voltage cross, customer should notice that there's voltage drop on the diode. And the signal's voltage level should meet the customer's electrical character. The recommend diode is Schottky diode e.g. RB551V-30TE-17 and SDM20U40.

If the voltage of UART is 5V on customer side, customer can use the following reference circuits :

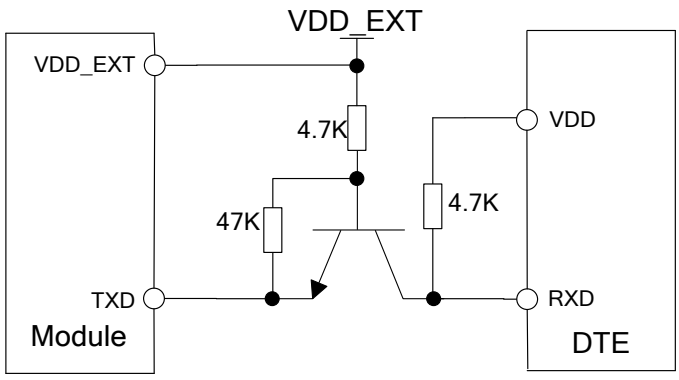

Figure 24: TX level converting by transistor

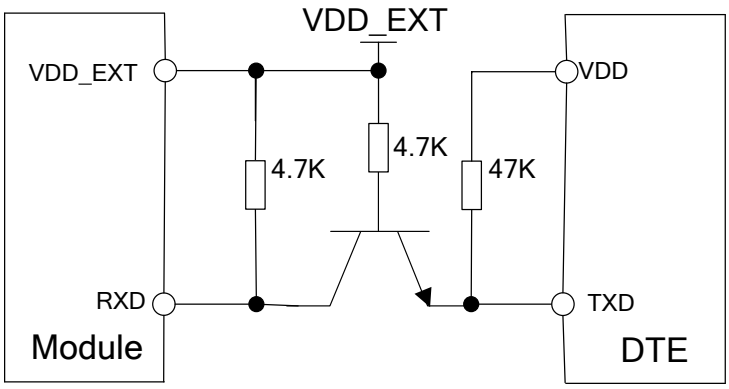

Figure 25: RX level converting by transistor

Note: The recommend Transistors' part numbers are 2SC4617TLR and PBHV8115Z.

4.6.3 USB Interface

USB interface supports software debug, firmware upgrade, do not support AT command by default. When power on the module, connect VCHG, USB_DP, USB_DN and GND to PC, then install the driver successfully, a UART port could be recognized by the PC, customer can achieve the software Debug purpose with this UART port.

The following diagram is recommended:

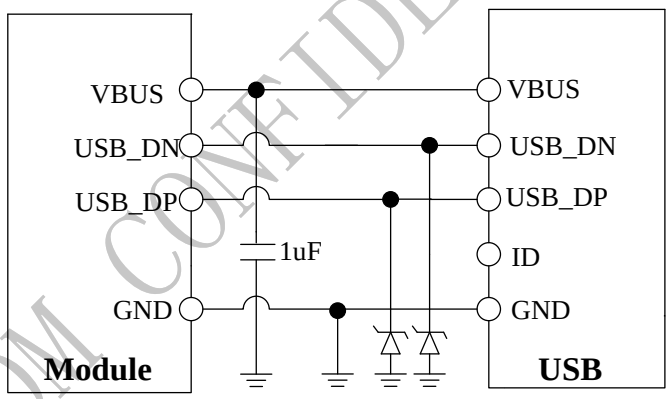

Figure 26: USB reference circuit

The maximum allowable cap load of TVS on USB data line should be less than 5pF (e.g. ESD9L5.0ST5G and ESD9M5.0ST5G). The USB_DP and USB_DN should be routed in differential traces.

Note: please reserve the USB interface or test point for debug and firmware upgrade.

Table 13: VCHG characteristics

Pin	Min	Typ	Max	Unit
VCHG	4.3	5.0	7.0	V

4.6.4 Software Upgrade and Debug

Both serial port and USB interface can be used for firmware upgrade.

If customer upgrading firmware via the USB port with the download tool, SIM808 power pin VBAT must be supplied first, then connect VCHG, USB_DP, USB_DN and GND to PC. There is no need to operate PWRKEY pin in the whole procedure, when SIM808 detects VCHG and could communicate normally by USB_DP and USB_DN, module will enter USB download mode automatically.

Note: When only USB_DP and USB_DN connected, no VCHG, customer need to pull down COL0 before power on the module, then press the PWRKEY button, the module will enter download mode.

Also only the USB interface can be used to debug by default.

4.7 RI Behaviors

Table 14: RI Behaviour

State	RI response
Standby	High
Voice call	The pin is changed to low. When any of the following events occur, the pin will be changed to high: (1)Establish the call (2)Hang up the call
Data call	The pin is changed to low. When any of the following events occur, the pin will be changed to high: (1)Establish the call (2)Hang up the call
SMS	The pin is changed to low, and kept low for 120ms when a SMS is received. Then it is changed to high.
URC	The pin is changed to low, and kept low for 120ms when some URCs are reported. Then it is changed to high. For more details, please refer to *document [4]*.

The behavior of the RI pin is shown in the following figure when the module is used as a receiver.

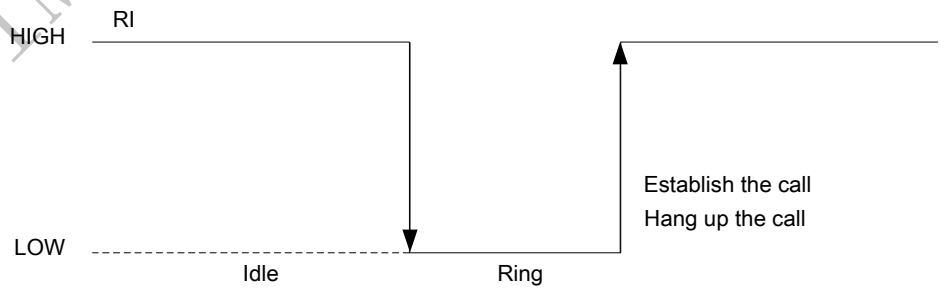

Figure 27: RI behaviour of voice calling as a receiver

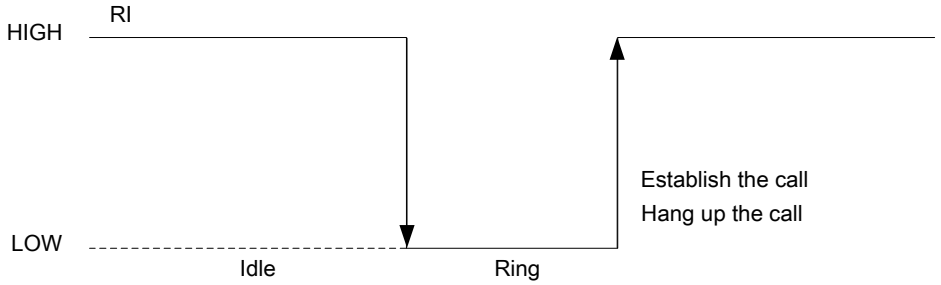

Figure 28: RI behaviour of data calling as a receiver

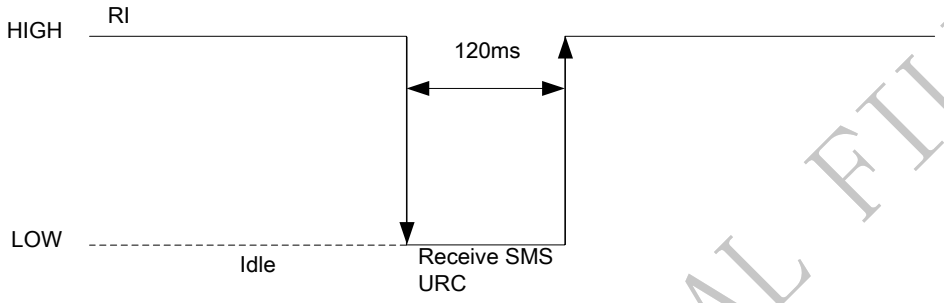

Figure 29: RI behaviour of URC or receive SMS

However, if the module is used as caller, the RI will remain high. Please refer to the following figure.

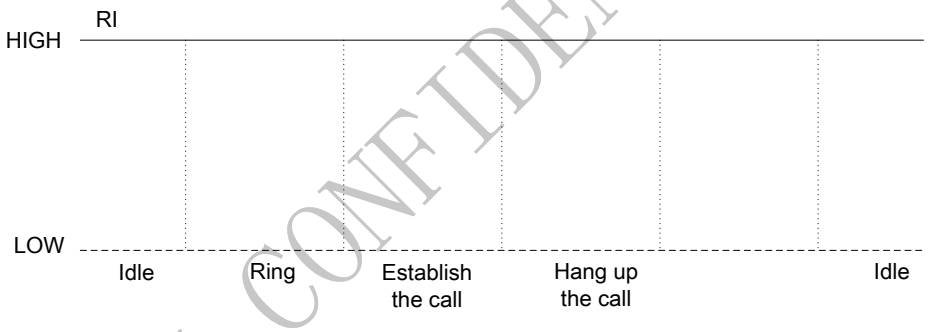

Figure 30: RI behaviour as a caller

4.8 Audio Interfaces

SIM808 provides one analog input, which could be used for electret microphone. The module also provides one analog output, which can directly drive 32Ω receiver.

Table 15: Audio interface definition

	Pin name	Pin number	Function
Audio channel	MIC1P	19	Main Audio input positive
	MIC1N	20	Main Audio input negative
	SPK1P	21	Main Audio output positive
	SPK1N	22	Main Audio output negative

"AT+CMIC" is used to adjust the input gain level of microphone. "AT+SIDET" is used to set the side-tone level. In addition, "AT+CLVL" is used to adjust the output gain level. For more details, please refer to *document [1]*

In order to improve audio performance, the following reference circuits are recommended. The audio signals have to be layout according to differential signal layout rules as shown in following figures.

4.8.1 Speaker Interface Configuration

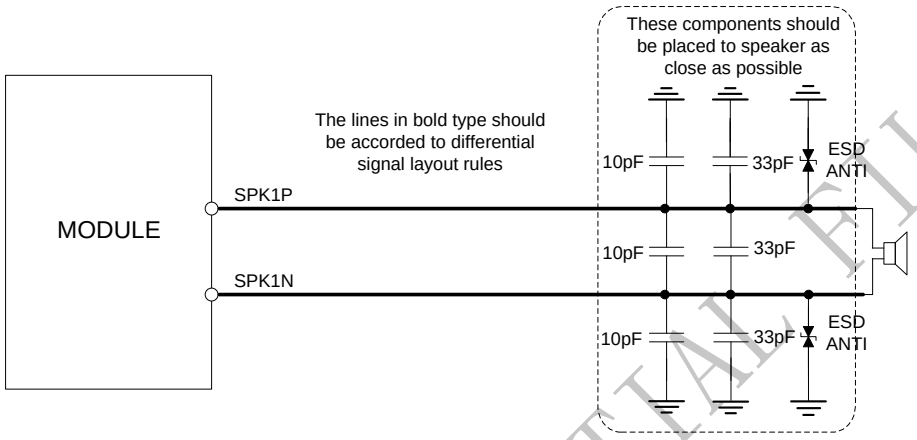

Figure 31: Speaker reference circuit

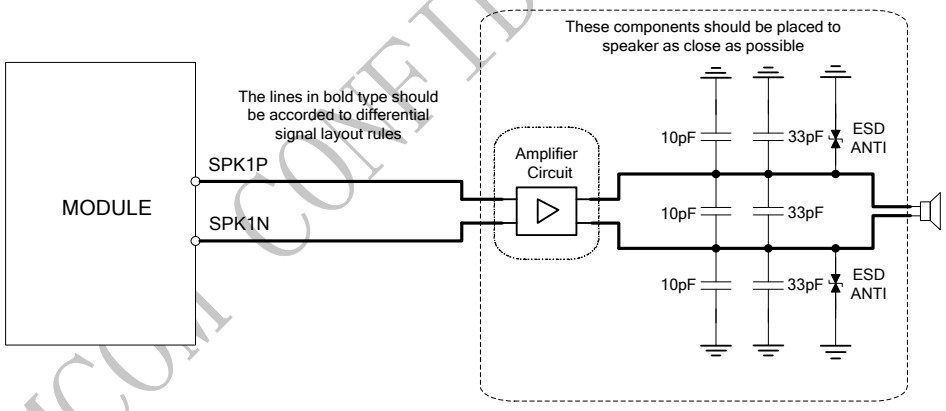

Figure 32 : Speaker with amplifier reference circuit

4.8.2 Microphone Interfaces Configuration

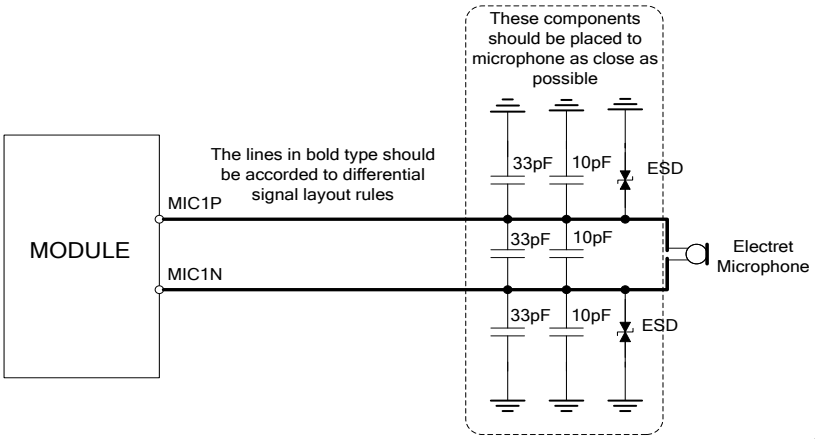

Figure 33: Microphone reference circuit

4.8.3 Audio Electronic Characteristics

Table 16: Microphone input characteristics

Parameter		Min	Typ	Max	Unit
Mic biasing voltage			1.9	2.2	V
Working Current				2	mA
Input impedance(differential)		13	20	27	KΩ
Idle channel noise				-67	dBm
SINAD	Input level:-40dBm0	29			dB
	Input level:0dBm0		69		dB

Table 17: Audio output characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Normal output	R_L=32 Ω receiver	-		90	mW

4.8.4 TDD

GSM signal could interfere with audio by coupling or conducting. Coupling noise could be filtered by adding 33 pF and 10pF capacitor over audio lines.33pF capacitor could eliminate noise from GSM900MHz, while 10pF capacitor could eliminate noise from DCS1800MHz frequency. Coupling noise has great relatives with PCB layout. Under some scenarios, TDD noise from GSM 900MHz frequency affects heavily, but some different story is from GSM1800MHz fervency, so customer should develop this filter solution according to field test result.

GSM antenna is the key coupling interfering source of TDD noise. Pay attention to the layout of audio lines which should be far away from RF cable & antenna and VBAT pin. The bypass capacitor for filtering should be placed near module and another group placed near to connector.

Conducting noise is mainly caused by the VBAT drop. If Audio PA was powered by VBAT directly, then there will be some cheep noise from SPK output easily. So, it's better to put big capacitor and ferrite bead near audio PA input.

TDD noise has something to do with GND signal surely. If GND signal is not well treated, lots of high-frequency noise will interfere with MIC and speaker over bypass capacitor. So, take good care of GND during PCB layout.

4.9 SIM Card Interface

The SIM interface complies with the GSM Phase 1 specification and the new GSM Phase 2+ specification for FAST 64 kbps SIM card. Both 1.8V and 3.0V SIM card are supported. The SIM interface is powered from an internal regulator in the module.

4.9.1 SIM Card Application

Table 18: SIM pin definition

Name	Pin	Function
SIM_VDD	29	Voltage supply for SIM card. Support 1.8V or 3V SIM card
SIM_DATA	30	SIM data input/output
SIM_CLK	31	SIM clock
SIM_RST	32	SIM reset
SIM_DET	33	SIM card detection

It is recommended to use an ESD protection component such as ON (http://onsemi.com) SMF12CT1G. Note that the SIM peripheral circuit should be close to the SIM card socket. The reference circuit of the 8-pin SIM card holder is illustrated in the following figure.

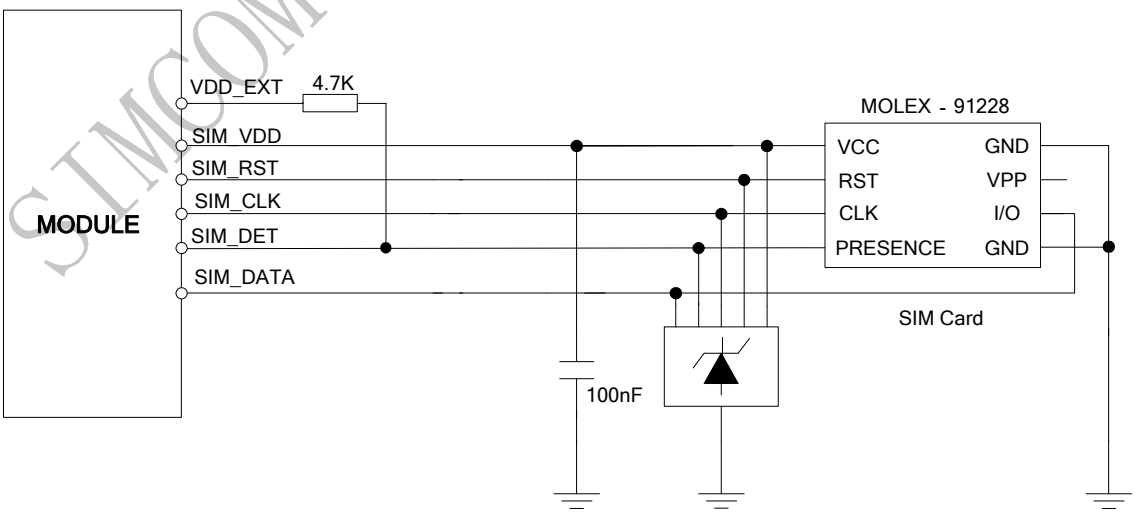

Figure 34: Reference circuit of the 8-pin SIM card holder

The SIM_DET pin is used for detection of the SIM card hot plug in. User can select the 8-pin SIM card holder to

implement SIM card detection function. AT command "AT+CSDT" is used to enable or disable SIM card detection function. For details of this AT command, please refer to *document [1]*.

If the SIM card detection function is not used, user can keep the SIM_DET pin open. The reference circuit of 6-pin SIM card holder is illustrated in the following figure.

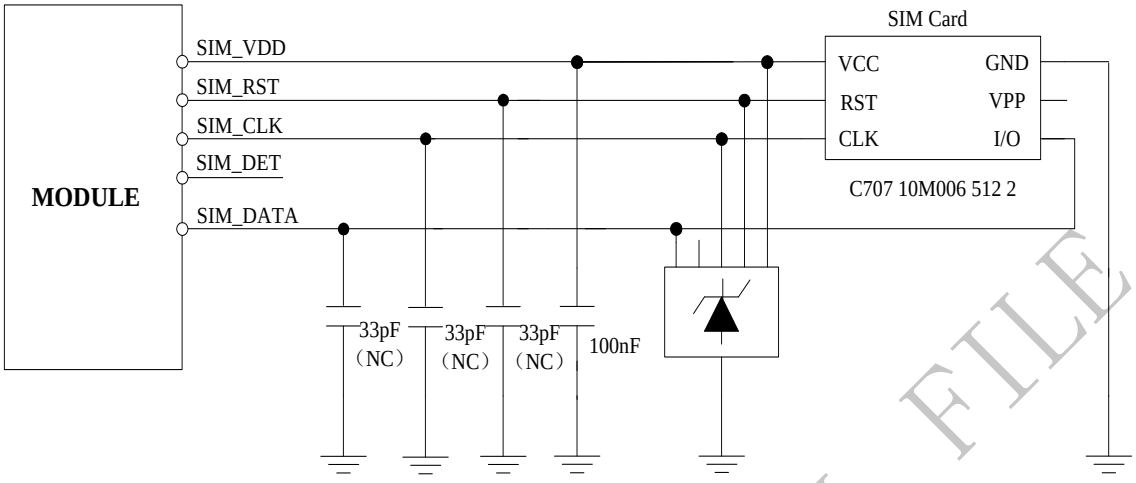

Figure 35: Reference circuit of the 6-pin SIM card holder

4.9.2 SIM Card Design Consideration

SIM card circuit is susceptible to interference, causing the SIM card failures or some other situations, so it is strongly recommended to follow these guidelines while designing:

- Make sure that SIM card holder should far away from GSM antenna while in PCB layout.
- SIM traces should keep away from RF lines, VBAT and high-speed signal lines.
- The traces should be as short as possible.
- Keep SIM holder's GND connect to main ground directly.
- Shielding the SIM card signal by ground well.
- Recommended to place a 1uF capacitor on VSIM line and keep close to the holder.
- Add some TVS and the parasitic capacitance should not exceed 50pF.

4.9.3 Design Considerations for SIM Card Holder

For 8 pins SIM card holder, SIMCom recommends to use Molex 91228.User can visit http://www.molex.com for more information about the holder.

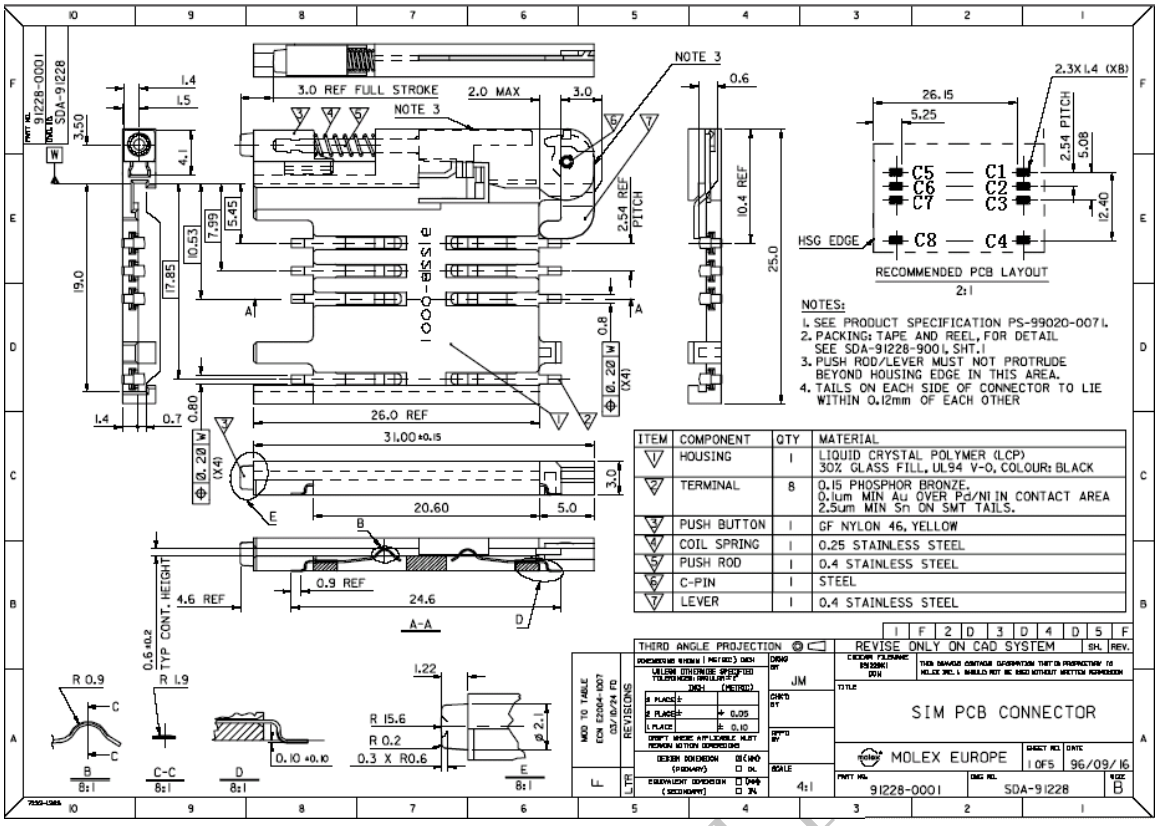

Figure 36: Molex 91228 SIM card holder

Table 19: Pin description (Molex SIM card holder)

Pin name	Signal	Description
C1	SIM_VDD	SIM card power supply
C2	SIM_RST	SIM card reset
C3	SIM_CLK	SIM card clock
C4	GND	Connect to GND
C5	GND	Connect to GND
C6	VPP	Not connect
C7	SIM_DATA	SIM card data I/O
C8	SIM_DET	Detect SIM card presence

For 6-pin SIM card holder, SIMCom recommends to use Amphenol C707 10M006 512 2 .User can visit http://www.amphenol.com for more information about the holder.

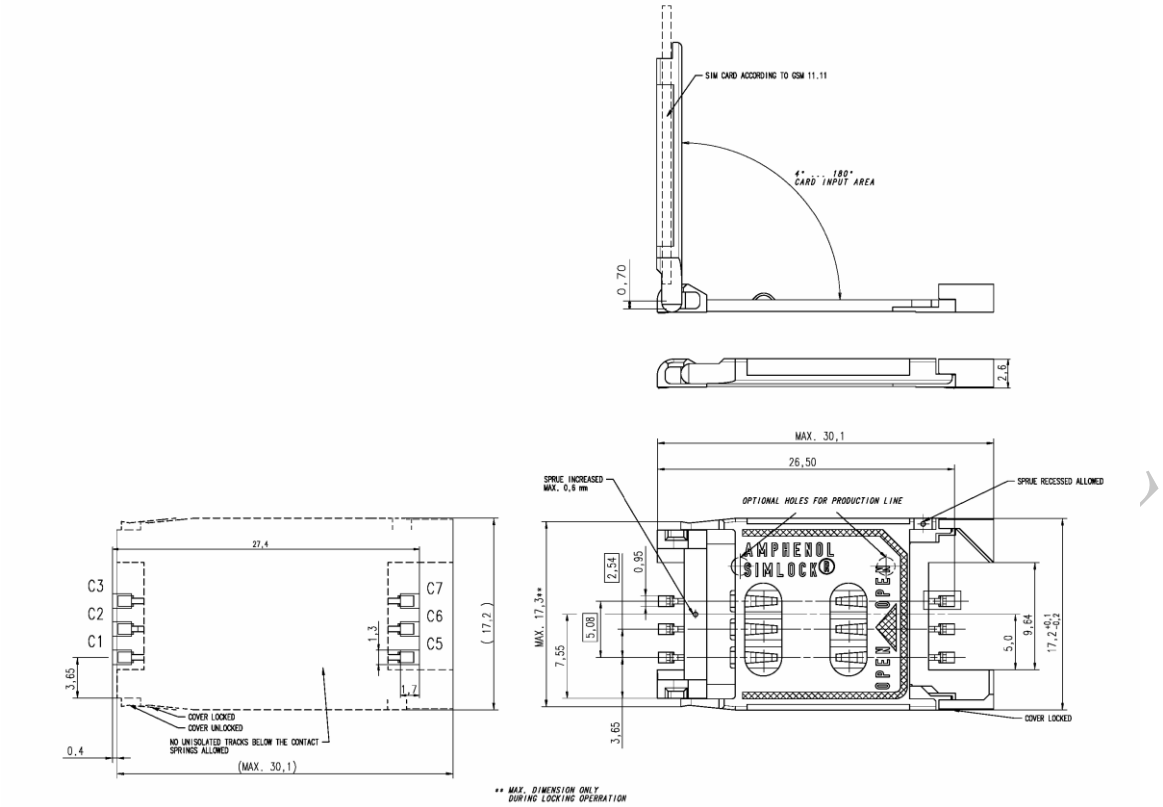

Figure 37: Amphenol C707 10M006 512 2 SIM card holder

Table 20: Pin description (Amphenol SIM card holder)

Pin name	Signal	Description
C1	SIM_VDD	SIM card power supply
C2	SIM_RST	SIM card reset
C3	SIM_CLK	SIM card clock
C5	GND	Connect to GND
C6	VPP	Not connect
C7	SIM_DATA	SIM card data I/O

4.10 PCM Interface

SIM808 provides PCM interface.

Table 21: PCM pin definition

Pin name	Pin number	Description
PCM_OUT	48	PCM data output
PCM_IN	47	PCM data input
PCM_SYNC	45	PCM synchrony
PCM_CLK	46	PCM clock

SIM808 PCM interface only supports master mode, data length is 16 bits (linear), and PCM clock rate is 256 KHz.

Table 22: PCM pin specification

Feature	Specification
Line Interface Format	Linear(Fixed)
Data length	16bits(Fixed)
PCM Clock/Sync Source	Master Mode(Fixed)
PCM Clock Rate	256KHz(Fixed)
PCM Sync Format	Short sync/Long sync both support
Zero Padding/Sign extension	Default Zero Padding
Data Ordering	MSB/LSB both support

Note: User can use AT command control PCM interface, for details please refer to document [1].

4.10.1 PCM Interface

Refer to the following figure for PCM design:

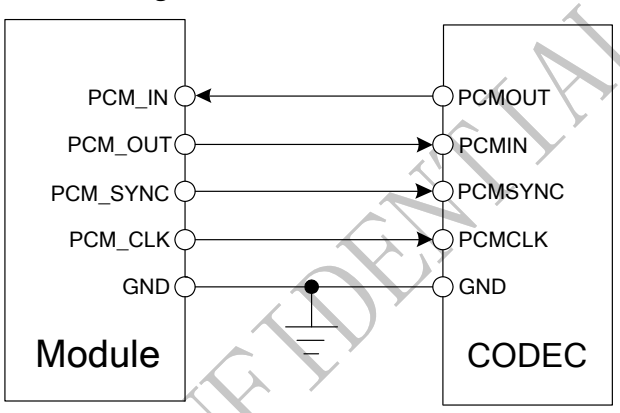

Figure 38: PCM reference circuit

4.11 Keypad Interface

SIM808 consists of 4 keypad column outputs and 4 keypad row inputs.

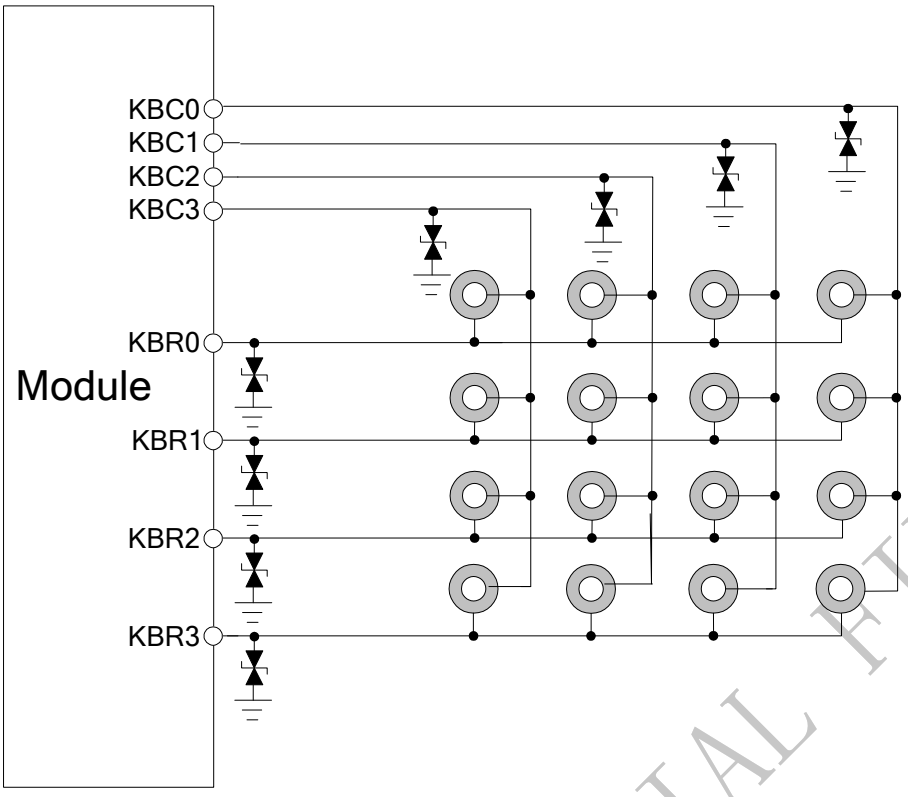

Figure 39: Traditional keypad reference circuit

Note:1、 According to the traditional 4*4 keypad matrix, when there are unused COLs or ROWs, user can execute AT command to define unused COLs and ROWs as GPIO, for details please see the document [1].

2、Press COL0 and ROW0 or pull down COL0 when power-on(PWRKEY, Charging, RTC alarm), power sequence is USB Download.

Customer should add a resistor to enhance the ESD performance and the value of resistor should be less than 1KΩ, the connection diagram is shown in follow figure as an example.

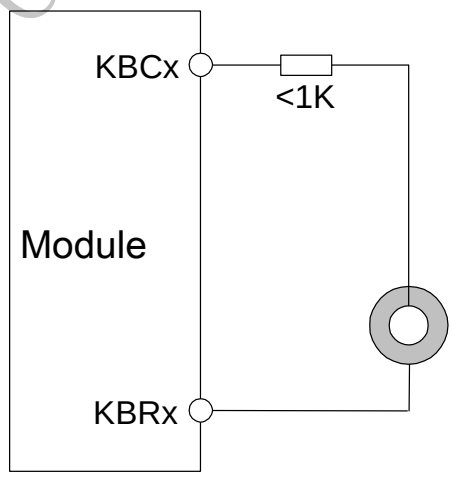

Figure 40: Enhance the ESD performance of keypad circuit

Table 23: Pin definition of the keypad interface

Name	Pin	Function	Default state
KBC0	62	Keypad matrix column	Pull up

KBC1	61		Pull up
KBC2	60		Pull up
KBC3	59		Pull up
KBR0	58	Keypad matrix row	Pull down
KBR1	57		Pull down
KBR2	56		Pull down
KBR3	55		Pull down

4.12 I2C Bus

The SIM808 provides an I2C interface, it can be driven by either the master or slave and conform to the I2C specification.

Table 24: Pin definition of the I2C

Pin name	Pin number	Description
SCL	39	I2C serial bus clock
SDA	38	I2C serial bus data

Note: I2C has been pulled up internal to 2.8V via 4.7KΩ.

4.13 General Purpose Input/Output (GPIO)

SIM808 provides 2 GPIO pins. The output voltage level of the GPIO can be set by the AT command "AT+ SGPIO". The input voltage level of the GPIO can also be read by the AT command "AT+ SGPIO". For more details, please refer to *document [1]*.

Table 25: Pin definition of the GPIO

Pin name	Pin number	Reset state
GPIO17	44	I/PU
GPIO19	43	I/PU

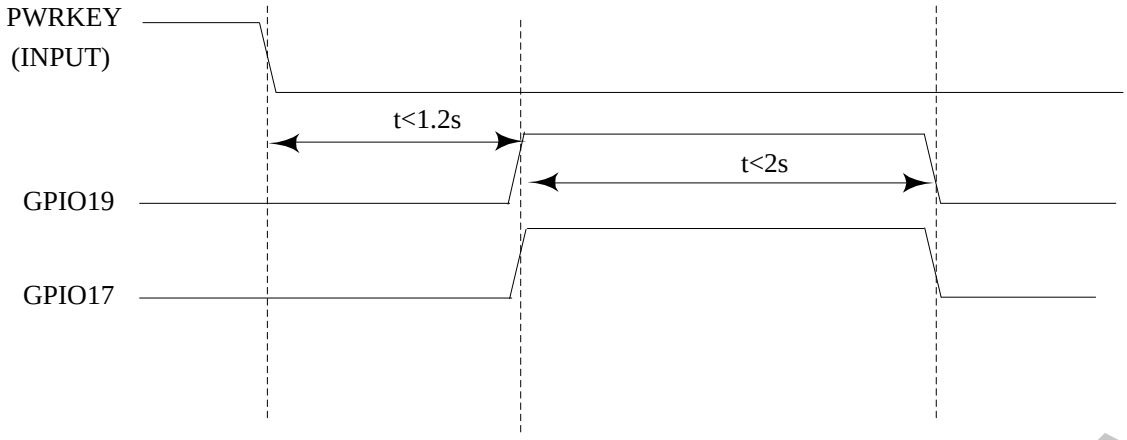

Figure 41: GPIO timing sequences

4.14 ADC

Table 26: Pin definition of the ADC

Pin name	Pin number	Description
ADC0	23	Analog to Digital Converter
ADC1	24	Analog to Digital Converter

SIM808 provides two auxiliary ADC, which can be used to measure the voltage. User can use AT command "AT+CADC" to read the voltage value. For details of this AT command, please refer to *document [1]*.

Table 27: ADC specification

Parameter	Min	Typ	Max	Unit
Voltage range	0	-	2.8	V
ADC Resolution	-	10	-	bits
Sampling rate	-	-	1.0833	MHz
ADC precision		10	30	mV

Note: The voltage should be less than 2.8V, or the ADC may be damaged.

4.15 PWM

Table 28: Pin definition of the PWM

Pin name	Pin number	Description
PWM1	42	Pulse Width Modulation 1
PWM2	41	Pulse Width Modulation 2

PWM output frequency varies from 200Hz to 100KHz.Two 7-bit unsigned binary parameters are used for the

output period and for the duty cycle. The AT command "AT + SPWM" is used to set the output period and duty cycle of the PWM. For details, please refer to *document [1]*.

A typical circuit of the PWM drives buzzer is shown in the following figure:

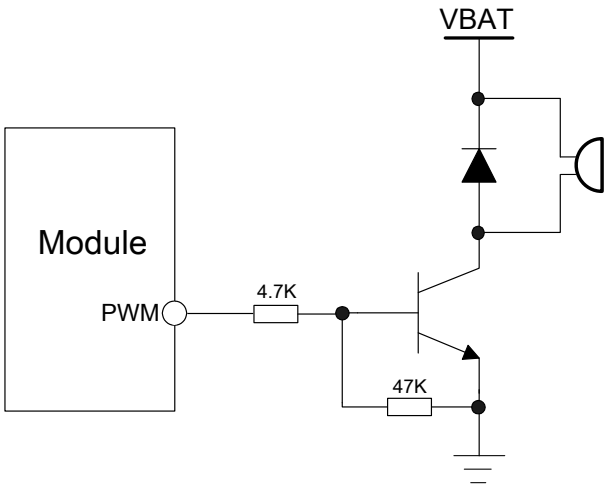

Figure 42: Reference circuit of PWM drive buzzer

Table 29: Buzzer output characteristics

Parameter	Min	Typ	Max	Unit
Working voltage	2.5	2.8	2.9	V
Working current		4	16	mA

Note: PWM pin must keep low when module in the boot process.

4.16 Network Status Indication

Table 30: Pin definition of the NETLIGHT

Pin name	Pin number	Description
NETLIGHT	50	Network Status Indication

The NETLIGHT pin can be used to drive a network status indication LED. The status of this pin is listed in following table:

Table 31: Status of the NETLIGHT pin

Status	SIM808 behavior
Off	SIM808 is not running
64ms On/ 800ms Off	SIM808 not registered the network
64ms On/ 3000ms Off	SIM808 registered to the network
64ms On/ 300ms Off	PPP GPRS communication is established

A reference circuit is recommended in the following figure:

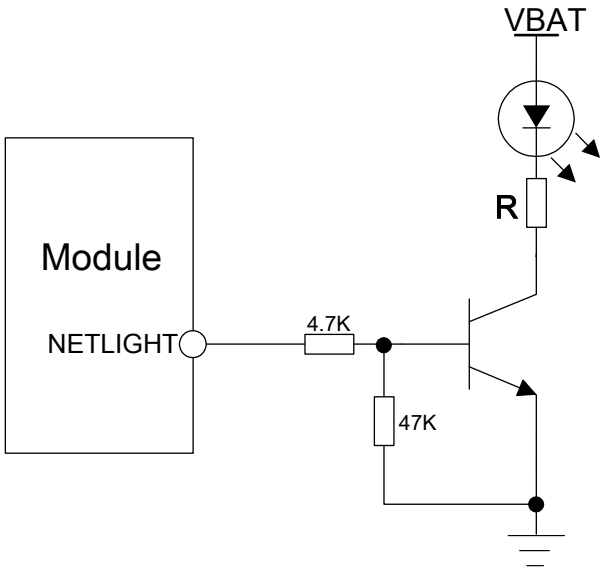

Figure 43: Reference circuit of NETLIGHT

4.17 Operating Status Indication

The STATUS pin indicates the operating status of module. The pin output high when module power on, output is low when module powered off.

Table 32: Pin definition of the STATUS

Pin name	Pin number	Description
STATUS	49	Operating status indication

4.18 RF Synchronization Signal

The synchronization signal serves to indicate growing power consumption during the transmit burst.

Table 33: Definition of the RF_SYNC pin

Pin name	Pin number	Description
RF_SYNC	63	Transmit synchronization signal

Note: Do not pull up RF_SYNC.

The timing of the synchronization signal is shown in the following figure. High level of the RF_SYNC signal indicates increased power consumption during transmission.

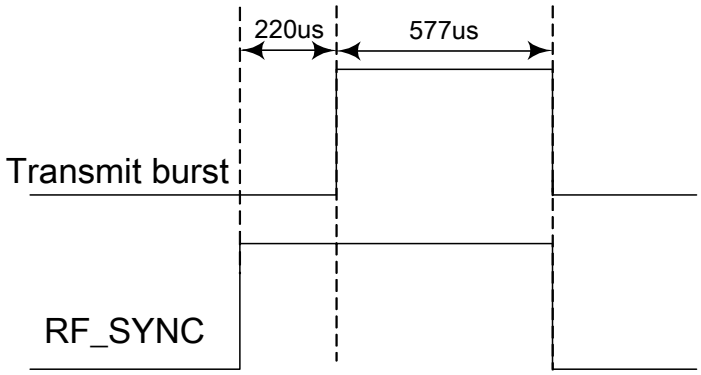

Figure 44: RF_SYNC signal during transmit burst

4.19 Bluetooth

SIM808 supports Bluetooth function, customer only needs to design the Bluetooth antenna, and then customer can operate Bluetooth conveniently by AT commands.

As module solution, SIM808 provides series of AT interface to operate Bluetooth function, including pairing, bonding, pushing or receiving file. Also including interface for SPP service, which could communicate between Bluetooth device and others via serial port.
When the module as a Bluetooth headset role, we provide a set of AT commands to control the remote smart phones, such as phone calls, turn on or hang up calls and so on.
For the detail commands about Bluetooth please refer to *document [9]*

The Bluetooth performance please refer to table 3.

The feature of Bluetooth is listed as below:

- Fully compliant with Bluetooth specification 3.0/2.1 + EDR
- Support operation with GNSS and GSM/GPRS worldwide radio systems
- Supports class 1 output power
- Up to 4 simultaneous active ACL links
- Support sniff mode
- Support PCM interface and built-in programmable transcoders for liner voice with transmission.

4.20 GNSS

4.20.1 GNSS Overview

SIM808 provide a high-performance L1 GNSS solution for cellular handset applications. The solution offers best-in-class acquisition and tracking sensitivity, Time-To-First-Fix (TTFF) and accuracy. The GNSS engine supports both fully-autonomous operations for use in handheld consumer navigation devices and other standalone navigation systems.
The module supports GPS, QZSS, SBAS ranging (WAAS, EGNOS, GAGAN, MSAS).
GNSS engine Performance, please refer to Table 2.

All the GNSS function is controlled by AT command via serial port. And the GNSS NMEA information is output

also by serial port. The default baud rate is 115200bps.
The GNSS functions of AT commands are listed in the following table.

Table 34: AT Commands for GNSS function

Command	Description
AT+CGNSPWR	GNSS power control
AT+CGNSSEQ	Define the last NMEA sentence that parsed
AT+CGNSINF	GNSS navigation information parsed from NMEA sentences
AT+CGNSURC	GNSS navigation, GEO-fence and speed alarm URC report control
AT+CGNSCMD	Send command to GNSS
AT+CGNSTST	Send data received from GNSS to AT UART

For details of these AT command, please refer to *document [8]*.

4.20.2 GNSS Operating Modes

GNSS has two operating modes which can be controlled by AT command: Active mode and Power down mode. The following describes how to power on GNSS and power down GNSS.

4.20.2.1 Power on GNSS

The GNSS engine is controlled by GSM engine, so when it is necessary to run GNSS，the GSM engine must be powered on and not in SLEEP mode.
User can power on GNSS engine by sending AT command “AT+CGNSSPWR=1”.
After powered on, GNSS is active as a GNSS receiver. The GNSS engine will automatically acquire and track GNSS satellites.

4.20.2.2 Power down GNSS

The GNSS engine will be set into power down mode by sending AT command “AT+CGNSSPWR=0”.
In this mode the internal power supply for GNSS will be shutdown, and the current consumption is very low. The last position, current time and ephemeris data will be stored in the GSM host memory.

4.20.3 1PPS Output

The 1PPS pin outputs pulse-per-second (1PPS) pulse signal for precise timing purposes. It will come out after successfully positioning .The 1PPS signal can be provided through designated output pin for many external applications.

4.21 Antenna Interface

There are three antenna ports for SIM808, GSM antenna port named GSM_ANT, Bluetooth antenna port named BT_ANT and GNSS antenna port named GPS_ANT. The RF interfaces of all the antenna ports have the impedance of 50Ω.

- The input impendence of the antenna should be 50Ω, and the VSWR should be less than 2.
- The traces from antenna pads to the corresponding antenna connections on the customer's application board should be treated as 50Ω impedance in PCB layout.
- It is recommended that the three antennas are placed far away from each other.
- The isolations of the three antennas should be more than 30dB.

Note: About the RF trace layout please refer to "AN_SMT Module_RF_Reference Design Guide"

4.21.1 GSM Antenna Interface

There is a GSM antenna pad named GSM_ANT to connect an external GSM antenna, the connection of the antenna must be decoupled from DC voltage. This is necessary because the antenna connector is DC coupled to ground via an inductor for ESD protection. The external antenna must be matched properly to achieve the best performance, so the matching circuit is necessary, the connection is recommended as following:

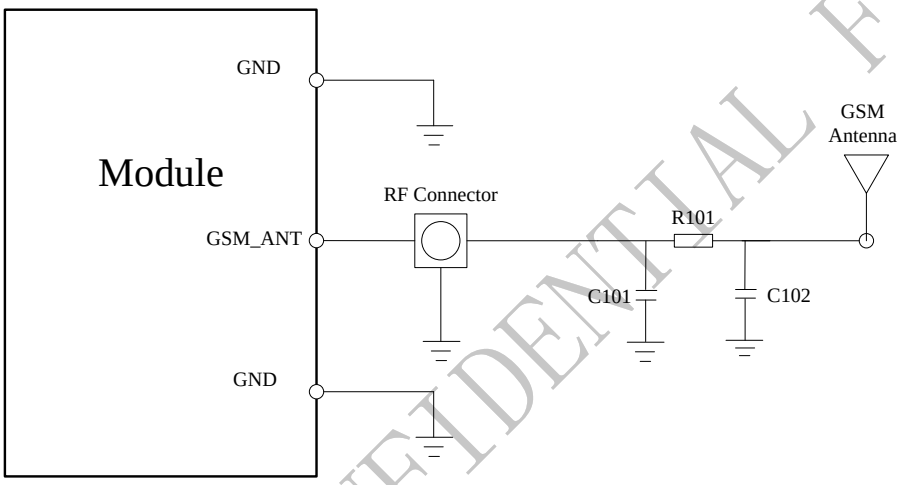

Figure 45: GSM antenna matching circuit

R101, C101, C102 are the matching circuit, the values depend on antenna debug result. Normally R101 is 0Ω, C101 and C102 are not mounted. The RF connector is used for conducted test, and should be placed as close as possible to the module's GSM_ANT pad.

If the space between GSM_ANT pin and antenna is not enough, the matching circuit could be simplified as the following figure:

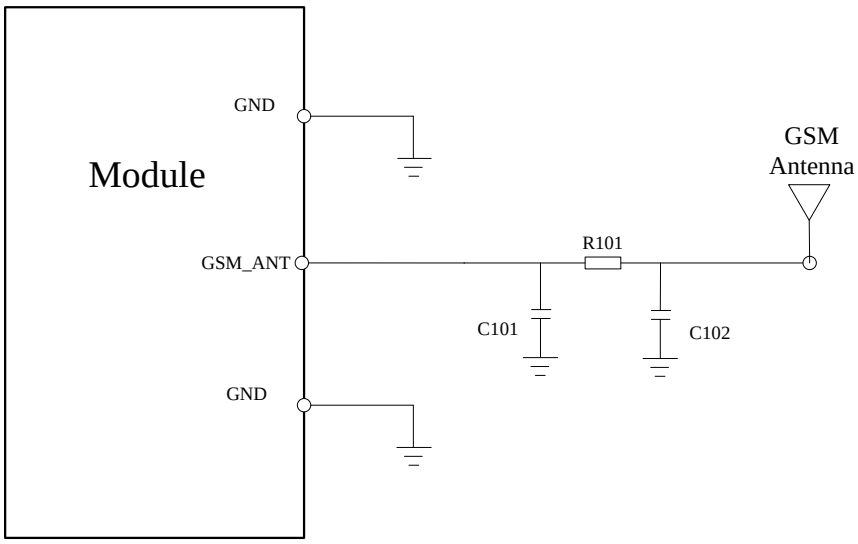

Figure 46: GSM simple antenna matching circuit

4.21.2 Bluetooth Antenna Interface

The module provides a Bluetooth antenna interface named BT_ANT.
The external antenna must be matched properly to achieve best performance, so the matching circuit is necessary, the connection is recommended as the following figure:

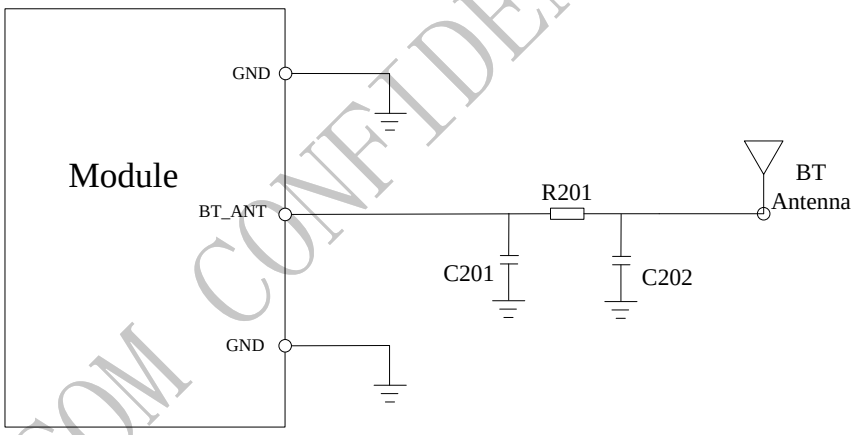

Figure 47: Bluetooth antenna matching circuit

R201, C201, C202 are the matching circuit, the values depend on antenna debug result. Normally R201 is 0Ω, C201 and C202 are not mounted.

4.21.3 GNSS Antenna Interface

The module also provides a GNSS antenna interface named GPS_ANT to connect the antenna on the customer's application board. 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. There are two normal options: passive antenna and active antenna. GNSS antenna choice should be based 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.

The external antenna must be matched properly to achieve best performance, so the matching circuit is necessary, the connection is recommended as the following figure:

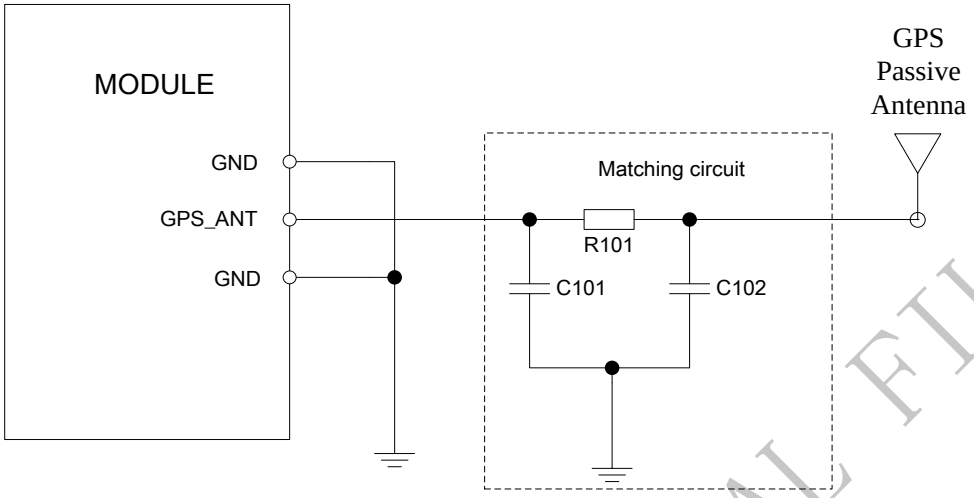

Figure 48: GNSS passive antenna matching circuit

The components R101, C101 and C102 are used for antenna matching, the components' value only can be got after the antenna tuning. Normally R101 is 0Ω , C101 and C102 are not mounted.

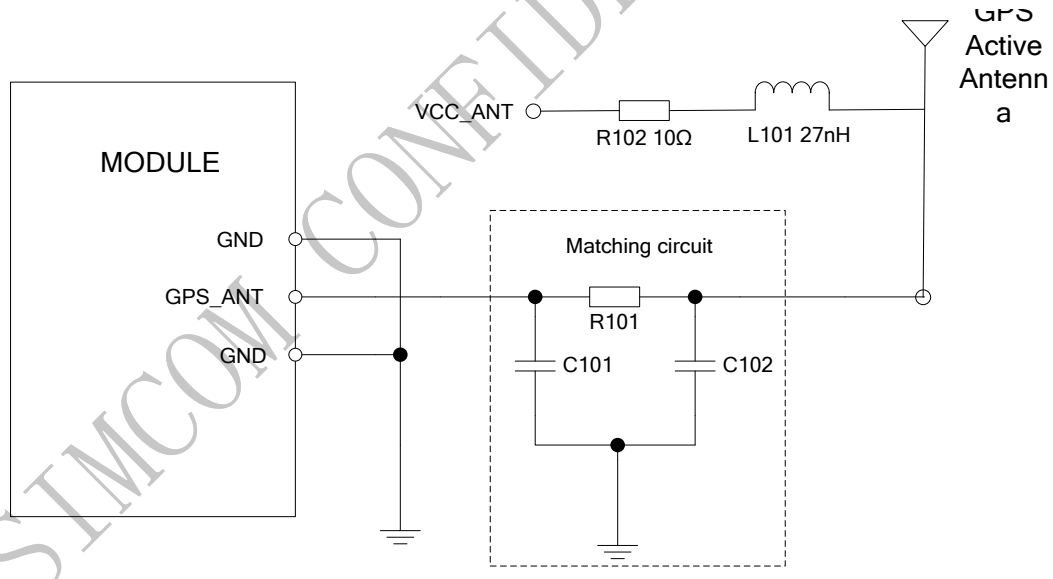

Figure 49: GNSS active antenna matching circuit

Active antennas have an integrated Low-Noise Amplifier (LNA). VCC_ANT is needed on customer's application board for the active antenna power input, as shown in Figure 54. The inductor L101 is used to prevent the RF signal from leaking into the VCC_ANT pass and route the bias supply to the active antenna, the recommended value of L101 is no less than 27nH. R102 can protect the whole circuit in case the active antenna is shorted to ground.

5 PCB Layout

Usually, most electronic products with good performance are based on good PCB layout. A bad PCB layout will lead to lots of issues, like TDD noise, SIM card can not be detected, etc. The final solution for these problems is to redo PCB layout. Making good PCB layout at beginning will save development schedule and cost as well.

This section as below will give some guidelines on PCB layout.

5.1 Pin Assignment

Before PCB layout, we should learn well about pin assignment in order to get reasonable layout with so many external components. Please refer figure2 for details.

5.2 Principle of PCB Layout

During layout, attention should be paid to the following interfaces, like Antenna, power supply, SIM card interface, audio interface, and so on.

5.2.1 Antenna Interface

There are some suggestions for components placing and routing of GSM and Bluetooth RF traces:

- The RF connector is used for conducted test, so keep it as close to the GSM_ANT pin as possible;
- Antenna matching circuit should be close to the antenna;
- Keep the RF traces as 50Ω;
- The RF traces should be kept far away from the high speed signals and strong disturbing source.
- If using a RF cable, kept it far away from SIM card, power ICs;

  It is recommended that GSM antenna and Bluetooth antenna be placed as far as possible.

5.2.2. Power Supply

Not only VBAT but also return GND are very important in layout. The positive line of VBAT should be as short and wide as possible. The correct flow from source to VBAT pin should go though Zener diode then huge capacitor. Pin 1, Pin 2, and Pin 3 are GND signals, and shortest layout to GND of power source should be designed.

There are 15 GND pads in middle of module, these pads could enhance the GND performances. On the upper layer of these pads, do not trace any signal if possible.

5.2.3 SIM Card Interface

SIM card holder will take large space on board, and there is no anti-EMI component inside. Thus SIM card interface may be interfered, please pay more attention on this interface during layout. Ensure SIM card holder is far way from antenna or RF cable inside. And it is better to put SIM card holder near the module, as nearer as possible. It is better to add ESD component to protect clock, data, reset and SIM_VDD signals which should be far away from power and high-speed-frequency signal.

5.2.4 Audio Interface

In order to avoid TDD noise, current noise, or some other noise, the signal trace of audio, which is recommended to surrounded by ground, should far away from antenna and power. And do not let audio trace and VBAT trace parallel.

5.2.5 Others

It is better to trace signal lines of UART bunched, as well as signals of USB and I2C.

5.3 Recommended PCB Layout

Based on above principles, recommended layout is shown in the following illustration.

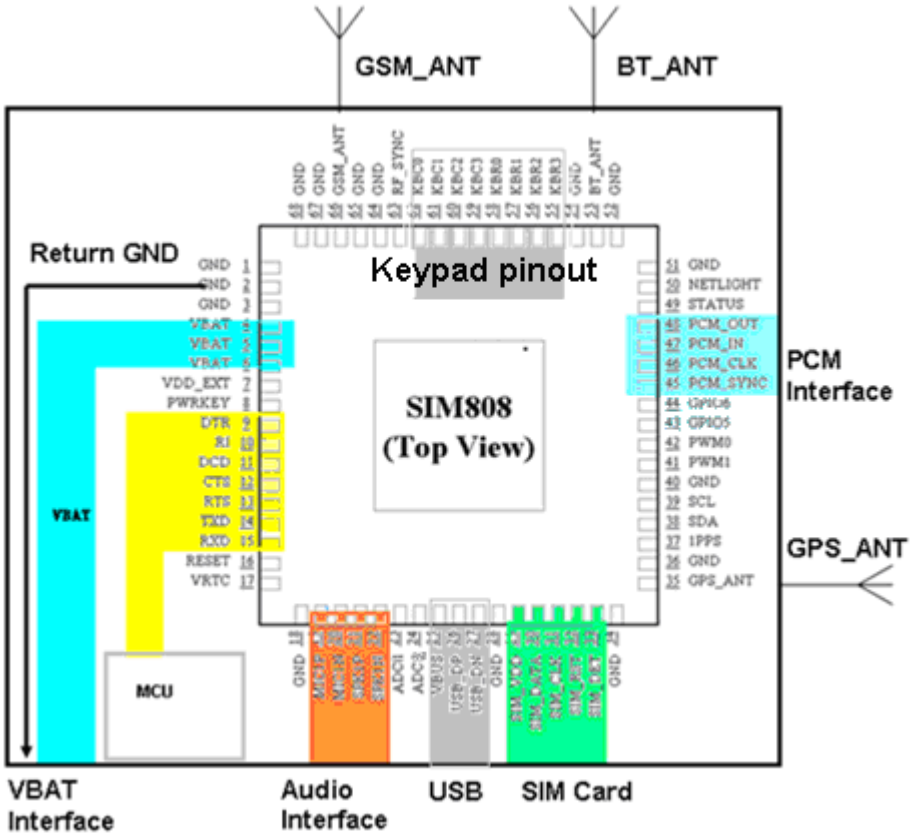

Figure 50: PCB layout pinout example

6 Electrical, Reliability and Radio Characteristics

6.1 Absolute Maximum Ratings

The absolute maximum ratings stated in following table are stress ratings under non-operating conditions. Stresses beyond any of these limits will cause permanent damage to SIM808.

Table 35: Absolute maximum ratings

Symbol	Min	Typ	Max	Unit
VBAT	-	-	4.5	V
Peak Current	0	-	2.0	A
VCHG	-	-	12	V
I_I*	-	4	-	mA
I_O*	-	4	-	mA

* These parameters are for digital interface pins, such as keypad, GPIO, I2C, UART, PWM and PCM..

6.2 Recommended Operating Conditions

Table 36: Recommended operating conditions

Symbol	Parameter	Min	Typ	Max	Unit
VBAT	Power supply voltage	3.4	4.0	4.4	V
T_{OPER}	Operating temperature	-40	+25	+85	℃
T_{STG}	Storage temperature	-45		+90	℃

6.3 Digital Interface Characteristics

Table 37: Digital interface characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_{IH}	High-level input voltage	2.1	-	3.0	V
V_{IL}	Low-level input voltage	-0.3	-	0.7	V
V_{OH}	High-level output voltage	2.4	2.8	-	V
V_{OL}	Low-level output voltage	-	-	0.4	V

* These parameters are for digital interface pins, such as keypad, GPIO, I^2C, UART, PWMs and DEBUG.

6.4 SIM Card Interface Characteristics

Table 38: SIM card interface characteristics

Symbol	Parameter	Min	Typ	Max	Unit
I_{IH}	High-level input current	-1	-	1	uA
I_{IL}	Low-level input current	-1	-	1	uA
V_{IH}	High-level input voltage	1.4	-	-	V
		2.4	-	-	V
V_{IL}	Low-level input voltage	-	-	0.27	V
				0.4	V
V_{OH}	High-level output voltage	1.62	-	-	V
		2.7	-	-	V
V_{OL}	Low-level output voltage	-	-	0.36	V
		-	-	0.4	V

6.5 SIM_VDD Characteristics

Table 39: SIM_VDD characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_O	Output voltage	-	3	-	V
		-	1.80	-	
I_O	Output current	-	-	10	mA

6.6 VDD_EXT Characteristics

Table 40: VDD_EXT characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_O	Output voltage	2.70	2.80	2.95	V
I_O	Output current	-	-	50	mA

6.7 VRTC Characteristics

Table 41: VRTC characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_{RTC-IN}	VRTC input voltage	1.2	2.8	3.0	V
I_{RTC-IN}	VRTC input current	-	3.0	5.0	uA

$V_{RTC-OUT}$	VRTC output voltage	-	2.8	-	V
$I_{RTC-OUT}$	VRTC output current	-		2.0	mA

6.8 Current Consumption (VBAT = 4V, GNSS engine is powered down)

Table 42: GSM current consumption*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VBAT	Voltage		3.4	4.0	4.4	V
	Voltage drop	PCL=5			350	mV
	Voltage ripple	PCL=5 @ f<200kHz @ f>200kHz			 50 2.0	 mV mV
I_{VBAT}	Average current	Power off mode		134	150	uA
		Sleep mode (AT+CFUN=1): (BS-PA-MFRMS=9) (BS-PA-MFRMS=5) (BS-PA-MFRMS=2)		 1.073 1.167 1.627		 mA mA mA
		Idle mode (AT+CFUN=1): EGSM900		 16.80		 mA
		Voice call (PCL=5): GSM850 EGSM900 Voice call (PCL=0): DCS1800 PCS1900		 216.6 221.7 140.3 155.0		 mA mA mA mA
		Data mode GPRS (1Rx,4Tx): GSM850 EGSM900 DCS1800 PCS1900		 445.5 433.7 287.1 296.5		 mA mA mA mA
		Data mode GPRS (3Rx,2Tx): GSM850 EGSM900 DCS1800 PCS1900		 332.9 333.5 222.0 229.8		 mA mA mA mA
		Data mode GPRS (4Rx,1Tx): GSM850 EGSM900 DCS1800 PCS1900		 222.6 224.7 158.4 165.2		 mA mA mA mA
I_{MAX}	Peak current	During TX burst			2.0	A

* In above table the current consumption value is the typical one of the module tested in laboratory. In the mass production stage,

there may be differences among each individual.

6.9 Electro-Static Discharge

SIM808 is an ESD sensitive component, so more attention should be paid to the procedure of handling and packaging. The ESD test results are shown in the following table.

Table 43: The ESD characteristics (Temperature: 25℃, Humidity: 45 %)

Pin	Contact discharge	Air discharge
VBAT	±5KV	±10KV
GND	±5KV	±10KV
RXD, TXD	±2KV	±8KV
Antenna port	±5KV	±10KV
SPK1P/ SPK1N MIC1P/ MIC1N	±4KV	±8KV
PWRKEY	±4KV	±8KV

Note: It is suggested that customers in serials with 100ohm resistances on UART lines for ESD consideration.

6.10 Radio Characteristics

6.10.1 Module RF Output Power

The following table shows the module conducted output power, it is followed by the 3GPP TS 05.05 technical specification requirement.

Table 44: SIM808 GSM 900 and GSM 850 conducted RF output power

GSM 900 and EGSM 850			
PCL	Nominal output power (dBm)	Tolerance (dB) for conditions	
		Normal	Extreme
0-2	39	±2	±2.5
3	37	±3	±4
4	35	±3	±4
5	33	±3	±4
6	31	±3	±4
7	29	±3	±4
8	27	±3	±4
9	25	±3	±4
10	23	±3	±4
11	21	±3	±4
12	19	±3	±4
13	17	±3	±4

14	15	±3	±4
15	13	±3	±4
16	11	±5	±6
17	9	±5	±6
18	7	±5	±6
19-31	5	±5	±6

Table 45: SIM808 DCS 1800 and PCS 1900 conducted RF output power

DCS 1800 and PCS 1900			
PCL	**Nominal output power (dBm)**	**Tolerance (dB) for conditions**	
		Normal	**Extreme**
29	36	±2	±2.5
30	34	±3	±4
31	32	±3	±4
0	30	±3	±4
1	28	±3	±4
2	26	±3	±4
3	24	±3	±4
4	22	±3	±4
5	20	±3	±4
6	18	±3	±4
7	16	±3	±4
8	14	±3	±4
9	12	±4	±5
10	10	±4	±5
11	8	±4	±5
12	6	±4	±5
13	4	±4	±5
14	2	±5	±6
15-28	0	±5	±6

For the module's output power, the following should be noted:

At GSM900 and GSM850 band, the module is a class 4 device, so the module's output power should not exceed 33dBm, and at the maximum power level, the output power tolerance should not exceed +/-2dB under normal condition and +/-2.5dB under extreme condition.

At DCS1800 and PCS1900 band, the module is a class 1 device, so the module's output power should not exceed 30dBm, and at the maximum power level, the output power tolerance should not exceed +/-2dB under normal condition and +/-2.5dB under extreme condition.

6.10.2 Module RF Receive Sensitivity

The following table shows the module's conducted receive sensitivity, it is tested under static condition.

Table 46: SIM808 conducted RF receive sensitivity

Frequency	Receive sensitivity（Typical）	Receive sensitivity(Max)
GSM850	-109dBm	-107dBm
EGSM900	-109dBm	-107dBm
DCS1800	-109dBm	-107dBm
PCS1900	-109dBm	-107dBm

6.10.3 Module Operating Frequencies

The following table shows the module's operating frequency range; it is followed by the 3GPP TS 05.05 technical specification requirement.

Table 47: SIM808 operating frequencies

Frequency	Receive	Transmit
GSM850	869 ~ 894MHz	824 ~ 849 MHz
EGSM900	925 ~ 960MHz	880 ~ 915MHz
DCS1800	1805 ~ 1880MHz	1710 ~ 1785MHz
PCS1900	1930 ~ 1990MHz	1850 ~ 1910MHz

7 Manufacturing

7.1 Top and Bottom View of SIM808

Figure 51: Top and Bottom View of SIM808

7.2 Typical Solder Reflow Profile

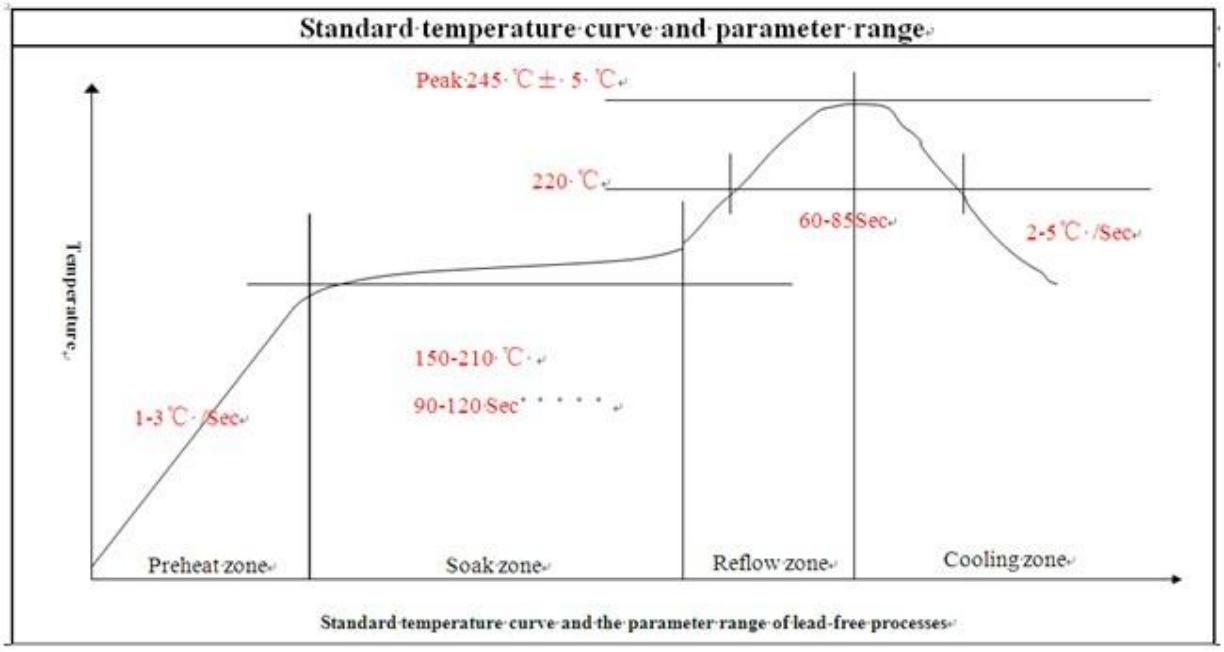

Figure 52: Typical Solder Reflow Profile

Note: Please refer to《Module secondary-SMT-UGD》 for more information about the module shipping and manufacturing.

7.3 The Moisture Sensitivity Level

The moisture sensitivity level of SIM808 is 3. The module should be mounted within 168 hours after unpacking in the environmental conditions of temperature <30℃ and relative humidity of <60% (RH). It is necessary to bake the module if the above conditions are not met:

Table 48: 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, it must be reflowed within the time limit specified on the label.

NOTES:

1. If the vacuum package is not open for 6 months or longer than the packing date, baking is also recommended before re-flow soldering.

2. For product handling, storage, processing, IPC / JEDEC J-STD-033 must be followed.

7.4 Baking Requirements

SIM808 modules are vacuum packaged, and guaranteed for 6 months storage without opening or leakage under the following conditions: the environment temperature is lower than 40℃, and the air humidity is less than 90%.

If the condition meets one of the following ones shown below, the modules should be baked sufficiently before re-flow soldering, and the baking condition is shown in below table; otherwise the module will be at the risk of permanent damage during re-flow soldering.

- If the vacuum package is broken or leakage;
- If the vacuum package is opened after 6 months since it's been packed;
- If the vacuum package is opened within 6 months but out of its Floor Life at factory ambient≦30℃ /60%RH or as stated.

Table 49: Baking requirements

Baking temperature	Moisture	Time
40℃±5℃	<5%	192 hours
120℃±5℃	<5%	6 hours

Note: Care should be taken if that plastic tray is not heat-resistant, the modules should be taken out for preheating, otherwise the tray may be damaged by high-temperature heating.

Appendix

I. Related Documents

Table 50: Related documents

SN	Document name	Remark
[1]	SIM808 Series AT Command Manual	
[2]	SIM808 Series_TCPIP_Application Note_	TCP/IP Applications User Manual
[3]	SIM808 Series UART Port Application Note	
[4]	AN_Serial Port	AN_Serial Port
[5]	AN_SMT Module_RF_Reference Design_Guide	
[6]	Module secondary-SMT-UGD	Module secondary SMT User Guide
[7]	ITU-T Draft new recommendation V.25ter：	Serial asynchronous automatic dialing and control
[8]	SIM800 Series_GNSS_Application Note	
[9]	SIM808_Series_Bluetooth_Application_Note	
[10]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[11]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[12]	GSM 07.05	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[13]	GSM 11.14	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[14]	GSM 11.11	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[15]	GSM 03.38	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[16]	GSM 11.10	Digital cellular telecommunications system (Phase 2)； Mobile Station (MS) conformance specification； Part 1： Conformance

		specification

II. Terms and Abbreviations

Table 51: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
CEP	Circular Error Probable
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EGNOS	European Geostationary Navigation Overlay Service
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
GPS	Global Positioning System
GAGAN	The GPS Aided Geo Augmented Navigation
HR	Half Rate
IMEI	International Mobile Equipment Identity
Li-ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
MSAS	Multi-Functional Satellite Augmentation System
NMEA	National Marine Electronics Association
PAP	Password Authentication Protocol
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
QZSS	Quasi-Zenith Satellites System

RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
RX	Receive Direction
SIM	Subscriber Identification Module
SBAS	Satellite Based Augmentation Systems
SMS	Short Message Service
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
WAAS	Wide Area Augmentation System
Phonebook abbreviations	
FD	SIM fix dialing phonebook
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ON	SIM (or ME) own numbers (MSISDNs) list
RC	Mobile Equipment list of received calls
SM	SIM phonebook
NC	Not connect

III. Safety Caution

Table 52: 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 to not operate normally for 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. Forget to think much of these instructions may lead to the flight safety or offend against 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.
	GSM cellular terminals or mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, for example no mobile fee or a invalid SIM card. While you are in this condition and need emergent help, please remember using 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 SIM card be properly inserted in the cellular terminal or mobile.

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