



SIM7000 Series Hardware Design

LPWA Module

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1 Introduction

This document describes the electronic specifications, RF specifications, interfaces, mechanical characteristics and testing results of the SIMCom SIM7000 series module. With the help of this document and other SIM7000 series software application notes/user guides, users can understand and use SIM7000 series module to design and develop applications quickly.

1.1 Product Outline

The SIM7000 series modules support LTE CAT-M1、LTE CAT-NB1、GPRS and EDGE.
The physical dimension of SIM7000 is 24×24×2.6mm mm. And the physical dimension is compatible with the packaging of SIM900, SIM800 and SIM800F.

Table 1: SIM7000 frequency bands and air interface

Standard	Frequency	Variants						
		SIM7000A	SIM7000C	SIM7000E	SIM7000JC	SIM7000C-N	SIM7000E-N	SIM7000G
GPRS	GSM850MHz							✓
	EGSM900MHz		✓	✓				✓
	DCS1800MHz		✓	✓				✓
	PCS1900MHz							✓
LTE-FDD HD-FDD	LTE-FDD B1		✓		✓	✓		✓
	LTE-FDD B2	✓						✓
	LTE-FDD B3		✓	✓	✓	✓	✓	✓
	LTE-FDD B4	✓						✓
	LTE-FDD B5		✓		✓	✓		✓
	LTE-FDD B8		✓	✓	✓	✓	✓	✓
	LTE-FDD B12	✓						✓
	LTE-FDD B13	✓						✓
	LTE-FDD B18				✓			✓
	LTE-FDD B19				✓			✓
	LTE-FDD B20			✓			✓	✓
	LTE-FDD B25							✓
	LTE-FDD B26				✓			✓
	LTE-FDD B28			✓			✓	✓
	LTE-FDD B39							✓

Category	LTE-M1	✓	✓	✓	✓			✓
Category	LTE-NB1		✓	✓	✓	✓	✓	✓
GNSS	GPS	✓	✓	✓	✓			✓
	GLONASS	✓	✓	✓	✓			✓
	BeiDou		✓	✓	✓			✓
	Galileo			*				

NOTE

Galileo is default closed in software. But users can open it via AT command “AT+CGNSMOD”.For more information about these AT commands, please refer to Document [1]

1.2 Hardware Interface Overview

The interfaces are described in detail in the next chapters include:

- Power Supply
- USB Interface
- UART Interface
- SIM Interface
- ADC
- LDO Power Output
- PCM Interface
- I2C Interface
- GPIOs
- Antenna Interface

1.3 Hardware Block Diagram

The block diagram of the SIM7000 module is shown in the figure below.

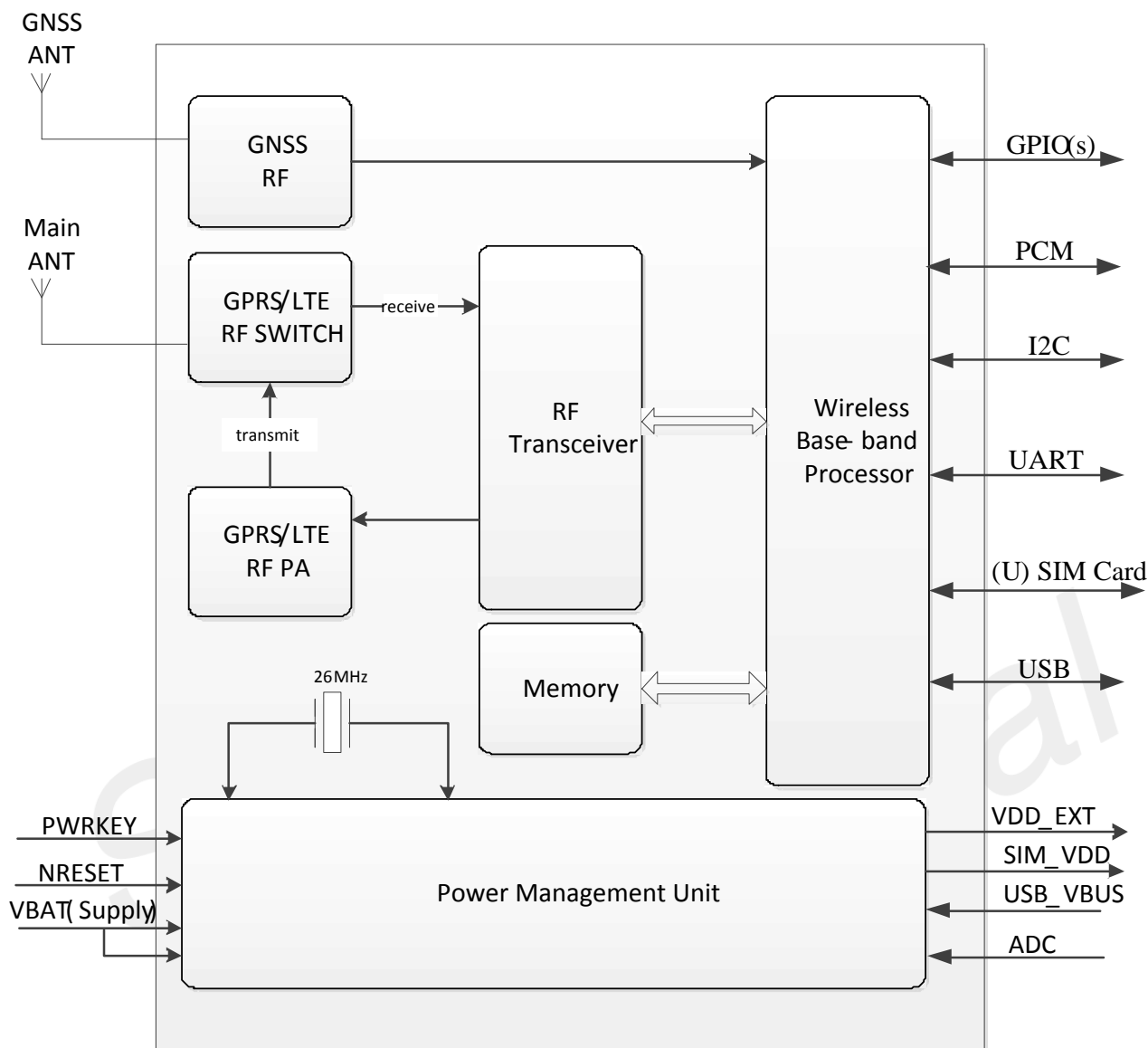


Figure 1: SIM7000 block diagram

1.4 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	Power supply voltage 3.0~4.3V.
Power saving	Current in sleep mode: 1.2mA (@DRX=2.56s). Current in PSM mode: 9uA.
Radio frequency bands	Please refer to the table 1
Transmitting power	GPRS power class:

	--EGSM900: 4 (2W). --DCS1800: 1 (1W). EDGE power class: --EGSM900: E2 (0.5W). --DCS1800: E1 (0.4W). LTE power class:3 (0.25W).
Data Transmission Throughput	GPRS multi-slot class 12. EDGE multi-slot class 12. LTE CAT M1: 300Kbps (DL). LTE CAT M1: 375Kbps (UL). LTE CAT NB1: 34Kbps (DL). LTE CAT NB1: 66Kbps (UL).
Antenna	GPRS/EDGE/LTE main antenna. GNSS antenna.
GNSS	GNSS engine (GPS, GLONASS, BD and Galileo). Protocol: NMEA.
SMS	MT, MO, CB, Text and PDU mode. SMS storage: SIM card or ME(default).
SIM interface	Support identity card: 1.8V/ 3V.
SIM application toolkit	Support SAT class 3, GSM 11.14 Release 98. Support USAT.
Audio feature	Support PCM interface. Only support PCM master mode and short frame sync, 16-bit linear data formats.
UART interface	A full modem serial port by default. Baud rate: 300bps to 3686400bps. Default rate is 0bps (auto baud rate). Support auto baud rate, but only limited to 9600, 19200, 38400, 57600 and 115200 bps. Can be used as the AT commands or data stream channel. Support RTS/CTS hardware handshake.
USB	USB 2.0 high speed interface.
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size: 24x24x2.6mm Weight: 3g
Temperature range	Normal operation temperature: -30°C to +80°C Extended operation temperature: -40°C to +85°C* Storage temperature -45°C to +90°C

NOTE

Module is able to make and receive voice calls, data calls, SMS and make GPRS/EDGE/LTE traffic in -40°C ~ +85°C. The performance will be reduced slightly from the 3GPP specifications if the temperature is outside the normal operating temperature range and still within the extreme operating temperature range.

2 Package Information

2.1 Pin Assignment Overview

All functions of the SIM7000 will be provided through 68 pads that will be connected to the customers' platform. The following Figure is the pin assignment of the SIM7000.

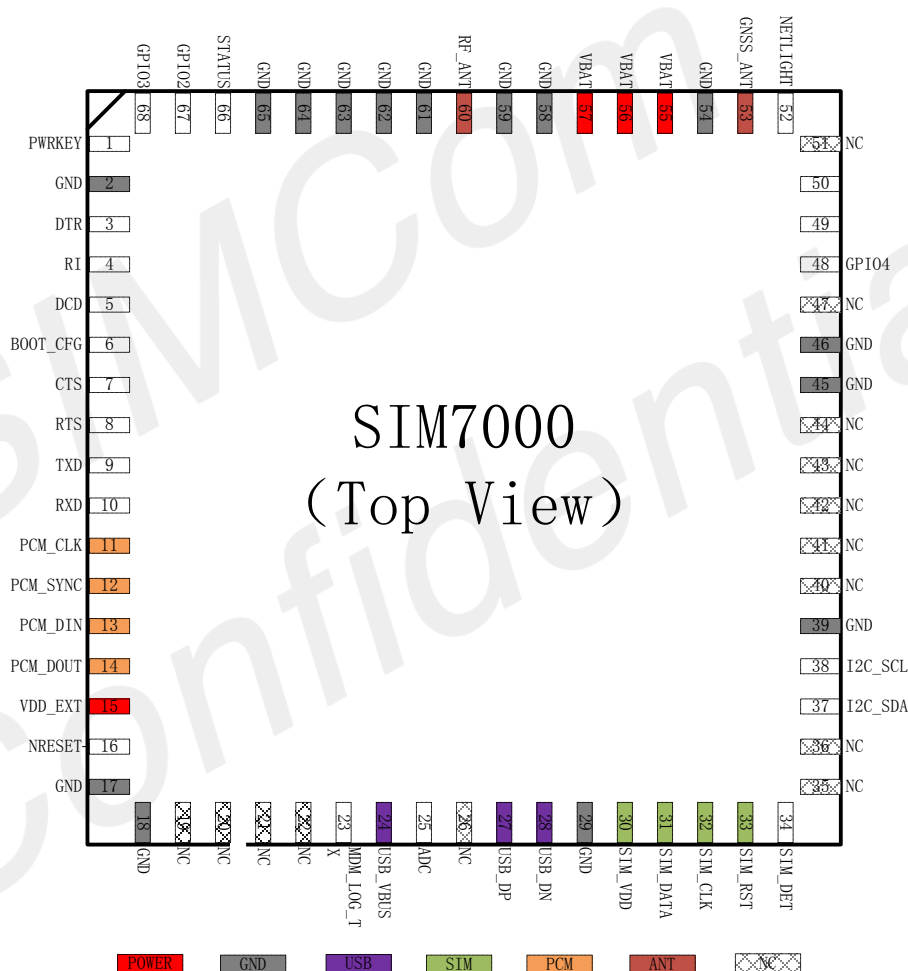


Figure 2: Pin assignment overview

Table 3: Pin definition

Pin No.	Pin Name	Pin No.	Pin Name
1	PWRKEY	2	GND
3	DTR	4	RI
5	DCD	6	BOOT_CFG

7	CTS	8	RTS
9	TXD	10	RXD
11	PCM_CLK	12	PCM_SYNC
13	PCM_DIN	14	PCM_DOUT
15	VDD_EXT	16	NRESET
17	GND	18	GND
19	NC	20	NC
21	NC	22	NC
23	MDM_LOG_TX	24	USB_VBUS
25	ADC	26	NC
27	USB_DP	28	USB_DM
29	GND	30	SIM_VDD
31	SIM_DATA	32	SIM_CLK
33	SIM_RST	34	SIM_DET
35	NC	36	NC
37	I2C_SDA	38	I2C_SCL
39	GND	40	NC
41	NC	42	NC
43	NC	44	NC
45	GND	46	GND
47	NC	48	GPIO4
49	GPIO1/UART3_RXD	50	GPIO0/UART3_TXD
51	NC	52	NETLIGHT
53	GNSS_ANT	54	GND
55	VBAT	56	VBAT
57	VBAT	58	GND
59	GND	60	RF_ANT
61	GND	62	GND
63	GND	64	GND
65	GND	66	STATUS
67	GPIO2	68	GPIO3

NOTE

Before the normal power up, BOOT_CFG cannot be pulled up.

2.2 Pin Description

Table 4: IO parameters definition

Pintype	Description
PI	Power input
PO	Power output
AI	Analog input
AIO	Analog input/output
I/O	Bidirectional input /output
DI	Digital input
DO	Digital output
DOH	Digital output with high level
DOL	Digital output with low level
PU	Pull up
PD	Pull down

Table 5: Pin description

Pin name	Pin No.	Default status	Description	Comment
Power supply				
VBAT	55、 56、 57	PI	Power supply, voltage range: 3.0~4.3V.	
VDD_EXT	15	PO	LDO power output 1.8V for other external circuits with Max 50mA current output.	This power supply only use for external GPIO pulling up or level shift circuit. If unused, keep it open.
GND	2、 17、 18、 29、 39、 45、 46、 54、 58、 59、 61、 62、 63、 64、 65		Ground	
System Control				
PWRKEY	1	DI,PU	System power on/off control input, active low. The efficient input level must be below 0.5V.	The level is 0.8V when this PIN is floating;
NRESET	16	DI, PU	System reset control input, active low.	NRESET has been pulled up to 1.8V via 40Kohmresistor internally.
SIM interface				
SIM_DATA	31	I/O,PU	SIM Card data I/O, which has been pulled up via a 10KR resistor to SIM_VDD internally. Do not pull it up or down externally.	All lines of SIM interface should be protected against ESD.

SIM_RST	33	DO	SIM Reset	
SIM_CLK	32	DO	SIM clock	
SIM_VDD	30	PO	Power output for SIM card, its output Voltage depends on SIM card type automatically. Its output current is up to 50mA.	
SIM_DET	34	DI	SIM card detecting input.	
				If used, keep a 10k Ω resistor pulling up to the VDD_EXT

USB*

USB_VBUS	24	DI,PD	Valid USB detection input with 3.5~5.25V detection voltage	Software download interface.
USB_DP	27	I/O	Positive line of the differential, bi-directional USB signal.	
USB_DM	28	I/O	Negative line of the differential, bi-directional USB signal.	

UART interface

DTR	3	DI,PU	DTE get ready	If unused, keep them open.
RI	4	DOH	Ring Indicator	
DCD	5	DOH	Carrier detects	
CTS	7	DOL	Clear to Send	
RTS	8	DI,PD	Request to send	
TXD	9	DOH	Transmit Data	
RXD	10	DI,PD	Receive Data	

I2C interface

I2C_SDA	37	DO	I2C data input/output	If unused, keep open, or else pull them up via 2.2K Ω resistors to the VDD_EXT.
I2C_SCL	38	I/O	I2C clock output	

PCM interface

PCM_CLK	11	DOH	PCM data bit clock.	If unused, please keep them open.
PCM_SYNC	12	DO	PCM data frame sync signal.	
PCM_DIN	13	DI	PCM data input.	
PCM_DOUT	14	DO	PCM data output.	

GPIO

NETLIGHT	52	DO	LED control output as network status indication.	If unused, keep them open.
STATUS	66	DOH	Operating status output. High level: Power on and firmware ready Low level: Power off	
GPIO0	50	IO	Default: GPIO Optional: UART3_TXD in DAM application	
GPIO1	49	IO	Default: GPIO Optional: UART3_RXD in DAM application	

GPIO2	67	IO	GPIO	
GPIO3	68	DOH	GPIO	
GPIO4	48	DOH	GPIO	
RF interface				
GNSS_ANT	53	AI	GNSS antenna soldering pad	
RF_ANT	60	AIO	MAIN antenna soldering pad	
Other interface				
BOOT_CFG	6	DI,PD	If it needs to enter into forced USB download mode, it must be pulling up this pin to VDD_EXT before press the PWRKEY. If it needs to boot up normally, please keep this pin open.	Reserve a test points for it. Keep it open. DO NOT PULL UP DURING NORMAL POWER UP!
MDM_LOG_TX	23	DO	Module log output for SW debug. (only used for platform)	Reserve a test point for it.
ADC	25	AI	Analog-digital converter input. voltage range: 0~VBAT.	If unused, keep them open.
NC	19、20、 21、22、 26、35、 36、40、 41、42、 43、44、 47、51、		No connection.	Keep it open

NOTE

Please reserve a test point for BOOT_CFG, VDD_EXT and MDM_LOG_TX. If there is no USB connector, please also reserve a test point for USB_VBUS, USB_DP, and USB_DM for Firmware upgrade.

2.3 Mechanical Information

The following figures howsthe package outline drawing ofSIM7000.

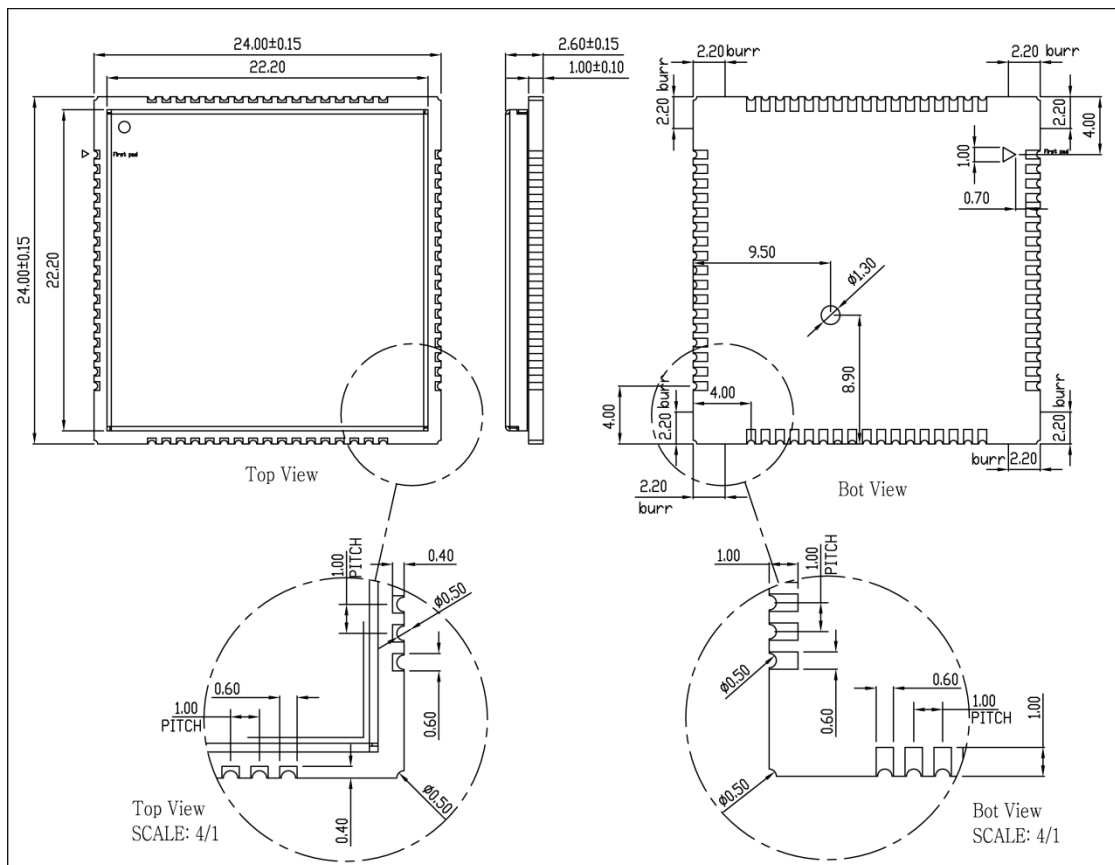


Figure 3: Dimensions (Unit: mm)

2.4 Footprint Recommendation

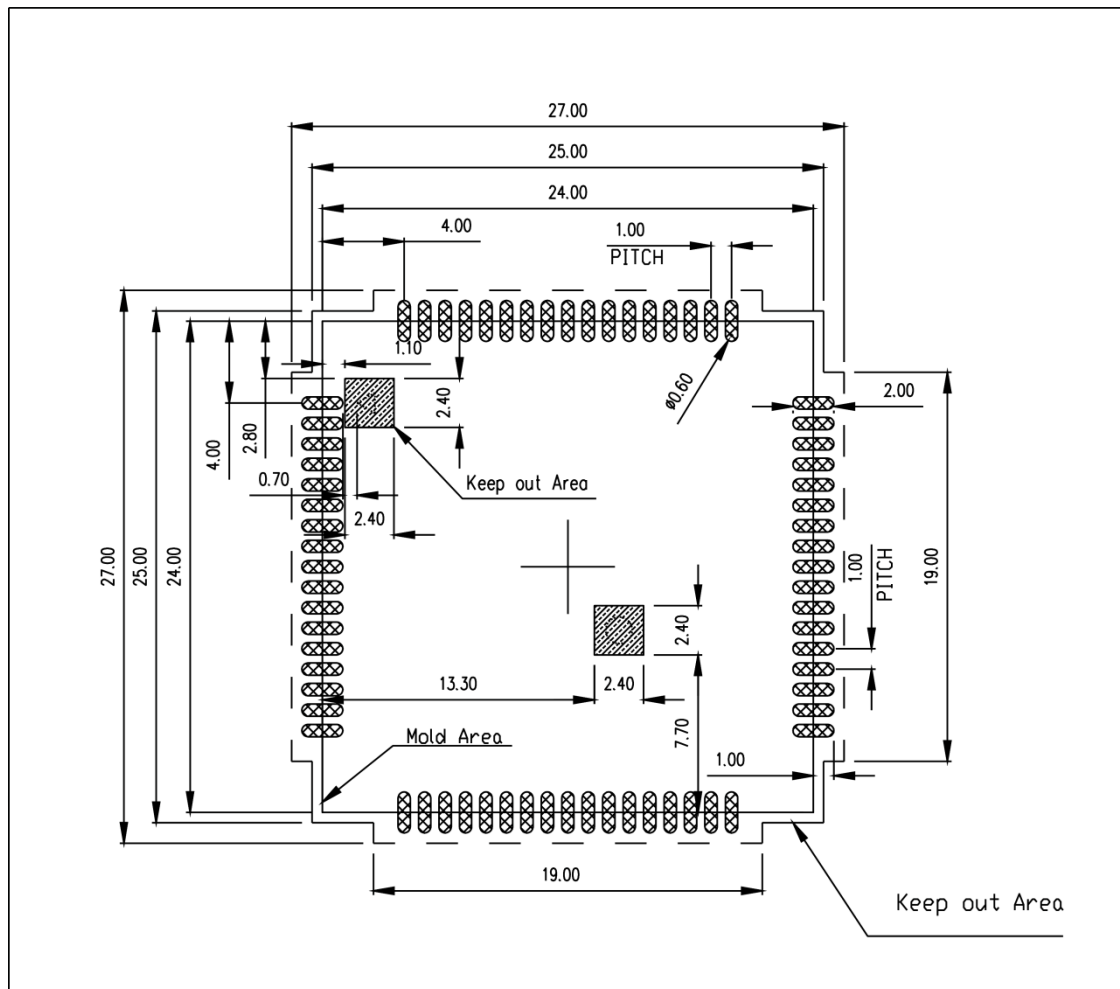


Figure 4: Footprint recommendation (Unit: mm)

3 Interface Application

3.1 Power Supply

Pin 55, pin 56 and pin 57 are VBAT power input.

On VBAT pads, when module works on CAT-M1 or NB-IoT mode, the ripple current is up to 0.6A typically. For steady voltage, the power supply capability must be up to 0.6A.

On VBAT pads, when module works on EDGE or GPRS mode, the ripple current is up to 2A typically. For steady voltage, the power supply capability must be up to 2A.

In order to avoid the voltage dropped down more than 300mV, the load capacitor on VBAT pads must be more than 300uF.

The following figure shows the VBAT voltage ripple wave at the maximum power transmit phase in EDGE/GPRS emission mode.

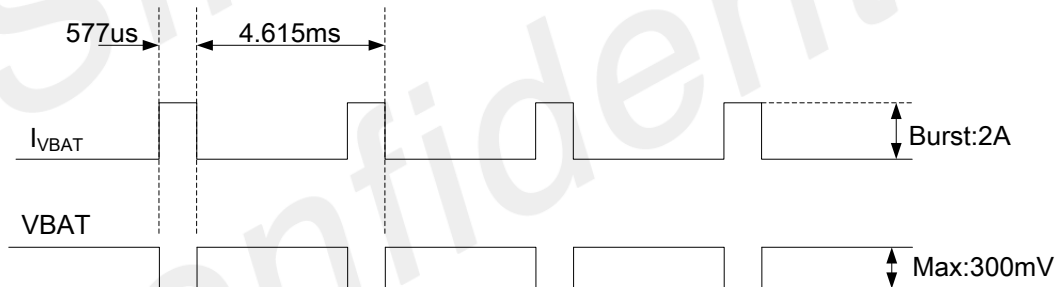


Figure 5: VBAT voltage drop during burst emission (EDGE/GPRS)

NOTE

The test condition: The voltage of power supply for VBAT is 3.8V, $C_a=100\ \mu\text{F}$ tantalum capacitor (ESR=0.7 Ω) and $C_e = 100\text{Nf}$ (Please refer to Figure 6—Application circuit).

Table 6: VBAT pins electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VBAT	Module power voltage	3.0	3.8	4.3	V
$I_{VBAT(peak)}$	Module power peak current in GSM and EDGE emission mode.	-	2	-	A

	Module power peak current in CAT-M1 and NB-IoT emission mode.	-	0.6	-	A
$I_{VBAT(average)}$	Module power average current in normal mode	Please refer to the chapter 5.4			
$I_{VBAT(sleep)}$	Power supply current in sleep mode				
$I_{VBAT(power-off)}$	Module power current in power off mode.	-	-	7	uA

3.1.1 Power Supply Design Guide

Make sure that the voltage on the VBAT pins will never drop below 3.0V, even during a transmit burst when current consumption may rise up to 2A. If the voltage drops below 3.0V, module will be shutdown.

NOTE

If the power supply for VBAT pins can support up to 2A, using a total of more than 300uF capacitors is recommended, or else users must using a total of 1000uF capacitors typically, in order to avoid the voltage drop is more than 300mV.

Some multi-layer ceramic chip (MLCC) capacitors (0.1uF, 1uF) with low ESR in high frequency band can be used for EMC.

These capacitors should be put as close as possible to VBAT pads. Also, users should keep VBAT trace on circuit board wider than 2 mm to minimize PCB trace impedance. The following figure shows the recommended circuit.

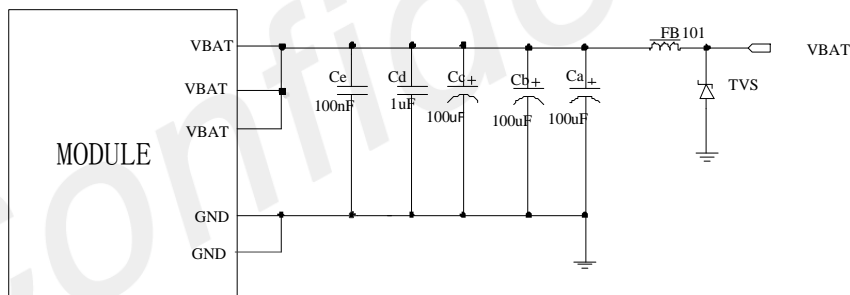


Figure 6: Power supply application circuit

In addition, for ESD protection, it is suggested to add a TVS diode near the VBAT PINs.

Table 7: Recommended TVS diode list

No.	Manufacturer	Part Number	Package
1	Prisemi	PESDHC2FD4V5B	DFN1006
2	Prisemi	PESDHC3D3V3U	SOD323
3	WILLsemi	ESD5651N-2/TR	DFN1006

3.1.2 Recommended Power Supply Circuit

It is recommended that a switching mode power supply or near regulator power supply is used. It is important to make sure that all the components used in the power supply circuit can resist a peak current up to 2A when used GPRS/EDGE.

The following figure shows the linear regulator reference circuit with 5V input and 3.8V output. But this linear regulator has a minimum load current, and it is even bigger than 7mA. So if users care the system power consumption very much, it is not recommended to use.

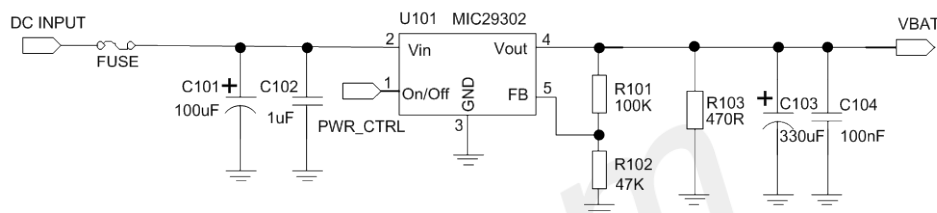


Figure 7: Linear regulator reference circuit

If users used LTE mode only and never used EDGE/GPRS mode, switching mode power supply is recommended to use. And the maximum output current must be meeting the requirement. The following figure shows these switching mode power supply reference circuit.

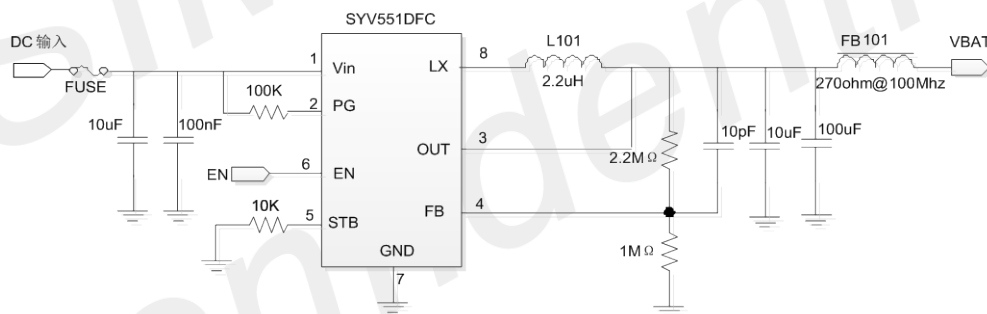


Figure 8: power supply reference circuit (NB only)

3.1.3 Voltage Monitor

To monitor the VBAT voltage, the AT command "AT+CBC" can be used.

AT command "AT+CBATCHK=1" can be used to enable the overvoltage warning function and the under-voltage warning function. The default value of the over voltage warning function in the software is 4.3V, and the default value of the under-voltage warning function is 3.1V. If the power supply for VBAT pins is up 4.3V or under 3.1V, module will be warning.

The AT command "AT+CBATCHK=1" also can be used to enable the overvoltage power-off function and the under-voltage power-off function. The default value of the overvoltage power-off function is 4.4V, and the default value of the under-voltage power-off function is 2.9V. If the VBAT voltage is up 4.4V or

under 2.9V, module will be power off.

NOTE

Under-voltage warning function and under-voltage power-off function are disabled by default. For more information about these AT commands, please refer to Document [1].

3.2 Power on/Power off/Reset Function

3.2.1 Power on

SIM7000 can be powered on by pulling the PWRKEY pin to ground.

The PWRKEY pin has been pulled up with a diode to 1.8V internally, so it does not need to be pulled up externally. It is strongly recommended to put a 100nF capacitor and an ESD protection diode close to the PWRKEY pin, as it would strongly enhance the ESD performance of PWRKEY pin. Please refer to the following figure for the recommended reference circuit.

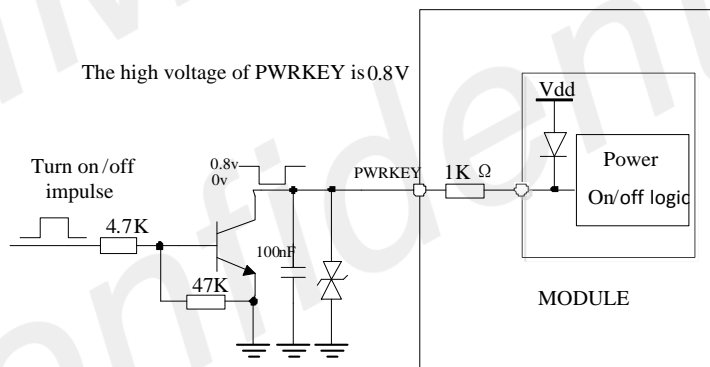


Figure 9: Reference power on/off circuit

The power-on scenarios are illustrated in the following figure.

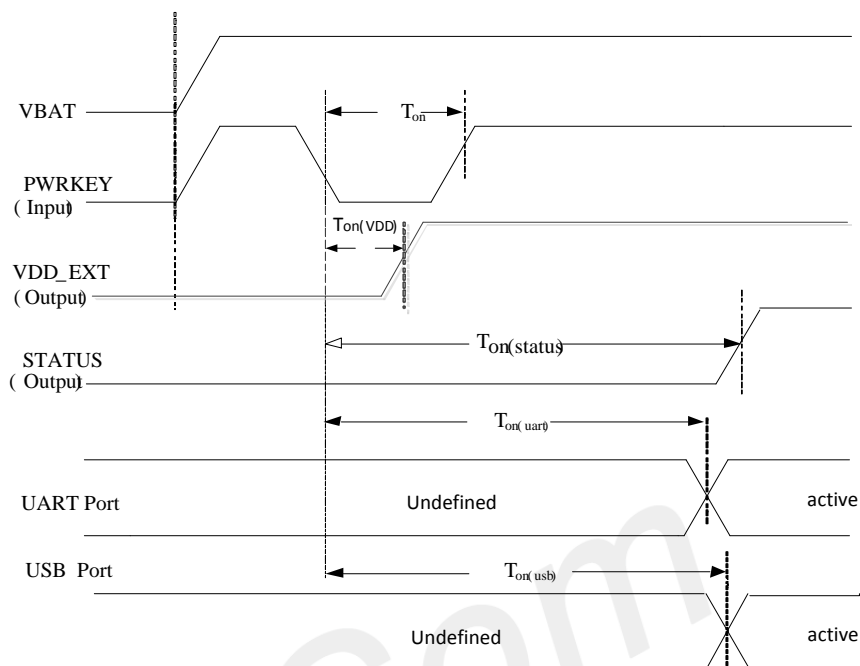


Figure 10: Power on timing sequence

Table 8: Power on timing and electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{on}	The time of active low level impulse of PWRKEY pin to power on module	1	-	-	s
$T_{on}(Vdd)$	The time from power-on issue to VDD_EXT pin output high level.		64		ms
$T_{on}(status)$	The time from power-on issue to STATUS pin output high level(indicating power up ready)	4.5	-	-	s
$T_{on}(uart)$	The time from power-on issue to UART port ready	4.5	-	-	s
$T_{on}(usb)$	The time from power-on issue to USB port ready	4.5	-	-	s
V_{IH}	Input high level voltage on PWRKEY pin	0.6	0.8	1.8	V
V_{IL}	Input low level voltage on PWRKEY pin	-0.3	0	0.5	V

3.2.2 Power off

The following methods can be used to power off SIM7000.

- Method 1: Power off SIM7000 by pulling the PWRKEY pin to ground.
- Method 2: Power off SIM7000 by AT command “AT+CPOWD=1”.
- Method 3: over-voltage or under-voltage automatic power off. The function can be enabled by AT command “AT+CBATCHK=1”. Default is disabled.

NOTE

For details about “AT+CPOWD” and “AT+CBATCHK”, please refer to Document [1].

These procedures will make modules disconnect from the network and allow the software to enter a safe state, and save data before module be powered off completely.

The power off scenario by pulling down the PWRKEY pin is illustrated in the following figure.

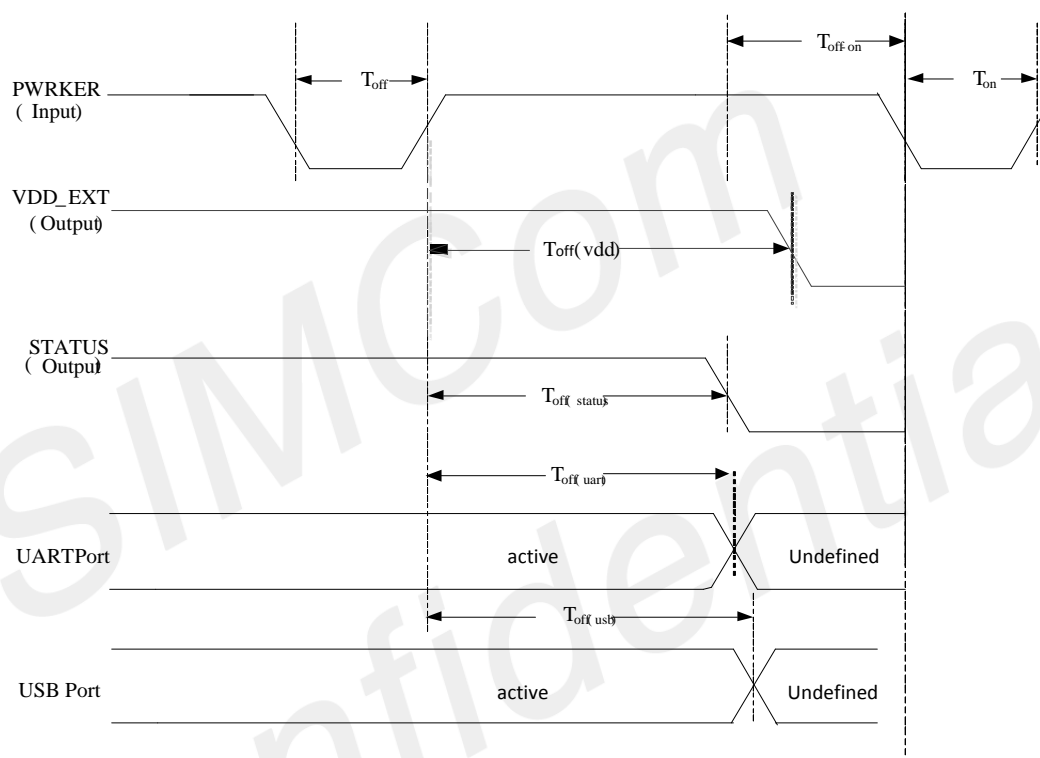


Figure 11: Power off timing sequence

Table 9: Power off timing and electronic characteristic

Symbol	Parameter	Time value			Uni
		Min.	Typ.	Max.	
Toff	The active low level time pulse on PWRKEY pin to power off module	1.2	-	-	s
Toff (vdd)	The time from power-off issue to VDD_EXT pin output low level	1.8	-	6.9	s
Toff(status)	The time from power-off issue to STATUS pin output low level(indicating power off)*	1.8	-	6.9	s
Toff(usb)	The time from power-off issue to USB port off	1.8	-	6.9	s
Toff-on	The buffer time from power-off issue to power-on issue	2	-	-	s

NOTE

The STATUS pin can be used to detect whether module is powered on or not. When module has been powered on and firmware goes ready, STATUS will be high level, or else STATUS will still low level.

3.2.3 Reset Function

SIM7000 can be reset by pulling the RESET pin to ground.

NOTE

This function is only used as an emergency reset. The RESET pin will be ineffectiveness in the power off mode.

The RESET pin has been pulled up to 1.8V with a 40K Ω resistor internally. So it does not need to be pulled up externally. It is strongly recommended to put a 100nF capacitor and an ESD protection diode close to the RESET pin. Please refer to the following figure for the recommended reference circuit.

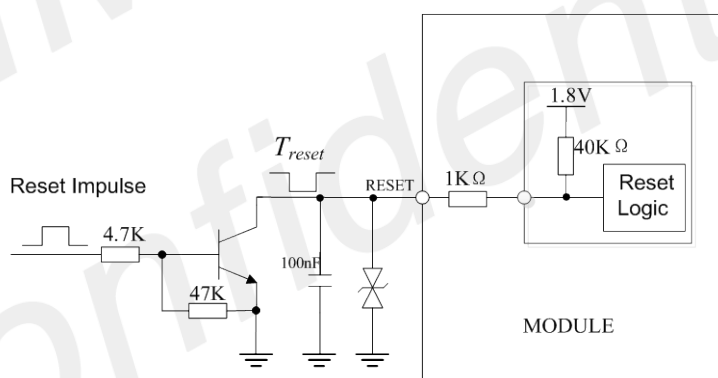


Figure 12: Reference reset circuit

Table 10: RESET pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
Treset	The active low level time impulse on RESET pin to reset module	252			ms
V _{IH}	Input high level voltage	1.2	1.8	2.1	V
V _{IL}	Input low level voltage	-0.3	0	0.8	V

3.3 UART Interface

SIM7000 provides a 7-wire UART (universal asynchronous serial transmission) interfaces DCE (Data Communication Equipment). AT commands and data transmission can be performed through this UART interface.

In DAM (Downloadable Application Module) application, SIM7000 provides a UART interface to use. This UART multiplexed from GPIO. The GPIO0 multiplex as TXD and the GPIO1 multiplex as RXD. This UART interface can't use as AT port or data transmission. It is only used as UART in DAM application when secondary development.

SIM7000 support high speed UART, the baud rate is up to 4Mbps. The communication baud rates include: 0, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 2000000, 3000000, 3200000, 3686400 bps. The rate 0bps mark auto baud rate. And it supports auto baud rate, but the rate only supported on 9600, 19200, 38400, 57600, 115200. If users need to change to other baud rate, it needs to switch via manual operation.

3.3.1 UART Design Guide

The following figures show the reference design.

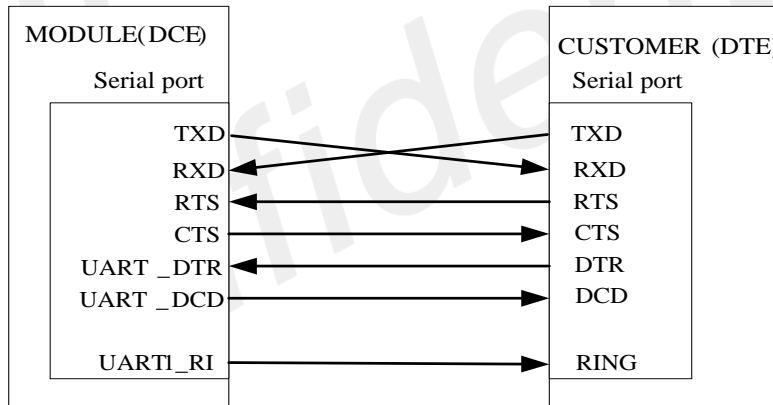


Figure 13: UART full modem

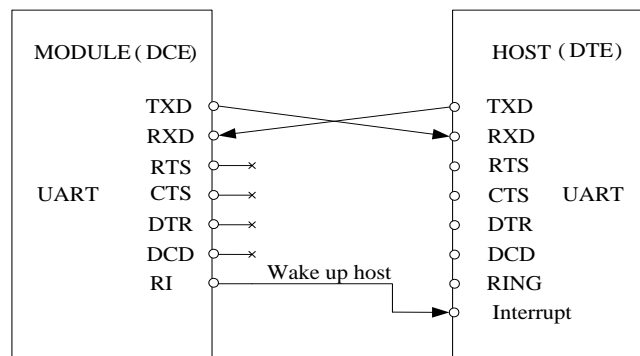


Figure 14: UART null modem

Table 11: UART electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VIH	UART input high level voltage	1.17	1.8	2.1	V
VIL	UART input low level voltage	-0.3	0	0.63	V
VOH	UART output high level voltage	1.35	1.8	1.8	V
VOL	UART output low level voltage	0	0	0.45	V

The SIM7000 UART is 1.8V voltage interface. If user's UART application circuit is 3.3V voltage interface, the level shifter circuits should be used for voltage matching. The following figure shows the voltage matching reference design.

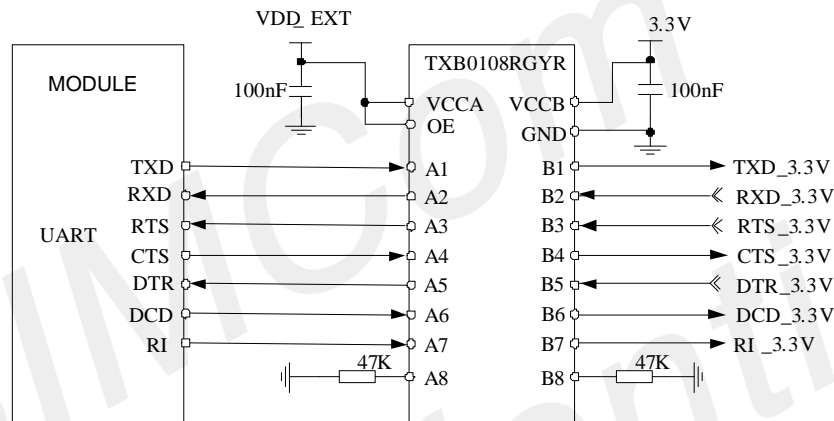


Figure 15: Reference circuit of level shift

NOTE

When it uses the level shifter IC, the pull up resistance on TXD_3.3V, RTS_3.3V, DCD_3.3V and RI_3.3V should not be less than 47KΩ.

3.3.2 RI and DTR Behavior

The RI pin description:

The RI pin can be used to interrupt output signal to inform the host controller such as application CPU. Before that, users must use AT command "AT+CFGRI=1" to enable this function.

Normally RI will keep high level until certain conditions such as receiving SMS, or a URC report coming, then it will output a low level pulse 120ms, in the end, it will become high level.

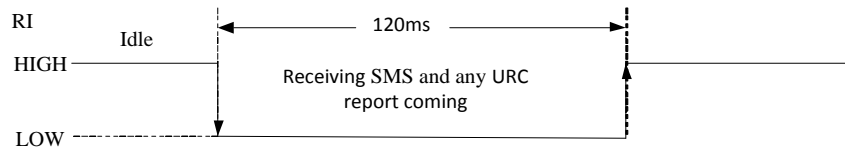


Figure 16: RI behaviour (SMS and URC report)

The DTR pin description:

After setting the AT command “AT+CSCLK=1”, and then pulling up the DTR pin, SIM7000 will enter sleep mode when module is in idle mode. In sleep mode, the UART is unavailable. When SIM7000 enters sleep mode, pulling down DTR can wake up module.

After setting the AT command “AT+CSCLK=0”, SIM7000 will do nothing when the DTR pin is pulling up.

NOTE

For more details of AT commands about UART, please refer to document [1] and [20].

3.4 USB Interface

The SIM7000 contains a USB interface compliant with the USB2.0 specification as a peripheral, but the USB charging function is not supported.

USB_VBUS is the detecting signal for USB inserting. The input voltage range on the USB_VBUS pin is from 3.5V to 5.25V. If the voltage is out of this range, it may cause USB port unidentifiable.

The reference circuit refers to the following figure.

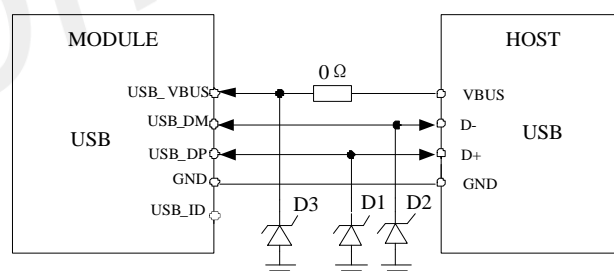


Figure 17: USB reference circuit

Because of the high speed on USB bus, more attention should be paid to the influence of the junction capacitance of the ESD component on USB data lines. Typically, the capacitance of the D1 and D2 should be less than 1pF.

D3 is suggested to select the diode with anti-ESD and voltage surge function, or customer could add a ZENER diode for surge clamping.

Table 12: SIM TVS recommended model list

NOI	Factory	P/N.	Load cap	Pack
1	NXP	PESD5V0X1BCA L	0.85pF	0402
2	Willsemi	ESD5301N	0.4pF	0402
3	NXP	PESD5V0H1BSF	0.15pF	0201
4	Willsemi	ESD5311Z-2/TR	0.25pF	0201

NOTE

The USB_DM and USB_DP nets must be traced by 90Ohm+/-10% differential impedance.

3.5 SIM Interface

SIM7000 supports both 1.8V and 3.0V SIM Cards.

Table 13: SIM electronic characteristic in 1.8V mode (SIM_VDD=1.8V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
SIM_VDD	LDO power output voltage	1.75	1.8	1.95	V
VIH	High-level input voltage	0.65*SIM_VDD	-	SIM_VDD +0.3	V
VIL	Low-level input voltage	-0.3	0	0.35*SIM_VDD	V
VOH	High-level output voltage	SIM_VDD -0.45	-	SIM_VDD	V
VOL	Low-level output voltage	0	0	0.45	V

Table 14: SIM electronic characteristic 3.0V mode (SIM_VDD=2.95V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
SIM_VDD	LDO power output voltage	2.75	2.95	3.05	V
VIH	High-level input voltage	0.65*SIM_VDD	-	SIM_VDD +0.3	V
VIL	Low-level input voltage	-0.3	0	0.25*SIM_VDD	V
VOH	High-level output voltage	SIM_VDD -0.45	-	SIM_VDD	V
VOL	Low-level output voltage	0	0	0.45	V

3.5.1 SIM Application Guide

It is recommended to use an ESD protection component such as ESDA6V1W5 produced by ST (www.st.com) or SMF15C produced by ON SEMI (www.onsemi.com). Note that the SIM peripheral circuit should be close to the SIM card socket. The following figure shows the 6-pin SIM card holder reference circuit.

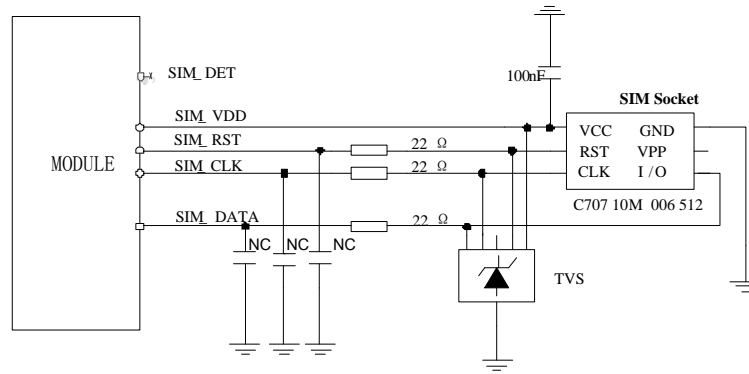


Figure 18: SIM interface reference circuit

SIM_DATA has been pulled up with a 10KΩ resistor to SIM_VDD in module, so it does not need to pulled up resistor anymore.

SIM_VDD needs a 100nF capacitor close to SIM socket.

SIM_CLK is very important signal, the rise time and fall time of SIM_CLK should be less than 40ns. So the junction capacity of the TVS needs to be less 50pF.

SIM_DET is the detecting signal for SIM card to insert and pull out. There is no pull up resistor in module, so a 10KΩ resistor is necessary to pulling up to the power VDD_EXT. This function is disabled default by software. Users can enable it by AT comment "AT+CSDT". And the Interrupt state can be set by AT comment "AT+CSPOL".

NOTE

For more details of AT commands about "AT+CSDT" and "AT+CSPOL", please refer to document [1]

SIM card circuit is easy to be interfered, resulting in unrecognized card or card out of the situation, so please follow the following principles in the design:

- It is recommended to place a 100nF capacitor near the SIM card holder on the SIM_VDD signal line
- Place near SIM gets stuck, TVS, the parasitic capacitance of TVS should not greater than 50 pf, 22 Ω resistance in series between the SIM gets stuck and module can enhance ESD protection performance
- Be sure to keep the SIM card holder away from the main antenna during the PCB layout phase
- The SIM card line should be far away from RF line, VBAT line and high-speed signal line, and the SIM card line should not be too long
- SIM card signal line line avoid line branch
- The GND of the SIM card holder should maintain good connectivity with the GND of the module and make the two GND equipotential
- Each signal of SIM card should be protected by GND, and SIM_CLK should be protected separately.

3.6 PCM Interface

SIM7000 provides a PCM interface for external codec, which can be used in master mode with short sync and 16 bits linear format.

Table 15: PCM format

Characteristics	Specification
Line Interface Format	Linear(Fixed)
Data length	16bits(Fixed)
PCM Clock /Sync Source	Master Mode(Fixed)
PCM Clock Rate	2048 KHz (Fixed)
PCM Sync Format	Short sync(Fixed)
Data Ordering	MSB

NOTE

For more details about PCM AT commands, please refer to document [1].

3.6.1 PCM timing

SIM7000 supports 2.048 MHz PCM data and sync timing for 16 bits linear format codec.

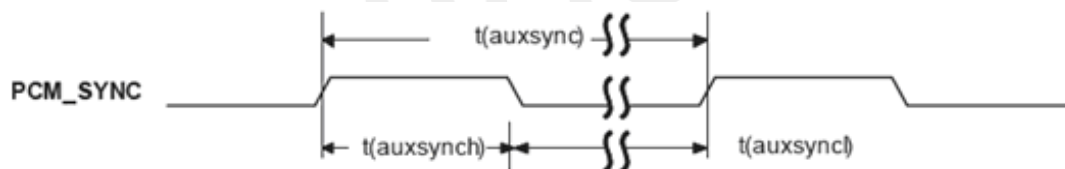


Figure 19: PCM_SYNC timing

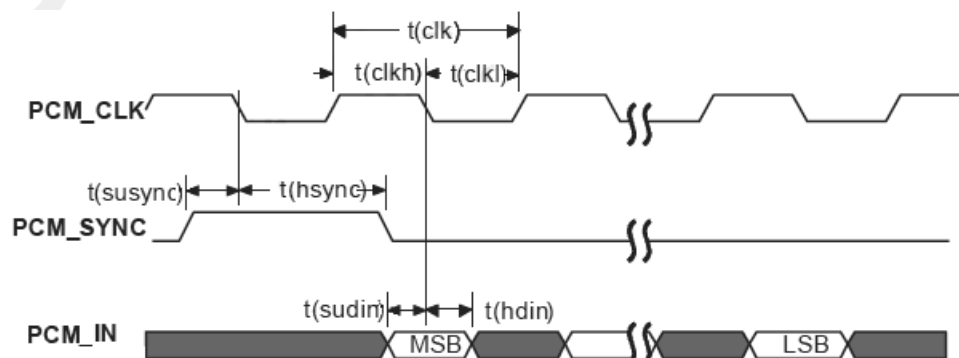


Figure 20: External codec to module timing

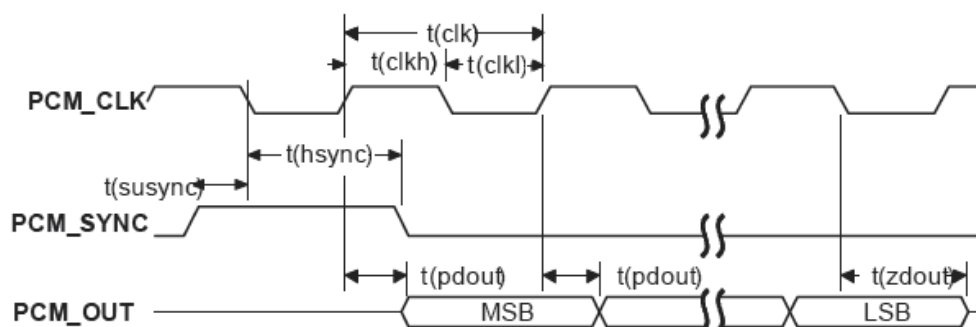


Figure 21: Module to external codec timing

Table 16: PCM timing parameters

Parameter	Description	Min.	Typ.	Max.	Unit
T(sync)	PCM_SYNC cycle time	—	125	—	μs
T(sync _h)	PCM_SYNC high level time	—	488	—	ns
T(sync _l)	PCM_SYNC low level time	—	124.5	—	μs
T(clk)	PCM_CLK cycle time	—	488	—	ns
T(clk _h)	PCM_CLK high level time	—	244	—	ns
T(clk _l)	PCM_CLK low level time	—	244	—	ns
T(susync)	PCM_SYNC setup time high before falling edge of PCM_CLK	—	122	—	ns
T(hsync)	PCM_SYNC hold time after falling edge of PCM_CLK	—	366	—	ns
T(sudin)	PCM_IN setup time before falling edge of PCM_CLK	60	—	—	ns
T(hdin)	PCM_IN hold time after falling edge of PCM_CLK	60	—	—	ns
T(pdout)	Delay from PCM_CLK rising to PCM_OUT valid	—	—	60	ns
T(zdout)	Delay from PCM_CLK falling to PCM_OUT HIGH-Z	—	—	60	ns

3.6.2 PCM Application Guide

The following figure shows the external codec reference design.

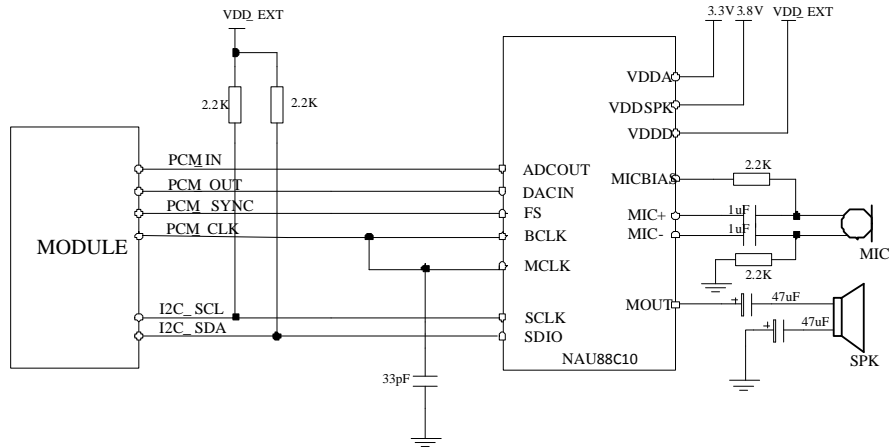


Figure 22: Audio codec reference circuit

3.7 I2C Interface

SIM7000 provides an I2C interface compatible with I2C specification, version 5.0, with clock rate up to 400 kHz. Its operation voltage is 1.8V.

The following figure shows the I2C bus reference design.

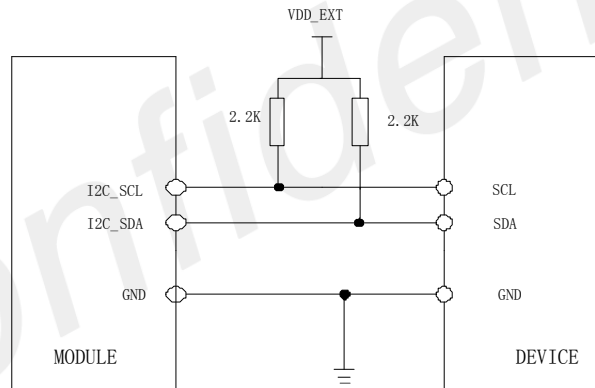


Figure 23: I2C reference circuit

The I2C signal has no pull-up resistors in module. So the pulling up resistors 2.2KΩ to VDD_EXT are necessary in application circuit.

3.8 Network status

The NETLIGHT pin is used to control Network Status LED, its reference circuit is shown in the following figure.

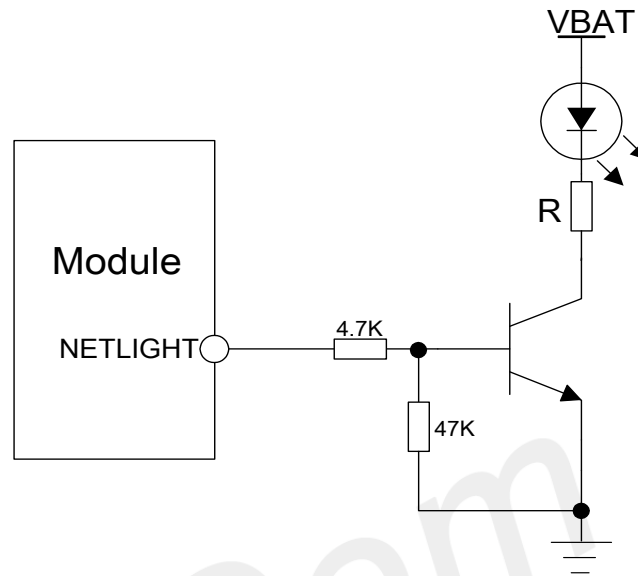


Figure 24: NETLIGHT reference circuit

NOTE

The value of the resistor named “R” depends on the LED characteristic.

Table 17: NETLIGHT pin status

NETLIGHT pin status	Module status
64ms ON, 800ms OFF	No registered network
64ms ON, 3000ms OFF	Registered network (PS domain registration success)
64ms ON, 300ms OFF	Data transmit (PPP dial-up state and use of data services such as internal TCP/FTP/HTTP)
OFF	Power off or PSM mode

NOTE

NETLIGHT output low level as “OFF” and high level as “ON”.

3.9 Other interface

3.9.1 ADC

SIM7000 has a dedicated ADC pin. It is available for digitizing analog signals such as battery voltage and so on. Its input voltage range is from 0V to VBAT. That is the maximum measurement range of ADC cannot exceed the input voltage of VBAT (3V~4.3V). When the voltage of the VBAT is reduced during use, the range of ADC will also be reduced. If the input voltage of ADC PIN exceeds its range, it is necessary to implement the resistance partial pressure on the hardware

The electronic specifications are shown in the following table.

Table 18: ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	–	15	Bits
Input Range	0		VBAT	V
Input serial resistance	1	–	–	MΩ

NOTE

“AT+CADC” can be used to read the voltage of the ADC pin, for more details, please refer to document [1].

3.9.2 LDO

SIM7000 has a LDO power output named VDD_EXT. The output voltage is 1.8V. This voltage can only be pulled up for the external GPIO or power supply for the level conversion circuit.

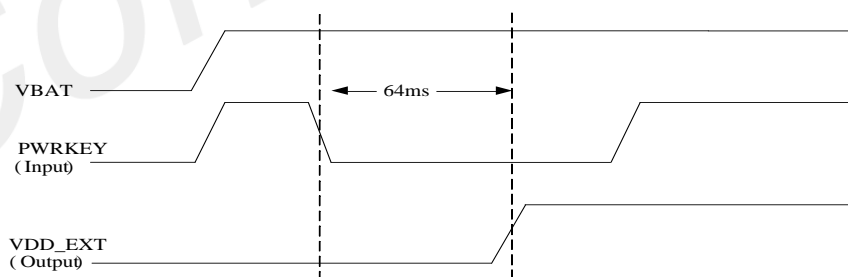


Figure 25: Power on sequence of the VDD_EXT

Table 19: Electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VDD_EXT	Output voltage	1.7	1.8	1.9	V
IO	Output current	-	-	50	mA

NOTE

The VDD_EXT is used to the IO power in the module. The Output voltage is not supported to adjust.

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4 RF Specifications

4.1 GSM/LTE RF Specifications

Table 20: Conducted transmission power

Frequency	Power	Min.
EGSM900	33dBm \pm 2dB	5dBm \pm 5dB
DCS1800	30dBm \pm 2dB	0dBm \pm 5dB
LTE-FDD B1	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B2	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B3	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B4	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B5	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B6	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B8	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B12	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B13	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B18	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B19	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B20	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B26	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B28	23dBm \pm 2.7dB	<-40dBm
LTE-FDD B39	23dBm \pm 2.7dB	<-40dBm

NOTE

The max power is tested result for 1RB in CAT-M1 and single-tone in CAT-NB1. MPR for CAT-M1 please refer to 6.2.3EA.5 part for 3GPP. Multi-tone test results please refer to part 6.2.3F.3 for CAT-NB1.

Table21: Maximum Power Reduction (MPR) for UE category NB1 Power Class 3

Modulation	QPSK		
Tone positions for 3 Tones allocation	0-2	3-5 and 6-8	9-11
MPR	\leq 0.5 dB	0 dB	\leq 0.5 dB

Tone positions for 6 Tones allocation	0-5 and 6-11	
MPR	≤ 1 dB	≤ 1 dB
Tone positions for 12 Tones allocation	0-11	
MPR	≤ 2 dB	

Table 22: Operating frequencies

Frequency	Receiving	Transmission
EGSM900	925~960MHz	880~915 MHz
GSM850	869~894MHz	824~849 MHz
DCS1800	1805~1880 MHz	1710~1785 MHz
PCS1900	1844.9~1879.9MHz	1749.9~1784.9MHz
GPS L1 BAND	1574.4 ~1576.44 MHz	-
GLONASS	1598 ~1606 MHz	-
BD	1559~1563 MHz	
LTE BAND	Refers to Table 22	

Table 23: E-UTRA operating bands

E-UTRA	UL Freq.	DL Freq.	Duplex Mode
1	1920 ~1980 MHz	2110 ~2170 MHz	HD-FDD
3	1710 ~1785 MHz	1805 ~1880 MHz	HD-FDD
5	824 ~849 MHz	869 ~894 MHz	HD-FDD
6	830 ~840 MHz	875 ~885 MHz	HD-FDD
8	880 ~915 MHz	925 ~960 MHz	HD-FDD
12	699 ~716 MHz	729 ~746 MHz	HD-FDD
13	777 ~787 MHz	746 ~756 MHz	HD-FDD
18	815 ~830 MHz	860 ~875 MHz	HD-FDD
19	830 ~845 MHz	875 ~890 MHz	HD-FDD
20	832 ~862 MHz	791 ~821 MHz	HD-FDD
26	814 ~849 MHz	859 ~894 MHz	HD-FDD
28	703 ~748 MHz	758 ~803 MHz	HD-FDD
39	1880 ~1920 MHz	1880 ~1920 MHz	TDD

Table 24: Conducted receive sensitivity

Frequency	Receive sensitivity(Typical)	Receive sensitivity(MAX)
EGSM900	< -109dBm	3GPP
GSM850	< -109dBm	3GPP
DCS1800	< -109dBm	3GPP

PCS1900	< -109dBm	3GPP
LTE FDD/TDD	Refers to Table 24	

Table 25: CAT-M1 Reference sensitivity (QPSK)

E-UTRA Band	REFSENS MAX(dBm) 3GPP	REFSENS Typical(dBm)	Duplex Mode
1	-102.2	-102.2	HD-FDD
2	-100.2	-100.2	HD-FDD
3	-99.2	-99.2	HD-FDD
4	-102.2	-102.2	HD-FDD
5	-100.7	-100.7	HD-FDD
8	-99.7	-99.7	HD-FDD
12	-99.2	-99.2	HD-FDD
13	-98.7	-98.7	HD-FDD
18	-102.2	-102.2	HD-FDD
19	-102.2	-102.2	HD-FDD
20	-99.7	-99.7	HD-FDD
26	-100.2	-100.2	HD-FDD
28	-100.7	-100.7	HD-FDD
39	-103.7	-103.7	TDD

Table 26: CAT-NB1 Reference sensitivity (QPSK)

Operating band	REFSENS (dBm) 3GPP Request	REFSENS Typical (dBm)	REFSENS Typical Repeated 7/128 [EPREdBm/15KHz]
1, 2, 3, 4, 5, 8, 12, 13, 17, 18, 19, 20, 26, 28	-108.2	-114	-145

4.2 GSM/LTE Antenna Design Guide

Users should connect antennas to SIM7000's antenna pads through micro-strip line or other types of RF trace and the trace impedance must be controlled in 50Ω . SIMCom recommends that the total insertion loss between the antenna pads and antennas should meet the following requirements:

Table 27: Trace loss

Frequency	Loss
700MHz-960MHz	<0.5dB
1710MHz-2170MHz	<0.9dB
2300MHz-2650MHz	<1.2dB

To facilitate the antenna tuning and certification test, a RF connector and an antenna matching circuit should be added. The following figure is the recommended circuit.

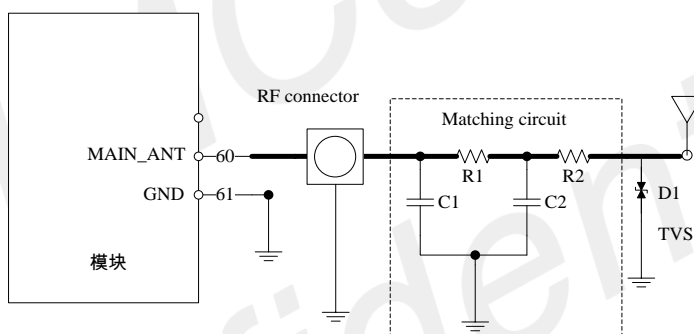


Figure 26: Antenna matching circuit (MAIN_ANT)

In above figure, the components R1, C1, C2 and R2 are used for antenna matching, the values of components can only be achieved after the antenna tuning and usually provided by antenna vendor. By default, the R1, R2 are 0Ω resistors, and the C1, C2 are reserved for tuning. The component D1 is a TVS for ESD protection, and it is optional for users according to application environment.

The RF test connector is used for the conducted RF performance test, and should be placed as close as to the module's MAIN_ANT pin. The traces impedance between SIM7000 and antenna must be controlled in 50Ω .

Two TVS are recommended in the table below.

Table 28: Recommended TVS

Package	Part Number	Vender
0201	LXES03AAA1-154	Murata
0402	LXES15AAA1-153	Murata

4.3 GNSS

SIM7000 merges GNSS (GPS/GLONASS/BD) satellite and network information to provide a high-availability solution that offers industry-leading accuracy and performance. This solution performs well, even in very challenging environmental conditions where conventional GNSS receivers fail, and provides a platform to enable wireless operators to address both location-based services and emergency mandates.

4.3.1 GNSS Technical specification

- Tracking sensitivity: -162 dBm (GPS) /-157 dBm (GLONASS) /TBD (BD)
- Cold-start sensitivity: -148 dBm
- Accuracy (Open Sky): 2.5m (CEP50)
- TTFF (Open Sky) : Hot start <1s, Cold start<35s
- Receiver Type: 16-channel, C/A Code
- GPS L1 Frequency: 1575.42±1.023MHz
- GLONASS: 1597.5~1605.8 MHz
- BD: 1559.05~1563.14 MHz
- Update rate: Default 1 Hz
- GNSS data format: NMEA-0183
- GNSS Current consumption :30mA (GSM/LTE Sleep, in total on VBAT pins)
- GNSS antenna: Passive/Active antenna

NOTE

If the antenna is active type, the power should be given by main board because there is no power supply on the GPS antenna pad. If the antenna is passive, it is suggested that the external LNA should be used.

4.3.2 GNSS Application Guide

Users can adopt an active antenna or a passive antenna to SIM7000. If using a passive antenna, an external LNA is a must to get better performance. The following figures are the reference circuits.

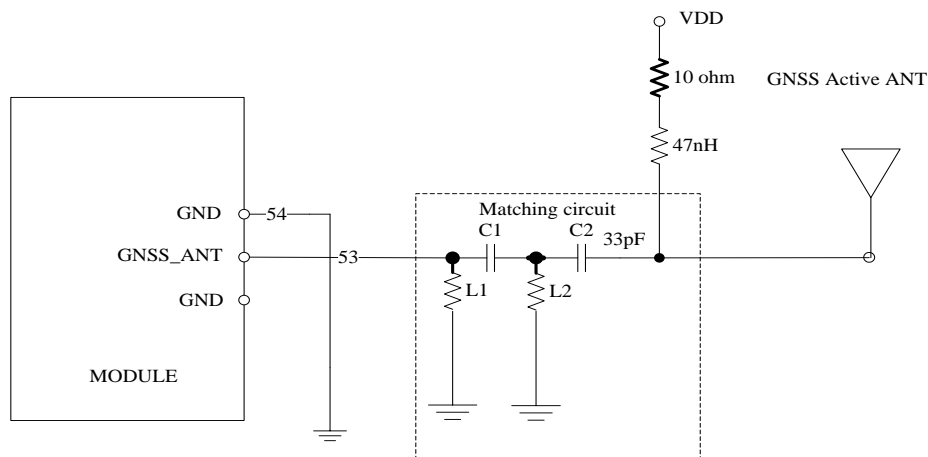


Figure 27: Active antenna circuit

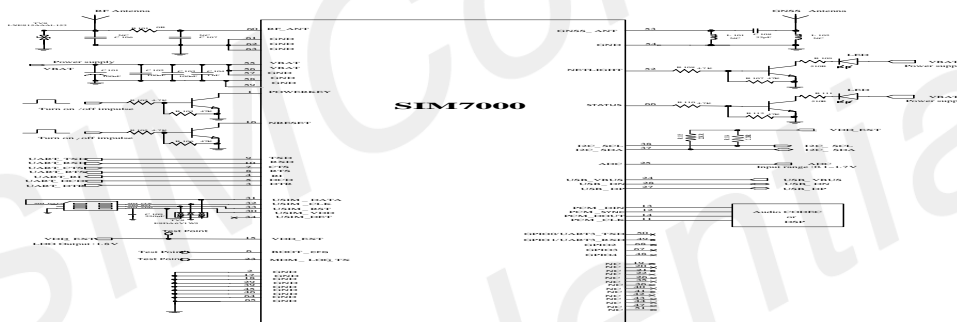


Figure 28: Passive antenna circuit (Default)

In above figures, the components C1, L1 and L2 are used for antenna matching. Usually, the values of the components can only be achieved after antenna tuning and usually provided by antenna vendor. C2 is used for DC blocking. L3 is the matching component of the external LNA, and the value of L3 is determined by the LNA characteristic and PCB layout. Both VDD of active antenna and V_LNA need external power supplies which should be considered according to active antenna and LNA characteristic. LDO/DCDC is recommended to get lower current consuming by shutting down active antennas and LNA when GNSS is not working.

GNSS can be tested by NMEA port. NMEA sentences can be obtained through UART or USB automatically. NMEA sentences include GSV, GGA, RMC, GSA, and VTG. Before using GNSS, user should configure SIM7000 in proper operating mode by AT command. Please refer to related documents for details. SIM7000 can also get position location information through AT directly.

NOTE

1. GNSS is closed by default and can be started by “AT+CGNSPWR=1”. The AT command has two parameters, the first is on/off, and the second is GNSS mode. Default mode is standalone mode. AGPS mode needs more support from the mobile telecommunication network. Please refer to

document [21] for more details.

2. If the passive antenna is used, put the LNA close to the antenna.
3. Make sure there are no noise signals around GNSS antenna.

4.4 RF traces note

4.4.1 RF traces layout

- Keep the RF trace from module ant pin to antenna as short as possible
- RF trace should be 50 Ω either on the top layer or in the inner layer
- RF trace should be avoided right angle and sharp angle.
- Put enough GND vias around RF traces.
- RF trace should be far away from other high speed signal lines.

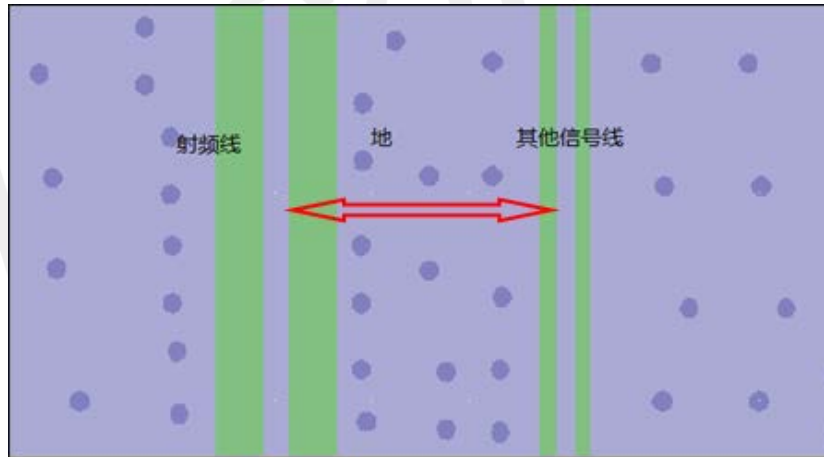


Figure 29: RF trace should be far away from other high speed signal lines

- Avoiding the paroling rout of other system antennas nearby.
- There should be some distance from The GND to the inner conductor of the SMA connector. It is better to keep out all the layers from inner to the outer conductor.

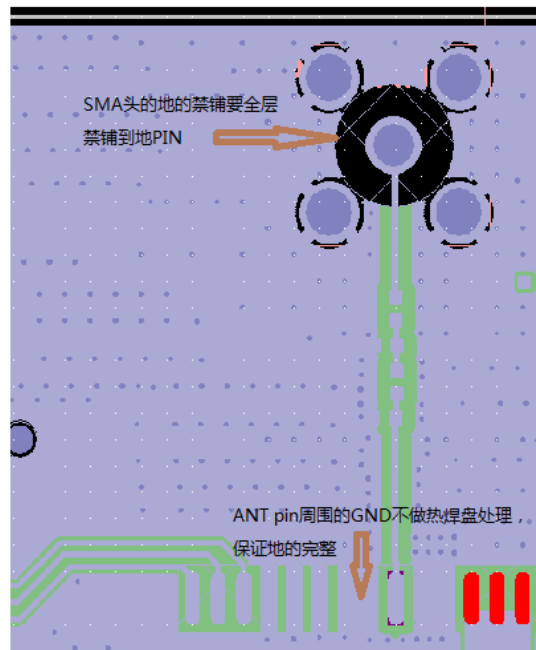


Figure 30: The distance between GND to the inner conductor of SMA

- GND pads around the ANT pad should not be hot pad to keep the GND complete.

4.4.2 LTE ANT and other system ANT decoupling

- Make sure the efficiency of LTE main ANT more than 40%
- Keep the decoupling of LTE main ANT to WLAN ANT more than 15dB
- Keep the decoupling of LTE main ANT to GNSS ANT more than 30dB

NOTE

The decoupling value can be provided by ANT adventure. More details can refer to the document[22].

5 Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of SIM7000 are listed in the following table:

Table 29: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage on VBAT	-0.3	-	5.5	V
Voltage on USB_VBUS	-0.3	-	5.8	V
Voltage at digital pins (RESET,GPIO,I2C,UART,PCM)	-0.3	-	2.1	V
Voltage at PWRKEY	-0.3	-	3.4	V
ADC	-0.3	-	VBAT	V

The absolute parameter is tested when VBAT has the power but the PWRKEY has no pulled down. If it is over the range, the module will be damage. If the power supply on VBAT pin had been shut down, and the other pin should not have the voltage. Otherwise, it may lead to abnormally boot up or damage the module.

5.2 Operating conditions

Table 30: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.0	3.8	4.3	V
Voltage at USB_VBUS	3.5	5.0	5.25	V

Make sure that the voltage on the VBAT pins will never drop below 3.0V, even during a transmit burstwhen current consumption may rise up to 2A. If the voltage drops below 3.0V, module will be power down.

Table 31: 1.8V Digital I/O characteristics*

Parameter	Description	Min.	Typ.	Max.	Unit
VIH	High-level input voltage	1.17	1.8	2.1	V
VIL	Low-level input voltage	-0.3	0	0.63	V
VOH	High-level output voltage	1.35	-	1.8	V
VOL	Low-level output voltage	0	-	0.45	V
IOH	High-level output current(no pull	-	2	-	mA

	down resistor)				
IOL	Low-level output current(no pull up resistor)	-	-2	-	mA
I _{IH}	Input high leakage current (no pull down resistor)	-	-	1	uA
I _{IL}	Input low leakage current(no pull up resistor)	-1	-	-	uA

NOTE

These parameters are for digital interface pins, such as GPIOs (including NETLIGHT,STATUS, SIM_DET), I2C, UART, PCM, MDM_LOG_TX and BOOT_CFG.

The operating temperature of SIM7000 is listed in the following table.

Table 32: Operating temperature

Parameter	Min.	Typ.	Max.	Unit
Normal operation temperature	-30	25	80	°C
Extended operation temperature*	-40	25	85	°C
Storage temperature	-45	25	+90	°C

NOTE

Module is able to make and receive voice calls, data calls, SMS and make GPRS/LTE traffic in -40°C ~ +85°C. The performance will be reduced slightly from the 3GPP specifications if the temperature is outside the normal operating temperature range and still within the extreme operating temperature range.

5.3 Operating Mode

5.3.1 Operating Mode Definition

The table below summarizes the various operating modes of SIM7000 product.

Table 33: Operating mode Definition

Mode		Function
Normal operation	GPRS/EDGE/LTE Sleep	In this case, the current consumption of module will be reduced to the minimal level and the module can still receive paging message and SMS.
	GPRS/EDGE /LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	LTETCat-M1Talk	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, and antenna.
	GPRS/EDGE/LTE Standby	Module is ready for data transmission, but no data is currently sent or received. In this case, power consumption depends on network settings.
	GPRS/EDGE/LTE Data transmission	There is data transmission in progress. In this case, power consumption is related to network settings (e.g. power control level); uplink/downlink data rates, etc.
Minimum functionality mode		AT command “AT+CFUN=0” and “AT+CSCLK=1” 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 and the SIM card will not be accessible, but the serial port and USB ports are still accessible. The power consumption in this mode is lower than normal mode.
Flight mode		AT command “AT+CFUN=4” can be used to set the module to flight mode without removing the power supply. In this mode, the RF part of the module will not work, but the serial port and USB ports are still accessible. The power consumption in this mode is lower than normal mode.
Power Saving Mode (PSM)		Setting AT command” AT+CPSMS=1” can be enable the PSM mode. In this mode, The mode is similar to power-off. But the module remains registered on the network and there is no need to re-attach or re-establish the network connections. And all of the functions will be unavailable except the RTC function. PWRKEY admit expires can wake up the module.
Extended Mode (e-DRX)	DRX	In idle or sleep mode, module and the network may negotiate over non-access stratum signaling the use of extended mode DRX for reducing power consumption.

5.3.2 Sleep mode

Module can enter into sleep mode for reducing its power consumption in idle module. In sleep mode, the current consumption of module will be reduced to very small level, and module can still receive paging message and SMS.

Several hardware and software conditions must be satisfied together in order to let SIM7000 enter sleep mode:

- USB condition: Connected USB can't enter into sleep mode. So if module wants to enter into sleep mode, it must disconnect the power supply for USB_VBUS first.
- Software condition: If module wants to enter into sleep mode, AT comment "AT+CSCLK=1" must be set to close some clock in the module. If the value "AT+CSCLK" is "0", module will never enter into sleep mode.
- UART condition: If module wants to enter into sleep mode, AT comment "AT+CSCLK=1" must be set to close some clock in the module. If the value "AT+CSCLK" is "0", module will never enter into sleep mode.

If it meets all the conditions at the same time, module will enter into sleep mode. In sleep mode, the UART is unavailable. If the host need to communicate with module, it need to pull down DTR can wake up module.

5.3.3 Minimum functionality mode and Flight 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

If SIM7000 has been set to minimum functionality mode, the RF function and SIM card function will be closed. In this case, the serial port and USB are still accessible, but RF function and SIM card will be unavailable.

If SIM7000 has been set to flight mode, the RF function will be closed. In this case, the serial port and USB are still accessible, but RF function will be unavailable.

When SIM7000 is in minimum functionality or flight mode, it can return to full functionality by the AT command "AT+CFUN=1".

5.3.4 Power Saving Mode (PSM)

SIM7000 module can enter into PSM for reducing its power consumption. The mode is similar to power-off, but the module remains registered on the network and there is no need to re-attach or re-establish the

network connections. So in PSM all the functions will be unavailable except the RTC function, module cannot immediately respond users' requests.

When the module wants to use the PSM, it can be enabled via "AT+CPSMS=1" command. The command takes effect after module reboot. If the network supports PSM and accepts that the module uses PSM, the network confirms usage of PSM by allocating an Active Time value to the module. Module will be into PSM according to the command from network.

Either of the following methods will wake up the module from PSM:

- Pulling PWRKEY pin to low level will wake up the module.
- When the timer expires, the module will be automatically woken up.

5.4 Current Consumption

The current consumption is listed in the table below.

Table 34: Current consumption on VBAT Pins (VBAT=3.8V)

GNSS	
GNSS supply current (AT+CFUN=0, without USB connection)	Tracking, typical: 30mA In DPO mode, typical: 6mA
GSM sleep/idle mode	
GSM supply current (GNSS off, without USB connection)	Sleep mode@BS_PA_MFRMS=2 Typical: 1.7mA Idle mode@BS_PA_MFRMS=2 Typical: 11.4mA
LTE sleep/idle mode	
LTE supply current (GNSS off, without USB connection)	Sleep mode Typical: 1.2mA Idle mode Typical: 11mA
Power Saving Mode	
PSM supply current	PSM mode Typical: 9uA
LTE Cat-M1 Talk	
TBD	TBD
TBD	TBD
GPRS	
EGSM900(2 Rx, 4 Tx)	@power level #5 Typical: 422mA
DCS1800(2 Rx, 4 Tx)	@power level #0 Typical: 345mA
EGSM900(3Rx, 2 Tx)	@power level #5 Typical: 321mA
DCS1800(3Rx, 2 Tx)	@power level #0 Typical: 249mA
EDGE	
EGSM900(2 Rx, 4 Tx)	@power level #8 Typical: 426mA
DCS1800(2 Rx, 4 Tx)	@power level #2 Typical: 327mA

EGSM900(3Rx, 2 Tx)	@power level #8Typical:263mA
DCS1800(3Rx, 2 Tx)	@power level #2Typical:200mA
LTE Cat-M	
LTE-FDD B1	@23dbm Typical: 161mA @10dbm Typical: 111mA @0dbm Typical: 98mA
LTE-FDD B2	@23dbmTypical: 160mA @10dbm Typical: 116mA @0dbm Typical: 102mA
LTE-FDD B3	@23dbmTypical: 150mA @10dbm Typical: 110mA @0dbm Typical: 102 mA
LTE-FDD B4	@23dbmTypical: 150mA @10dbm Typica : 114mA @0dbm Typical: 102mA
LTE-FDD B5	@23dbmTypical: 168mA @10dbm Typical: 117mA @0dbm Typical: 113mA
LTE-FDD B8	@23dbmTypical: 165mA @10dbm Typical: 110mA @0dbm Typical: 98mA
LTE-FDD B12	@23dbmTypical: 167mA @10dbm Typical: 109mA @0dbm Typical: 96mA
LTE-FDD B13	@23dbmTypical: 168mA @10dbm Typical: 114mA @0dbm Typical: 97mA
LTE-FDD B18	@23dbmTypical: 167mA @10dbm Typical: 109mA @0dbm Typical: 98mA
LTE-FDD B19	@23dbmTypical: 171mA @10dbm Typical: 110mA @0dbm Typical: 99mA
LTE-FDD B20	@23dbmTypical: 167mA @10dbm Typical: 110mA @0dbm Typical: 98mA
LTE-FDD B26	@23dbmTypical: 168mA @10dbm Typical: 109mA @0dbm Typical: 98mA
LTE-FDD B28	@23dbmTypical: 195mA @10dbm Typical: 135mA @0dbm Typical: 115mA

LTE Cat-NBdata transmission		
B5	UL mac padding _15KHZ_1RU_1 subcarrier_0dbm	59.94 mA
	UL mac padding _15KHZ_1RU_1 subcarrier_10dbm	68.48 mA
	UL mac padding _15KHZ_1RU_1 subcarrier_23dbm	143.22 mA
	UL mac padding _3.75KHZ_1RU_1 subcarrier_0dbm	83.60 mA
	UL mac padding _3.75KHZ_1RU_1 subcarrier_10dbm	100.03 mA
	UL mac padding _3.75KHZ_1RU_1 subcarrier_23dbm	244.96 mA
	UL mac padding _15KHZ_12subcarrier_23dbm	92mA
	DL mac padding _15KHZ_12subcarrier_23dbm	66.42mA

B8	UL mac padding _15KHZ_1RU_1 subcarrier_0dbm	60.42 mA
	UL mac padding _15KHZ_1RU_1 subcarrier_10dbm	69.54 mA
	UL mac padding _15KHZ_1RU_1 subcarrier_23dbm	144.60 mA
	UL mac padding _3.75KHZ_1RU_1 subcarrier_0dbm	83.84 mA
	UL mac padding _3.75KHZ_1RU_1 subcarrier_10dbm	101.37 mA
	UL mac padding _3.75KHZ_1RU_1 subcarrier_23dbm	248.67 mA
	UL mac padding _15KHZ_12subcarrier_23dbm	93mA
	DL mac padding _15KHZ_12subcarrier_23dbm	68.4mA

5.5 ESD Notes

SIM7000 is sensitive to ESD in the process of storage, transporting, and assembling. When SIM7000 is mounted on the users' mother board, the ESD components should be placed beside the connectors which human body may touch, such as SIM card holder, audio jacks, switches, keys, etc. The following table shows the SIM7000 ESD measurement performance without any external ESD component.

Table 35: The ESD performance measurement table (Temperature: 25°C, Humidity: 45%.)

Part	Contact discharge	Air discharge
VBAT,GND	+/-6K	+/-12K
Antenna port	+/-5K	+/-10K
Other PADs	+/-1K	+/-3K

6 Electrical Specifications

6.1 Top and Bottom View of SIM7000

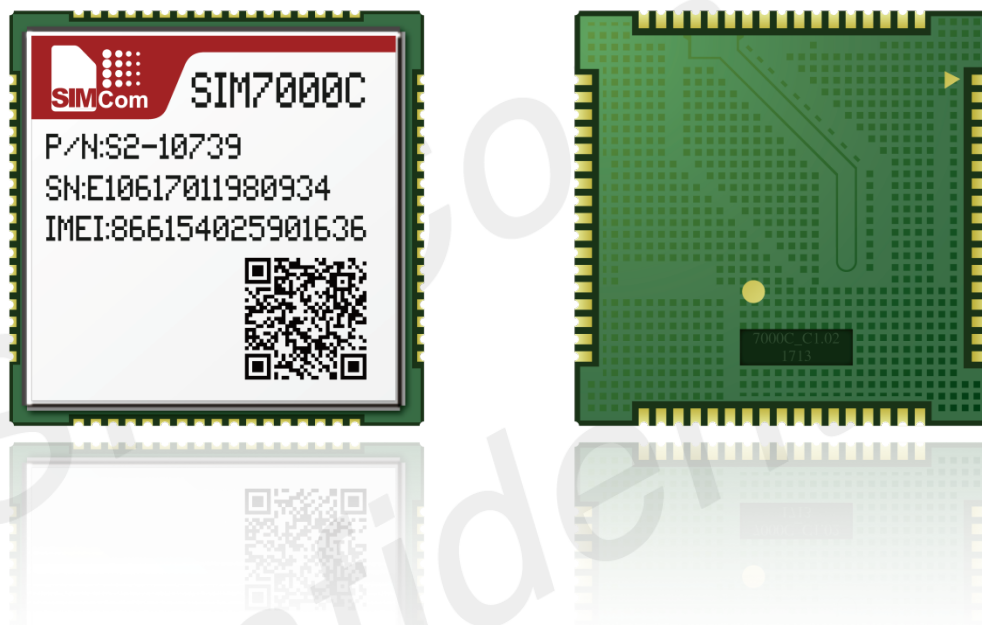


Figure 31: Top and bottom view of SIM700

6.2 Label Information

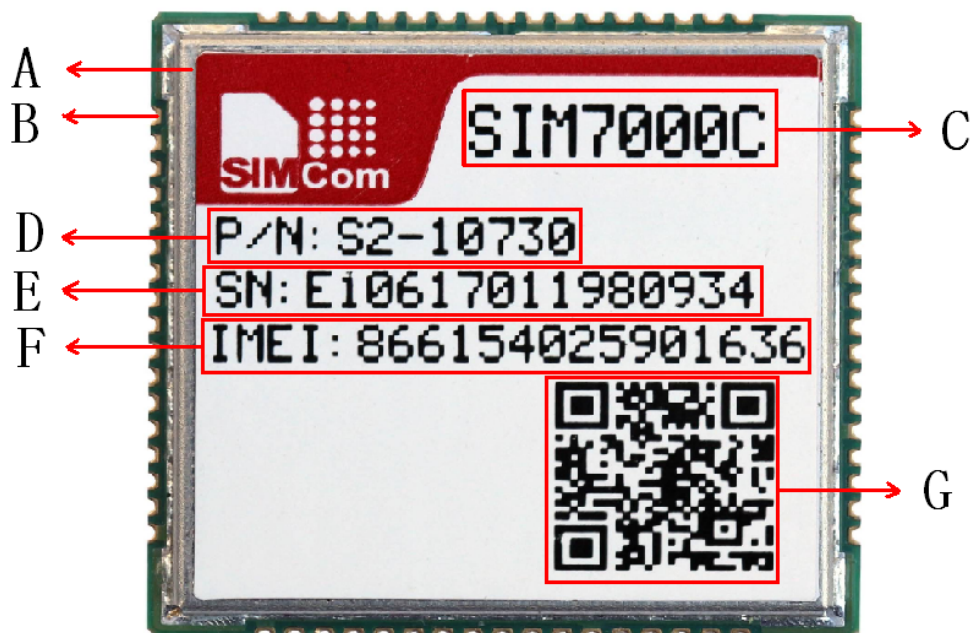


Figure 32: Label information

Table 36: The description of label information

No.	Description
A	LOGO
B	No.1 Pin
C	Project name
D	Product code
E	Serial number
F	International mobile equipment identity
G	QR code

6.3 Typical SMT Reflow Profile

SIMCom provides a typical soldering profile. Therefore the soldering profile shown below is only a generic recommendation and should be adjusted to the specific application and manufacturing constraints.

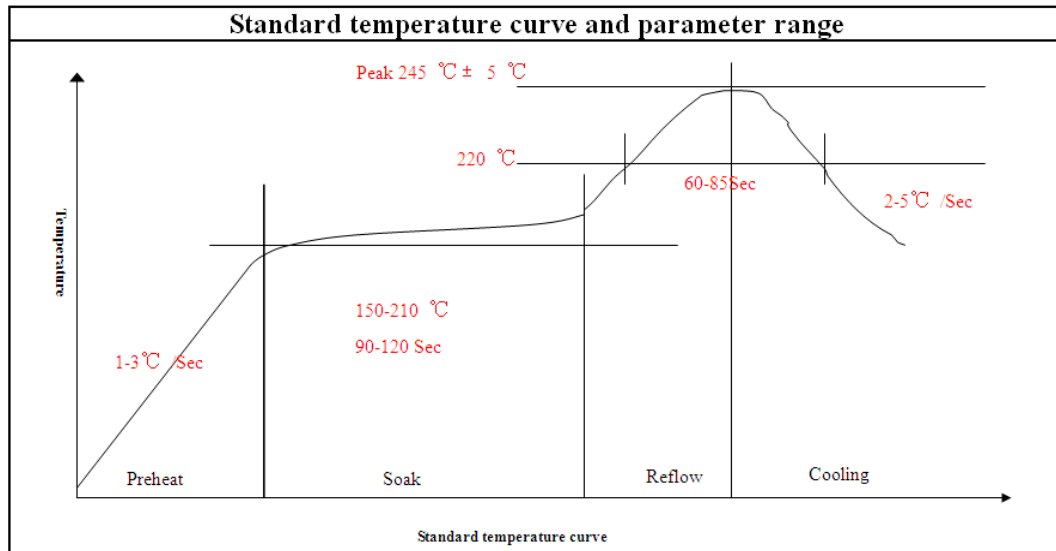


Figure 33: The ramp-soak-spike reflow profile of SIM7000

NOTE

For more details about secondary SMT, please refer to the document [19].

6.4 Moisture Sensitivity Level (MSL)

SIM7000 is qualified to Moisture Sensitivity Level (MSL) 4 in accordance with JEDEC J-STD-033.

The following table shows the features of Moisture Sensitivity Level (MSL). After seal off, storage conditions must meet the following table. If the storage time was expired, module must be baking before SMT.

Table 37: Moisture Sensitivity Level and Floor Life

Moisture Sensitivity Level (MSL)	Floor Life (out of bag) at factory ambient $\leq 30^{\circ}\text{C}/60\% \text{ RH}$ or as stated
1	Unlimited at $\leq 30^{\circ}\text{C}/85\% \text{ RH}$
2	1 year at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
2a	4 weeks at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
3	168 hours at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
4	72 hours at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
5	48 hours at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
5a	24 hours at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.

6.5 Baking

In order to get better yield, the module need to bake before SMT.

- If the packaging is in perfect condition, the module which date of production is within six months has no use for baking. If the date of production is more than six months, the module must be baking.
- If the packaging had been opened or damaged, the module must be baking.

Table 38: Baking conditions

conditions	parameters
Baking temperature	120 $^{\circ}\text{C}$
Baking time	8 hours

NOTE

IPC / JEDEC J-STD-033 standard must be followed for production and storage.

6.6 Stencil Foil Design Recommendation

The recommended thickness of stencil foil is 0.15mm.

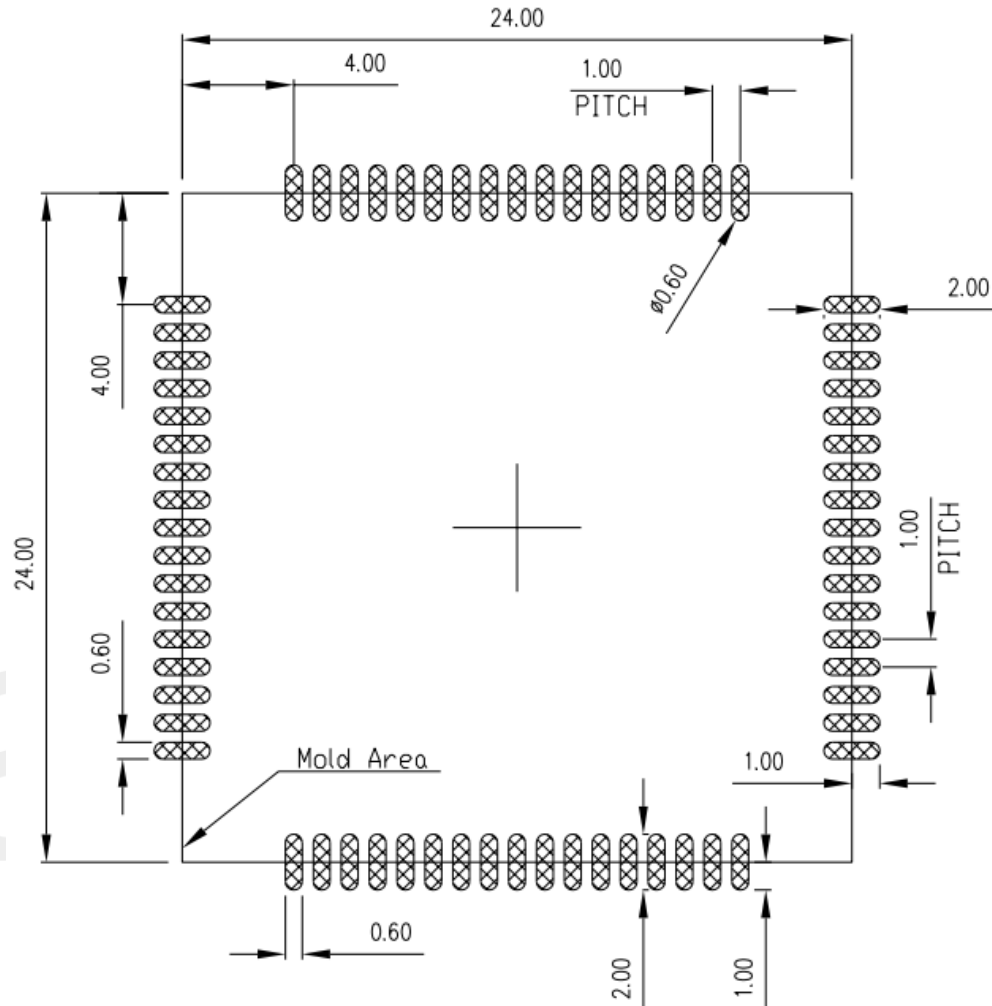


Figure 34: stencil recommendation (Unit: mm)

7 Electrical Specifications

7.1 Tray packaging

SIM7000 module support tray packaging.

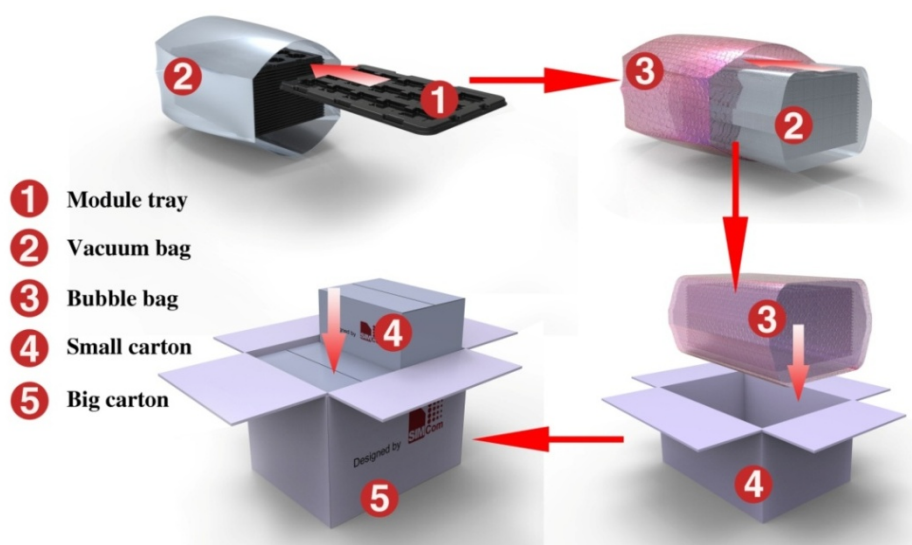


Figure 35: packaging diagram

Module tray drawing:

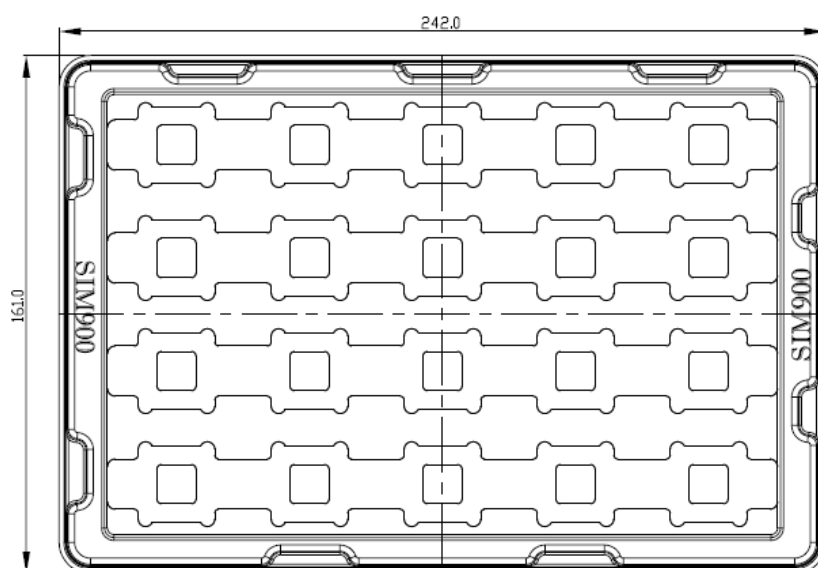


Figure 36: Tray drawing

Table 39: Tray size

Length ($\pm 3\text{mm}$)	Width ($\pm 3\text{mm}$)	Module number
242.0	161.0	20

Small carton drawing:

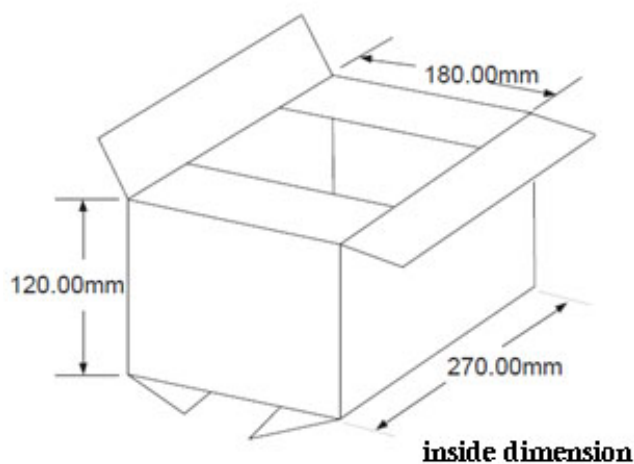


Figure 37: Small carton drawing

Table 40: Small Carton size

Length ($\pm 10\text{mm}$)	Width ($\pm 10\text{mm}$)	Height ($\pm 10\text{mm}$)	Module number
270	180	120	20*20=400

Big carton drawing:

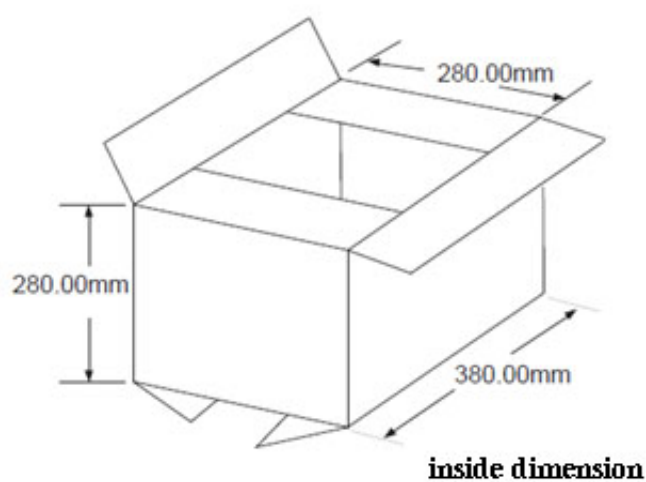


Figure 38: Big carton drawing

Table 41: Big Carton size

Length (±10mm)	Width (±10mm)	Height (±10mm)	Module number
380	280	280	400*4=1600

Appendix

I. Reference Design

Refer to <SIM7000 Reference Design V1.01> for the details.

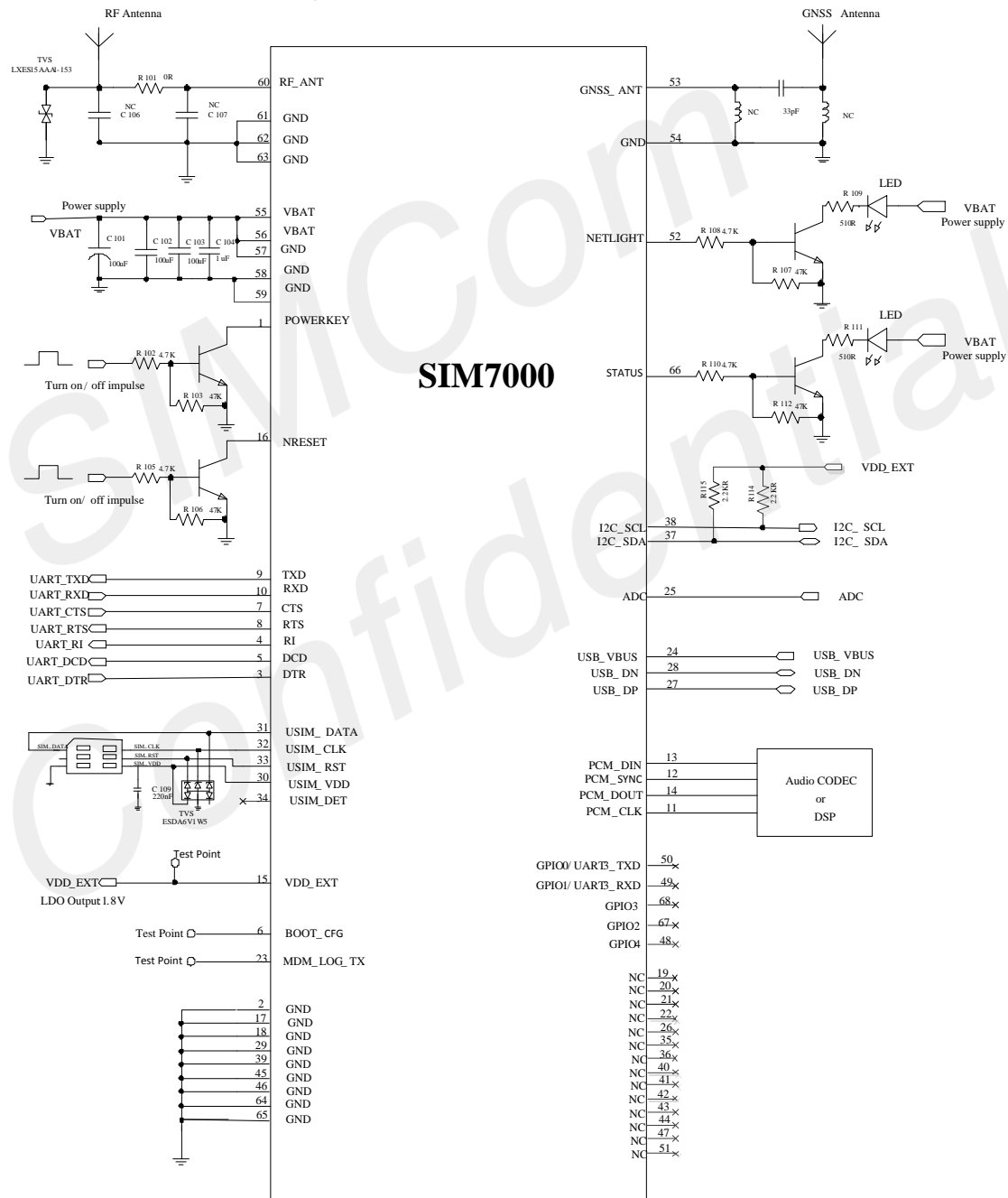


Figure 39: Reference design

II. Design check list

Table 42: SchematicCheck List

NO.	Items
1	Insure the supply voltage for VBAT is within the range of 3V~4.3V.
2	Insure the maximum supply current for VBAT is above its consumption when it is maximum power emission. The maximum current is 2A during GPRS/EDGE emission maximum power, and it 0.6A during LTE emission maximum power.
3	Insure the capacitor for VBAT is meet its request, in order to avoid the voltage drop exceed 300mV. And the voltage never dropped below 3V.
4	Insure the input signal for PWRKEY pin meet its electrical level match. It recommended use BJT to shift its level.
5	Insure the input signal for NRESET pin meet its electrical level match.
6	Insure the netconnections of UART be correct ness according to signal direction. Insure the signal for UART pins meet its electrical level match. It recommended use BJT or level shift IC to shift its level.
7	Insure USB port had used TVS to protect signal. And the junction capacity of TVS for DP/DM must be less than 1pf.
8	Insure SIM card signal had used TVS to protect. And the junction capacity of TVS must be less than 50pf.
9	Insure SIM_DET had used resistor 10Kohm pull up to VDD_EXT if used this signal.
10	Insure I2C signal had used resistors 2.2Kohm pull up to VDD_EXT if used.
11	The electrical level of all GPIOs is 1.8V. Insure the signal for GPIO pins meet its electrical level match.
12	The input range of ADC is 0V~VBAT. Insure the input signal never exceed its range.
13	User must pull up DTR when module enters into sleep mode. Insure DTR can be controlled by host.
14	Suggesting to reserve test ports for VDD_EXT and BOOT_CFG. BOOT_CFG should keep open before boot up.
15	The power supply of the active antenna should be controlled and closed.
16	LTE main ANT should have a PI type matching to debug antenna
17	LTE main ANT should Keep TVS to prevent ESD destroyed. And the TVS should be Low junction capacitance.

Table 43: PCB LayoutCheck List

NO.	Items
1	Insure the capacitor placement for VBAT be near module pin.
2	Insure VBAT trace width be greater than 2mm. If NB only, insure VBAT trace width be greater than 0.6mm. And the VIA number must be enough for getting through the current.
3	Insure the return path GND of the power supply is good. Insure the connectivity between module GND and mother board GND is good.
4	Insure PCM trance is protected by GND, and keep it far from interference source, such as power supply trace, USB trace, RF trace and so on.
5	Insure USB trance is protected by GND, and keep it far from interference source, such as power supply trace, RF trace and so on. Insure DM/DP trace is differential routing, and differential impedance is 90 ohm.
6	Insure ADC trance is protected by GND.

7	Insure SIM card signal trance is protected by GND. Especially SIM_CLK must be protected alone. And avoid signal trace branched Routing.
8	Insure I2C trance is protected by GND.
9	Insure TVS avoid bypass. The trace must go through TVS pad first, and then arrived module pad.
10	There should be enough ground around the RF line. RF lines Routing prohibit right angles and sharp angles, trying to trace circular or obtuse angle line.
11	The RF line reference GND should be complete. And avoid high speed lines crossing below it.
12	the GND side of the RF output pin should be no hot welding disk
13	The routing which is RF output PIN to antenna should be isolated from other high-speed lines. And the routing should be 50 Ω impedance control.

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III. Coding Schemes and Maximum Net Data Rates over Air Interface

Table 44: Coding Schemes and Maximum Net Data Rates over Air Interface

Multislot definition(GPRS/EDGE)			
Slot class	DL slot number	UL slot number	Active slot number
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5
GPRS coding scheme	Max data rata (4 slots)		Modulation type
CS 1 = 9.05 kb/s / time slot	36.2 kb/s		GMSK
CS 2 = 13.4 kb/s / time slot	53.6 kb/s		GMSK
CS 3 = 15.6 kb/s / time slot	62.4 kb/s		GMSK
CS 4 = 21.4 kb/s / time slot	85.6 kb/s		GMSK
EDGE coding scheme	Max data rata (4 slots)		Modulation type
MCS 1 = 8.8 kb/s/ time slot	35.2 kb/s		GMSK
MCS 2 = 11.2 kb/s/ time slot	44.8 kb/s		GMSK
MCS 3 = 14.8 kb/s/ time slot	59.2 kb/s		GMSK
MCS 4 = 17.6 kb/s/ time slot	70.4 kb/s		GMSK
MCS 5 = 22.4 kb/s/ time slot	89.6 kb/s		8PSK
MCS 6 = 29.6 kb/s/ time slot	118.4 kb/s		8PSK
MCS 7 = 44.8 kb/s/ time slot	179.2 kb/s		8PSK
MCS 8 = 54.4 kb/s/ time slot	217.6 kb/s		8PSK
MCS 9 = 59.2 kb/s/ time slot	236.8 kb/s		8PSK
LTE-FDD device category (Downlink)	Max data rate (peak)		Modulation type
Category M1	1Mbps		QPSK/16QAM
LTE-FDD device category (Uplink)	Max data rate (peak)		Modulation type
Category M1	375kbps		QPSK/16QAM

IV. Related Documents

Table 45: Related Documents

NO.	Title	Description
[1]	SIM7000 Series AT Command Manual V1.xx	AT Command Manual
[2]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[3]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[4]	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)
[5]	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
[6]	GSM 11.11	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[7]	GSM 03.38	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[8]	GSM 11.10	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification; Part 1: Conformance specification
[9]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[10]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[11]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[12]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[13]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[14]	EN 301 908-02 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000. Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive
[15]	EN 301 489-24 V1.2.1	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
[16]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[17]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[18]	2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
[19]	Module	Module secondary SMT Guidelines

	secondary-SMT-UGDV1.xx	
[20]	SIM7000 Series UART Application Note_V1.xx	This document describes how to use UART interface of SIMCom modules.
[21]	ETSI EN 301 908-13 (ETSI TS 136521-1 R13.4.0)	IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 13
[22]	ANTENNA DESIGN GUIDELINES FOR MULTI-ANTENNA SYSTEM V1 01	Design notice for multi-antenna.

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V. Terms and Abbreviations







Table 46: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
ARP	Antenna Reference Point
BER	Bit Error Rate
BD	BeiDou
BTS	Base Transceiver Station
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
DAM	Downloadable Application Module
DPO	Dynamic Power Optimization
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FD	SIM fix dialing phonebook
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global Standard for Mobile Communications
HR	Half Rate
I2C	Inter-Integrated Circuit
IMEI	International Mobile Equipment Identity
LTE	Long Term Evolution
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated

NMEA	National Marine Electronics Association
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCS	Personal Communication System, also referred to as GSM 1900
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SMPS	Switched-mode power supply
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
VSWR	Voltage Standing Wave Ratio
SM	SIM phonebook
NC	Not connect
EDGE	Enhanced data rates for GSM evolution
ZIF	Zero intermediate frequency
WCDMA	Wideband Code Division Multiple Access
VCTCXO	Voltage control temperature-compensated crystal oscillator
SIM	Universal subscriber identity module
UMTS	Universal mobile telecommunications system
UART	Universal asynchronous receiver transmitter
PSM	Power saving mode
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

VI. Safety Caution

Table 47: Safety Caution

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