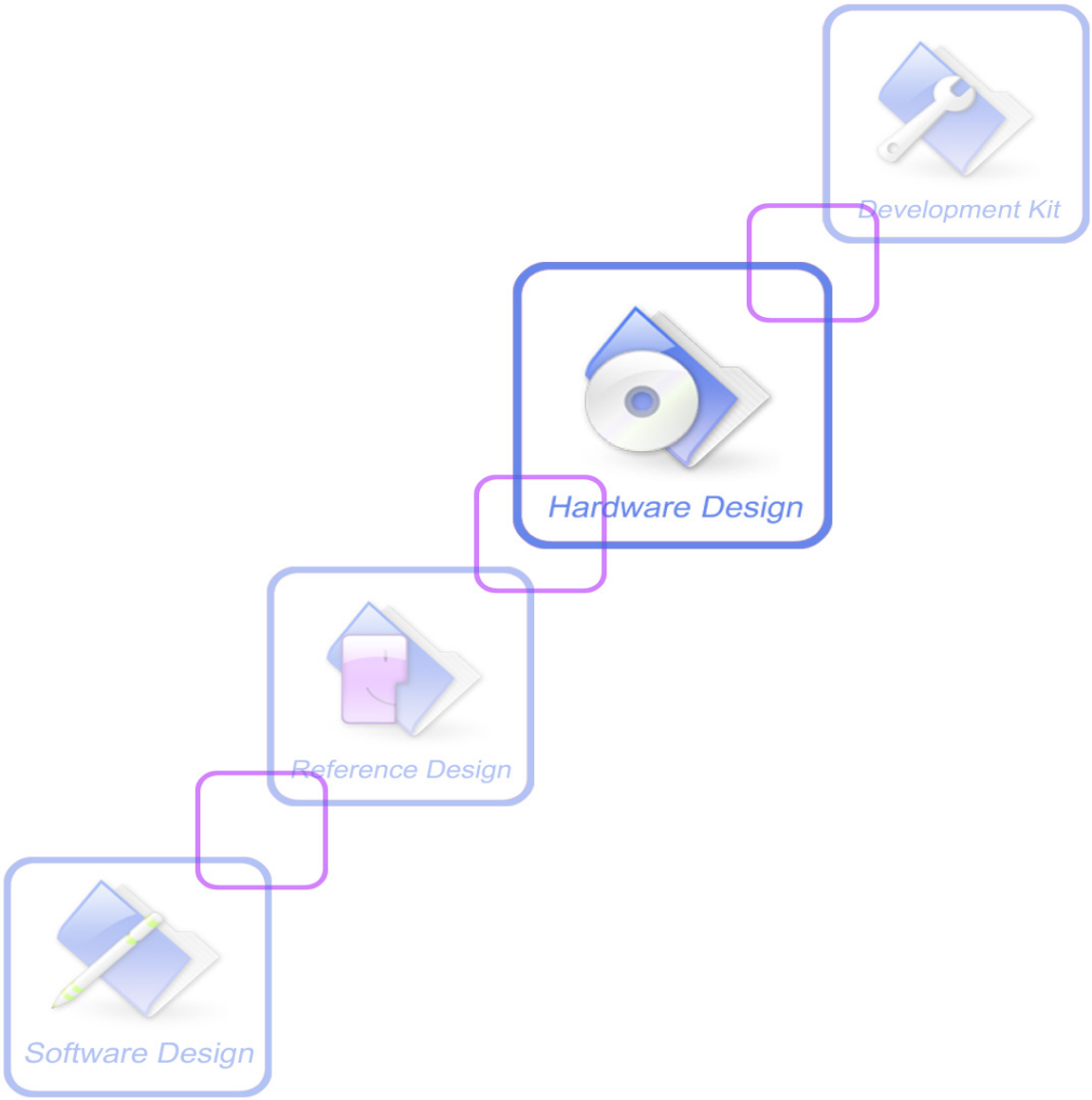
SIM7060R Hardware Design_V1.00



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Revision History

Data	Version	Description of change	Author
2019-05-28	1.00	Original	Lijuan.Yin Xiaomeng.Guo

1 Introduction

This document describes SIM7060R hardware interface in great detail. The document can help customer to quickly understand SIM7060R interface specifications, electrical and mechanical details. With the help of this document and other SIM7060R application notes, customer guide, customers can use SIM7060R to design various applications quickly.

1.1 Product Outline

The SIM7060R module supports LTE CAT-NB1. The physical dimension of SIM7060R is 24x24x2.6 mm，compatible with SIM7000 package. For the detailed description of the frequency band, please refer to the following table:

Table 1：SIM7060R frequency bands

Standard	Frequency	Variants
		SIM7060R
HD-FDD	B1	✓
	B2	✓
	B3	✓
	B4	✓
	B5	✓
	B8	✓
	B11	✓
	B12	✓
	B13	✓
	B17	✓
	B18	✓
	B19	✓
	B20	✓
	B25	✓
	B26	✓
	B28	✓
	B31	✓
	B66	✓
	B70	✓

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 Interface
- I2C Interface
- Power output
- GPIOs
- Antenna Interface

1.3 Hardware Block Diagram

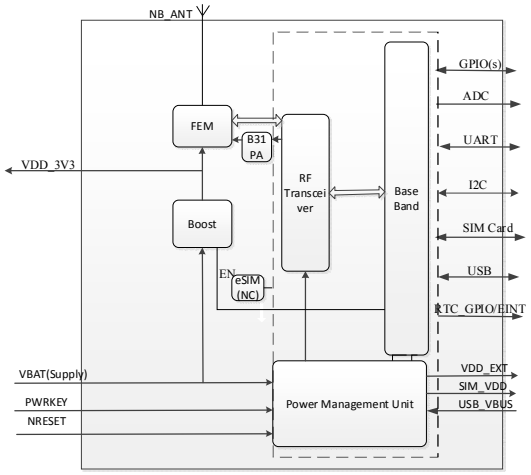

Figure 1：SIM7060R block diagram

1.4 Functional Overview

Table 2：General features

feature	Implementation
Power supply	Power supply voltage:2.1V ~3.6V，type:3.3V
Power saving	Current in PSM mode: 4uA
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: auto baud rate Can be used as the AT commands or data stream channel Support RTS/CTS hardware handshake
UART0 interface	Baud rate: It is 921600bps when used download mode. Can be used for debugging and upgrading firmware

USB	USB 1.1 interface for debugging (Log port can be selected by AT command.)
Firmware upgrade	Firmware upgrade over UART0 interface
Physical characteristics	Size:24x24x2.6 mm Weight: TBD
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

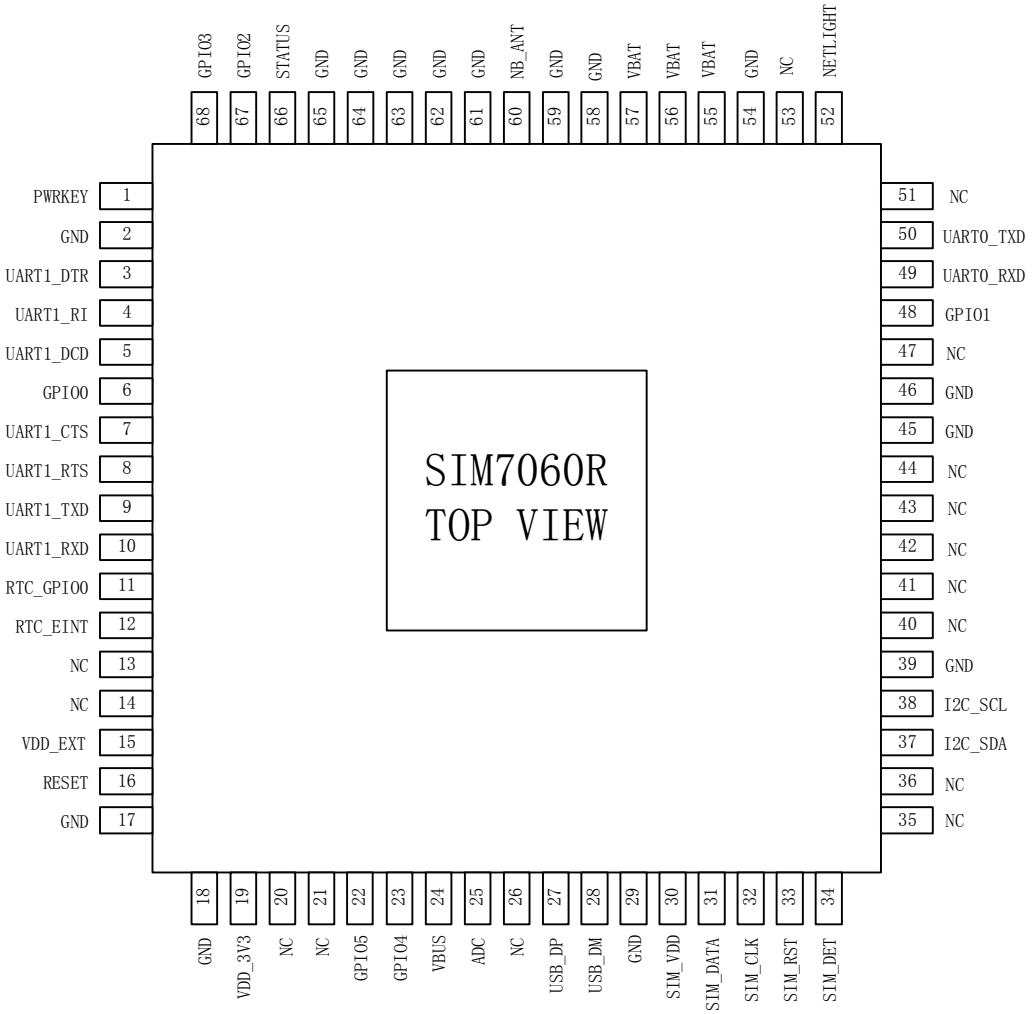

Figure 2: Pin assignment overview

Table 3：Pin definition

Pin No.	Pin Name	Pin No.	Pin Name
1	PWRKEY	2	GND
3	UART1_DTR	4	UART1_RI
5	UART1_DCD	6	GPIO0
7	UART1_CTS	8	UART1_RTS
9	UART1_TXD	10	UART1_RXD
11	RTC_GPIO0	12	RTC_EINT
13	NC	14	NC
15	VDD_EXT	16	RESET
17	GND	18	GND
19	VDD_3V3	20	NC
21	NC	22	GPIO5
23	GPIO4	24	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	GPIO1
49	UART0_RXD	50	UART0_TXD
51	NC	52	NETLIGHT
53	NC	54	GND
55	VBAT	56	VBAT
57	VBAT	58	GND
59	GND	60	NB_ANT
61	GND	62	GND
63	GND	64	GND
65	GND	66	STATUS
67	GPIO2	68	GPIO3

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.	I/O	Description	Comment
Power supply				
VBAT	55、56、57	PI	NB-IOT power input	2.1V-3.6V
VDD_EXT	15	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	19	PO	Power output 3.3V for other external circuits with Max 50mA current output. Not present in PSM mode.	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.	PWRKEY has been pulled up to VBAT via 40Kohm resistor internally.
RESET	16	DI，PU	System reset control input, active low.	RESET has been

				pulled up to VBAT via 40Kohm resistor internally.
SIM interface				
SIM_DATA	31	I/O，PU	SIM Card data I/O	
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.	
SIM_DET	34	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 interface				
VBUS	24	DI,PD	Valid USB detection input with 3.6~5.25V detection voltage	USB interface for debugging
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				
UART0_TXD	50	DOH	Transmit Data	If unused, keep them open.
UART0_RXD	49	DI，PU	Receive Data	
UART1_TXD	9	DOH	Transmit Data	
UART1_RXD	10	DI，PU	Receive Data	
UART1_RTS	8	DI，PU	Request to send	
UART1_CTS	7	DOH	Clear to Send	
UART1_DCD	5	DOH	Data carrier detect	
UART1_DTR	3	DI，PU	Transmit Data	
UART1_RI	4	DOH	Ring Indicator	
I2C interface				
I2C_SDA	37	I/O	I2C data input/output	If used, keep a 4.7kΩ resistor pulling up to the VDD_EXT.
I2C_SCL	38	O	I2C clock output	
Indicate and Control in PSM Mode				
RTC_GPIO0	11	DO	In PSM, RTC_GPIO0 will change state from low to high if RTC_EINT receive interrupt event.	Voltage Domain: VBAT
RTC_EINT	12	DI、PU	RTC_EINT can be the wake up source for exiting PSM.	
GPIO				
NETLIGHT	52	DO	LED control output as network status indication.	If unused, keep them
STATUS	66	DO	Operating status output. High level: Power on and firmware ready Low level: Power off	
GPIO0	6	IO	Do not pull down before power on	

GPIO1	48	IO	Programmable general purpose input and output.	open.
GPIO2	67	IO		
GPIO3	68	IO		
GPIO4	23	IO		
GPIO5	22	IO		
RF interface				
NB_ANT	60	I	NB-IOT antenna	
Other interface				
ADC	25	AI	Analog-digital converter input. Voltage range: 0.1−1.4V.	If unused, keep them open.
NC	13、14、20、21、26、35、36、40、41、42、43、44、47、51、53		No connection.	Keep it open

2.3 Mechanical Information

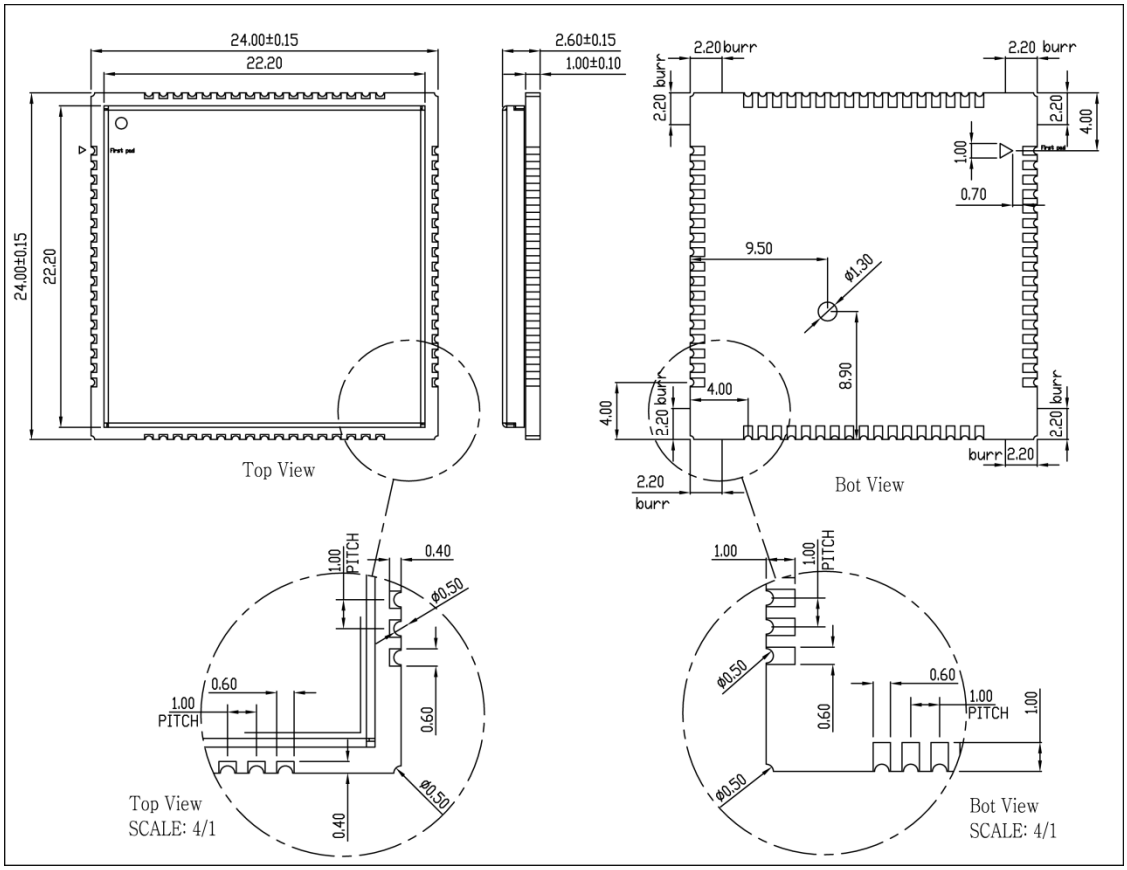

Figure 3：Dimensions (Unit: mm)

2.4 Footprint Recommendation

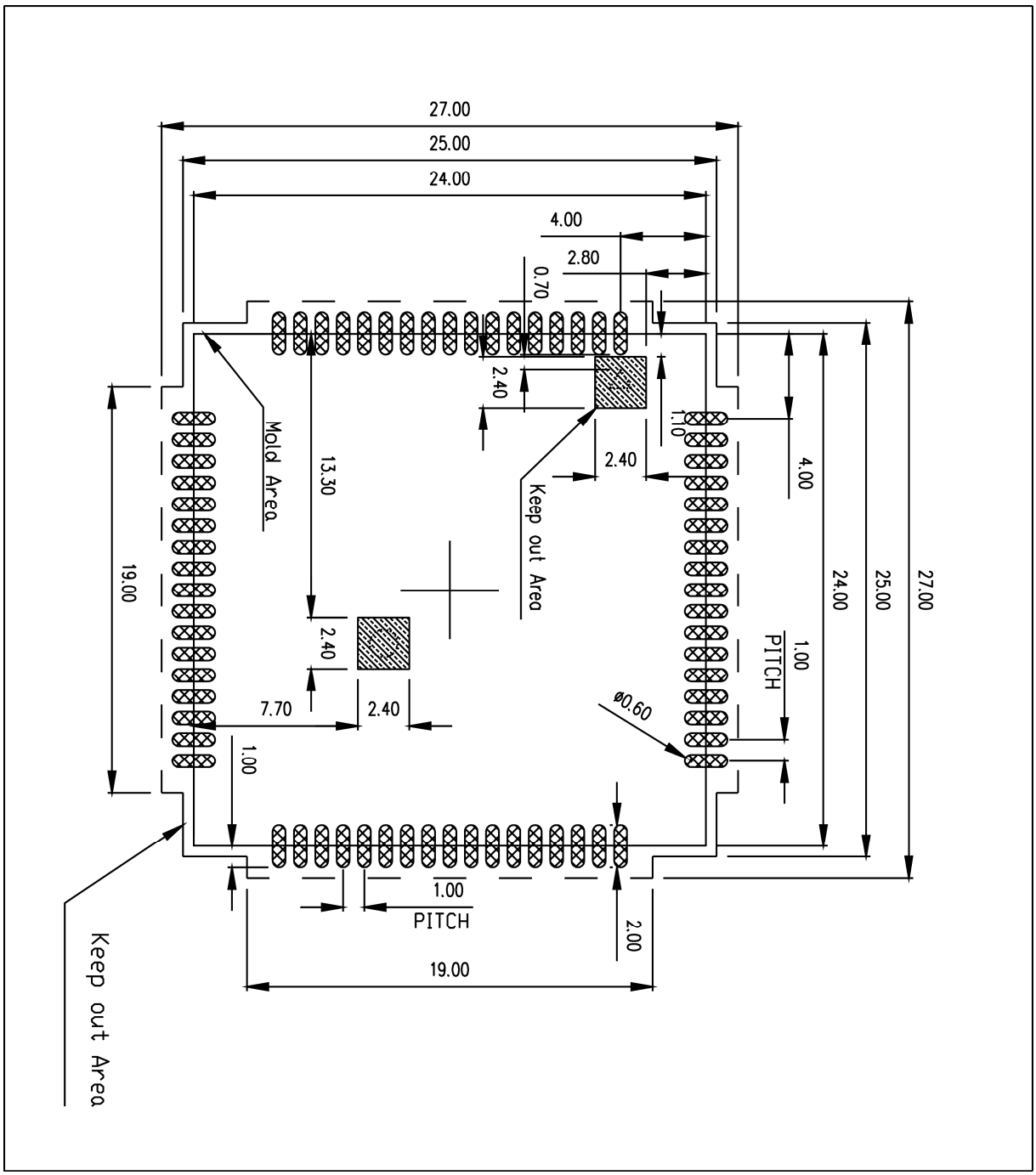

Figure4: Footprint recommendation (Unit: mm)

3 Interface Application

3.1 Power supply

The module VBAT power supply range is from 2.1v to 3.6V and the recommended voltage is 3.3V. When the module is transmitting at maximum power in the NB-IOT network, the peak current can reach to 800mA instantaneously.

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	800	-	-	mA
$I_{VBAT(average)}$	Module power average current in normal mode	Please refer to the table 31			
$I_{VBAT(sleep)}$	Power supply current in sleep mode				
$I_{VBAT(PSM)}$	Power supply current in PSM mode	-	4	-	uA
$I_{VBAT(power-off)}$	Module leakage current	-	-	12	uA

3.2 Power Supply Design Guide

Make sure that the voltage on the VBAT pins will never drop below 2.1V.If the voltage drops below 2.1V, the module may shut down due to low voltage.

Note: If the power supply for VBAT pins can support up to 800mA, using a total of more than 100uF capacitors is recommended, or else users must use a total of 300uF capacitors typically, in order to avoid the voltage drop. The module power peak current depends on the total capacitance.

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.

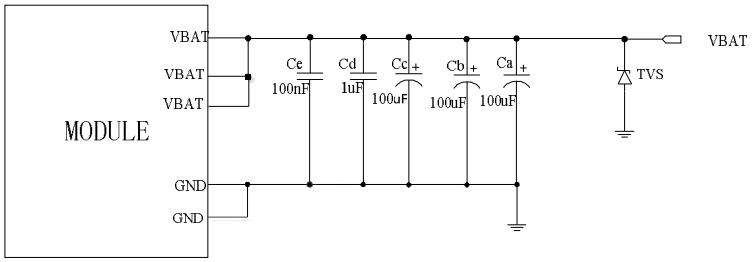

Figure 5：Power supply application circuit

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

3.3 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 NB-IOT part will be powered 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

SIM7060R 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.

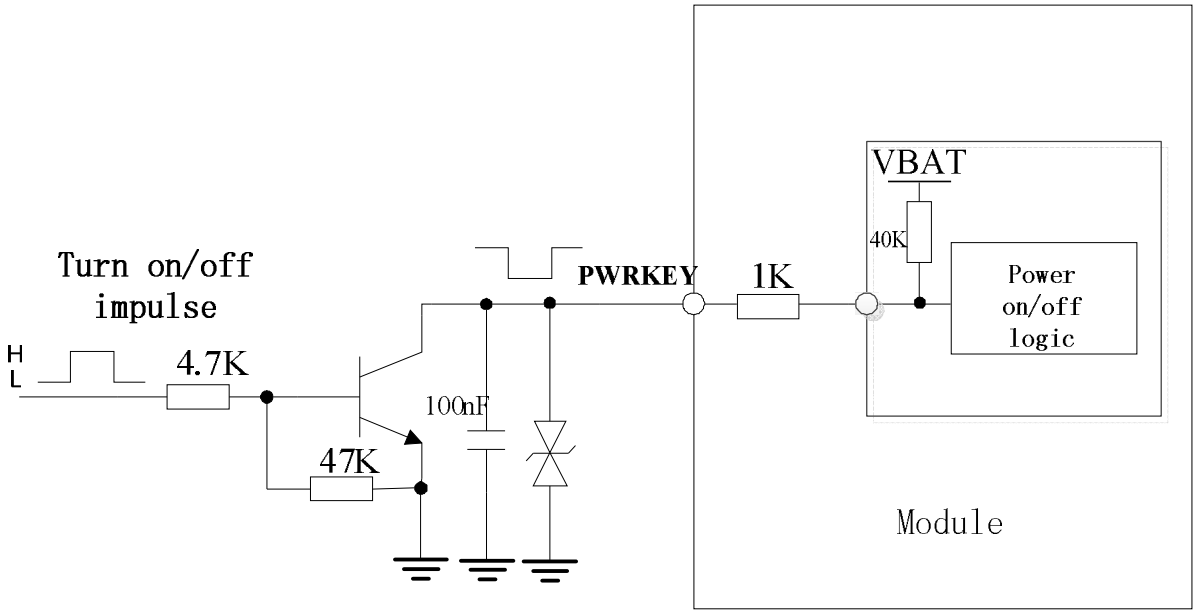

Figure 6: Reference power on/off circuit

Note: Do not pull GPIO0 (Pin6) to low before powering on SIM7060R.

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

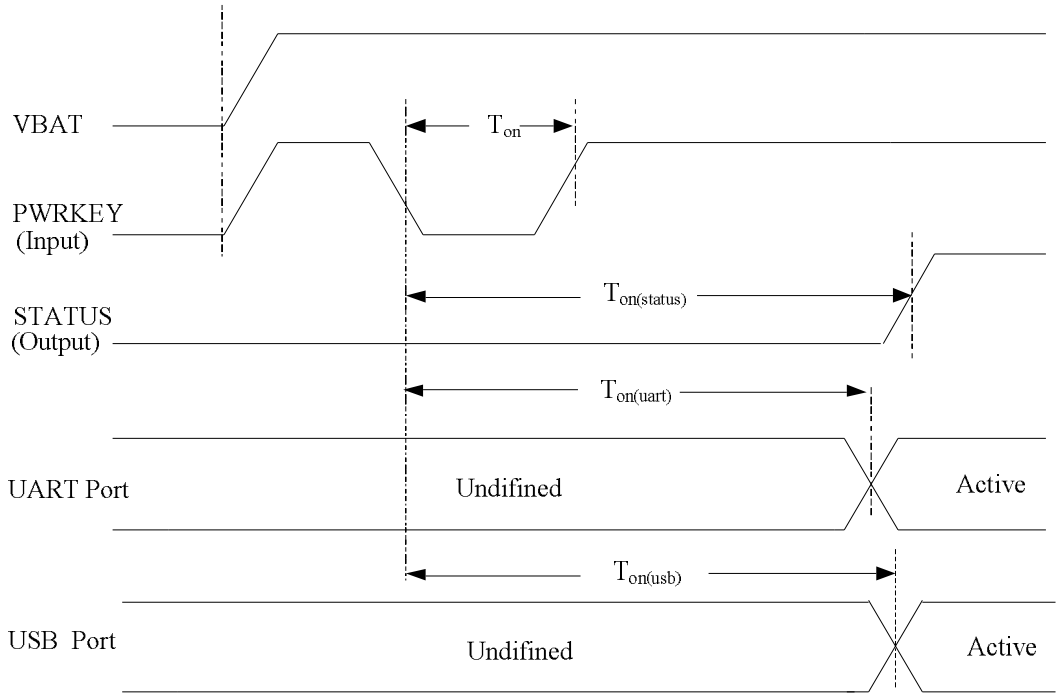

Figure 7：Power on timing sequence

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	215	800	-	ms
$T_{on(status)}$	The time from power-on issue to STATUS pin output high level(indicating power up ready)	-	440	-	ms
$T_{on(uart)}$	The time from power-on issue to UART port ready	TBD			s
V_{IH}	Input high level voltage on PWRKEY pin	0.7*VBAT			V
V_{IL}	Input low level voltage on PWRKEY pin			0.3*VBAT	V

3.4.2 NB-IOT power off

The following methods can be used to power off NB-IOT:

- Method 1: Power off SIM7060R by pulling the PWRKEY pin to ground
- Method 2: Power off SIM7060R 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”.It is disabled by default.

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

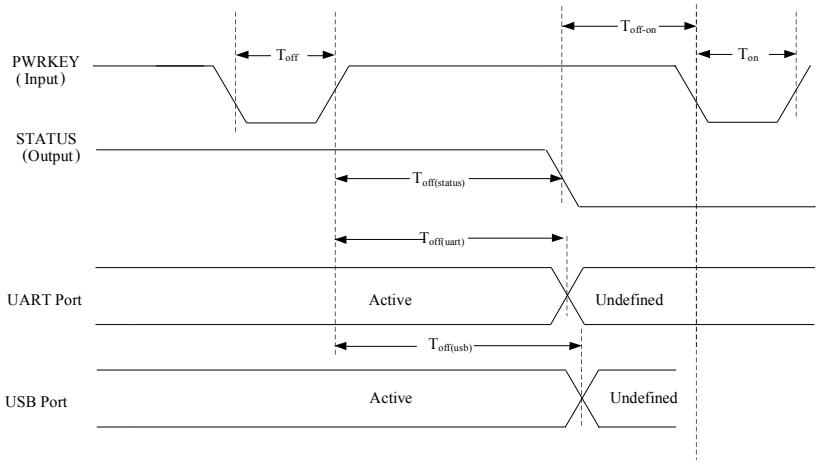

Figure 8：Power off timing sequence

Table 9：Power off timing and electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{off}	The active low level time pulse on PWRKEY pin to power off module	1	-	-	s
$T_{off(status)}$	The time from power-off issue to STATUS pin output low level(indicating power off)*	-	-	TBD	s

Note: The STATUS pin can be used to detect whether SIM7060R is powered on or not. When SIM7060R has been powered on , STATUS will be high level, otherwise STATUS will still be with the low level.

3.4.3 Reset function

SIM7060R 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 VBAT 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.

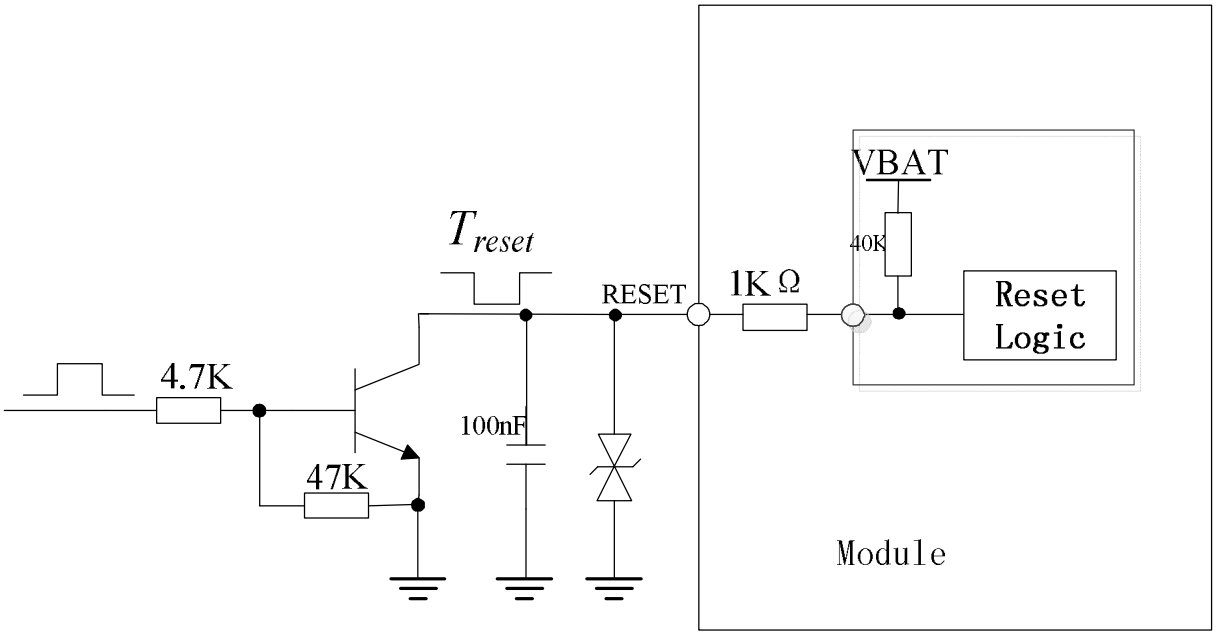

Figure 9：Reference reset circuit

Table 10：RESET pin electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{reset}	The active low level time impulse on RESET pin to reset module	40	-	-	ms
V_{IH}	Input high level voltage	0.7*VBAT			V
V_{IL}	Input high level voltage			0.3*VBAT	V

3.5 UART Interface

SIM7060R 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. UART0 can be used for debugging and firmware update.

3.5.1 UART Design Guide

The following figures show the reference design.

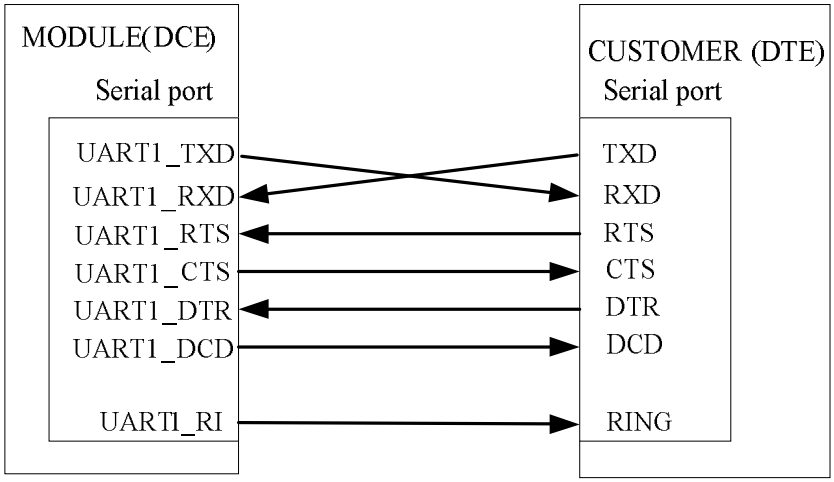

Figure 10：UART full modem

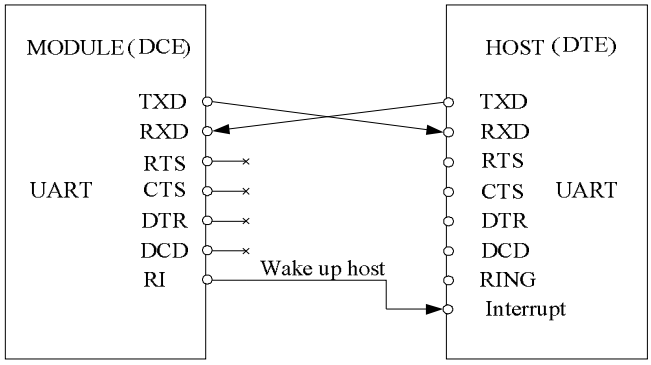

Figure 11：UART null modem

The SIM7060R 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.

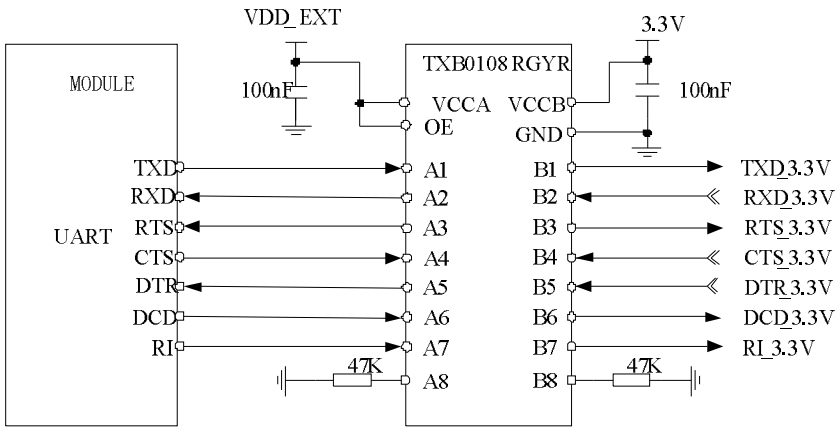

Figure 12：Reference circuit of level shift

Note: When use the level shifter IC, the pull up resistance on TXD_3.3V，RTS_3.3V，DCD_3.3V should not be less than 47K Ω.

Also the following reference circuit is recommended:

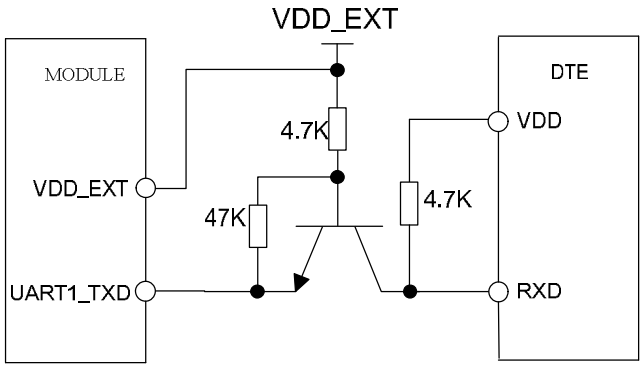

Figure 13：TX level matching circuit

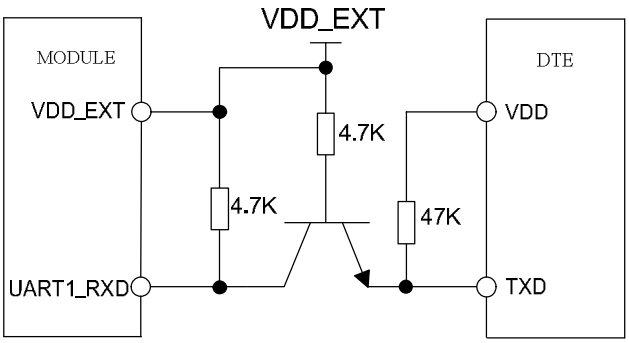

Figure 14：RX level matching circuit

Note: The triode conversion circuit is not suitable for high baud rate more than 460800bps. When using UART0 for downloading software, the baud rate is 921600bps, please pay attention to the device's speed support.

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.

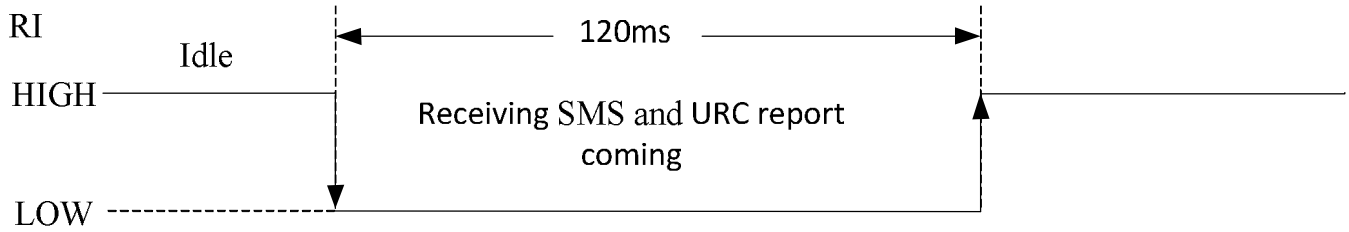

Figure 15：RI behaviour （SMS and URC report）

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", the NB-IOT part of SIM7060R will enter into sleep mode by

pulling up the DTR pin when module is in idle mode. In sleep mode, the UART is unavailable. Pulling down the DTR pin can be used to wake up the NB-IOT part of SIM7060R from the sleep mode.

AT command "AT+CSCLK=0" can bse used to disable the sleep mode.

3.6 USB Interface

The SIM7060R contains a USB interface compliant with the USB1.1 specification as a peripheral, but the USB charging function is not supported.

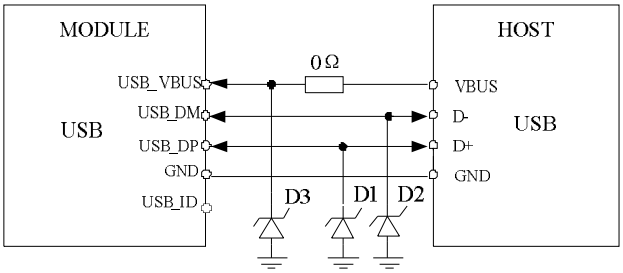

Figure 16: USB reference circuit

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

SIM7060R supports both 1.8V and 3.0V SIM Cards.
A 2*2mm eSIM chip location is reserved inside the module. For internal SIM card chip, please contact SIMCOM.

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=3V)

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.

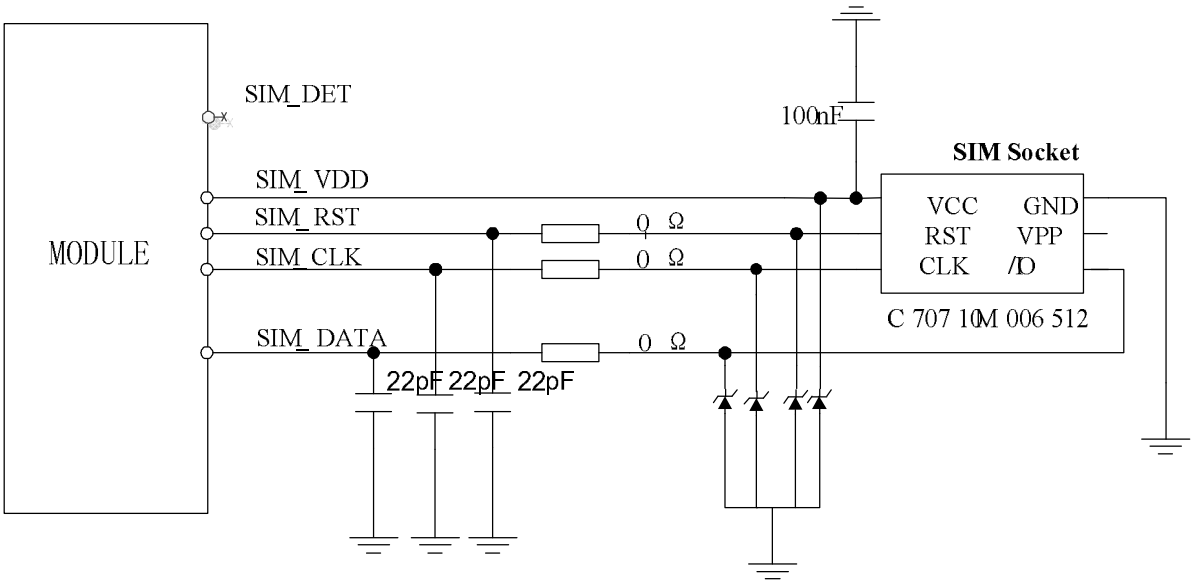

Table 17：SIM interface reference circuit

Note: 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.

3.8 Network status

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

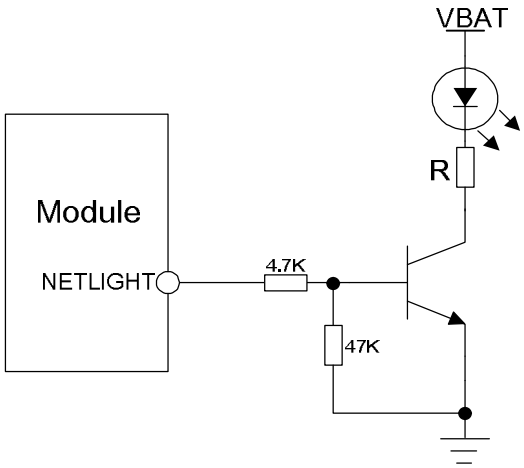

Figure 18: NETLIGHT reference circuit

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

Table 14: 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

3.9 ADC

SIM7060R 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 15: ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	10	–	Bits
Input Range	0.1	–	1.4	V

3.10 I2C Interface

SIM7060R provides one I2C master controllers. There are three types of speed modes in the I2C controllers: standard mode (100kbit/s), fast mode (400kbit/s) and high-speed mode (3.4Mbit/s), supporting 7-bit/10-bit addressing and can be served by the DMA controller.

The following figure shows the I2C bus reference design.

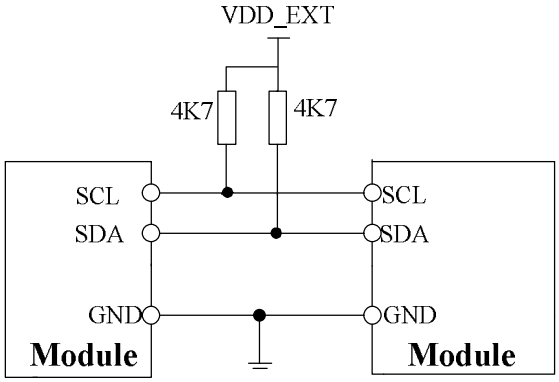

Figure 19：I2C reference circuit

3.11 Power Supply Output

SIM7060R has a LDO power output named VDD_EXT, the output voltage is 1.8V. Meanwhile it has a DCDC power output named VDD_3V3, the output voltage is 3.3V. Both of them are not present in PSM mode.

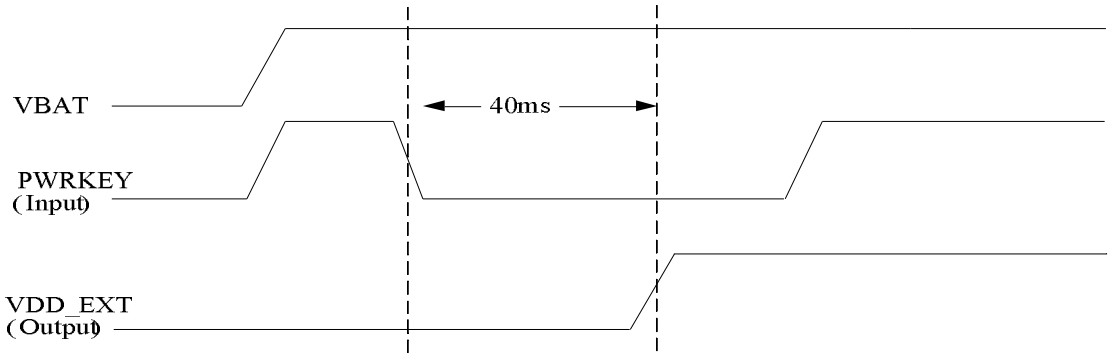

Figure 20：Power on sequence of the VDD_EXT

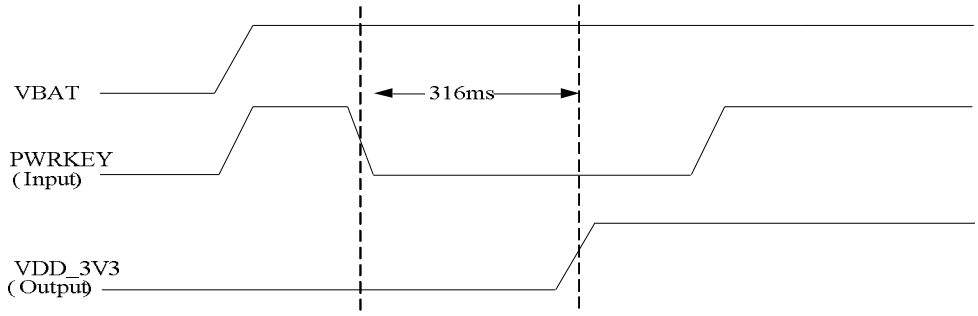

Figure 21：Power on sequence of the VDD_3V3

Table 16：Electronic characteristic

Pin name	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 17：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 B8	23dBm +/-2.7dB	<-40dBm
LTE-FDD B11	23dBm +/-2.7dB	<-40dBm
LTE-FDD B12	23dBm +/-2.7dB	<-40dBm
LTE-FDD B13	23dBm +/-2.7dB	<-40dBm
LTE-FDD B17	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 B25	23dBm +/-2.7dB	<-40dBm
LTE-FDD B26	23dBm +/-2.7dB	<-40dBm
LTE-FDD B28	23dBm +/-2.7dB	<-40dBm
LTE-FDD B31	23dBm +/-2.7dB	<-40dBm
LTE-FDD B66	23dBm +/-2.7dB	<-40dBm
LTE-FDD B70	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.***

Table 18: 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 18: E-UTRA operating bands

E-UTRA	UL Freq.	DL Freq.	Duplex Mode
1	1920~1980 MHz	2110~2170 MHz	HD-FDD
2	1850~1910 MHz	1930~1990 MHz	HD-FDD
3	1710~1785 MHz	1805~1880 MHz	HD-FDD
4	1710~1755 MHz	2110~2155 MHz	HD-FDD
5	824~849 MHz	869~894 MHz	HD-FDD
8	880~915 MHz	925~960 MHz	HD-FDD
11	1427.9~1447.9 MHz	1475.9~1495.9 MHz	HD-FDD
12	699~716 MHz	729~746 MHz	HD-FDD
13	777~787 MHz	746~756 MHz	HD-FDD
17	704~716 MHz	734~746 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
25	1850~1915 MHz	1930~1995 MHz	HD-FDD
26	814 ~849 MHz	859~894 MHz	HD-FDD
28	703~748 MHz	758~803 MHz	HD-FDD
31	452.5~457.5MHz	462.5~467.5MHz	HD-FDD
66	1710~1780 MHz	2110~2200 MHz	HD-FDD
70	1695~1710 MHz	1995~2020 MHz	HD-FDD

Table 19: CAT-NB1 Reference sensitivity (QPSK)

Operating band	REFSENS (dBm) 3GPP Request	REFSENS Typical(dBm)	REFSENS Typical(dBm repeated)
All band	-108.2	-114	-131

4.2 Antenna Design Guide

Users should connect antennas to SIM7060R'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 20: 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.

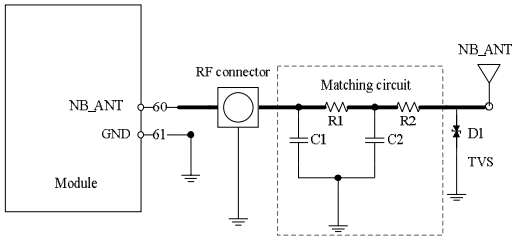

Figure 22: Antenna matching circuit

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 NB_ANT pin. The traces impedance between SIM7060R and antenna must be controlled in 50Ω.

Two TVS are recommended in the table below.

Table 21: 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.

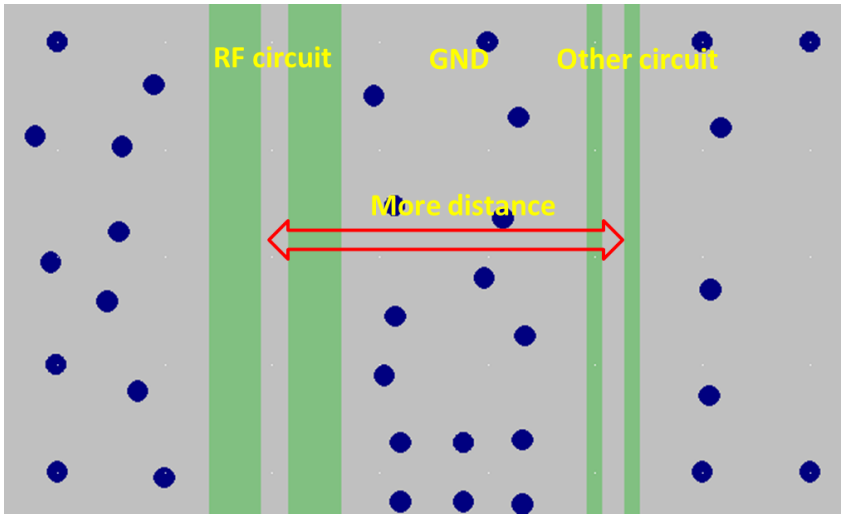

Figure 23: RF trace should be far away from other high speed signal lines

- Avoiding the paralleling layout 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.

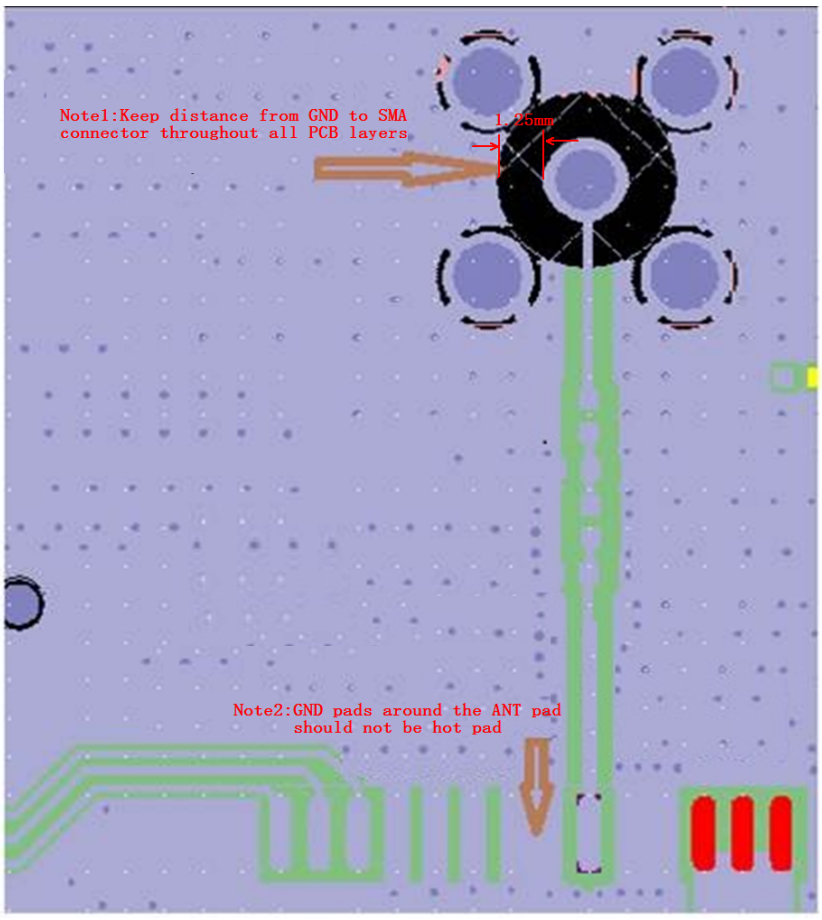

Figure 24: The distance between GND to the inner conductor of SMA

- GND pads around the ANT pad should not be hot pad to keep the GND complete, as shown in fig.31 Note2.

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 *ANTENNA DESIGN GUIDELINES FOR DIVERSITY RECEIVER SYSTEM V1.01.pdf*

5 Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of SIM7060R are listed in the following table:

Table 22：Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	-0.3	-	3.63	V
Voltage at VBUS	-0.3	-	5.85	V
Voltage at digital pins (GPIO, UART etc)	-0.3	-	2.1	V
Voltage at digital pins (SIM)	-0.3	-	3.05	V
PWRKEY、RESET、RTC_EINT、RTC_GPIO0	-0.3	-	3.63	

5.2 Operating conditions

Table 23：Recommended operating ratings

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

Table 24：1.8V 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)			4	mA
I_{OL}	Low-level output current(no pull up resistor)			4	mA
I_{IH}	Input high leakage current (no pull down resistor)			5	uA
I_{IL}	Input low leakage current(no pull up resistor)			5	uA

Note: These parameters are for digital interface pins, such as GPIOs (including NETLIGHT, STATUS, SIM_DET), UART0, UART1.

5.3 Operating Modes

5.3.1 Operating Mode Definition

The table below summarizes the various operating modes of SIM7060R product.

Table 25：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 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” 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=1” or pull down the PWRKEY pin. In this mode the power management unit shuts down the power supply, and software is not active. The serial port and USB are 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 SIM7060R enter sleep mode:

1. UART condition
2. Software condition
3. USB 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 SIM7060R 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 SIM7060R 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 SIM7060R 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)

SIM7060R 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.

In PSM, RTC_GPIO0 will change state from low to high if RTC_EINT receive interrupt event.

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

- Pulling PWRKEY or RTC_EINT to low level will wake up the module.
- When the T3412 timer expires, the module will be automatically woken up.

Power domain of RTC_GPIO0 and RTC_EINT is VBAT, please consider the electrical characteristics when connecting to external IO (suggest to use trigger as low-active).

Table 26: RTC_GPIO0/RTC_EINT characteristics

IO	Vih(min).	Vih(max).	Vil(min).	Vil(max).	VBAT
RTC_EINT	1.575	2.1	0	0.525	2.1(min)
RTC_EINT	2.725	3.6	0	0.905	3.6(max)
IO	**Voh(min).**	**Voh(max).**	**Vol(min).**	**Vol(max).**	**VBAT**
RTC_GPIO0	1.785	-	-	0.315	2.1(min)
RTC_GPIO0	3.085	-	-	0.545	3.6(max)

5.3.5 Extended Mode DRX (e-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.

5.4 Current Consumption

Table 27：Current consumption on VBAT Pins (VBAT=3.3V)

Sleep/Idle Mode	
LTE supply current (without USB connection)	Sleep mode Typical:TBD （AT+CFUN=0） Idle mode Typical:6.1mA
Power Saving Mode	
PSM supply current	PSM mode Typical:4uA
eDRX	
eDRX mode supply current （Tested in sleep mode）	@PTW=40.96s, eDRX=81.92s, DRX=2.56s Typical： TBD

5.5 ESD Notes

SIM7060R is sensitive to ESD in the process of storage, transporting, and assembling. When SIM7060R 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, switches, keys, etc. The following table shows the SIM7060R ESD measurement performance without any external ESD component.

Table 28: The ESD performance measurement table

Part	Contact discharge(kV)	Air discharge(kV)
GND（Shield）	TBD	TBD
GND （RF）	TBD	TBD
VBAT	TBD	TBD
Antenna port	TBD	TBD

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

6 SMT Production Guide

6.1 Top and Bottom View of SIM7060R

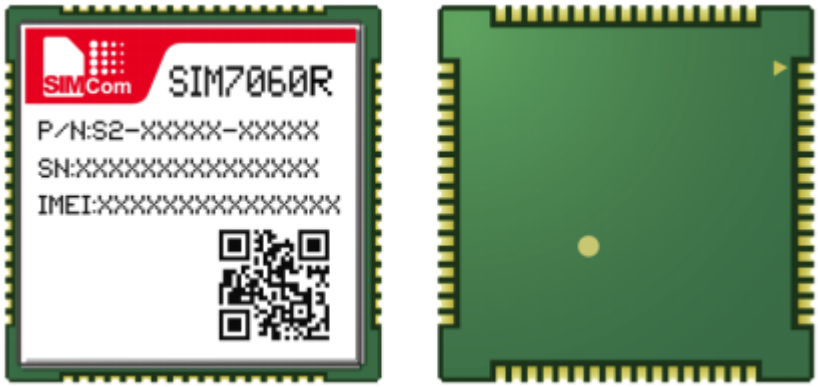

Figure 25: Top and bottom view of SIM7060R

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.

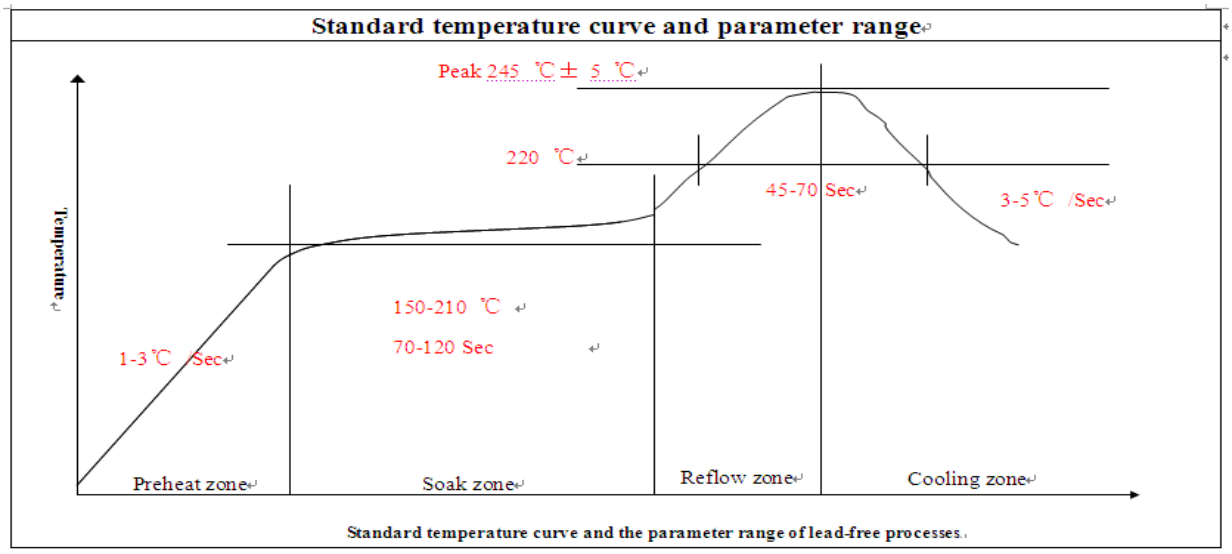

Figure 26: The ramp-soak-spike reflow profile of SIM7060R

6.3 Moisture Sensitivity Level (MSL)

SIM7060R is qualified to Moisture Sensitivity Level (MSL) **3** 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 29：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.

6.4 Baking Requirements

SIM7060R 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 30：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.

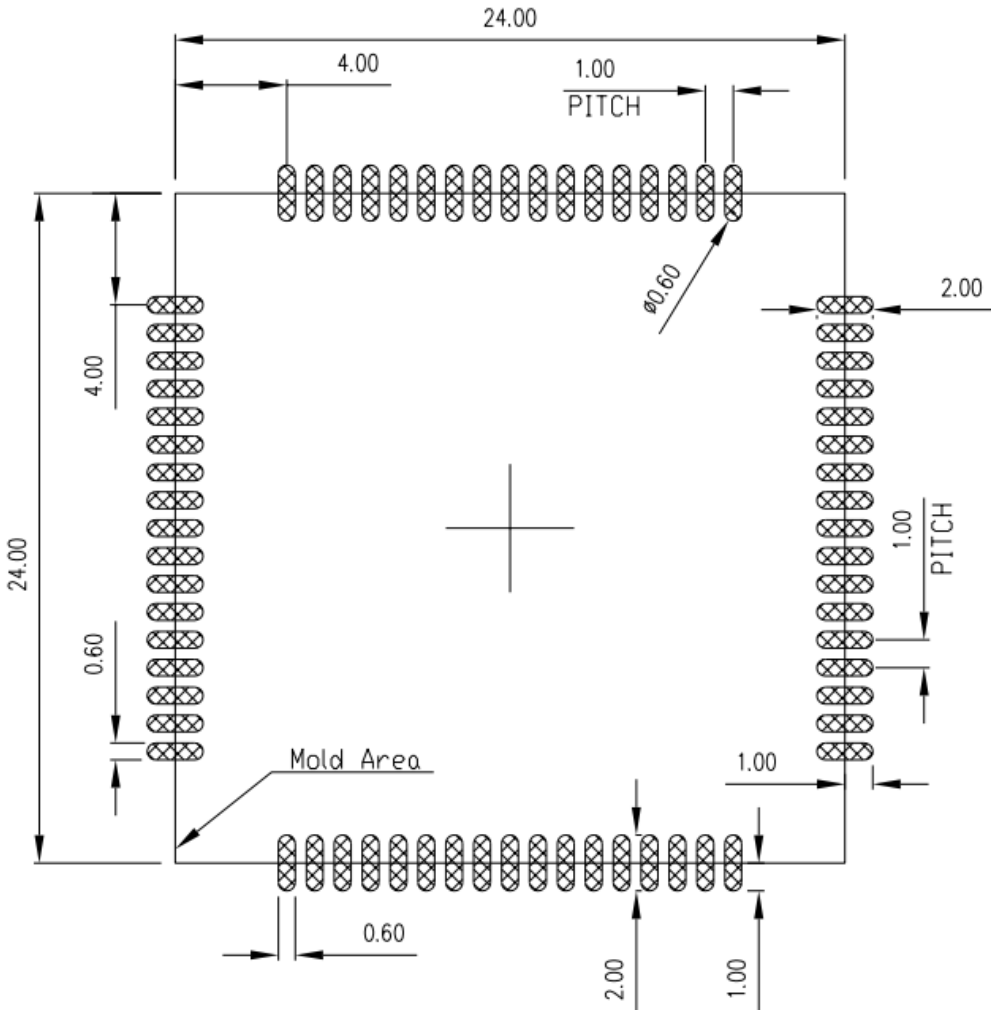

Figure 26：Recommended SMT stencil footprint outline

7 Packaging

SIM7060R module support tray packaging (default packaging).

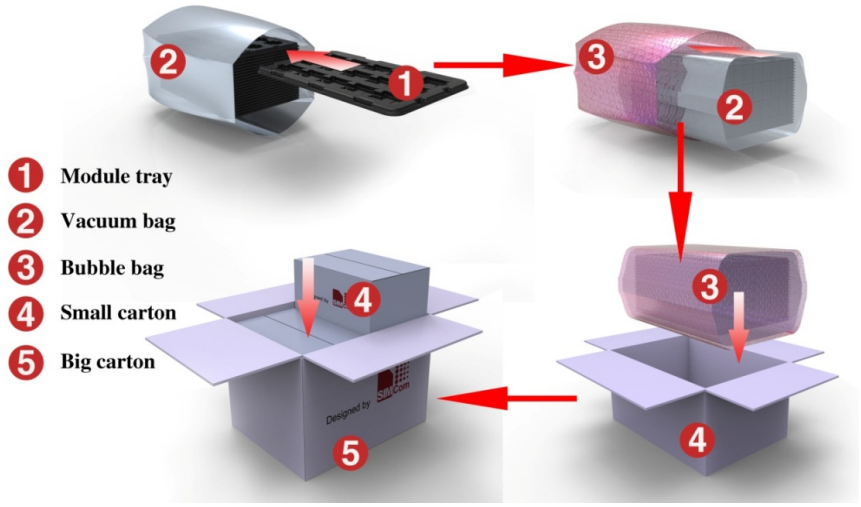

Figure 27：packaging diagram

Module tray drawing:

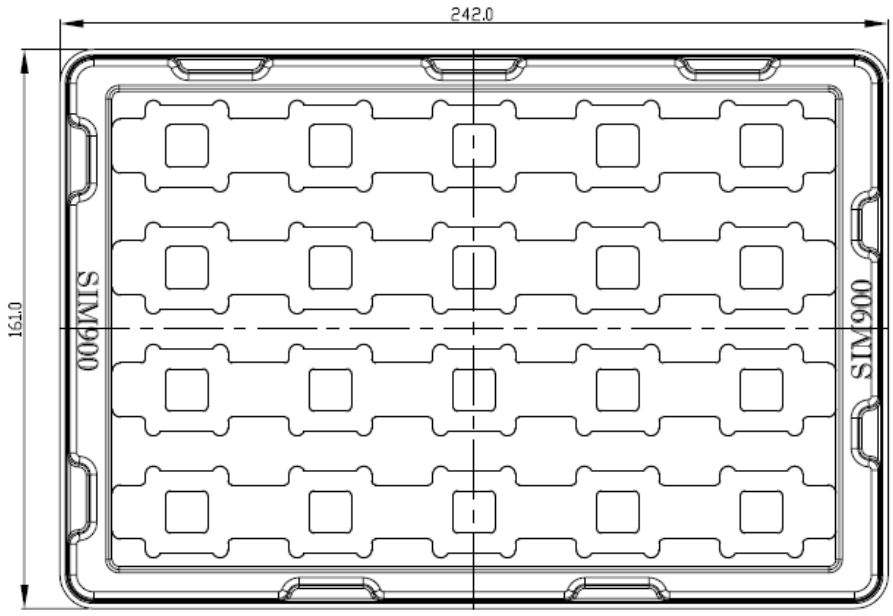

Figure 28: Tray drawing

Figure 31: Tray size

Length（±3mm）	Width（±3mm）	Module number
242. 0	161. 0	20

Small carton drawing:

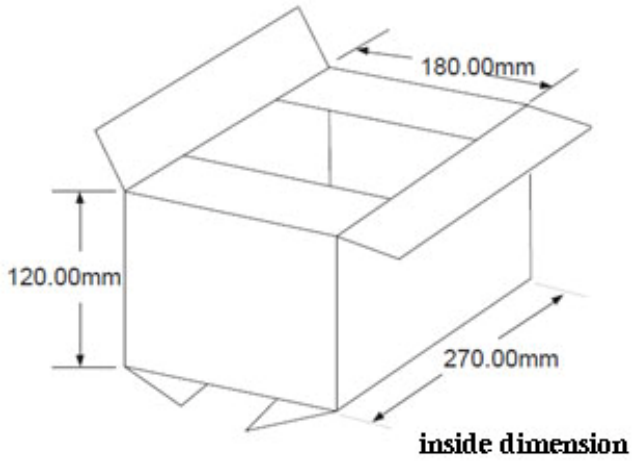

Figure 29: Small carton drawing

Table 32：Small Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Module number
270	180	120	20*20=400

Big carton drawing：

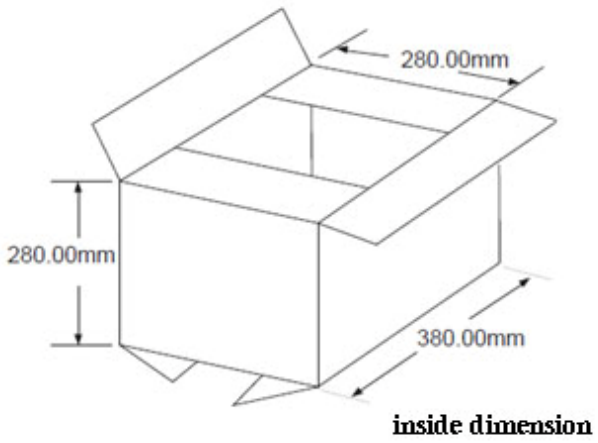

Figure 30：Big carton drawing

Table 33：Big Carton size

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

8 Appendix

I. Related Documents

Table 34：Related Documents

NO.	Title	Description
[1]	SIM7020 Series_AT Command Manual_V1.xx	AT Command Manual
[2]	ITU-T Draft new recommendationV.25ter	Serial asynchronous automatic dialing and control
[3]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[4]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[5]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[6]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[7]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[8]	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
[9]	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
[10]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[11]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[12]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[13]	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)
[14]	Module secondary-SMT-UGD-V1.xx	Module secondary SMT Guidelines
[15]	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
[16]	SIM868_NMEA Message Specification_V1.xx	
[17]	SIM7060 Series_GNSS_Application Note_V1.02	

II. Terms and Abbreviations

Table 35：Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
IMEI	International Mobile Equipment Identity
Li-ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
PAP	Password Authentication Protocol
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
RX	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter

URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
PSM	Power saving mode
BD	BeiDou

III. Safety Caution

Table 36: 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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