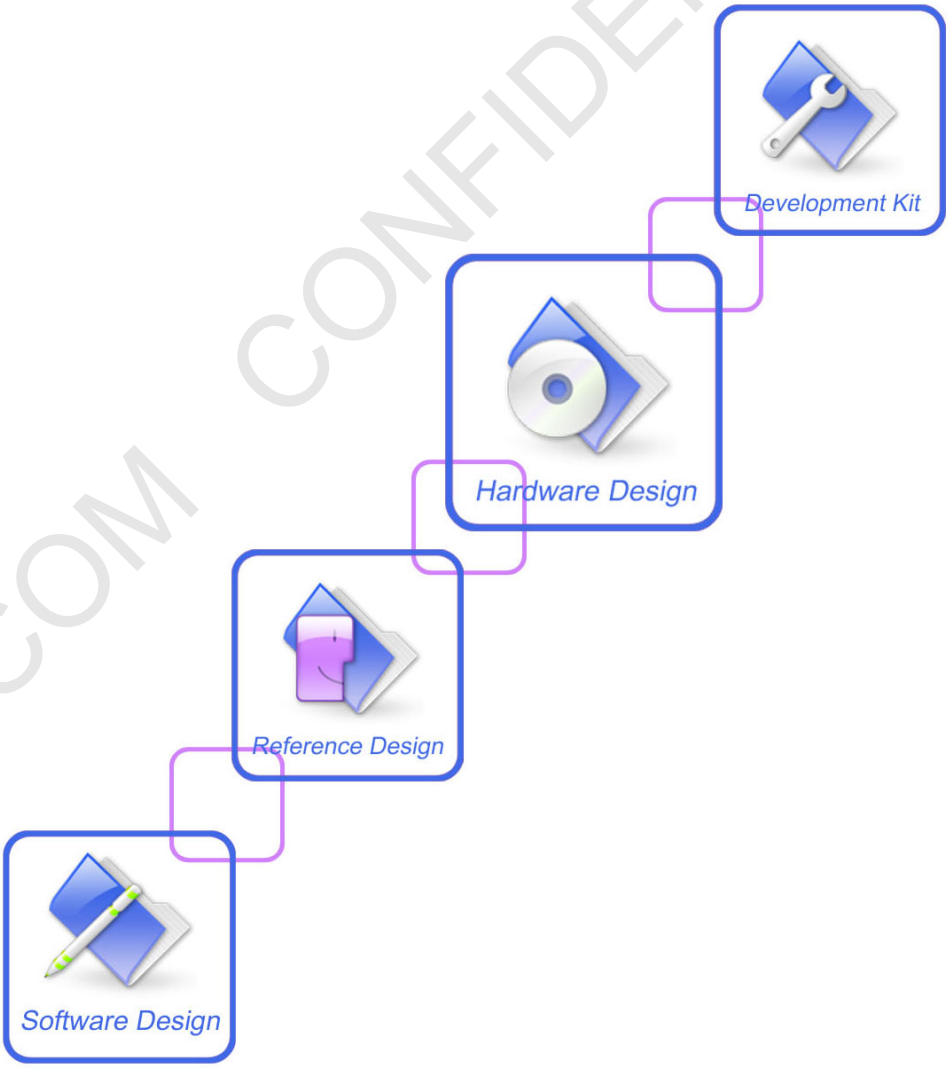
SIM7020 _Hardware Design_V1.00



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Revision History

Data	Version	Description of change	Author
2018-02-07	1.00	Original	Ya.li Ming.zhu

1 Introduction

This document describes SIM7020 hardware interface in great detail. The document can help customer to quickly understand SIM7020 interface specifications, electrical and mechanical details. With the help of this document and other SIM7020 application notes, customer guide, customers can use SIM7020 to design various applications quickly.

1.1 Product Outline

The SIM7020 series modules support LTE CAT-NB1.
With a tiny configuration of 17.6*15.7*2.3mm, SIM7020 can meet almost all the space requirements in customers' applications, such as smart phone, PDA and other mobile devices. And the physical dimension is compatible with the packaging of SIM800C.

Table 1: SIM7020 frequency bands and air interface

Standard	Frequency	Variants	
		SIM7020C	SIM7020E
HD-FDD	B1	✓	✓
	B3	✓	✓
	B5	✓	✓
	B8	✓	✓
	B20		✓
	B28		✓

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**
- **Power Output**
- **GPIOs**
- **Antenna Interface**

1.3 Hardware Block Diagram

The block diagram of the SIM7020 module is shown in the figure below.

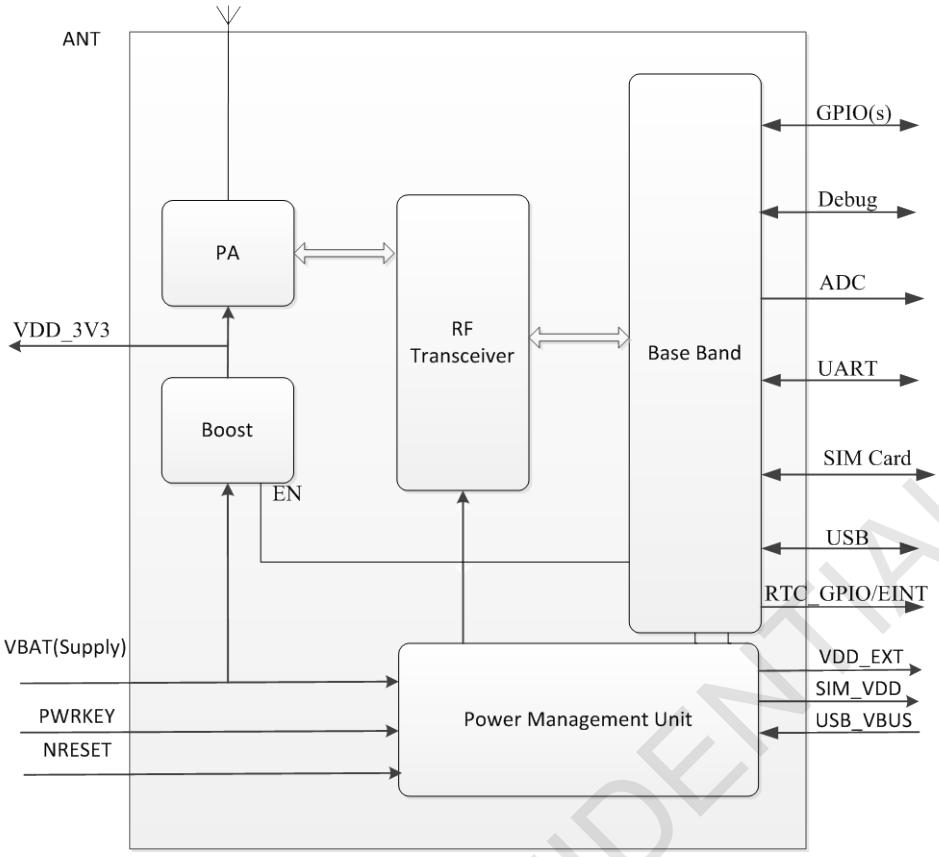

Figure 1: SIM7020 block diagram

1.4 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	Power supply voltage 2.1～3.6V,Typ=3.3V
Power saving	Current in sleep mode: TBD Current in PSM mode: 5uA
Radio frequency bands	Please refer to the table 1
Transmitting power	LTE 23dBm
Data Transmission Throughput	LTE CAT NB1: 26.15Kbps (DL) LTE CAT NB1: 62.5Kbps (UL)
Antenna	LTE antenna.
SMS	MT, MO, Text and PDU mode
SIM interface	Support identity card: 1.8V/ 3V
UART1 interface	A full modem serial port by default Baud rate: default:115200bps Can be used as the AT commands or data stream channel

	Support RTS/CTS hardware handshake
UART2 interface	Baud rate: default:115200bps Can be used for debugging and upgrading firmware
USB	USB 1.1 interface for debugging
Firmware upgrade	Firmware upgrade over UART2 interface
Physical characteristics	Size: 17.6*15.7*2.3mm Weight: 1.3g±0.2g
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: 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

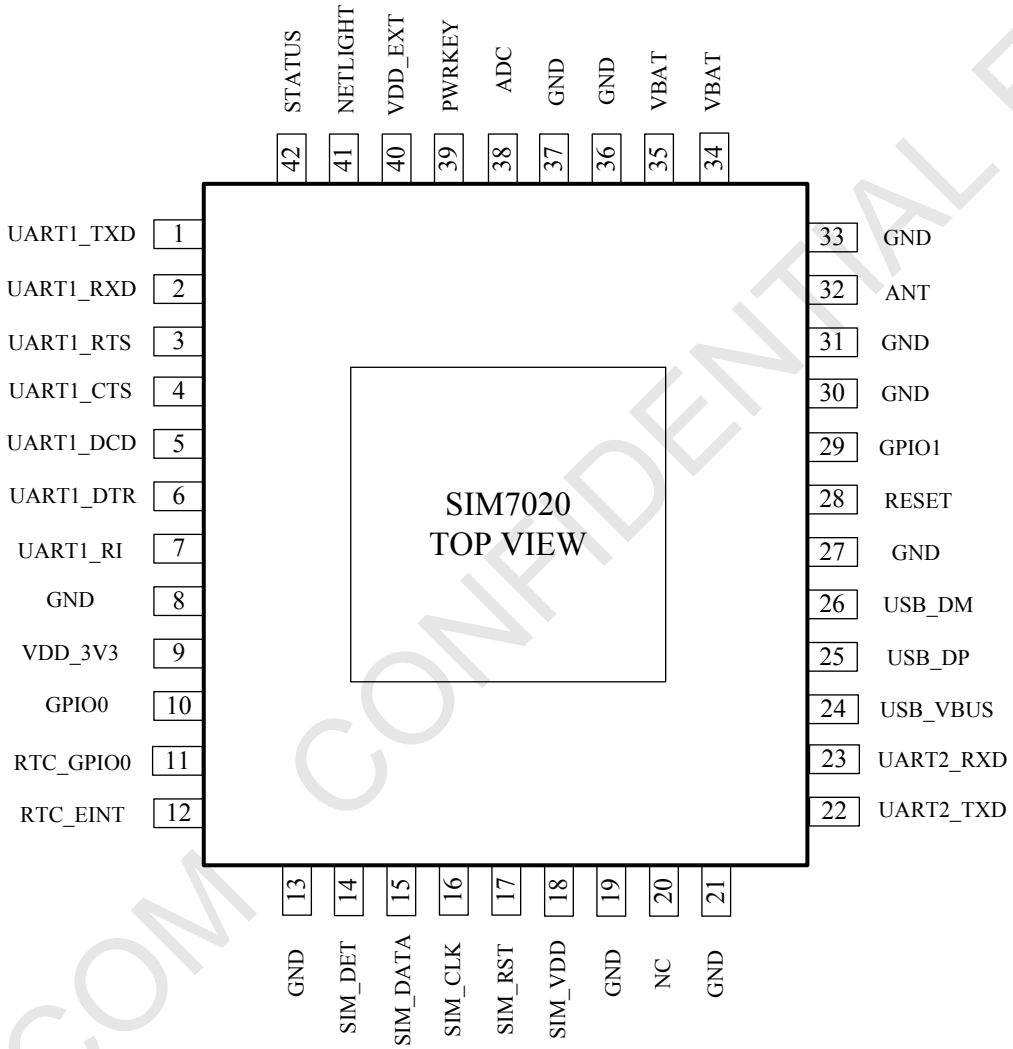

Figure 2: Pin assignment overview

Table 3: Pin definition

Pin No.	Pin Name	Pin No.	Pin Name
1	UART1_TXD	22	UART2_TXD
2	UART1_RXD	23	UART2_RXD
3	UART1_RTS	24	USB_VBUS
4	UART1_CTS	25	USB_DP
5	UART1_DCD	26	USB_DN
6	UART1_DTR	27	GND
7	UART1_RI	28	RESET
8	GND	29	GPIO1
9	VDD_3V3	30	GND
10	GPIO0	31	GND
11	RTC_GPIO0	32	ANT
12	RTC_EINT	33	GND
13	GND	34	VBAT
14	SIM_DET	35	VBAT
15	SIM_DATA	36	GND
16	SIM_CLK	37	GND
17	SIM_RST	38	ADC
18	SIM_VDD	39	PWRKEY
19	GND	40	VDD_EXT
20	NC	41	NETLIGHT
21	GND	42	STATUS

2.2 Pin Description

Table 4: IO parameters definition

Pin type	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	34 、	PI	Power supply, voltage range: 2.1−3.6V.	
VDD_EXT	40	PO	Power output 1.8V for other external circuits with Max 50mA current output, such as level shift circuit. Not present in PSM mode.	If unused, keep it open.
VDD_3V3	9	PO	Power output 3.3V for other external circuits with Max 50mA current output. Not present in PSM mode.	Voltage range 3.3V-3.5V(depend on VBAT). If unused, keep it open.
GND	8 、 19 、 、27、30 、 33 、 、37		Ground	
System Control				
PWRKEY	39	DI，PU	System power on/off control input, active low. The efficient input level must be below 0.5V.	PWRKEY has been pulled up to VBAT via 40Kohm resistor internally.
RESET	28	DI，PU	System reset control input, active low.	RESET has been pulled up to VBAT via 40Kohm resistor internally.
SIM interface				
SIM_DATA	15	I/O，PU	SIM Card data I/O	All lines of SIM interface should be protected against ESD.
SIM_RST	17	DO	SIM Reset	
SIM_CLK	16	DO	SIM clock	
SIM_VDD	18	PO	Power output for SIM card, its output Voltage depends on SIM card type automatically. I	
SIM_DET	14	DI	SIM card detecting input. (This function do not support yet in standard software.)	If used, keep a 10kΩ resistor pulling up to the VDD_EXT

USB				
USB_VBUS	24	DI,PD	Valid USB detection input with 2.5~5.25V detection voltage	USB interface for debugging
USB_DP	25	I/O	Positive line of the differential, bi-directional USB signal.	
USB_DN	26	I/O	Negative line of the differential, bi-directional USB signal.	
UART interface				
UART1_TXD	1	DOH	Transmit Data	If unused, keep them open.
UART1_RXD	2	DI，PU	Receive Data	
UART1_RTS	3	DI，PU	Request to send	
UART1_CTS	4	DOH	Clear to Send	
UART1_DCD	5	DOH	Data carrier detect	
UART1_DTR	6	DI，PU	Transmit Data	
UART1_RI	7	DOH	Ring Indicator	
UART2_TXD	22	DOH	Transmit Data	
UART2_RXD	23	DI ，	Receive Data	
Indicate and Control in PSM Mode				
RTC_GPIO0	11	DO		Voltage Domain: VBAT
RTC_EINT	12	DI 、		
GPIO				
NETLIGHT	41	DO	LED control output as network status indication.	If unused, keep them open.
STATUS	42	DO	Operating status output. High level: Power on and firmware ready Low level: Power off	
GPIO0	10	IO	Do not pull down before power on	
GPIO1	29	IO		
RF interface				
ANT	32	AI	antenna	
Other interface				
ADC	38	AI	Analog-digital converter input. Voltage range: 0−1.4V.	If unused, keep them open.
NC	20		No connection.	Keep it open

2.3 Mechanical Information

The following figure shows the package outline drawing of SIM7020.

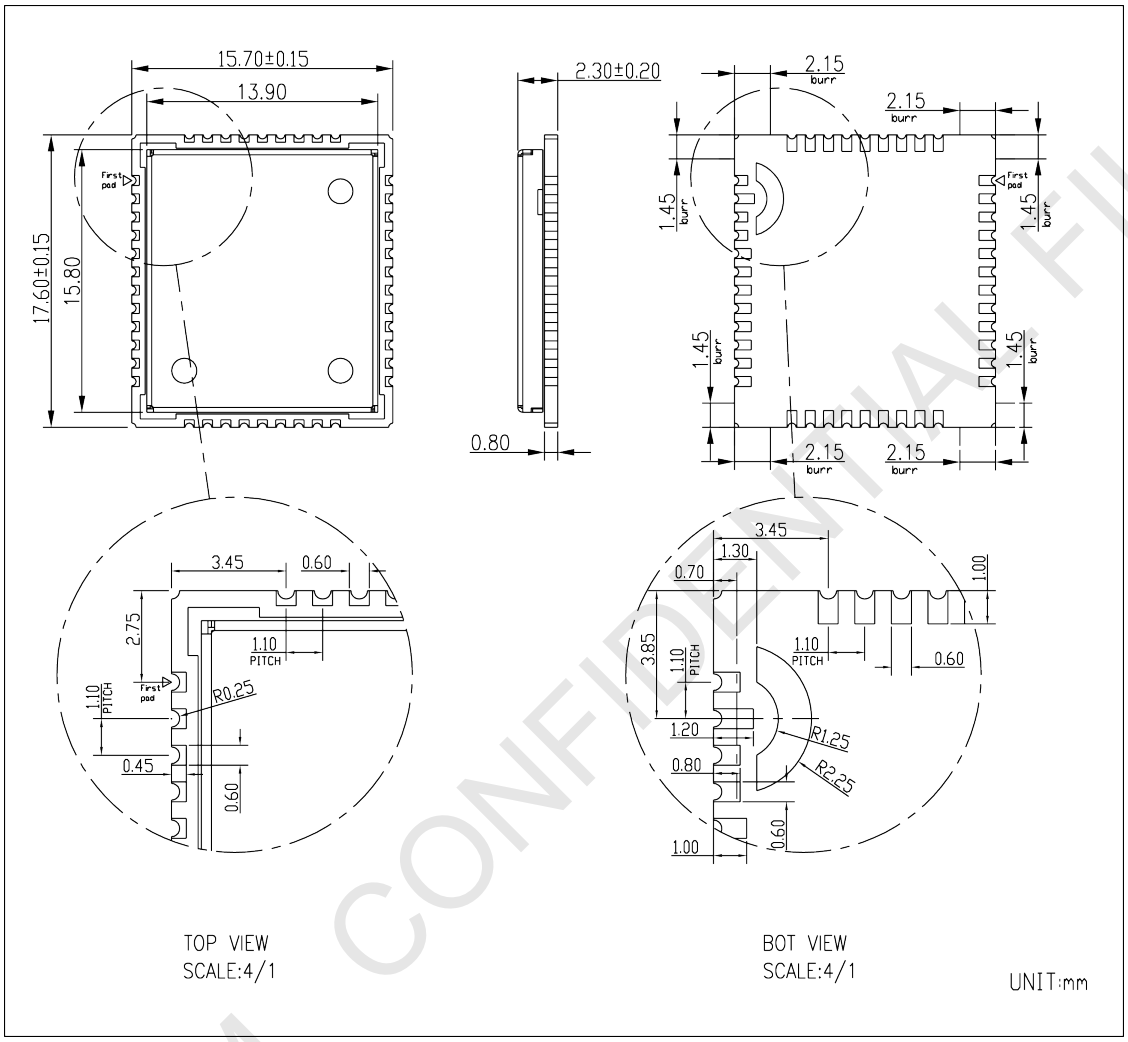

Figure 3: Dimensions (Unit: mm)

2.4 Footprint Recommendation

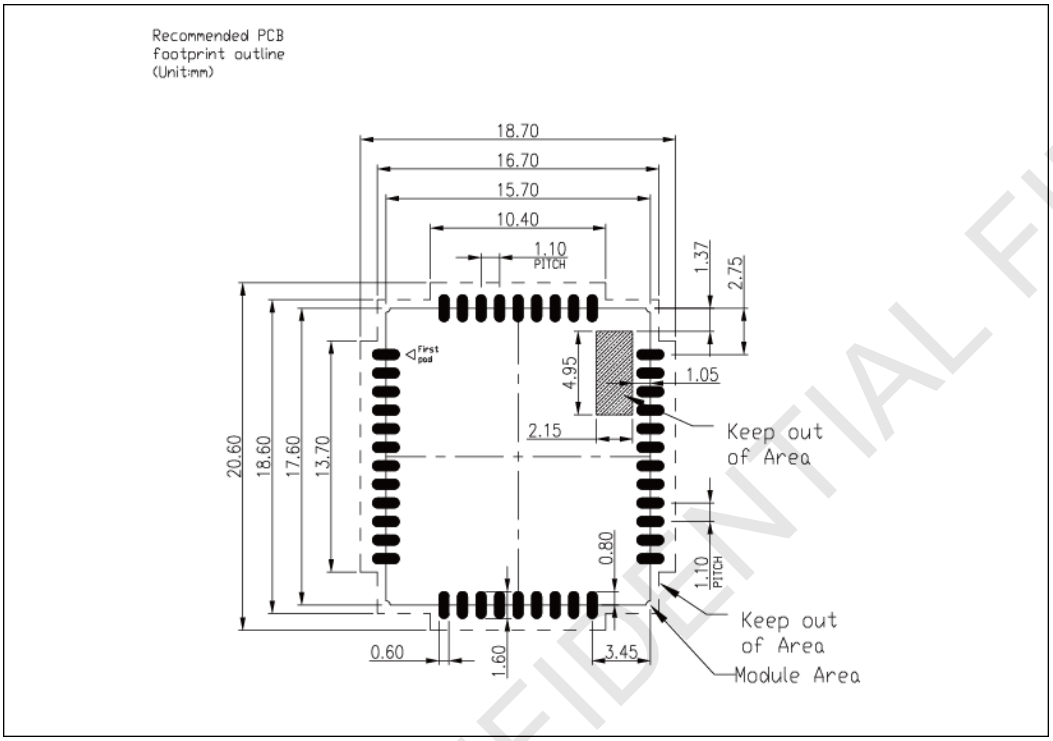

Figure 4: Footprint recommendation (Unit: mm)

3 Interface Application

3.1 Power Supply

The power supply for SIM7020 must be able to provide sufficient current up to more than 500mA in order to satisfy the power supply current for maximum consumption.

Table 6: VBAT pins electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VBAT	Module power voltage	2.1	3.3	3.6	V
$I_{VBAT(peak)}$	Module power peak current in NB emission	-	500	-	mA
$I_{VBAT(average)}$	Module power average current in normal mode	Please refer to the table 32			
$I_{VBAT(sleep)}$	Power supply current in sleep mode				
$I_{VBAT(PSM)}$	Power supply current in PSM mode	-	5	-	uA
$I_{VBAT(power-off)}$	Module power current in power off mode.	-	-	12	uA

3.2 Power Supply Design Guide

Make sure that the voltage on the VBAT pins will never drop below 2.1V, or module will be work abnormally.

Note: If the power supply for VBAT pins can support up to500mA, using a total of more than 100uF capacitors is recommended, or else users must using a total of 300uF capacitors typically, in order to avoid the voltage drop. The module power peak current depends on the total capacitance. Using a total of 1000uF capacitors in the test that will reduce the peak current to 320mA.

The following figure shows the recommended circuit .These capacitors should be put as close as possible to VBAT pads. Also, users should keep VBAT trace on circuit board wider than 1 mm to minimize PCB trace impedance.

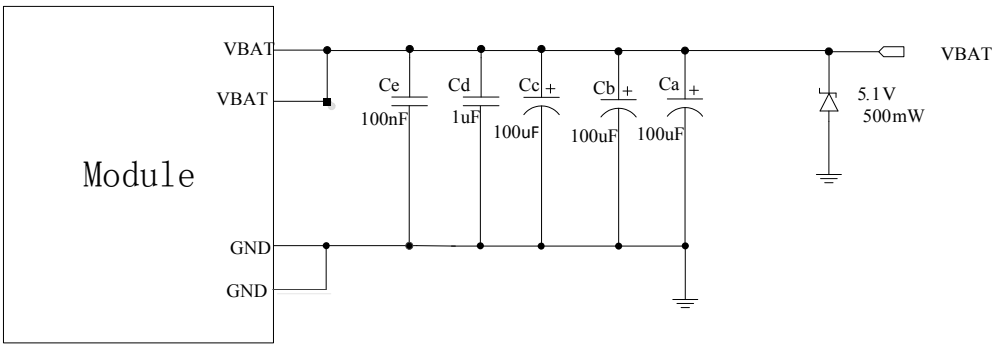

Figure 5: Power supply application circuit

In addition, for over voltage protection, it is suggested to use a zener diode with 5.1V reverse voltage and more than 500mW power dissipation.

Table 7: Recommended Zener diode list

No.	Manufacturer	Part Number	Power dissipation	Package
1	On semi	MMSZ5231BT1G	500mW	SOD123
2	Prisemi	PZ3D4V2H	500mW	SOD323
3	Vishay	MMSZ4689-V	500mW	SOD123
4	Crownpo	CDZ55C5V1SM	500mW	0805

3.3 Voltage Monitor

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

When the VBAT voltage is out of the range, the module will be power off when the overvoltage power-off function is enabled. The AT command “AT+CBATCHK=1” can be used to enable the overvoltage power-off function and the under-voltage power-off function.

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].

3.4 Power on/Power off/Reset Function

3.4.1 Power on

SIM7020 can be powered on by pulling the PWRKEY pin to ground.
The PWRKEY pin has been pulled up with a resistance to VBAT 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.

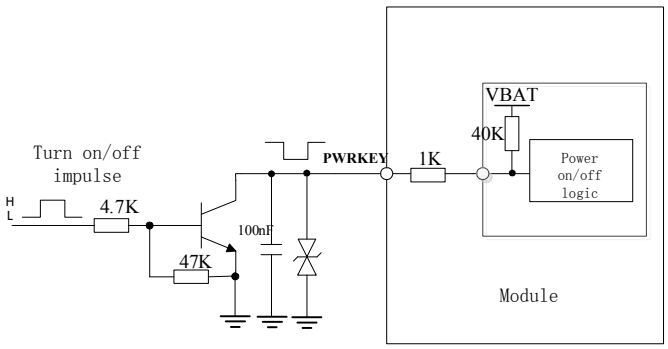

Figure 6: Reference power on/off circuit

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

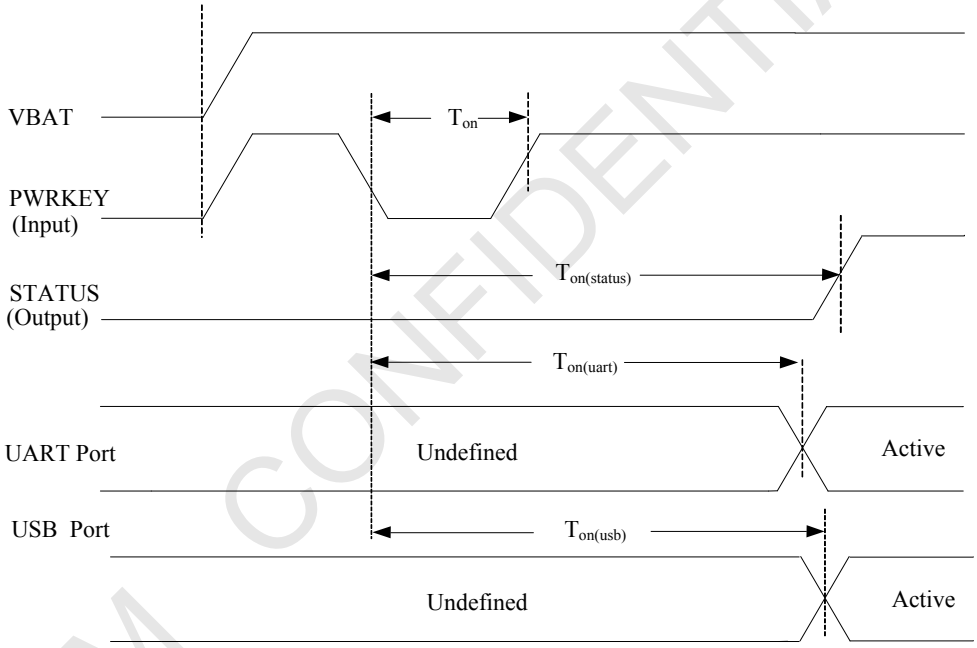

Figure 7: Power on timing sequence

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	TBD	800	-	ms
$T_{on(status)}$	The time from power-on issue to STATUS pin output high level(indicating power up ready)	-	-	-	s
$T_{on(uart)}$	The time from power-on issue to UART port ready	-	-	-	s
$T_{on(usb)}$	The time from power-on issue to USB port ready	-	-	-	s
V_{IH}	Input high level voltage on PWRKEY pin	-	-	-	V
V_{IL}	Input low level voltage on PWRKEY pin	-	-	-	V

3.4.2 Power off

The following methods can be used to power off SIM7020.

- Method 1: Power off SIM7020 by pulling the PWRKEY pin to ground.
- Method 2: Power off SIM7020 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.

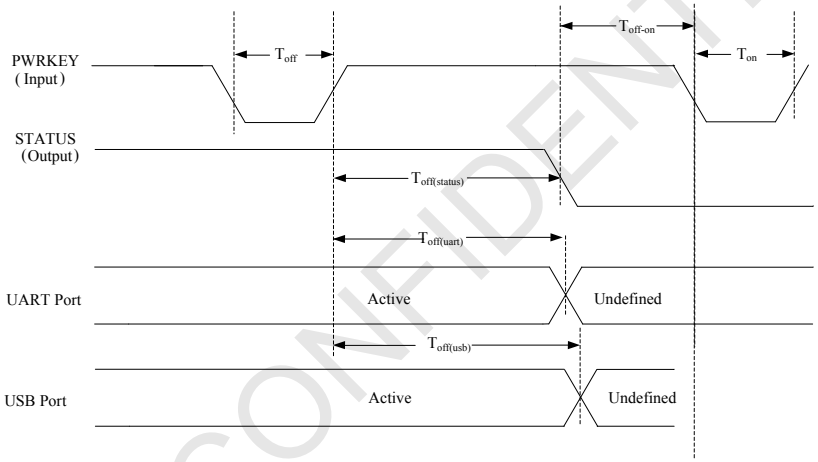

Figure 8: Power off timing sequence

Table 9: Power off timing and electronic characteristic

Symbol	Parameter	Time value			Unit
		Min.	Typ.	Max.	
T_{off}	The active low level time pulse on PWRKEY pin to power off module	-	-	-	s
$T_{off(status)}$	The time from power-off issue to STATUS pin output low level(indicating power off)*	-	-	-	s
$T_{off(uart)}$	The time from power-off issue to UART port off	-	-	-	s
$T_{off(usb)}$	The time from power-off issue to USB port off	-	-	-	s
T_{off-on}	The buffer time from power-off issue to power-on issue	-	-	-	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.

3.4.3 Reset Function

SIM7020 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 40KΩ resistor internally. So it does not need to be pulled up externally. It is strongly recommended to put a100nF capacitor and an ESD protection diode close to the RESET pin. Please refer to the following figure for the recommended reference circuit.

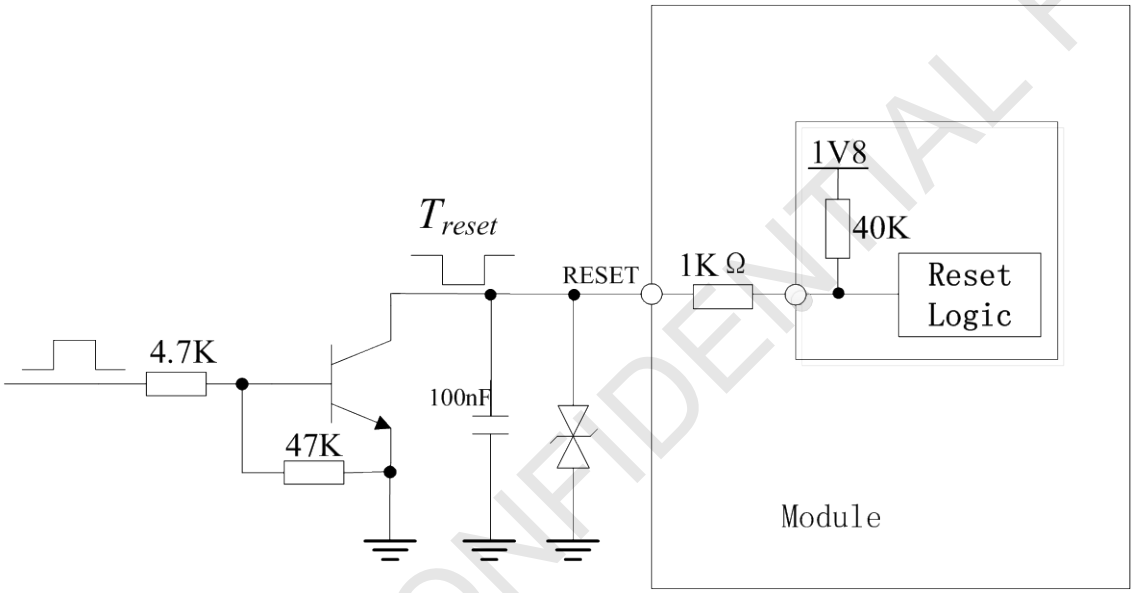

Figure 9: Reference reset circuit

Table 10: RESET pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset}	The active low level time impulse on RESET pin to reset module	-	-	-	ms
V_{IH}	Input high level voltage	-	-	-	V
V_{IL}	Input low level voltage	-	-	-	V

3.5 UART Interface

SIM7020 provides a 7-wire UART1 (universal asynchronous serial transmission) interface as DCE (Data Communication Equipment). AT commands and data transmission can be performed through UART1 interface.UART2 can be used for debugging and download software.

3.5.1 UART Design Guide

The following figures show the reference design.

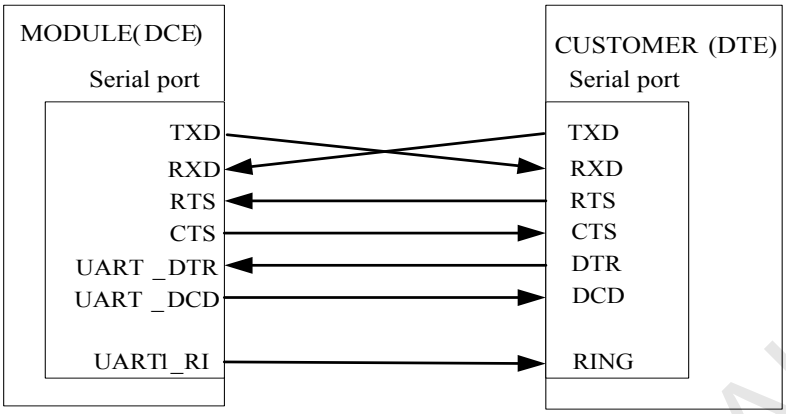

Figure 10: UART full modem

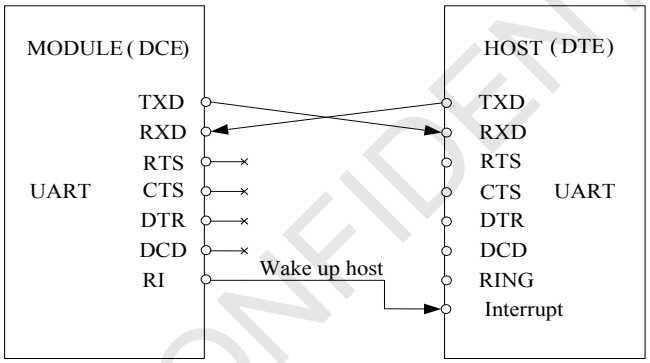

Figure 11: UART null modem

The SIM7020 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 TXB0108RGYR provided by Texas Instruments is recommended. The following figure shows the voltage matching reference design.

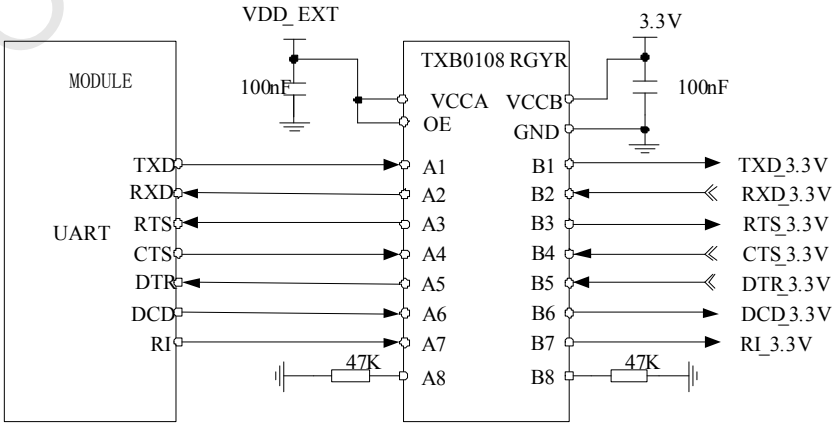

Figure 12: Reference circuit of level shift

Also the following reference circuit is recommended:

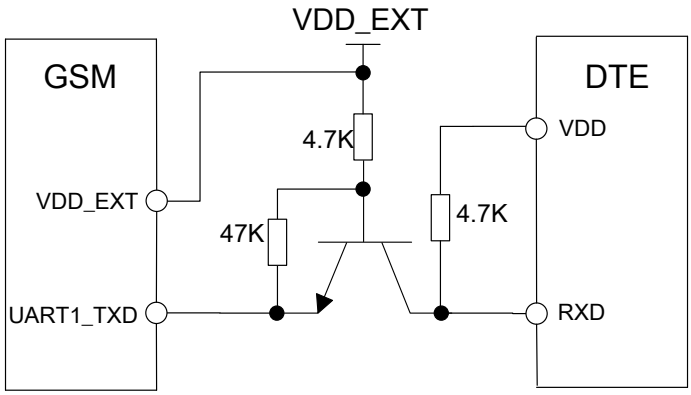

Figure 13: TX level matching circuit

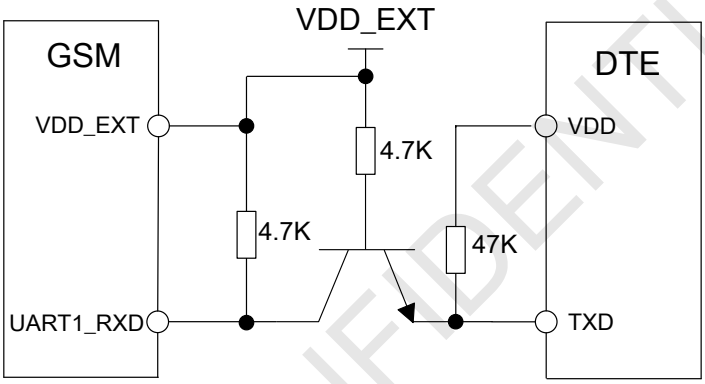

Figure 14: RX level matching circuit

Note: The default band rate is 115200bps. The triode conversion circuit is not suitable for high band rate more than 460800.

3.5.2 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.

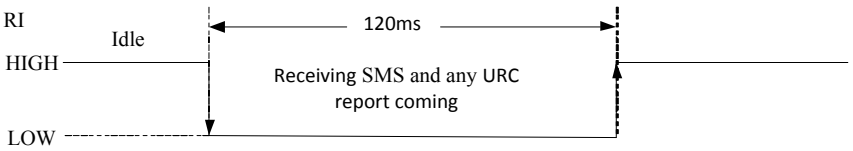

Figure 15: RI behaviour （SMS and URC report）

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

The DTR pin description:

After setting the AT command “AT+CSCLK=1”, SIM7020 will enter sleep mode by pulling up the DTR pin when module is in idle mode. In sleep mode, the UART is unavailable. When SIM7020 enters sleep mode, pulling down DTR can wake up module.\

After setting the AT command “AT+CSCLK=0”, SIM7020 will do nothing when the DTR pin is pulling up.

3.6 USB Interface

The SIM7020 contains a USB interface compliant with the USB1.1 specification as a peripheral, but the USB charging function is not supported.

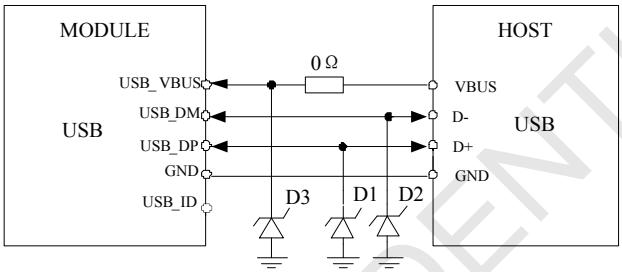

Figure 16: USB reference circuit

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 2pF.

Table 11: Recommended TVS list

No.	Manufacturer	Part Number	Description	Package
1	ON Semi	ESD9L5.0ST5G	TVS 5V 0.5PF 150mW RO	SOD-923
2	TOSHIBA	DF2S6.8UFS	TVS 5V 2PF 150mW RO	SOD-923
3	ON Semi	ESD9L5.0ST5G	TVS 5V 0.5PF 150mW RO	SOD-923
4	TOSHIBA	DF2S6.8UFS	TVS 5V 2PF 150mW RO	SOD-923

3.7 SIM Interface

SIM7020 supports both 1.8V and 3.0V SIM Cards.

Table 12: 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

V_{IH}	High-level input voltage	0.65*SIM_VDD	-	SIM_VDD +0.3	V
V_{IL}	Low-level input voltage	-0.3	0	0.25*SIM_VDD	V
V_{OH}	High-level output voltage	SIM_VDD -0.45	-	SIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.45	V

Table 13: SIM electronic characteristic 3.0V mode (SIM_VDD=2.95V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
SIM_VDD	LDO power output voltage	2.75	3	3.05	V
V_{IH}	High-level input voltage	0.65*SIM_VDD	-	SIM_VDD +0.3	V
V_{IL}	Low-level input voltage	-0.3	0	0.25*SIM_VDD	V
V_{OH}	High-level output voltage	SIM_VDD -0.45	-	SIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.45	V

3.7.1 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.

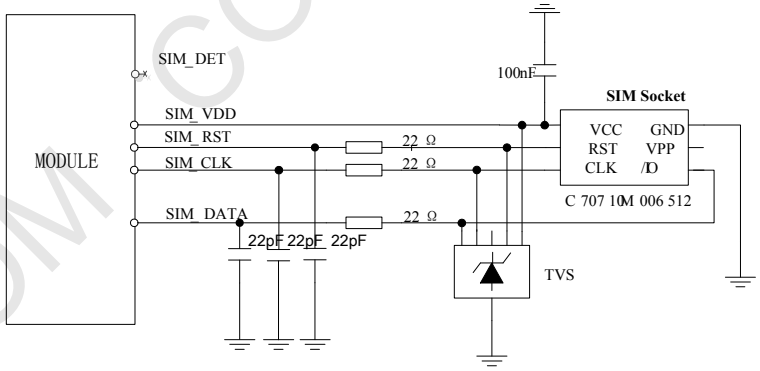

Figure 17: SIM interface reference circuit

Note: SIM_DATA has been pulled up with a 10KΩ resistor to SIM_VDD in module. A 100nF capacitor on SIM_VDD is used to reduce interference. For more details of AT commands about SIM, please refer to document [1].SIM_CLK is very important signal, the rise time and fall time of SIM_CLK should be less than 40ns, otherwise the SIM card might not be initialized correctly. If SIM_DET is used, a 10KΩ resistor is necessary to pulling up to the power VDD_EXT.

3.7.2 Recommended SIM Card Holder

It is recommended to use the 6-pin SIM socket such as C707 10M006 512 produced by Amphenol. User can visit http://www.amphenol.com for more information about the holder.

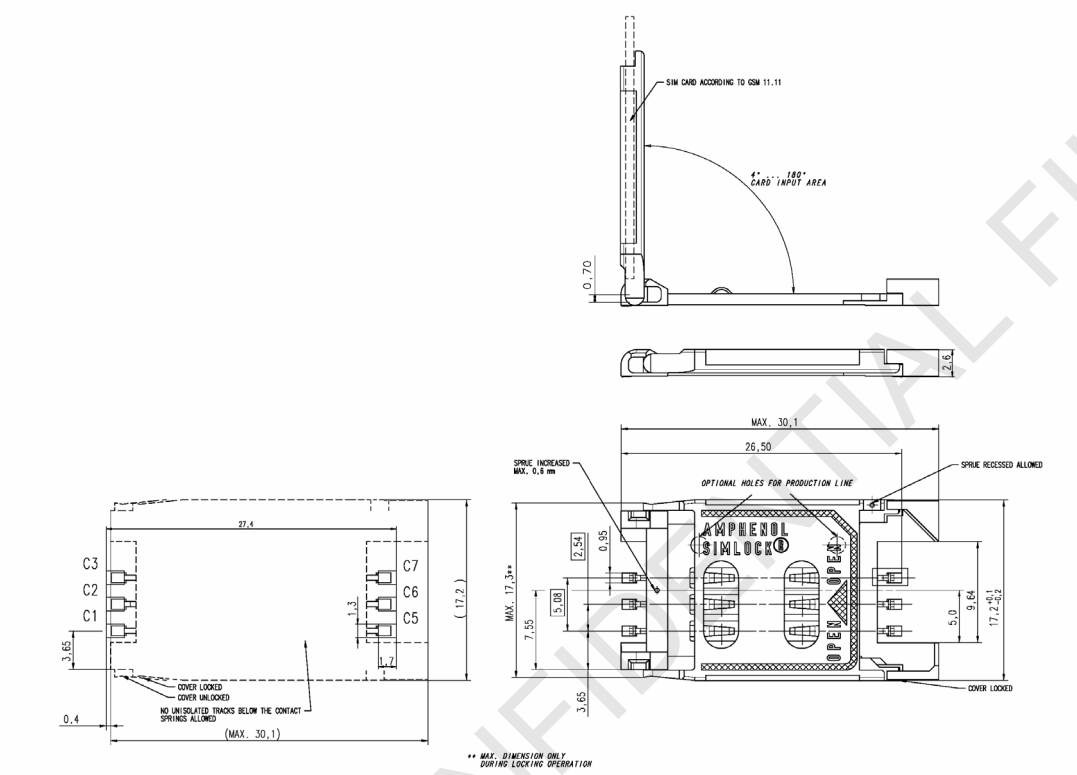

Figure 18: Amphenol SIM card socket

Table 14: Amphenol SIM socket pin description

Pin	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	
C7	SIM_DATA	SIM Card data I/O.

3.8 Network status

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

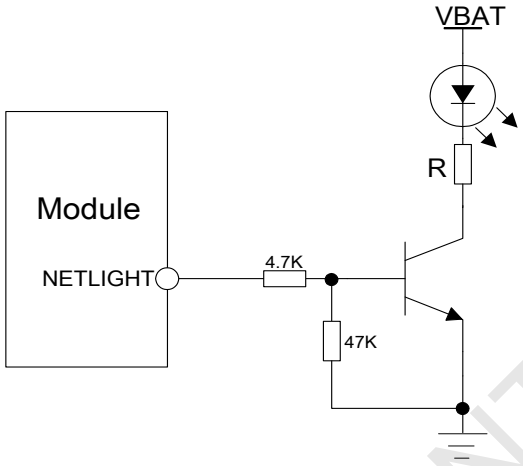

Figure 19: NETLIGHT reference circuit

Note: The value of the resistor named "R" depends on the LED characteristic.

Table 15: NETLIGHT pin status

NETLIGHT pin status	Module status
64ms ON, 800ms OFF	No registered network
64ms ON, 3000ms OFF	Registered network
64ms ON, 300ms OFF	Data transmit
OFF	Power off or PSM mode

Note: NETLIGHT output low level as "OFF", and high level as "ON".

3.9 ADC

SIM7020 has a dedicated ADC pin. It is available for digitizing analog signals such as battery voltage and so on. The electronic specifications are shown in the following table.

Table 16: ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	10	–	Bits
Conversion time	–		–	ms
Input Range	0.1	–	1.4	V
Input serial resistance		–	–	MΩ

Note: "AT+CADC" can be used to read the voltage of the ADC pin, for more details, please refer to

document [1].

3.10 Power Supply Output

SIM7020 has a LDO power output named VDD_EXT. The output voltage is 1.8V. Meanwhile it has a DCDC power output named VDD_3V3, which voltage range is 3.3V-3.5V (depend on VBAT). Both of them are not present in PSM mode.

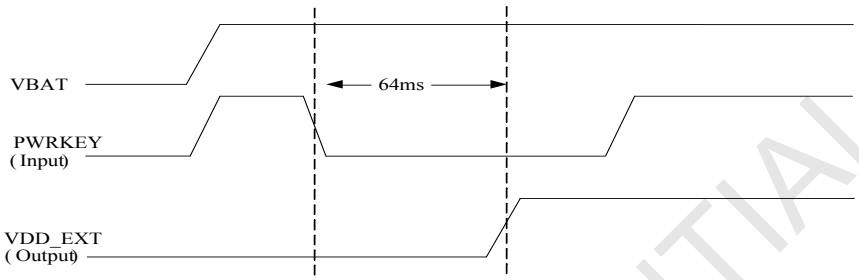

Figure 20：Power on sequence of the VDD_EXT

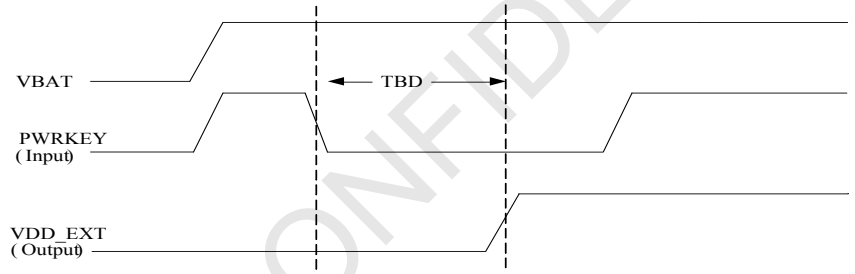

Figure 21：Power on sequence of the VDD_3V3

Table 17: Electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VDD_EXT					
V_{VDD_EXT}	Output voltage	1.7	1.8	1.9	V
I_O	Output current	-	-	50	mA
VDD_3V3					
V_{VDD_3V3}	Output voltage	3.2	3.3	VBAT-0.1	V
I_O	Output current	-	-	50	mA

4 RF Specifications

4.1 LTE RF Specifications

Table 18: Conducted transmission power

Frequency	Power	Min.
LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD B2	23dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23dBm +/-2.7dB	<-40dBm
LTE-FDD B4	23dBm +/-2.7dB	<-40dBm
LTE-FDD B5	23dBm +/-2.7dB	<-40dBm
LTE-FDD B6	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm
LTE-FDD B12	23dBm +/-2.7dB	<-40dBm
LTE-FDD B13	23dBm +/-2.7dB	<-40dBm
LTE-FDD B18	23dBm +/-2.7dB	<-40dBm
LTE-FDD B19	23dBm +/-2.7dB	<-40dBm
LTE-FDD B20	23dBm +/-2.7dB	<-40dBm
LTE-FDD B26	23dBm +/-2.7dB	<-40dBm
LTE-FDD B28	23dBm +/-2.7dB	<-40dBm
LTE-FDD B39	23dBm +/-2.7dB	<-40dBm

***Note** The max power is tested result single-tone in CAT-NB1. Multi-tone test results please refer to part 6.2.3F.3 for CAT-NB1.*

Table19: 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	≤ 0.5 dB	0 dB	≤ 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 20: 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

Table 21: CAT-NB1 Reference sensitivity (QPSK)

Operating band	REFSENS (dBm) 3GPP Request	REFSENS Typical(dBm)
1, 3,5, 8, 20, 28	-108.2	-115

4.2 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 22: 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.

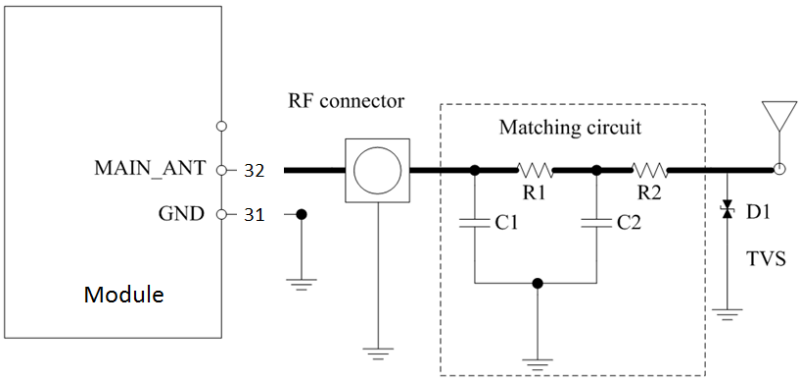

Figure 22: Antenna matching circuit (MAIN_ANT)

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 23: Recommended TVS

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

4.3 RF traces note

4.3.1 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.

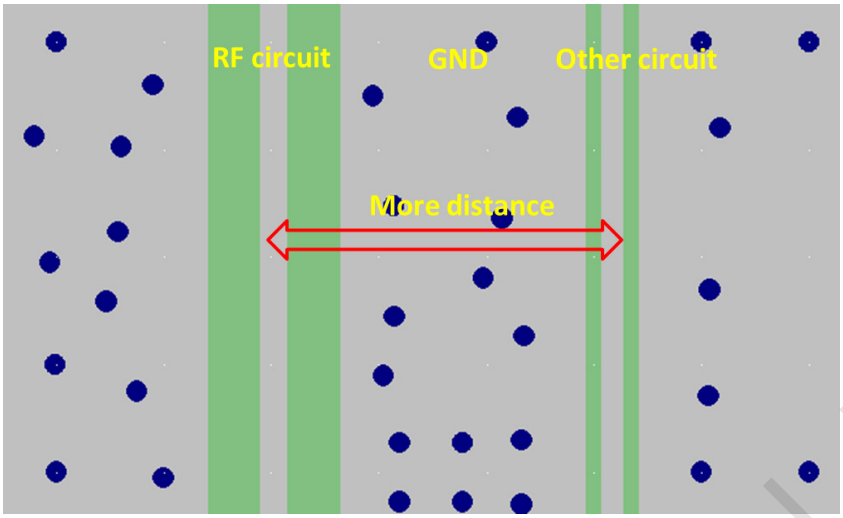

Figure 23: RF trace should be far away from other high speed signal lines

- Avoiding the paroling rout of other system antennas nearly.
- 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.

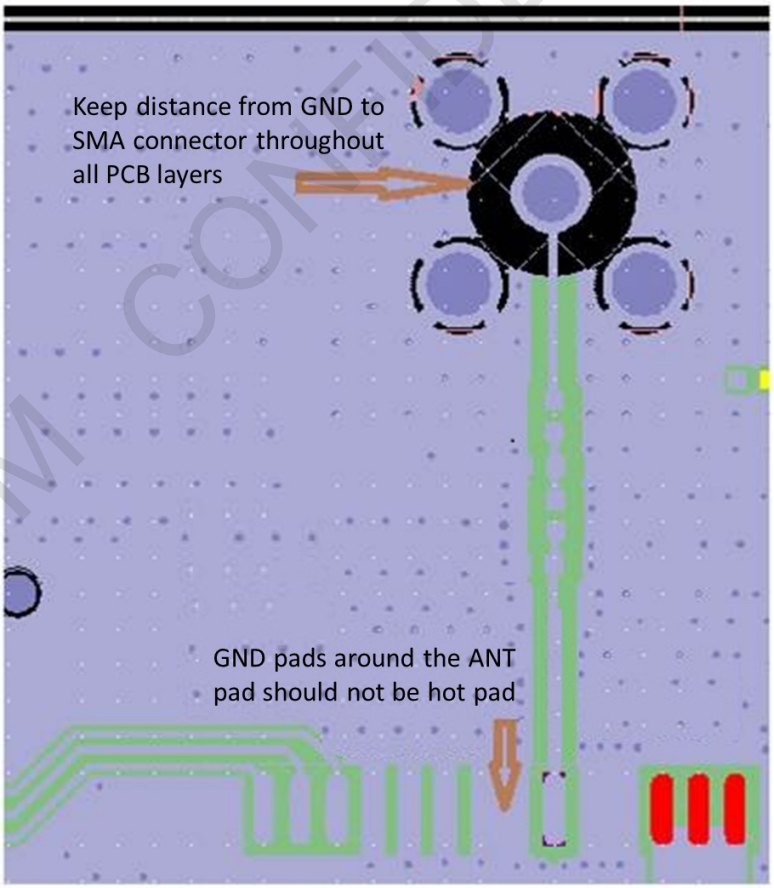

Figure 24: The distance between GND to the inner conductor of SMA

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

4.3.2 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[25].

5 Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of SIM7020 are listed in the following table:

Table 24: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	-0.5	-	4.5	V
Voltage at USB_VBUS	-0.5	-	5.85	V
Voltage at digital pins (RESET,GPIO, UART etc)	-0.3	-	2.1	V
Voltage at digital pins (SIM)	-0.3	-	3.05	V
Voltage at PWRKEY	-0.3	-	3.9	

5.2 Operating conditions

Table 25: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	2.1	3.3	3.6	V
Voltage at USB_VBUS	2.5	5.0	5.25	V

Table 26: 1.8V Digital I/O characteristics*

Parameter	Description	Min.	Typ.	Max.	Unit
V_{IH}	High-level input voltage	1.17	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	0	0.63	V
V_{OH}	High-level output voltage	1.35	-	1.8	V
V_{OL}	Low-level output voltage	0	-	0.45	V
I_{OH}	High-level output current(no pull down resistor)				mA
I_{OL}	Low-level output current(no pull up resistor)				mA
I_{IH}	Input high leakage current (no pull down resistor)				uA
I_{IL}	Input low leakage current(no pull up resistor)				uA

Note: These parameters are for digital interface pins, such as GPIOs (including NETLIGHT,

STATUS, SIM_DET), UART.

The operating temperature of SIM7020 is listed in the following table.

Table 27: Operating temperature

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

Note: 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 SIM7020 product.

Table 28: Operating mode Definition

Mode		Function
Normal operation	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.
	LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	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.
	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” 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 port 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 port are still

	accessible. The power consumption in this mode is lower than normal mode.
PSM mode	In this mode, the module will be the least current consumption. Meanwhile, all the output of the LDO and DCDC in the module will be closed except the RTC power. And also all of the functions will be unavailable except the RTC function. In PSM, RTC_GPIO0 will change state from high to low. RTC_EINT or PWRKEY can wake up the module.
Power off mode	Module will go into power off mode by sending the AT command "AT+CPOWD" or pull down the PWRKEY pin, normally. In this mode the power management unit shuts down the power supply, and software is not active. The serial port and USB are is not accessible.

5.3.2 Sleep mode

In sleep mode, the current consumption of module will be reduced to the minimal level, and module can still receive paging message and SMS.
Several hardware and software conditions must be satisfied together in order to let SIM7020 enter sleep mode:
1. UART condition
2. USB condition
3. Software condition

5.3.3 Minimum functionality mode and Flight mode

Minimum functionality mode ceases a majority function of the module, thus minimizing the power consumption. This mode is set by the AT command which provides a choice of the functionality levels.

- AT+CFUN=0: Minimum functionality
- AT+CFUN=1: Full functionality (Default)
- AT+CFUN=4: Flight mode

If SIM7020 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 SIM7020 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 SIM7020 is in minimum functionality or flight mode, it can return to full functionality by the AT command "AT+CFUN=1".

5.4 Current Consumption

The current consumption is listed in the table below.

Table 29: Current consumption on VBAT Pins (VBAT=3.8V)

Sleep/Idle Mode	
LTE supply current (without USB connection)	Sleep mode Typical: TBD Idle mode Typical: TBD
Power Saving Mode	
PSM supply current	PSM mode Typical: 5uA
eDRX	
eDRX mode supply current （Tested in sleep mode ）	@Cycle Length=10.24s, PTW=10.24s, Typical：TBD
	@Cycle Length=40.96s, PTW=20.48s, Typical：TBD
	@Cycle Length=10min55.36s, PTW=20.48s, Typical：TBD
	@Cycle Length=43min41.44s, PTW=20.48s, Typical：TBD
LTE data	
LTE-FDD B1	@23dbm Typical: 134mA @10dbm Typical: 42mA @0dbm Typical: 32mA
LTE-FDD B3	@23dbm Typical: 157mA @10dbm Typical: 44mA @0dbm Typical: 31 mA
LTE-FDD B5	@23dbm Typical: 116mA @10dbm Typical: 35mA @0dbm Typical: 25mA
LTE-FDD B8	@23dbm Typical: 128mA @10dbm Typical: 35mA @0dbm Typical: 25mA
LTE-FDD B20	@23dbm Typical: 113mA @10dbm Typical: 34mA @0dbm Typical: 26mA
LTE-FDD B28	@23dbm Typical: TBD @10dbm Typical: TBD @0dbm Typical: TBD

5.5 ESD Notes

SIM7020 is sensitive to ESD in the process of storage, transporting, and assembling. When SIM7020 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 SIM7020 ESD measurement performance without any external ESD component.

Table 30: The ESD performance measurement table

Part	Contact discharge	Air discharge
VBAT,GND	TBD	TBD
Antenna port	TBD	TBD
USB	TBD	TBD
UART	TBD	TBD
Other PADs	TBD	TBD

Note: Temperature: 25℃, Humidity: 45%, tested on SIMCOM-EVB.

6 SMT Production Guide

6.1 Top and Bottom View of SIM7020

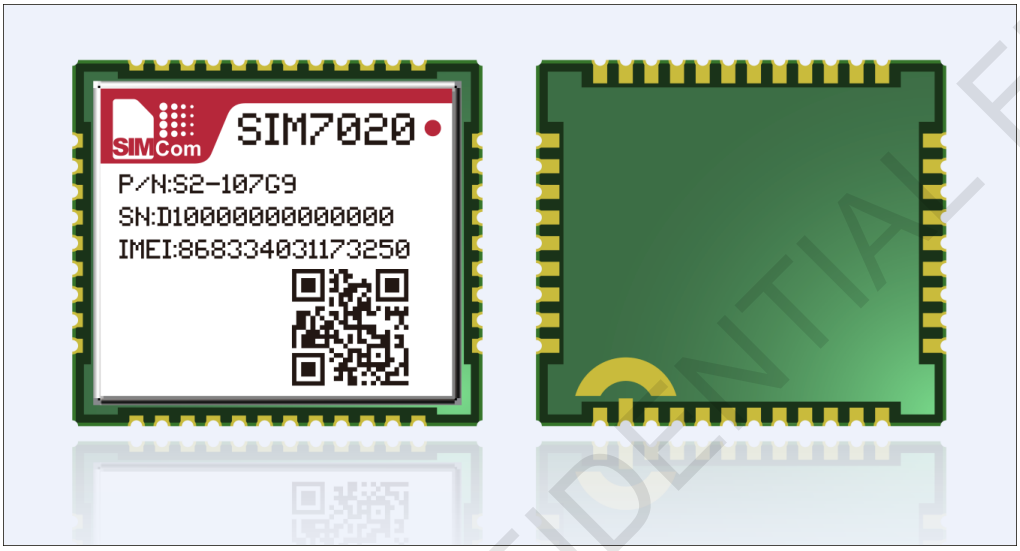

Figure 25: Top and bottom view of SIM7020

6.2 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.

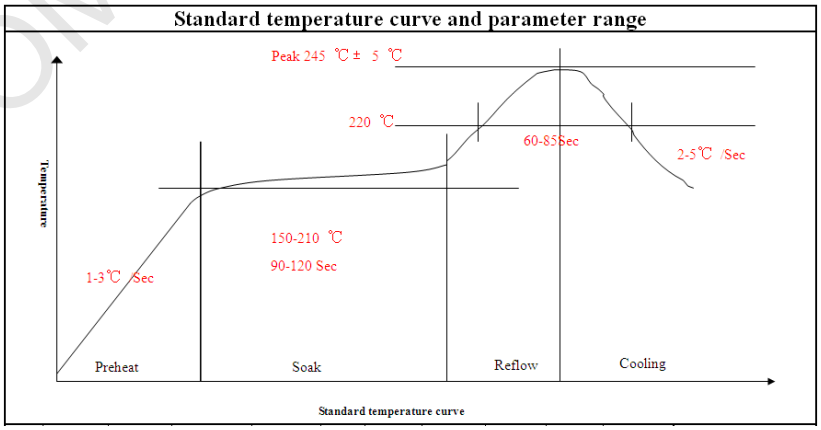

Figure 26: The ramp-soak-spike reflow profile of SIM7020

Note: For more details about secondary SMT, please refer to the document [21].

6.3 Moisture Sensitivity Level (MSL)

SIM7020 is qualified to Moisture Sensitivity Level (MSL) **4** in accordance with JEDEC J-STD-033. If the prescribed time limit is exceeded, users should bake modules for 192 hours in drying equipment (<5% RH) at 40+5/-0°C, or 72 hours at 85+5/-5°C. Note that plastic tray is not heat-resistant, and only can be baked at 45° C.

Table 31: Moisture Sensitivity Level and Floor Life

Moisture Sensitivity Level (MSL)	Floor Life (out of bag) at factory ambient≤30°C/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.

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

6.4 Baking Requirements

SIM7020 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 table below; 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 32: Baking requirements

Baking temperature	Moisture	Time
40℃±5℃	<5%	192 hours
120℃±5℃	<5%	4 hours

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

6.5 Stencil Foil Design Recommendation

The recommended thickness of stencil foil is 0.15mm.

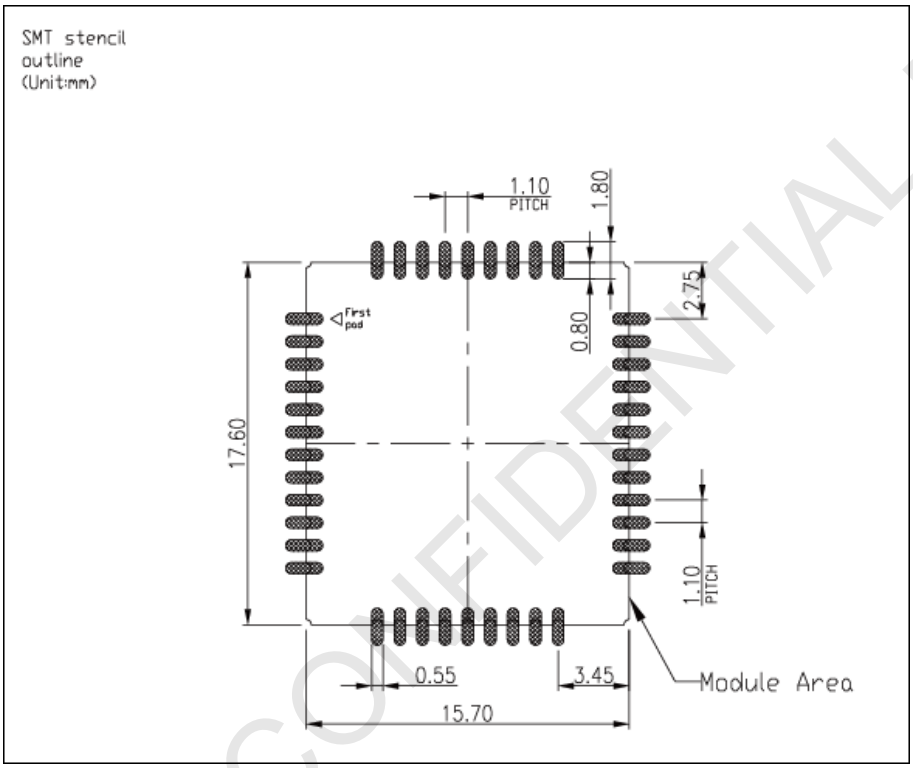

Figure 27: Recommended SMT stencil footprint outline

7 Packaging

SIM7020 module support tray packaging (default packaging).

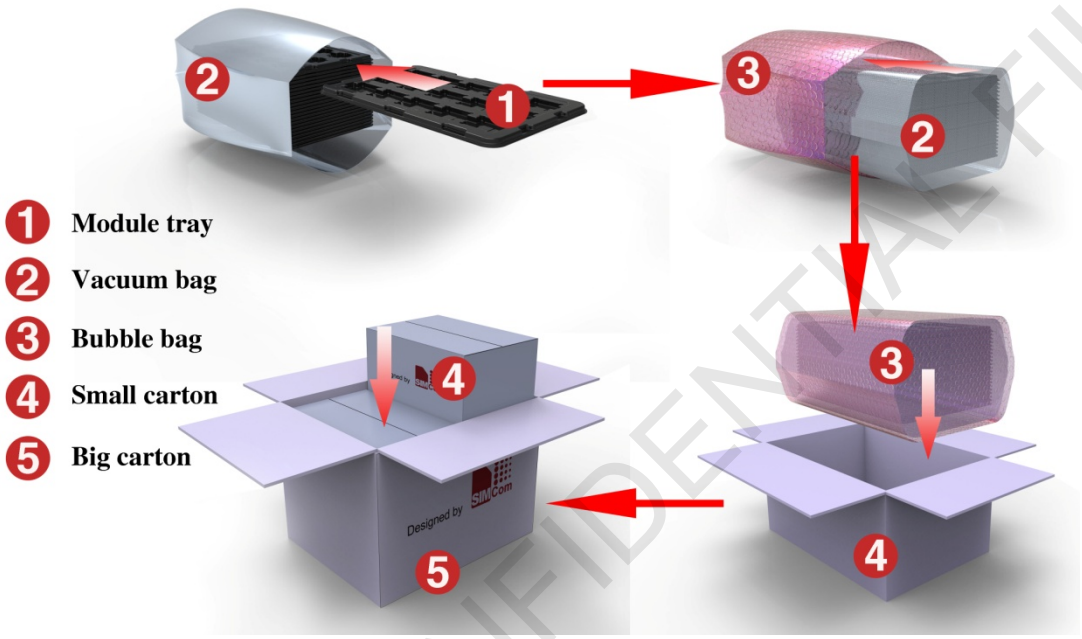

Figure 28: packaging diagram

Module tray drawing：

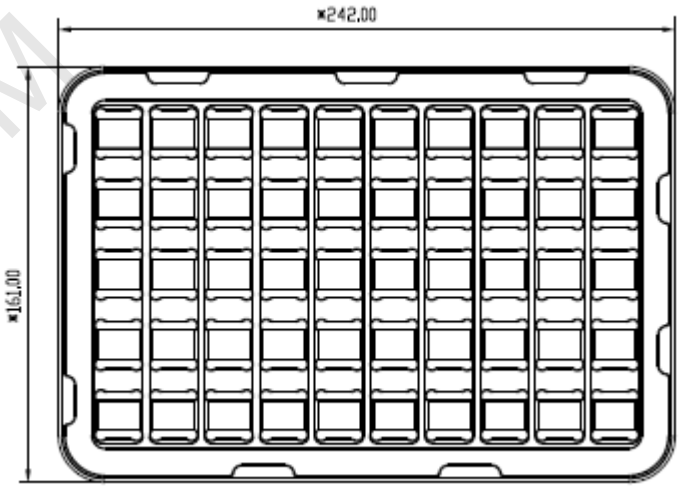

Figure 29: Tray drawing

Table 33: Tray size

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

Small carton drawing：

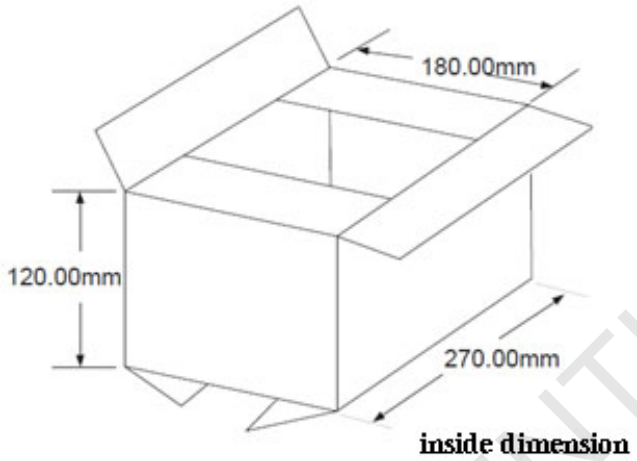

Figure 30: Small carton drawing

Table 34: Small Carton size

Length (	Width (	Height	Module number
270	180	120	50*20=1000

Big carton drawing ：

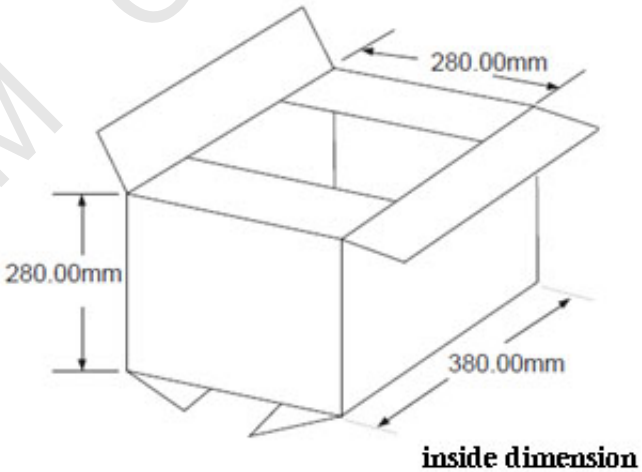

Figure 31: Big carton drawing

Table 35: Big Carton size

Length（	Width（	Height	Module number
380	280	280	1000*4=4000

8 Appendix

8.1 Related Documents

Table 36: Related Documents

NO.	Title	Description
[1]	SIM7X00 Series_AT Command Manual_V1.xx	AT Command Manual
[2]	ITU-T Draft new recommendationV.25ter	Serial asynchronous automatic dialing and control
[3]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[4]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[5]	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)
[6]	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
[7]	GSM 11.11	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[8]	GSM 03.38	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[9]	GSM 11.10	Digital cellular telecommunications system (Phase 2) Mobile Station (MS) conformance specification Conformance specification
[10]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[11]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[12]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[13]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[14]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[15]	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

[16]	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
[17]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[18]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[19]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[20]	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)
[21]	Module secondary-SMT-UGD-V1.xx	Module secondary SMT Guidelines
[22]	SIM7X00 Series_UART_Application Note_V1.xx	This document describes how to use UART interface of SIMCom modules.
[23]	SIM7X00 Series_USB AUDIO_Application Note_V1.xx	USB AUDIO Application Note
[24]	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
[25]	Antenna design guidelines for diversity receiver system	Antenna design guidelines for diversity receiver system
[26]	SIM7X00 Series_Sleep Mode_ Application Note_V1.xx	Sleep Mode Application Note

8.2 Terms and Abbreviations

Table 37: 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
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
EVDO	Evolution Data Only
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
HSPA	High Speed Packet Access
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
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
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 save mode

8.3 Safety Caution

Table 38: 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.
	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. 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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