A7677S Series Hardware Design

LTE Module

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Version History

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2023-09-12	1.00	Initial	Qiu Lei

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1 Introduction

This document describes the hardware interface of the module, which can help customers quickly understand the interface definition, electrical performance and structure size of the module. With this document and other application documents, customers can understand and use A7677S module to quickly design and develop applications.

SIMCom provides a set of evaluation boards to facilitate module testing and use. The evaluation board tools include an EVB board, a USB cable, an antenna, and other peripherals.

1.1 Document Overview

Table 1 mainly contains the technical information of the module. All documents in the table below must be studied to understand the device and applications fully.

Table 1: Overview of the A7677S documentation

No.	File Name	Description
1	A7677S Series Hardware Design_V1.00 (This document)	It mainly introduces hardware components such as interface functions, recommended circuits, PCB layout guides, packaging, and the use of some AT commands
2	SIMCom_A7670C R3&R5 Series_Reference_Design_20230809	Module reference circuit design
3	8BG000-A7670C-TE_V3.01_SCH&PCB	TE schematic and PCB information
4	SIMCOM EVB Kit User Guide	EVB kit user guide
5	MOD_A7670C_R3_130(230220)	Module reference package
6	A1602 & 1606 Series_AT Command Manual	AT command manual
7	Module Secondary SMT Process User Guide_V1.02	This paper mainly introduces the SMT process of module production, the requirements of steel mesh production, reflow welding, welding and repair.

※ NOTE

The document version in Table 1 may be an earlier version, and the content may change at any time, please contact SIMCom FAE for the latest version.

1.2 Product Outline

The module is designed for the global market and supports LTE-TDD and LTE-FDD, and customers can choose the module according to the radio network configuration. The supported radio frequency bands are shown in Table 2 below.

Table 2: Module frequency bands

Network	BAND	A7677S Series			
		LANS	LANV	MANS	MANV
LTE-FDD	LTE-FDD B1	✓	✓	✓	✓
	LTE-FDD B3	✓	✓	✓	✓
	LTE-FDD B5	✓	✓	✓	✓
	LTE-FDD B8	✓	✓	✓	✓
LTE-TDD	LTE TDD B34	✓	✓	✓	✓
	LTE TDD B38	✓	✓	✓	✓
	LTE TDD B39	✓	✓	✓	✓
	LTE TDD B40	✓	✓	✓	✓
	LTE TDD B41	✓	✓	✓	✓
Category		CAT1	CAT1	CAT1	CAT1

Table 3: Module functional differences

Function	A7677S Series			
	LANS	LANV	MANS	MANV
USIM	✓	✓	✓	✓
GNSS			✓	✓
MMC	✓	✓	✓	✓
VoLTE	✓	✓	✓	✓
SMS	✓	✓	✓	✓
Analog audio input	✓	✓	✓	✓
Analog audio output	✓	✓	✓	✓
Wi-Fi Scan	✓	✓	✓	✓
FOTA	✓	✓	✓	✓

※ NOTE

The functions supported by the module depend on the actual hardware model and software version.

The size of the module is only 24*24* 2.4mm, which can almost meet the space size requirements of all M2M applications, such as metering, security, routing, wireless POS, mobile computing devices, PDA, tablet computers, etc.

A7677S - LANS/LANV/ MANS/MANV module, a total of 130 pins, includes 80 LCC pins and 50 LGA pins.

1.3 Hardware Interface Overview

The module provides the following hardware interfaces:

- Power Supply * 2(One main power supply, one GNSS backup power supply (Only modules that support GNSS functions are required))
- USB 2.0 Interface * 1
- Three UART ports, one full-function serial port, one DEBUG serial port, and one two-line serial port
- USIM interfaces (LANS/LANV supports the USIM2 dual-card interface)
- Multiple programmable general input and output interfaces (GPIO)
- Two general ADC interfaces
- Built-in VBAT ADC interface
- 4*4 matrix keyboard interface
- Analog audio MIC input interface
- Analog audio SPK output interface
- SPI Interface * 1
- Three LDO power output
- I2C Interface * 1
- USB_BOOT download boot interface * 1
- MMC interfaces * 1
- Network status indication interface
- Indicator interface for module operating status
- Two antenna interfaces (GNSS optional)

1.4 Hardware Block Diagram

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

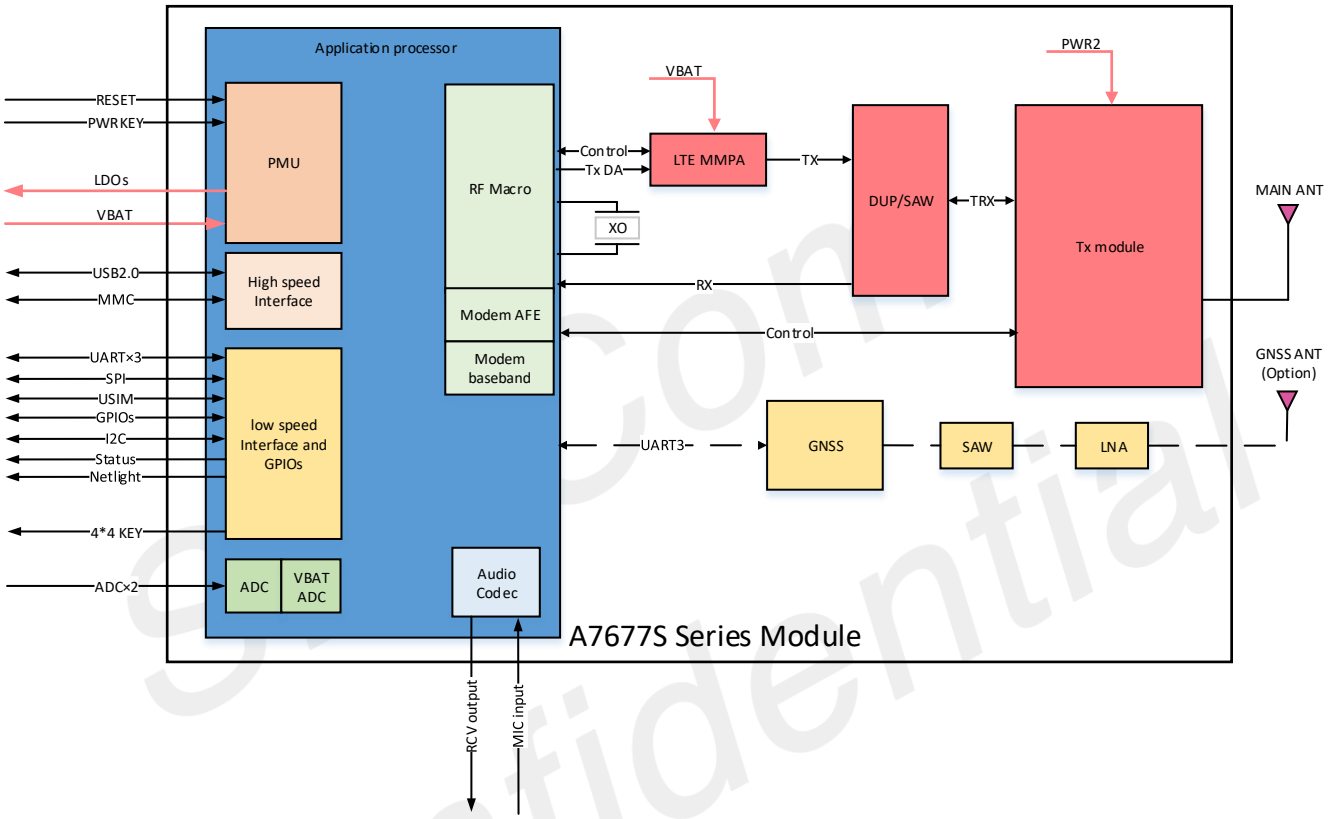

Figure 1: A7677S block diagram

1.5 Functional Overview

Table 4: General features

Feature	Description
Power supply	VBAT: 3.4V ~4.2V, Recommended VBAT: 3.8V
Power saving	Currently in sleep mode, typical value<2mA(VBAT=3.8V)
Radio frequency	Please refer to the Table 2

bands	
Transmitting power	LTE power level: 3 (23dBm±2.7dB)
Data Transmission Throughput	TDD/FDD-LTE category 1: 10 Mbps (DL),5 Mbps (UL)
Antenna	LTE antenna interface GNSS antenna interface(optional)
SMS	MT, MO, CB, Text and PDU mode Short Message (SMS)storage device: USIM Card, CB does not support saving in SIM Card Support CS domain and PS domain SMS
USIM interface	Support identity card: 1.8V/ 3V(LANS and LANV support dual SIM interface)
USIM application toolkit	Support SAT class 3, GSM 11.14 Release 99 Support USAT
MMC interface	Support SD3.0 and MMC/eMMC 4.5.1
Phonebook management	SM/FD/ON/AP/SDN
Audio interface	●Support one analog audio input interface ●Support one analog audio output interface
UART interface	●Full function serial port Baud rate support from 300bps to 3686400bps AT command and data can be sent through the serial port Support RTS/CTS Hardware flow control Support serial port multiplexing function conforming to GSM 07.10 protocol ●Debug serial port Support debug function ●UART3 serial port Ordinary two-wire serial port
I2C interface	●1 channel I2C interface ●Comply with I2C bus protocol specifications ●Multi-host mode is not supported
USB	It complies with USB 2.0 specifications and supports slave mode, and host mode unsupported. This interface can be used for AT command sending, data transmission, software debugging and upgrading.
Firmware upgrade	FOTA upgrade and firmware upgrade via USB port
Physical characteristics	Size:24*24*2.4m Weight:2.8±0.1g
Network protocols	●CMUX/PPP/MQTT/FTP/TCP/UDP/FTPS/MQTTS/HTTP/HTTPS/HTP/NTP/PING/SSL/FILE

	●PAP and CHAP certification following the PPP protocol. *The actual supported network protocol is subject to the software version
Temperature range	Normal operation temperature: -30°C to +75°C Extended operation temperature [2]: -40°C to +85°C* Storage temperature -40°C to +90°C

※ NOTE

1. When operating in the normal operating temperature range, the relevant performance of the module meets the requirements of 3GPP standard.
2. When the operating temperature range is extended, the module can still maintain the normal working state, with voice, short message, data transmission, emergency calls and other functions. There will be no unrecoverable failure. The radio frequency spectrum and network are unaffected. Only the values of individual indicators, such as output power, may be outside the range of the 3GPP standard. When the temperature returns to the normal operating temperature range, the indicators of the module still meet the 3GPP standard.

2 Package Information

2.1 Pin Assignment Overview

The detailed pin distribution is as follows:

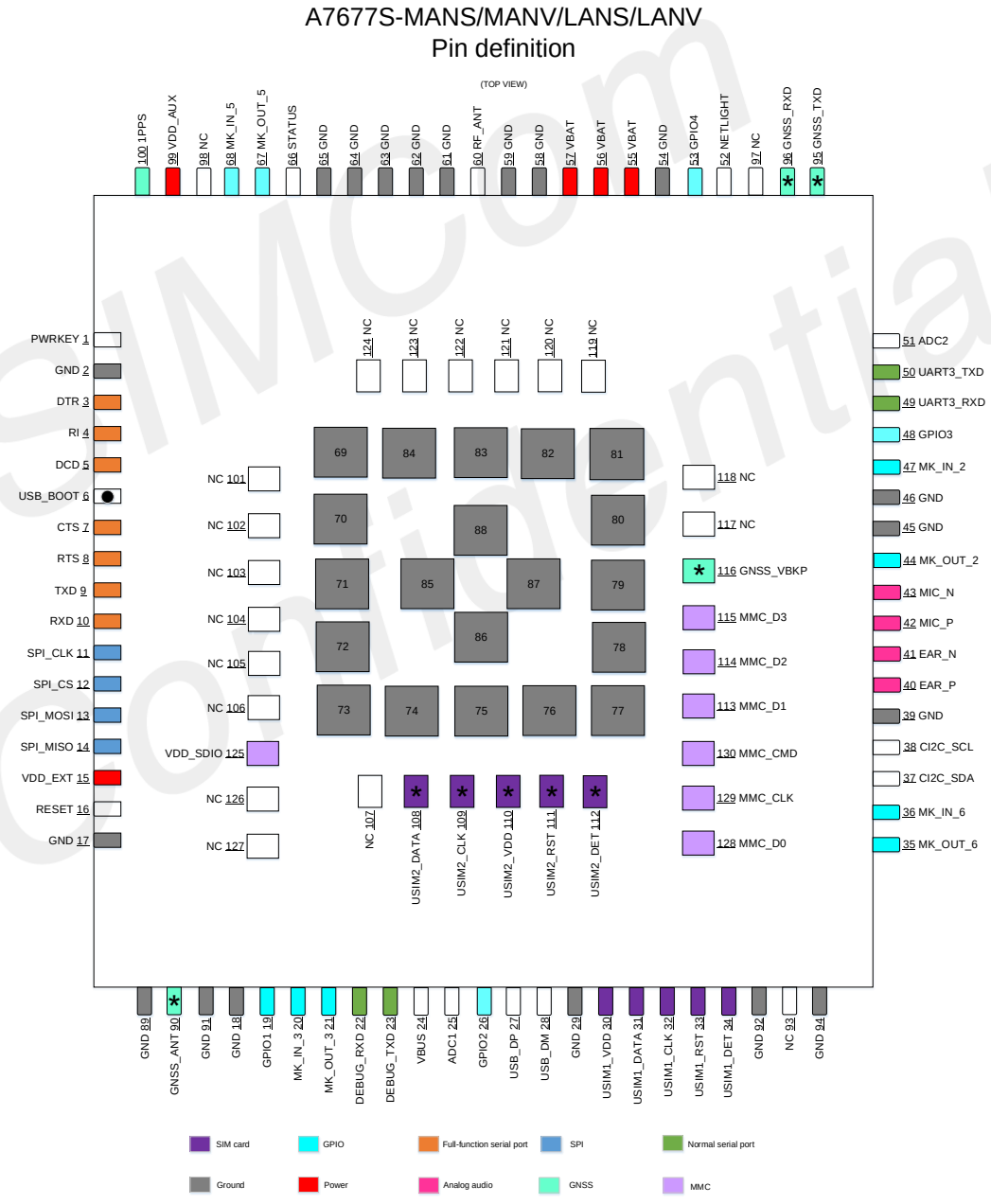

Figure 2: A7677S-MANS/MANV/LANS/LANV Standard Module Pin assignment (top view)

※ NOTE

1. '●' indicates that these Pins cannot be pulled down before the module is powered. Otherwise, it will affect the normal startup of the module;
2. '*' indicates the optional function, which only some models support.

Table 5: Pin Description

Pin No	Pin Name	Pin No	Pin Name
1	PWRKEY	2	GND
3	DTR	4	RI
5	DCD	6	USB_BOOT
7	CTS	8	RTS
9	TXD	10	RXD
11	SPI_CLK	12	SPI_CS
13	SPI_MOSI	14	SPI_MISO
15	VDD_EXT	16	RESET
17	GND	18	GND
19	GPIO_01	20	MK_IN_3
21	MK_OUT_3	22	DEBUG_RXD
23	DEBUG_TXD	24	VBUS
25	ADC1	26	GPIO_02
27	USB_DP	28	USB_DM
29	GND	30	USIM1_VDD
31	USIM1_DATA	32	USIM1_CLK
33	USIM1_RST	34	USIM1_DET
35	MK_OUT_6	36	MK_IN_6
37	CI2C_SDA	38	CI2C_SCL
39	GND	40	EAR_P
41	EAR_N	42	MIC_P
43	MIC_N	44	MK_OUT_2
45	GND	46	GND
47	MK_IN_2	48	GPIO_03
49	UART3_RXD	50	UART3_TXD
51	ADC2	52	NETLIGHT
53	GPIO_04	54	GND
55	VBAT	56	VBAT
57	VBAT	58	GND
59	GND	60	RF_ANT

61	GND	62	GND
63	GND	64	GND
65	GND	66	STATUS
67	MK_OUT_5	68	MK_IN_5
69	GND	70	GND
71	GND	72	GND
73	GND	74	GND
75	GND	76	GND
77	GND	78	GND
79	GND	80	GND
81	GND	82	GND
83	GND	84	GND
85	GND	86	GND
87	GND	88	GND
89	GND	90	GNSS_ANT
91	GND	92	GND
93	NC	94	GND
95	GNSS_TXD	96	GNSS_RXD
97	NC	98	NC
99	VDD_AUX	100	1PPS
101	NC	102	NC
103	NC	104	NC
105	NC	106	NC
107	NC	108	USIM2_DATA
109	USIM2_CLK	110	USIM2_VDD
111	USIM2_RST	112	USIM2_DET
113	MMC_D1	114	MMC_D2
115	MMC_D3	116	GNSS_VBKP
117	NC	118	NC
119	NC	120	NC
121	NC	122	NC
123	NC	124	NC
125	VDD_SDIO	126	NC
127	NC	128	MMC_D0
129	MMC_CLK	130	MMC_CMD

※ NOTE

1. Do not pull down the USB_BOOT pin before starting the module. Otherwise, the module will not start up properly.
2. Only MANS and MANV models support the GNSS interface, and these part of pins of other models is NC suspended.
3. Only LANS and LANV models support USIM2.

2.2 Pin Description

Table 6: Pin parameter abbreviation

Pin Type	Description
PI	Power input
PO	Power output
AIO	Analog signal input or output
AI	Analog input
AO	Analog output
DIO	Digital signal input or 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
OD	Open drain

Table 7: 1.8V IO electrical characteristics

Power Domain	Parameter	Description	Min.	Typ.	Max.
1.8V	DC input condition (VCC=1.8V)				
	V_{IH}	High-level input	VCC * 0.7	1.8V	VCC+0.2
	V_{IL}	Low-level input	-0.3V	0V	VCC *0.3
	R_{pu}	Pull up resistor	55K	79 K	121K
	R_{pd}	Pull down resistor	51K	87 K	169K
	Dc input condition (VCC=1.8V Typical)				
	I_{IL}	Input leakage	-	-	10uA

		current			
	Dc input condition (VCC=1.8V Typical)				
	V_{OH}	Output high range	VCC-0.2	-	-
	V_{OL}	Output low range	-	-	0.2V
	I_{OL}	Maximum current driving capacity at low level output Vpad=0.2V I_{OL} DCS[1:0]=			
		00		13 mA	
		01		25 mA	
		10		37 mA	
		11		49 mA	
	I_{OH}	Maximum current driving capacity at high level output Vpad=VCC-0.2V I_{OH} DCS[1:0]=			
		00		11 mA	
		01		21 mA	
		10		32 mA	
		11		42 mA	

Table 8: 3.0V IO electrical characteristics

Power Domain	Parameter	Description	Min.	Typ.	Max.
3.0V	V_{IH}	High level input	2V	-	VCC+0.3
	V_{IL}	Low level input	-0.3V	0V	0.8V
	R_{pu}	Pull up resistor	26K	47K	72K
	R_{pd}	Pull down resistor	27K	54K	267K
	I_{IL}	Input leakage current	-	-	10uA
	V_{OH}	Output level range	2.4V	-	-
	V_{OL}	Output low range	-	-	0.4V
	I_{OL}	Maximum current driving capacity at low level output Vpad=0.4V I_{OL} DS[2:0]=			
		000		7 mA	
		001		10 mA	

		010 011 100 101 110 111	14 mA 18 mA 21 mA 24 mA 28 mA 31 mA
	I_{OH}	Maximum current driving capacity at high level output Vpad=VCC-0.5V I_{OH} DS[2:0]= 000 001 010 011 100 101 110 111	 7 mA 10 mA 13 mA 16 mA 19 mA 23 mA 26 mA 29 mA

Table 9: Pin description

Pin Name	Pin No	Pin Parameter		Description	Note
		Power Domain	Type		
Power Supply					
VBAT	55,56,57	-	PI	Module power input	The input voltage ranges from 3.4V to 4.2V, and the external power supply must provide 700mA current carrying capacity.
VDD_EXT	15	-	PO	$V_{(nom)}$=1.8V $I_{o(max)}$=50mA	
VDD_AUX	99	-	PO	$V_{(nom)}$=3.0V $I_{o(max)}$=50mA	
GND	2,17,18,29,39,45,46,54, 58,59,61~65,69~89,91, 92,94	-	-	Ground	
System Control					
PWRKEY	1	-	DI,PU	Power ON/OFF input, active low. Power button defaults high	PMU has been internally pulled up to the VBAT with 50K

				V_{IH}: 0.7*VBAT V_{IL}: 0.3*VBAT $V_{(nom)}$=VBAT	(Typical).
RESET	16	-	DI,PU	System reset control input, active low. VIH: 0.7*VBAT VIL: 0.3*VBAT $V_{(nom)}$=VBAT	PMU has been internally pulled up to the VBAT with 50K (Typical).
USIM Interface					
USIM1_DATA	31	1.8/3.0V	DIO,PU	USIM1 data signal	Internal 4.7KΩ resistor pull up to USIM1_VDD
USIM1_RST	33	1.8/3.0V	DO,PU	USIM1 reset signal.	
USIM1_CLK	32	1.8/3.0V	DO,PU	USIM1 clock signal.	
USIM1_VDD	30	1.8/3.0V	PO	Power supply for USIM1	The module automatically recognizes 1.8V or 3.0V USIM cards.
USIM1_DET	34	1.8V	DI	USIM1 card detect signal, it can be set to high/low active with the AT command, refer to Document [18].	If unused, keep open
USIM2_DATA	108	1.8/3.0V	DIO,PU	USIM2 data signal	Internal 4.7KΩ resistor pull up to USIM2_VDD.
USIM2_RST	111	1.8/ 3.0V	DO,PU	USIM2 reset signal.	
USIM2_CLK	109	1.8/ 3.0V	DO,PU	USIM2 clock signal.	
USIM2_VDD	110	1.8/ 3.0V	PO	Power supply for USIM2	The module automatically recognizes 1.8V or 3.0V USIM cards.
USIM2_DET	112	1.8V	DI	USIM2 insert detect, it can be set to high/low active with the AT command, refer to Document [18].	If unused, keep open
USB Interface					
VBUS	24	-	PI	Valid USB detection input. Active high.	The minimum recognised voltage is 3.0V and the maximum is 5.2V.

USB_DM	28	-	AIO	USB bus differential negative terminal	90Ω differential impedance, if not in use, can be suspended
USB_DP	27	-	AIO	USB bus differential positive terminal	
Full Function UART Interface					
RTS	8	1.8V	DI	DTE request sent	RTS connected to DTE, suspended when not in use.
CTS	7	1.8V	DO	DTE clears sending	The CTS connected to DTE is suspended when not in use.
RXD	10	1.8V	DI	Data input	If unused, keep open
TXD	9	1.8V	DO	Data output	
RI	4	1.8V	DO	Ringing indicator	
DCD	5	1.8V	DO	Carrier detection	
DTR	3	1.8V	DI	DTE Ready	
Debug UART					
DEBUG_TXD	23	1.8V	DO	UART output	Default used as debug port.
DEBUG_RXD	22	1.8V	DI	UART input	
Serial Port UART3					
UART3_TXD	50	1.8V	DO	UART3 output	Default connected to the GNSS serial port. If unused, keep it open.
UART3_RXD	49	1.8V	DI	UART3 input	
I2C Interface					
CI2C_SCL	38	1.8V	OD	I2C clock output	If unused, keep it open. External VDD_EXT power supply (pin 15 of the module) is used for pull-up.
CI2C_SDA	37	1.8V	OD	I2C data input/output	
Analog Audio Interface					
EAR_P	40	-	AO	Audio receiver output positive	Can be used for handset interface.
EAR_N	41	-	AO	Audio receiver output negative	
MIC_P	42	-	AI	MIC input positive	
MIC_N	43	-	AI	MIC input negative	

MMC Interface					
MMC_DAT3	115	1.8/3.0V	DIO	MMC and SD data 3	
MMC_DAT2	114	1.8/3.0V	DIO	MMC and SD data 2	
MMC_DAT1	113	1.8/3.0V	DIO	MMC and SD data 1	
MMC_DAT0	128	1.8/3.0V	DIO	MMC and SD data 0	
MMC_CLK	129	1.8/3.0V	DO	MMC and SD clock	
MMC_CMD	130	1.8/3.0V	DIO	MMC and SD commands	
VDD_SDIO	125	1.8/3.0V	PO	DATA cable Digital pull-up power supply	
SPI Interface					
SPI_CLK	11	1.8V	DO	SPI clock	If unused, keep it open.
SPI_CS	12	1.8V	DO	SPI chip selection	
SPI_MOSI	13	1.8V	DO	SPI Main output slave input	
SPI_MISO	14	1.8V	DI	SPI Main input slave output	
GPIO					
GPIO_01	19	1.8V	DIO,PU	General purple I/O	If unused, keep it open.
GPIO_02	26	1.8V	DIO,PD	General purple I/O	If unused, keep it open.
GPIO_03	48	1.8V	DIO,PU	General purple I/O	If unused, keep it open.
GPIO_04	53	1.8V	DIO,PU	General purple I/O	If unused, keep it open.
GNSS Interface					
GNSS_VBKP	116	-	PI	GNSS standby power input, input voltage 1.4V~3.6V	It must be connected.
1PPS	100	1.8V	DO	1PPS pulse signal output	If unused, keep it open.
GNSS_RXD	96	1.8V	DI	GNSS UART RX	Use 1K resistors in series in module UART3_TX (pin 50).
GNSS_TXD	95	1.8V	DO	GNSS UART TX	Use 1K resistors in series in module UART3_RX (pin 49).

ANT Interface					
RF_ANT	60	-	AIO	Main antenna	
GNSS_ANT	90	-	AIO	GNSS antenna	
Keyboard Interface					
MK_IN_2	47	1.8V	DI	Keyboard input	If unused, keep it open.
MK_IN_3	20	1.8V	DI	Keyboard input	
MK_IN_5	68	1.8V	DI	Keyboard input	
MK_IN_6	36	1.8V	DI	Keyboard input	
MK_OUT_2	44	1.8V	DO	Keyboard output	
MK_OUT_3	21	1.8V	DO	Keyboard output	
MK_OUT_5	67	1.8V	DO	Keyboard output	
MK_OUT_6	35	1.8V	DO	Keyboard output	
Other Pins					
ADC1	25	-	AI	Universal analog-to-digital converter channel 1	Voltage input range 0 ~ 1.2 V.
ADC2	51	-	AI	Universal analog-to-digital converter channel 2	
NETLIGHT	52	1.8V	DO	Network registration status indicator.	If unused, keep it open.
STATUS	66	1.8V	DO	Module status indication High: Power on Low: Power off	If unused, keep it open.
USB_BOOT●	6	1.8V	DI	Force the download interface. Connect to GND and then power on the module. The module will enter the USB download mode.	It is recommended to place a test point for easy debugging and upgrade. Do not pull down before normal boot.
NC	93,97,98,101~107,117~124,126,127				Keep NC floating

※ NOTE

1. Please reserve a test point for USB_BOOT, VDD_EXT and DEBUG_TXD. If there is no USB connector, please also reserve a test point for USB_VBUS, USB_DP, and USB_DM for firmware upgrade.
2. '●' Indicates that these Pins cannot be pulled down before the module powered on, otherwise it will affect the normal startup of the module.

2.3 Mechanical Information

The following picture depicts the package dimensions of the A7677S module.

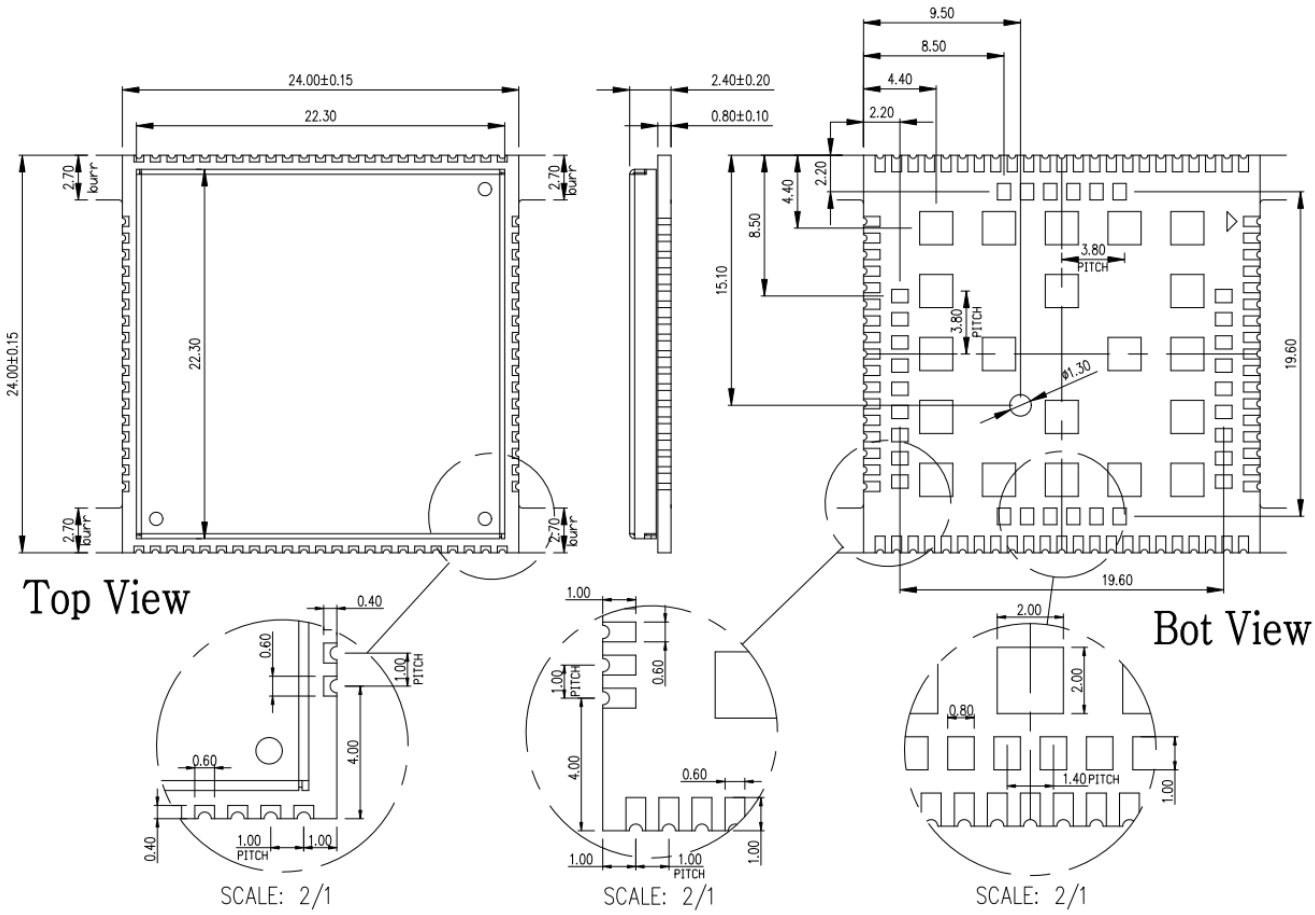

Figure 3: A7677S-MANS/MANV/LANS/LANV 3D dimensions (Unit: mm)

※ NOTE

1. The side length dimension is 24.00±0.15mm excluding the burr area.

2.4 Footprint Recommendation

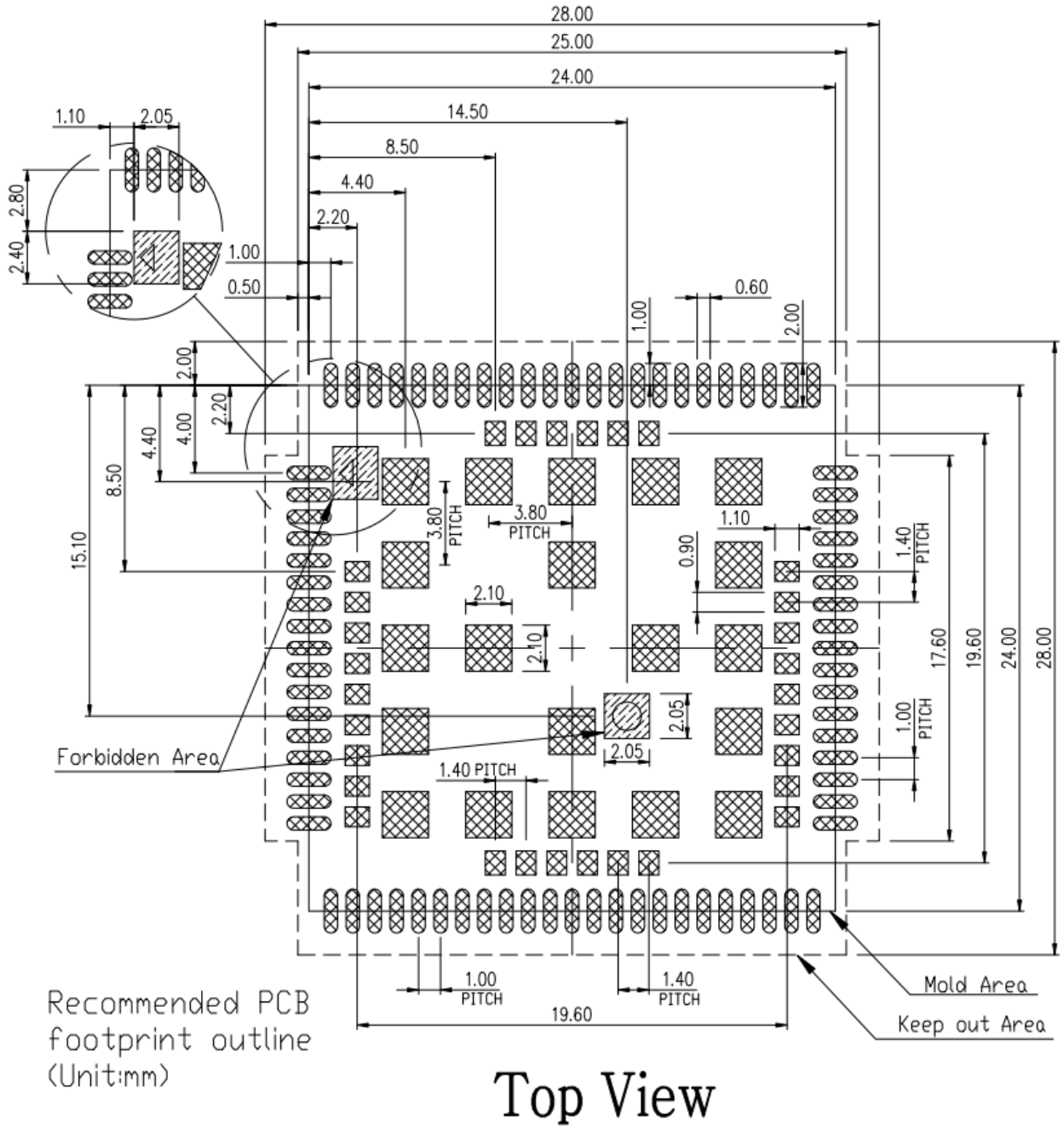

Figure 4: A7677S-MANS/MANV/LANS/LANV Footprint Recommendation (Unit: mm)

2.5 Recommend Stencil Size

Recommend stencil thickness≥0.12mm and <0.15mm.

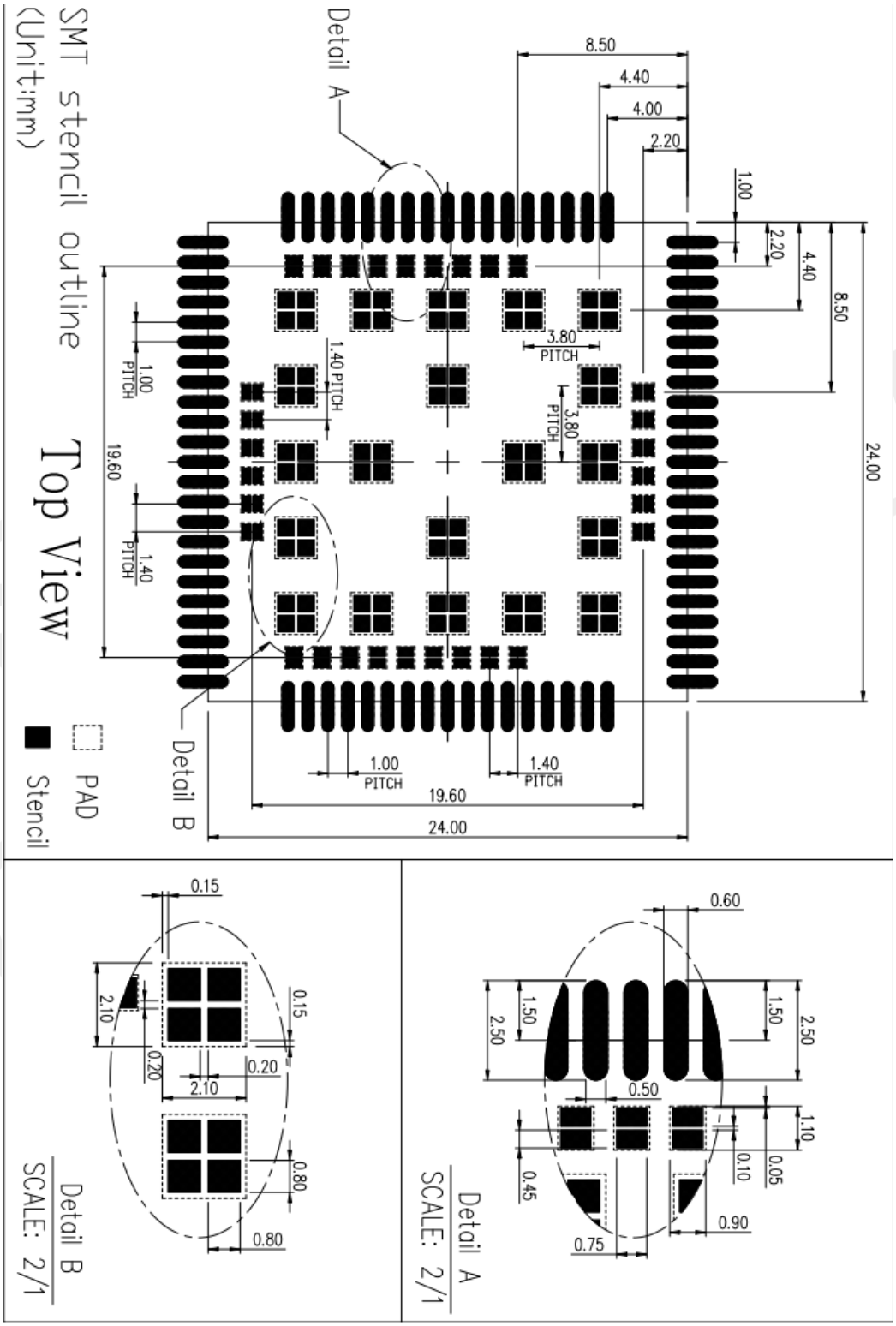

Figure 5: A7677S-MANS/MANV/LANS/LANV recommend stencil dimension (Unit: mm)

3 Interface Application

3.1 Power Supply

A7677S module is powered by a single power supply with three pins (55,56,57) as the VBAT power input.A7677S use these three pins to supply the internal RF and base-band circuit.

When the module is transmitted at maximum power in LTE mode, the peak current can reach as high as 700mA instantaneously, resulting in a large voltage sag on the VBAT. To ensure that the voltage sag is less than 300mV, ensure that the external power supply capacity is no less than 700mA.

Table 10: VBAT interface definition

Pin Name	Pin No	I/O	Description	Note
VBAT	55,56,57	PI	Module power input	The input voltage ranges from 3.4V to 4.2V, and the external power supply must provide 700mA current carrying capacity.
GND	2,17,18,29,39,45,46,54,58,59,61~65,69~89,91,92,94			

Table 11: VBAT pins electronic characteristic

Parameter	Description	Min.	Typ.	Max.	Unit
V_{BAT}	Module supply voltage	3.4	3.8	4.2	V
$I_{VBAT(peak)}$	Module consumption peak current	-	-	700	mA
$I_{VBAT(average)}$	Module average consumption current (normal mode)	-	17	-	mA
$I_{VBAT(sleep)}$	Module average consumption current (sleep mode)	-	2	-	mA
$I_{VBAT(power-off)}$	Module average consumption current (off leakage current)	-	18	-	uA

※ NOTE

1. Test condition: V_{BAT} power supply 3.8V, the module is tested on SIMCom EVB board, and the power input has a 200μF tantalum capacitor.
2. I_{VBAT} data in the preceding table is the overall data consumption of the module.

3.1.1 Power Supply Design Guide

In the customer's design, special attention must be paid to the design of the power supply. If the voltage drops below 3.4V, the RF performance of the module will be affected, the module will shut down if the voltage is too low. Selecting an LDO or DC-DC chip with an enable pin and having the MCU control the enable pin is recommended.

※ NOTE

When the power supply can provide a continuous current of 700mA, the total capacity of the external power supply capacitor is recommended to be no less than 200uF to ensure that the voltage on the VBAT falls not less than 3.4V.

It is recommended to place four 10PF/33NF/0.1UF/1UF ceramic capacitors near VBAT to improve RF performance and system stability. At the same time, it is recommended that the VBAT layout routing width from the power supply on the PCB to the module be at least 3mm. Reference design recommendations are as follows:

If the VBAT input contains high-frequency interference, adding magnetic beads for filtering is recommended. The recommended types of magnetic beads are BLM21PG300SN1D and MPZ2012S221A.

The reference design is shown below:

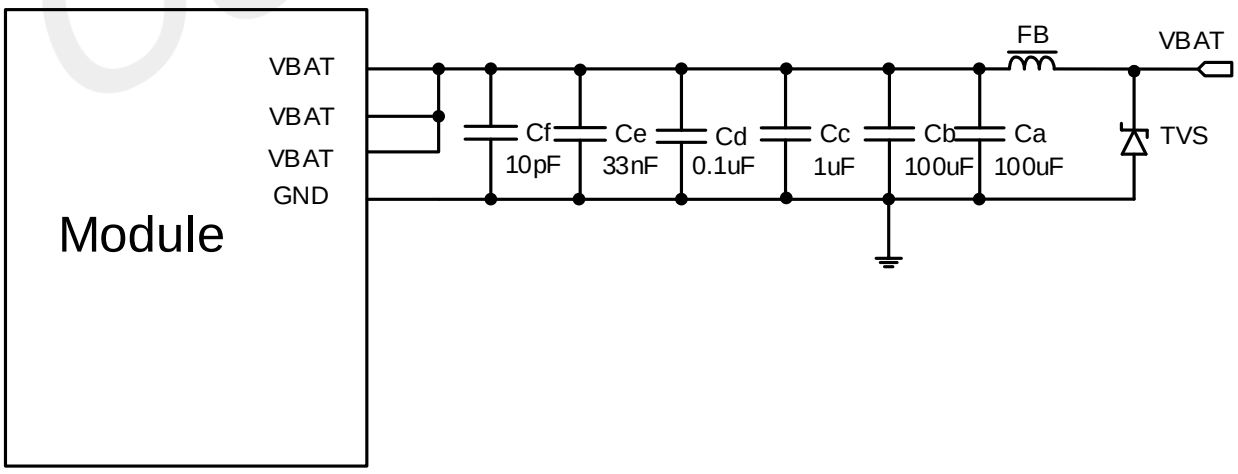

Figure 6: VBAT input reference circuit

In addition, in order to prevent damage to A7677S caused by surge and overvoltage, it is recommended to parallel one TVS on the VBAT pin of the module.

Table 12: List of recommended TVS for VBAT

No.	Manufacturer	Part Number	V_{RWM}	V_C(max)	P_{pp}(max)	C_J(max)	Package
1	WILL	ESD56301D05	5V	9.5V	1500W	700pF	DFN1610-2L
2	WILL	ESD56301D04-2/TR	4.85V	11V	2000W	480pF	DFN1610-2L
3	WAYON	WS2057KP	5V	12V	2040W	700pF	DFN1610-2L
4	WAYON	WS4.5DPHXM	4.85V	11V	2255W	700pF	DFN1610-2L

※ NOTE

When selecting a TVS for the customer, paying attention to the clamping voltage in the case of surge protection is necessary. The clamping voltage should not be higher than 10V when 100V surge input.

3.1.2 Recommended External Power Supply Circuit

In terms of design, MCU must have the function of powering off the module, but it is forbidden to power off the module in the normal use process. Only after the module is normally shut down or cannot be normally shut down or restarted due to abnormalities can the module be powered off. LDO or DC-DC chip with an enabling foot is recommended. When the input power is greater than 9V, it is recommended to use a DCDC chip. When the input is less than 9V, use the LDO power supply. If you use the module's OPEN LINUX secondary development feature, it's possible to add a low-cost MCU to control the startup and power-down of the POWERKEY pin via the watchdog function.

It is recommended that a switching mode power supply is used. The following figure shows the DC-DC regulator reference circuit:

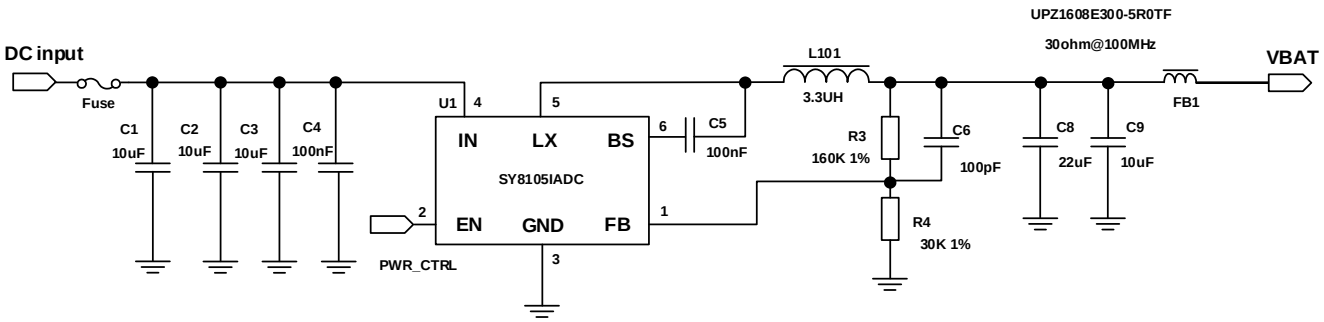

Figure 7: power supply reference circuit

When the VBAT power supply is disconnected, the voltage should drop rapidly within 50ms. To avoid abnormal voltage, when the VBAT is lower than the minimum value, the system must power on the VBAT to lower than 100mV for at least 2 seconds to restart the system.

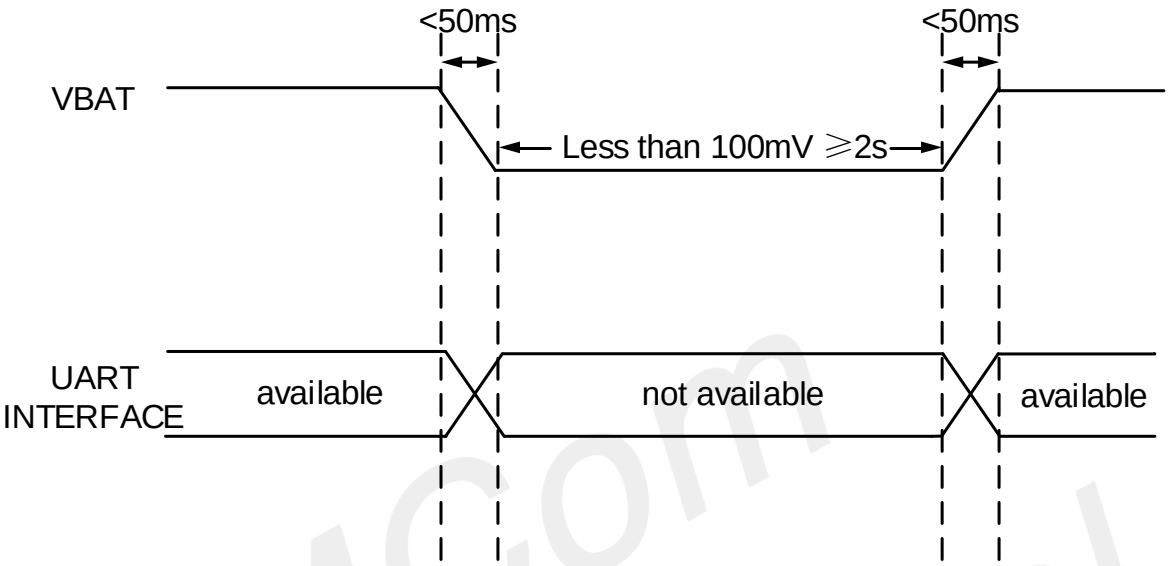

Figure 8: Power-off and power-on restart timing

3.1.3 Voltage Monitor

AT command ‘AT+CBC’ can be used to monitor VBAT voltage.

AT command ‘AT+CVALARM’ can be used to set high/low voltage alarms. A warning message will be reported through the AT port when the actual voltage exceeds the preset range.

AT command ‘AT+CPMVT’ can be used to set high/low voltage power off. The module will shut down automatically when the actual voltage exceeds the preset range.

※ NOTE

Voltage monitor function under debugging, Over-voltage alarm and over-voltage shutdown are off by default. For details of at commands, please refer to document [1].

3.2 Power On/ Off and Reset

3.2.1 Power on

Table 13: PWRKEY interface definition

Pin Name	Pin NO.	I/O	Description	Note
PWRKEY	1	DI	Module on/off	Control module on/off

Customer can power on the module by pulling down the PWRKEY pin. This pin has been pulled up inside the module to VBAT.

Adding a TVS diode at the module pin is recommended to enhance the ESD performance effectively when using the module.

The recommended circuit is as follows:

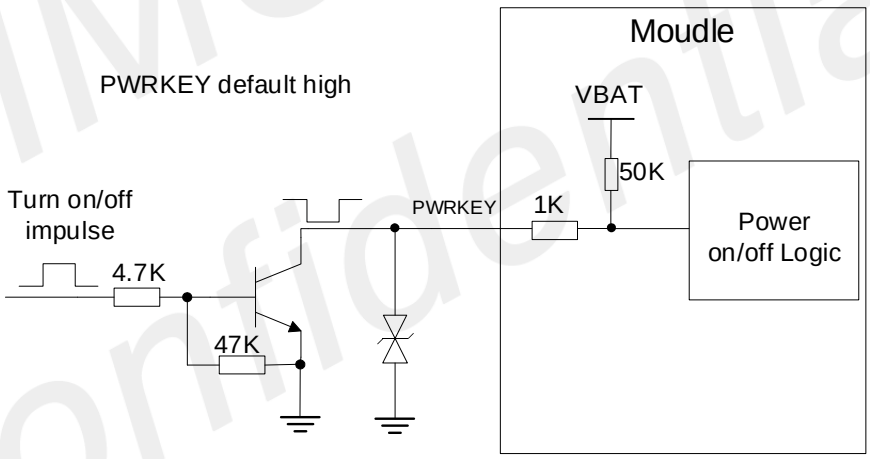

Figure 9: Reference power on/off circuit

※ NOTE

Do not connect more than 10pF capacitors in parallel on the PWRKEY. Otherwise, the module power-on detection of low level will cause automatic power-on. At the same time, pay attention to the TVS tube junction capacitance. If the junction capacitance is too large, there will be the same risk.

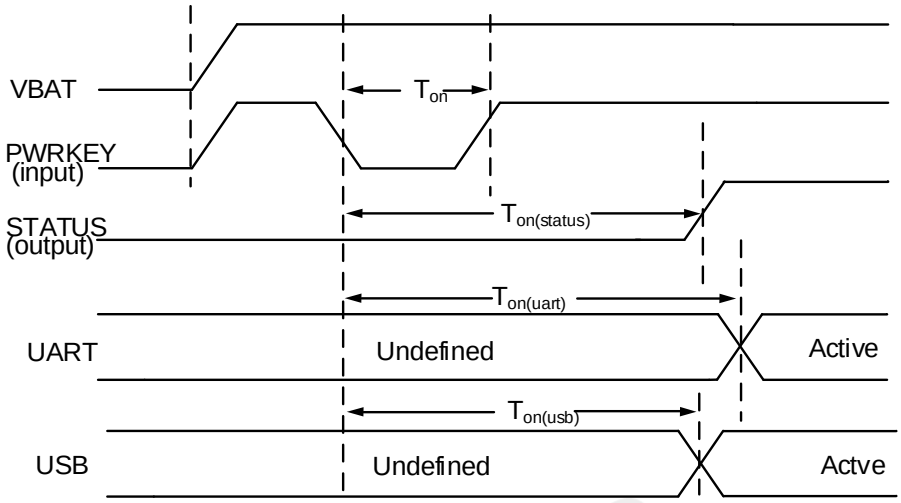

Figure 10: Power on timing sequence

Table 14: Startup timing parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{on}	Power-on low pulse width	-	50	-	ms
$T_{on(status)}$	Startup time (according to the STATUS pin)	-	7	-	s
$T_{on(uart)}$	Startup time (according to the UART pin)	-	8	-	s
$T_{on(usb)}$	Startup time (according to the USB pin)	-	9	-	s
V_{IH}	Input high level voltage on PWRKEY pin	0.7*VBAT	-	VBAT	
V_{IL}	Input low level voltage on PWRKEY pin	0	0	0.3*VBAT	

3.2.2 Power off

The module has the following shutdown methods:

- Power off by pulling the PWRKEY# pin down to a low level.
- Power off Module by AT command ‘AT+CPOF’.
- Over-voltage or under-voltage automatic power off. Use "AT+CPMVT" to set the voltage range.
- Over-temperature or under-temperature automatic power off.

It is strongly recommended that the customer use PWRKEY or ‘AT+CPOF’ to shut down and power off VBAT (especially when the module does not need to work). In addition, the customer cannot shut down VBAT by disconnecting it, which may cause damage to the flash.

※ NOTE

1. When the temperature exceeds the range of - 30 ~ + 75 ℃, module will report warning information through AT port. When the temperature exceeds the range of - 40 ~ + 85 ℃, module will shut down automatically. For a detailed description of 'AT+ CPOF' and 'AT+ CPMVT', please refer to document [1].
2. It is highly recommended that the design has the function to turn off the power supply to the module in an abnormal state, and then turn on the power to restart it.
3. It is highly recommended to connect the PWR_CTRL (DC_DC or LDO enable pin) signal to the master and be able to control it.

The module shuts down by pulling the PWRKEY pin low while the module is powered on, and this pin is pulled up to VBAT inside the module.

The following figure shows the power-off sequence:

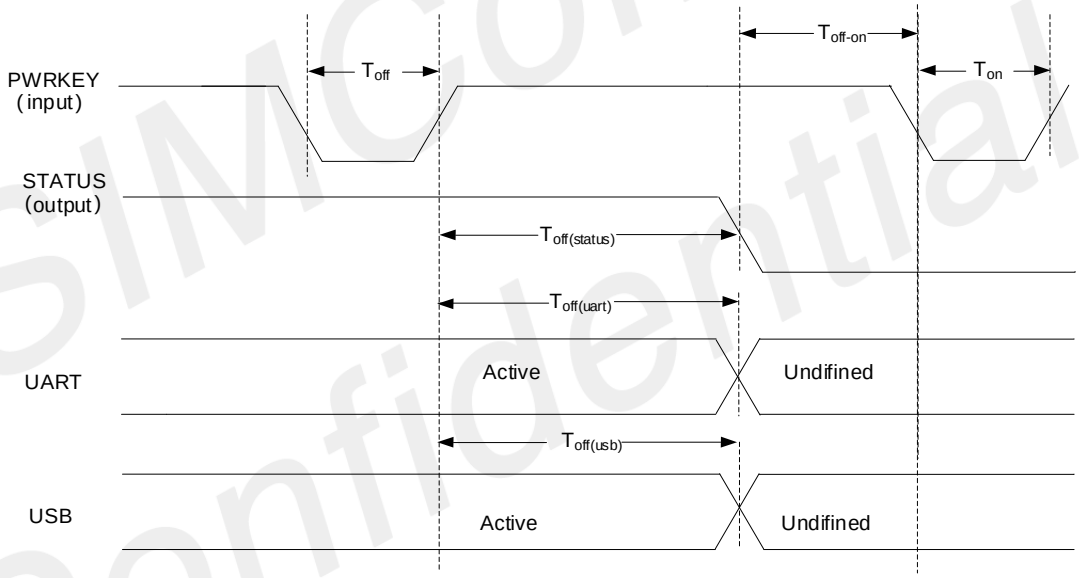

Figure 11: Power off timing sequence

Table 15: Power off timing parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{off}	Power off low level pulse width	2.5	-	-	s
$T_{off(status)}$	Power off time (according to status interface)	-	2.5	-	s
$T_{off(uart)}$	Power off time (according to UART interface)	-	2.5	-	s
$T_{off(usb)}$	Power off time (according to USB interface)	-	2.5	-	s
T_{off-on}	Power off - power on buffer time	2	-	-	s

※ NOTE

The status pin can be used to judge whether the module is powered on or not. When the module is powered on and initialization is completed, the status outputs a high level, otherwise the low level will be maintained all the time.

3.2.3 Reset

Table 16: RESET interface definition

Pin Name	Pin No.	I/O	Description	Note
RESET	16	DI	Module reset, low active	If unused, keep it open.

The module can be reset by pulling the RESET pin low while the module is powered on, and this pin has been pulled up to VBAT inside the module.

Adding TVS tubes to the module pins is recommended to enhance the antistatic ability. The recommended circuit is showed as follows:

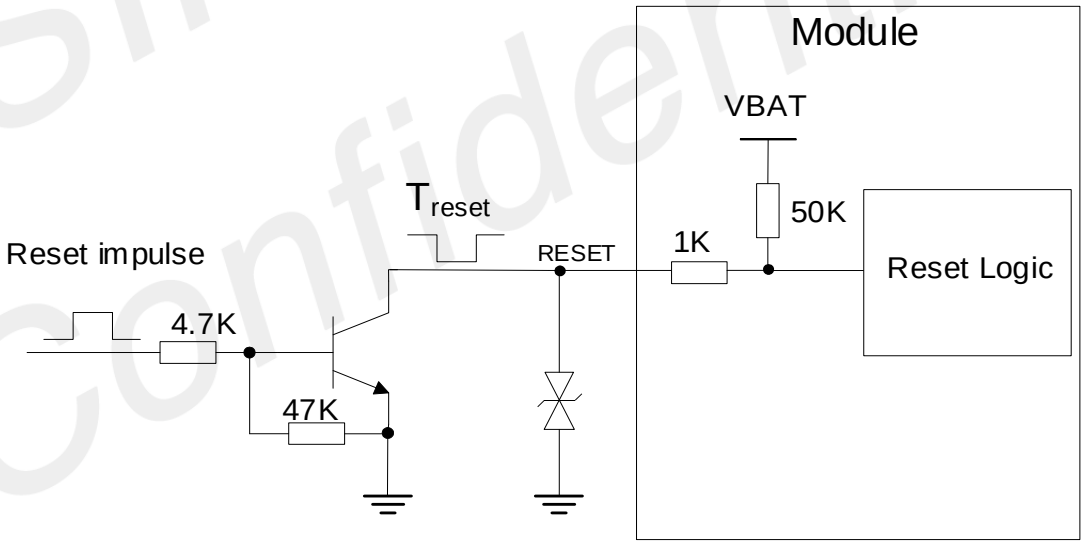

Figure 12: Reference reset circuit

Table 17: RESET pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset}	Restart low pulse width	2	2.5	-	S
V_{IH}	RESET pin input high level voltage	0.7*VBAT	-	VBAT	V
V_{IL}	RESET pin input low level voltage	0	0	0.3*VBAT	V

※ NOTE

1. It is recommended to use the reset pin only in case of emergency, such as the module is not responding. The reset time is recommended to be 2.5s.
2. Do not connect more than 10pF capacitors in parallel on the RESET, otherwise the module power-on detection of low level will cause automatic power-on. At the same time, pay attention to the TVS tube junction capacitance, if the junction capacitance is too large, there will be the same risk.

3.3 UART Interface

The module provides three serial ports: the main full-function communication serial port UART, one common two-cable serial port, and one DBG serial port UART for printing LOG. The module is a Data Communication Equipment (DCE).

Table 18: List of baud rate information for UART

UART Interface	Supported baud rates（bps）	Default baud rates（bps）	Function Description
Full-function UART	300、600、1200、2400、4800、9600、19200、38400、57600、115200、230400、460800、921600、1842000、3686400	115200	Data transmission and AT command sending
Debug UART2	115200	115200	Used for partial log output
Two-cable UART3	9600、115200、230400、921600	115200	Default for GNSS transparent transmission

Table 19: UART pin electronic characteristic

Pin Name	Pin No.	I/O	Description	Note
DTR	3	DI	DTE is ready	If unused, keep it open.
RI	4	DO	Ringing indication	
DCD	5	DO	Carrier detection	
TXD	9	DO	Data sending	
RXD	10	DI	Data reception	
CTS	7	DO	DTE clears sending	Connect to the CTS of DTE. If unused, keep it open.
RTS	8	DI	DTE request sent	RTS connected to DTE.

				If unused, keep open.
UART3_RXD	49	DI	Data reception of UART3	If unused, keep it open.
UART3_TXD	50	DO	Data sending of UART3	
DEBUG_RXD	22	DI	Data reception of Debug UART	If unused, keep it open.
DEBUG_TXD	23	DO	Data sending of Debug UART	

3.3.1 UART Design Guide

When the customer uses a full-function serial port, please refer to the following connection mode:

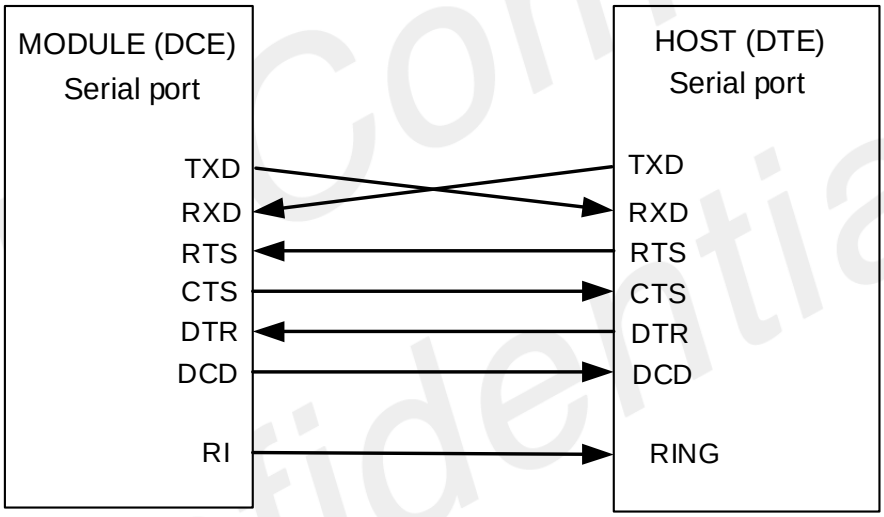

Figure 13: Serial port connection diagram (full-function mode)

When using a 2-wire serial port, please refer to the following connection mode:

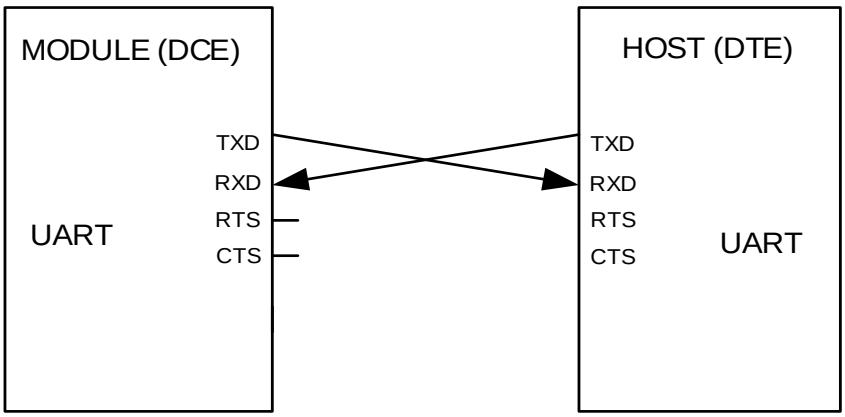

Figure 14: Serial port connection diagram (NULL mode)

The following figure shows the use of triode for level shifter circuits. The circuit with a dotted line can refer to the circuit with solid line TXD and RXD, and attention shall be paid to the direction of the signal. The recommended triode model is MMBT3904.

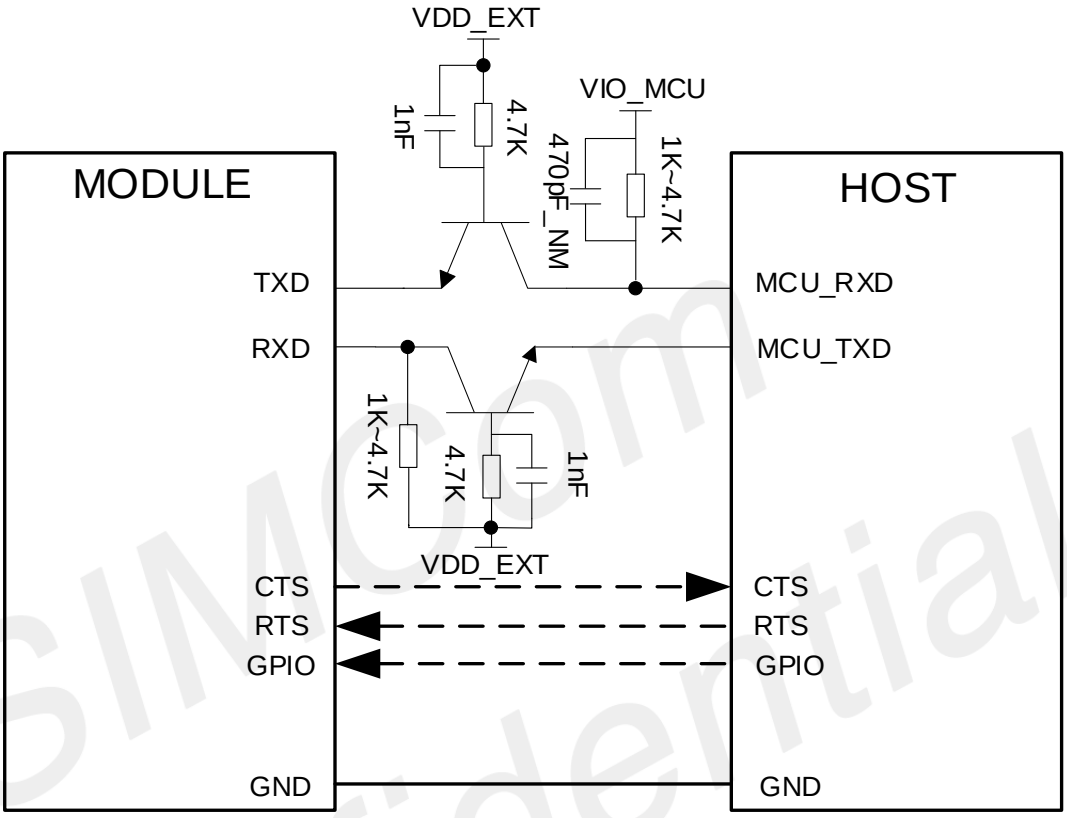

Figure 15: Triode level conversion circuit

※ NOTE

The parasitic capacitance of the transistor will affect the edge of the high-speed digital signal. It is not recommended to use this circuit when the signal speed is higher than 115200bps.

3.3.2 RI Function description

RI usually keeps high level output. When receiving a short message or URC report, RI outputs a low level for 120ms (short message)/60ms (URC), and then returns to a high-level state; When a phone call is received as the callee, the RI continuously outputs a 5.9s (low)/100ms (high) waveform until the host accepts the call using the "ATA" command, or the caller stops calling RI and resumes holding the high output after the next 100ms high.

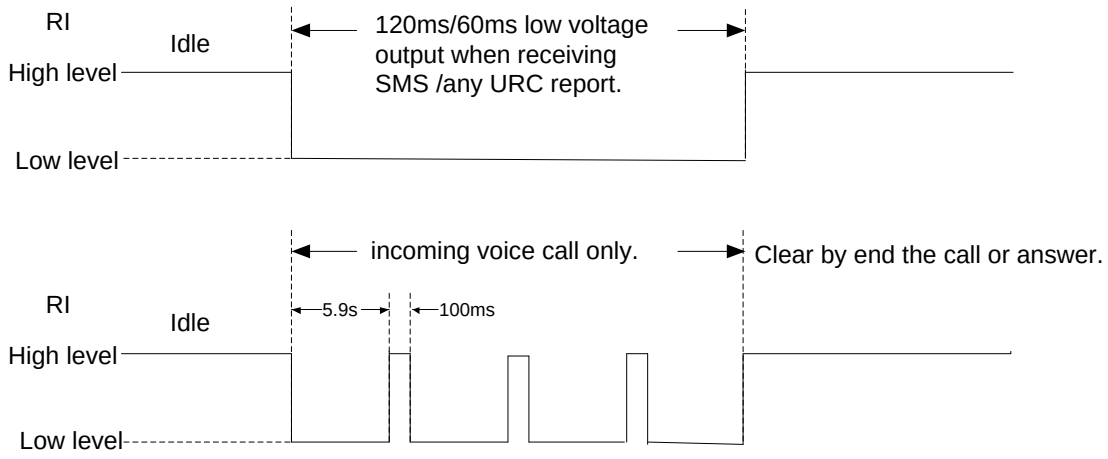

Figure 16: Level change on RI (SMS and URC report)

3.3.3 DTR Function description

The DTR can be used as the sleep-wake pin of the module. After the module enters sleep mode, lower the DTR to wake up the module.

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

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

3.4 USB Interface

The module has one USB 2.0 port and does not support USB charging or USB HOST mode. Support high speed (480Mbps) and full speed (12Mbps), the interface can be used for AT instruction sending, data transmission, software debugging and upgrades. Map ttyUSB1-ttyUSB2 on Linux or Android (see Linux or Android debugging documentation for details).

Table 20: USB interface definition

Pin Name	Pin No.	I/O	Description	Note
USB_DP	27	AIO	USB bus differential positive	Compliant with USB 2.0 specifications. A differential impedance of 90Ω is required. If unused,keep open。
USB_DM	28	AIO	USB bus differential negative	
USB_VBUS	24	PI	USB presence detection	Active high, maximum identification voltage 5.2V, minimum identification voltage 3.0V, typical value 5.0V.

USB is the main debugging port and software upgrade interface. It is recommended that customers reserve USB test points during design. If a main control chip is connected, 0R resistors must be reserved for switching external test points during design.

3.4.1 USB Reference Design

Module can be used as a USB slave device and supports USB sleep and wake-up mechanisms. The recommended connection circuit diagram is as follows:

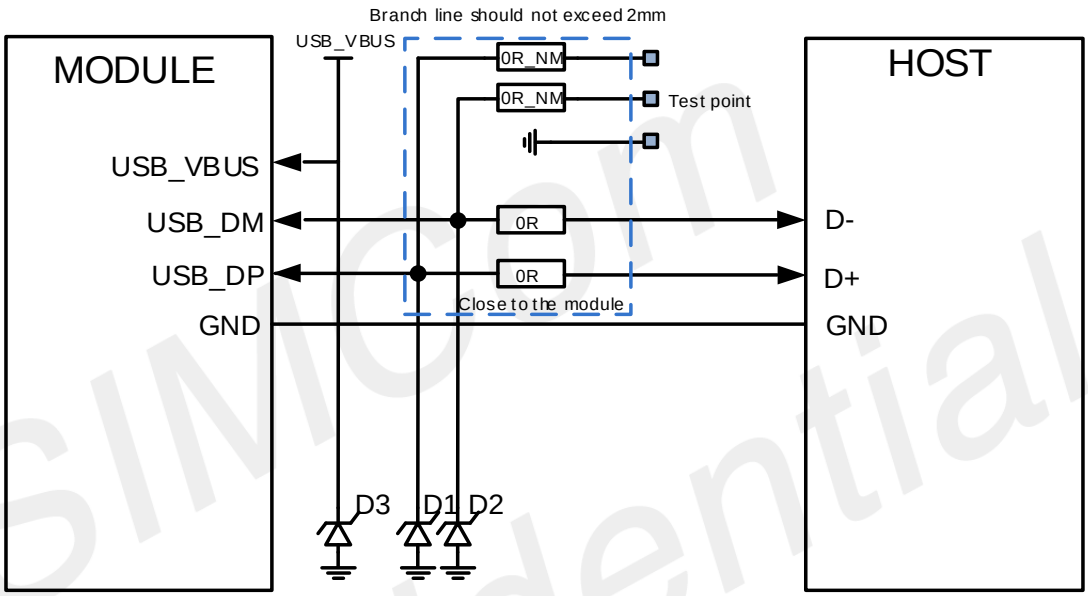

Figure 17: USB connection diagram

Customers should pay attention to the selection of D3 devices when using them. It is recommended to choose anti-static and anti-surge devices. A TVS tube can be placed, and the recommended model are AZ9707-01F and WS7.0P4S1.

USB_VBUS is the USB detection pin of the module, which is active high, and the available recognition voltage is 3.0V~5.2V. It is generally recommended to connect to the external USB connector or the VBUS signal of the microcontroller, or it can be connected to another power supply, such as VBAT. If the USB_VBUS pi to reserve a switching circuit to ensure that the power supply can be turned off and then on again to enable USB re-enumeration. and it is then turned on again to re-enumerate the USB.

※ NOTE

1. The USB data cable must be strictly routed in 90Ω +/- 10% differential. The TVS devices D1 and D2 on the data line must be selected with an equivalent capacitance of less than 1pF. The TVS device should be placed near the USB connector or test point, recommended models ESD73131CZ and ESD9L5.0ST5G.
2. The detection of USB 2.0 speed is determined automatically by the USB protocol. The customer does not need to pull up the DP externally. Otherwise, it may affect the device USB enumeration.

3.4.2 USB_BOOT Interface

Module provides one forced download boot interface 'USB_BOOT'.

Table 21: USB_BOOT interface definition

Pin Name	Pin Number	I/O	Description	Power Domain	Default State	Remark
USB_BOOT	6	DI	Force downloads Pull down to GND before booting, and the module will enter USB download mode.	1.8V	B-PU	Do not pull down the USB_BOOT before normal boot.

If the module upgrade fails to boot, you can force upgrade through the USB_BOOT port.

Before the module is powered on, pull the USB_BOOT pin to GND, apply VBAT power, and press RESET to enter the download mode. After entering the download mode, you must release USB_BOOT and remove the pull-down.

USB_BOOT in the process of short connection, it is easy to damage the internal device due to external static electricity. It is recommended to place TVS protection devices at the short contact position, and the USB_BOOT connection diagram is as follows:

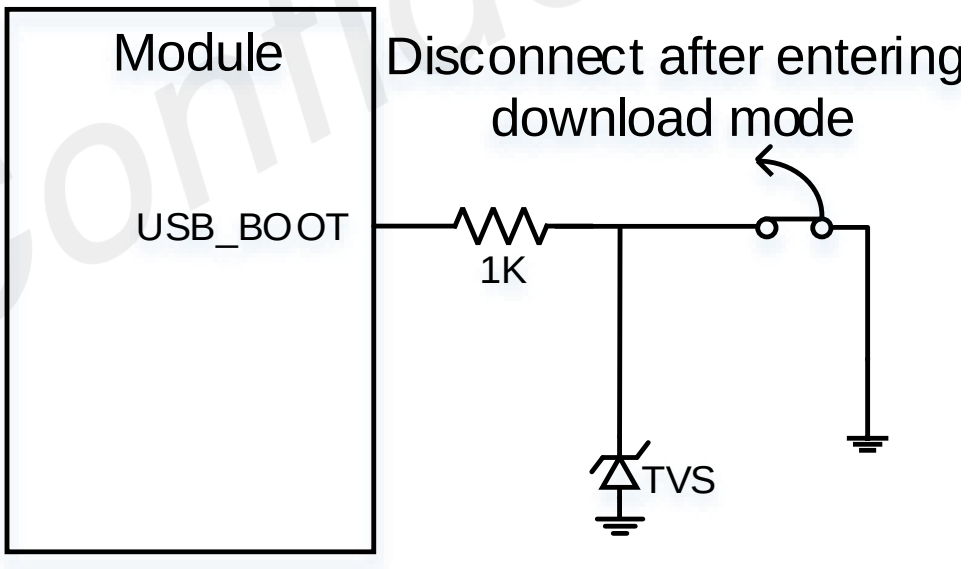

Figure 18: USB_BOOT connection circuit

Customers will see the download port in the device manager port of the Windows system.

Figure 19: Force-download port

※ NOTE

USB_BOOT only has the forced download boot function before booting (cannot be pulled down) and other functions after powering on.

3.5 USIM Interface

The module supports both 1.8V and 3.0V USIM Cards. The interface power of the USIM card is provided by the voltage regulator inside the module, and the normal voltage value is 3V or 1.8V.

Table 22: USIM interface definition

Pin Name	Pin No.	I/O	Description	Note
USIM1_DATA	31	DIO	USIM1 data	
USIM1_RST	33	DO	USIM1 reset	
USIM1_CLK	32	DO	USIM1 clock	
USIM1_VDD	30	PO	USIM1 power supply	The module automatically recognizes the 1.8V or 3.0V USIM card.
USIM1_DET	34	DI	USIM hot plug detection, can be set to high/low active with AT command; refer to document [18]	If unused, keep it open.
USIM2_DATA	108	DIO	USIM2 data	
USIM2_RST	111	DO	USIM2 reset	
USIM2_CLK	109	DO	USIM2 clock	
USIM2_VDD	110	PO	USIM2 power supply	The module automatically recognizes the 1.8V or 3.0V USIM card.
USIM2_DET	112	DI	USIM hot plug detection, can be set to high/low active with AT command, refer to document [18]	If unused, keep open.

※ Note

LANS and LANV models can support the USIM2 interface, while the rest only support a single card.

Table 23: USIM electronic characteristic in 1.8V mode (V_{USIM}=1.8V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{USIM}	Output power supply voltage to USIM card	1.62	1.8	1.98	V
V_{IH}	High-level input voltage	0.7*USIM_VDD	-	USIM_VDD +0.4	V
V_{IL}	Low-level input voltage	-0.4	0	0.25*USIM_VDD	V
V_{OH}	High-level output voltage	USIM_VDD -0.4	-	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.2	V

Table 24: USIM electronic characteristic 3.0V mode (V_{USIM}=3V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{USIM}	Output power supply voltage to USIM card	2.7	3	3.3	V
V_{IH}	High-level input voltage	0.7*USIM_VDD	-	USIM_VDD +0.4	V
V_{IL}	Low-level input voltage	-0.4	0	0.25*USIM_VDD	V
V_{OH}	High-level output voltage	USIM_VDD -0.45	-	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.3	V

3.5.1 USIM Hot swap function

SIM card has a physical detection point SIM_DET. After the SIM card is inserted, SIM_DET changes from high level to low level. The falling edge indicates that a SIM card is inserted. After the SIM card is removed, SIM_DET changes from low level to high level. The rising edge indicates that the SIM card is removed.

Use the "AT + UIMHOTSWAPON = 0 or 1" and "AT + UIMHOTSWAPLEVEL = 0 or 1" AT commands to set the SIM card hot-swap function and SIM card detection level for more details. Refer to the A7600 Series_AT command manual documentation.

If the SIM card hot-swap function is not used, the customer can keep the SIM_DET pin disconnected.

For more details on USIM hot-swap AT operation, refer to Document [18]. If the USIM card hot-swap feature is not used, the USIM_DET pin can be left floating.

3.5.2 USIM reference design

The USIM interface is susceptible to external electrostatic interference and must be protected from static electricity by placing a suitable TVS device close to the external USIM card slot; the ESD9L5.0ST5G type TVS is recommended.

The reference circuit is shown in the following figure.

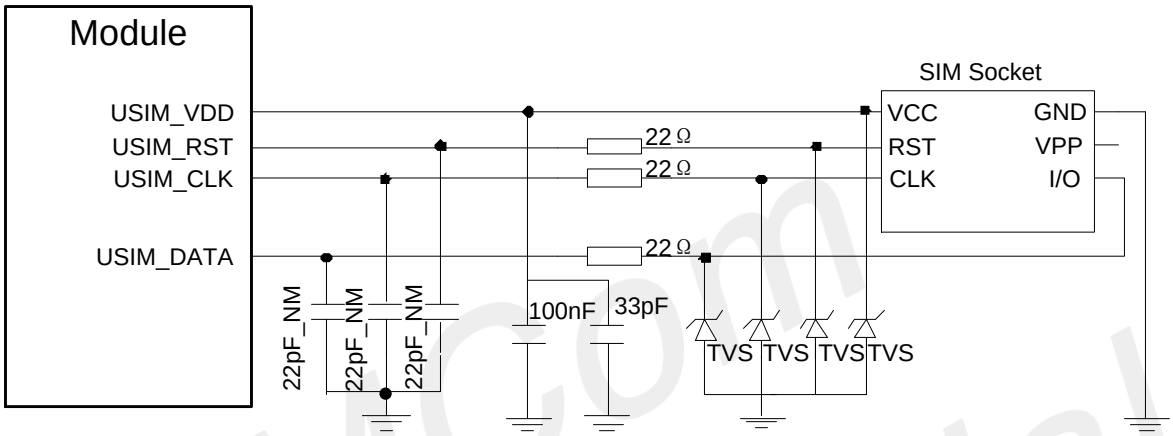

Figure 20: USIM interface reference circuit

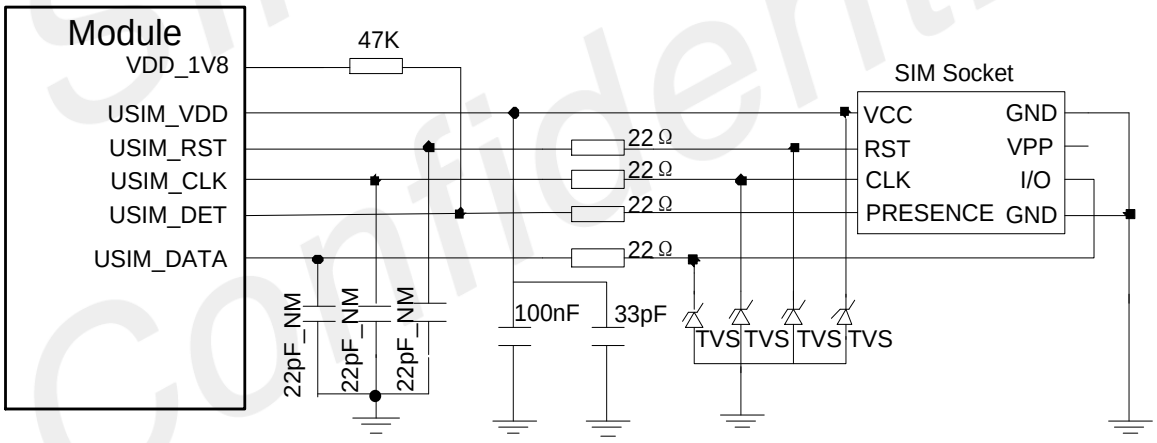

Figure 21: USIM interface reference circuit (8PIN)

※ NOTE

USIM_DATA is pulled up to the USIM_VDD through a 4.7KΩ resistor. The external circuit does not need to be pulled up. In addition, the 100nF decoupling capacitor recommendation on USIM_VDD must be retained.

USIM card circuit is easy to interfere with, causing card recognition or card drop, so please follow the following principles when designing:

- Always place the USIM booth away from the main antenna during the PCB layout phase.
- USIM card should be kept away from RF cables, VBAT cables, and high-speed signal cables. The USIM card should not be too long.
- The GND of the USIM card should be well connected with the GND of the module so that the two GND potentials are equal.
- To prevent USIM_CLK from interfering with other signals, you are advised to use USIM_CLK as a separate packet protection.
- It is recommended to place a 220nF capacitor on the USIM_VDD signal cable near the USIM card.
- Place TVS near the USIM booth and the parasitic capacitance of TVS should not be greater than 33pF, such as ESD9L5.0ST5G.
- A 22Ω resistor in series between the USIM card holder and the module can enhance ESD protection.
- For the smoothest routing, it is recommended to use single-channel TVS, which are placed near each pin of the booth.
- USIM_CLK signal is critical. The customer must ensure that the time between the rising edge and falling edge of the USIM_CLK signal is less than 40ns. Otherwise, abnormal card identification may occur.

※ Note

If it is an automotive product, choose a USIM card holder with better reliability.

3.6 Analog audio interface

3.6.1 Analog audio input interface

The module provides an analog audio MIC input interface, which can be connected to an external handle for voice calls.

Table 25: Analog audio MIC interface definition

Pin Name	Pin No.	I/O	Description	Note
MIC_P	42	AI	Microphone input channel (+)	If unused, keep it open.
MIC_N	43	AI	Microphone input channel (-)	

3.6.2 Analog audio output interface

The module provides an analog audio output interface, which can be connected to an external Receiver/Speaker for voice calls or multimedia playback.

Table 26: Analog audio output interface definition

Pin Name	Pin No.	I/O	Description	Note
EAR_P	40	AO	Handset differential output channel (+)	If unused, keep open.
EAR_N	41	AO	Handset differential output channel (-)	

3.6.3 Analog audio electrical characteristics

The A7677S series modules have built-in audio decoders and audio front-ends, and the main features are as follows:

ADC: 90dB SNR@20~20kHz

DAC: 95dB SNR@20~20kHz

(Class-AB): THD<-85dB@32-ohm

Table 27: Analog audio electrical parameters (AVDD_AUD=1.8V, T=25°C)

Parameter	Conditions	DR (Typ.)	THD+N (Typ.)	Max Power
DAC	RL=10K	101dBA	-96dB (@vout -2dBv)	1.59Vp
Class-AB	Mono,32Ω Difference	100dBA	-90dB (0.00316%) (@20mW output)	37mW

3.6.4 Analog audio reference design

The analog audio recommendation circuit is as follows:

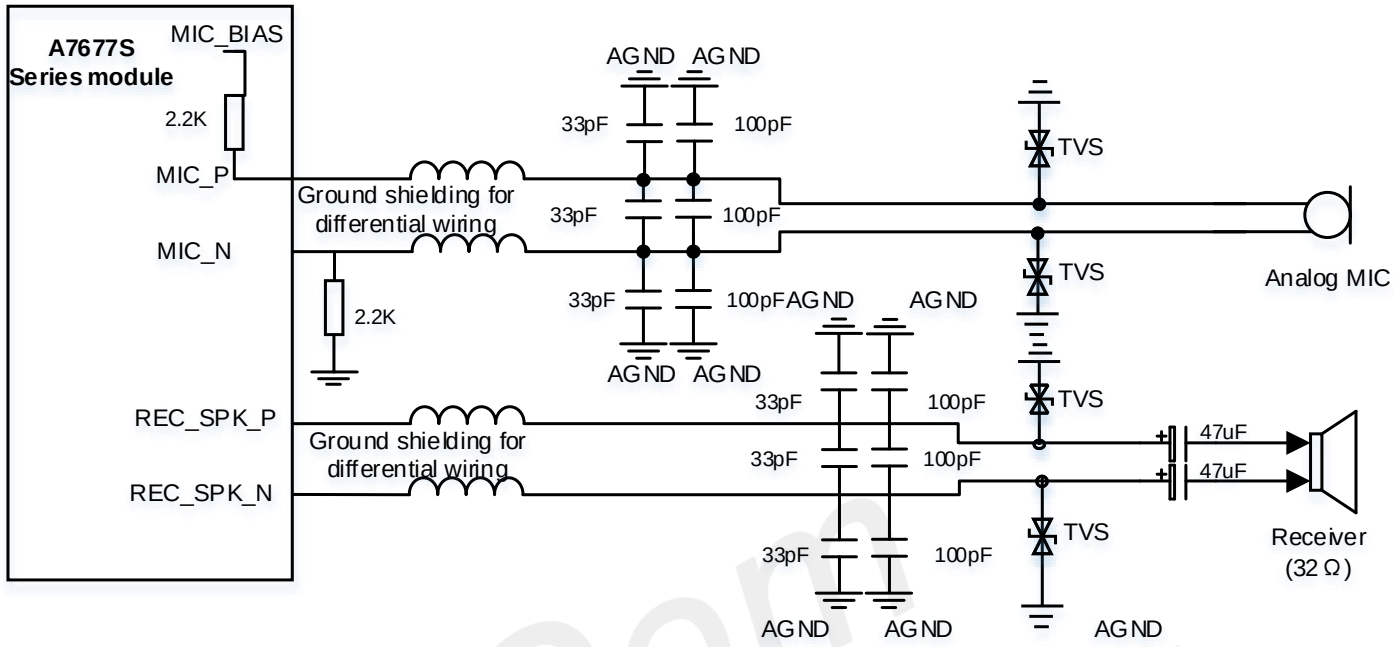

Figure 22: Analog audio interface reference circuit

3.7 Matrix keyboard interface

The module provides a 4*4 matrix keyboard interface.

Table 28: Keyboard interface definition

Pin Name	Pin No.	I/O	Description	Note
MK_IN_2	47	DI	Matrix keyboard input	If unused, keep it open.
MK_IN_3	20	DI		
MK_IN_5	68	DI		
MK_IN_6	36	DI		
MK_OUT_2	44	DO	Matrix keyboard output	If unused, keep it open.
MK_OUT_3	21	DO		
MK_OUT_5	67	DO		
MK_OUT_6	35	DO		

The recommended circuitry for the matrix keyboard interface is as follows:

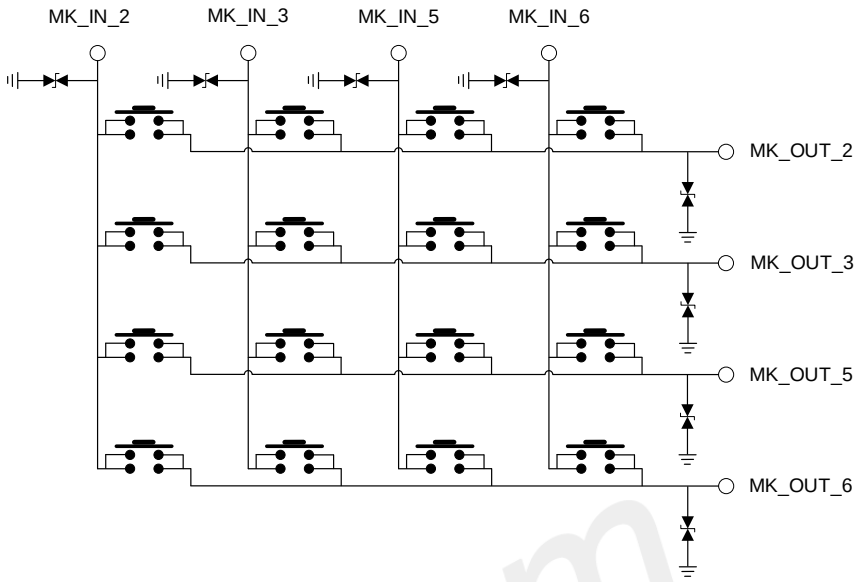

Figure 23: Matrix keyboard interface reference circuit

3.8 GPIO Interface

The module provides multiple GPIOs.

Table 29: GPIO interface definition

Pin No.	Pin Name	AT Command Operation GPIO Number	Pin Type	Power Domain	Default State	Default Function	Pad Edge Wakeup
19	GPIO_01	GPIO_01	IO	1.8V	PU	Common input/output	Yes
26	GPIO_02	GPIO_02	IO	1.8V	PD	Common input/output	Yes
48	GPIO_03	GPIO_03	IO	1.8V	PU	Common input/output	Yes
53	GPIO_04	GPIO_04	IO	1.8V	PU	Common input/output	Yes

3.9 I2C interface

Module provides a group of hardware I2C protocol interface, support standard mode 100Kbps, support

high-speed mode 400Kbps, working voltage of 1.8V.

Table 30: I2C interface definition

Pin Name	Pin No.	I/O	Description	Note
CI2C_SDA	37	OD	I2C2 bus data input/output	If unused, keep it open. A 4.7K pull-up resistor is required for the VDD_EXT power supply.
CI2C_SCL	38	OD	I2C2 bus clock output	

The reference circuit is shown below:

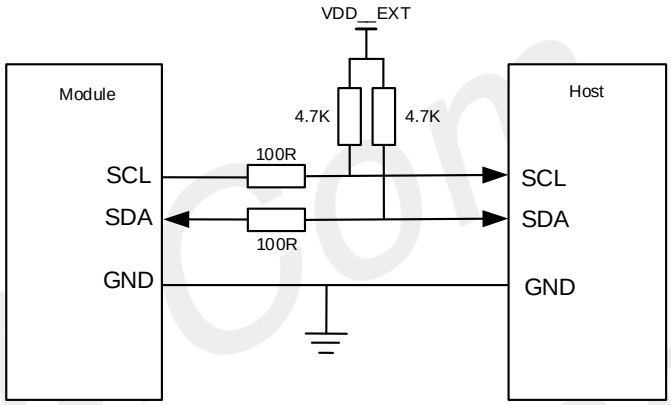

Figure 24: I2C reference circuit

※ NOTE

1. The SCL and SDA pins require pull-up resistors, and the pull-up power supply must be VDD_EXT of the module output.
2. Connecting a 100R resistor in series with the I2C signal line close to the module terminal is recommended to reduce overshoot on the signal line.

3.10 SPI interface

The module provides a set of hardware SPI interfaces, supports host mode only, operates at 1.8V, and clocks at a maximum clock frequency of 52MHz.

Table 31: SPI interface definition

Pin Name	Pin No.	I/O	Description	Note
SPI_CLK	11	DO	SPI bus clock output	If unused, keep it open.
SPI_CS	12	DO	SPI bus chip select signal	
SPI_MOSI	13	DO	SPI bus host output	
SPI_MISO	14	DI	SPI bus host input	

The reference circuit is shown below:

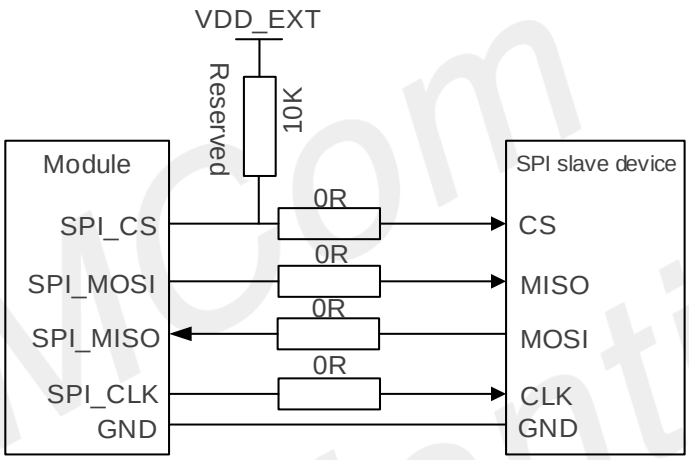

Figure 25: SPI reference circuit

3.11 Module netlight status indication

NETLIGHT can indicate the current network status. It is usually used to drive the LED light indicating the network status.

Table 32: NETLIGHT interface definition

Pin Name	Pin No.	I/O	Description	Note
NETLIGHT	52	DO	Network status indication	If unused, keep it open.

The reference circuit is shown below:

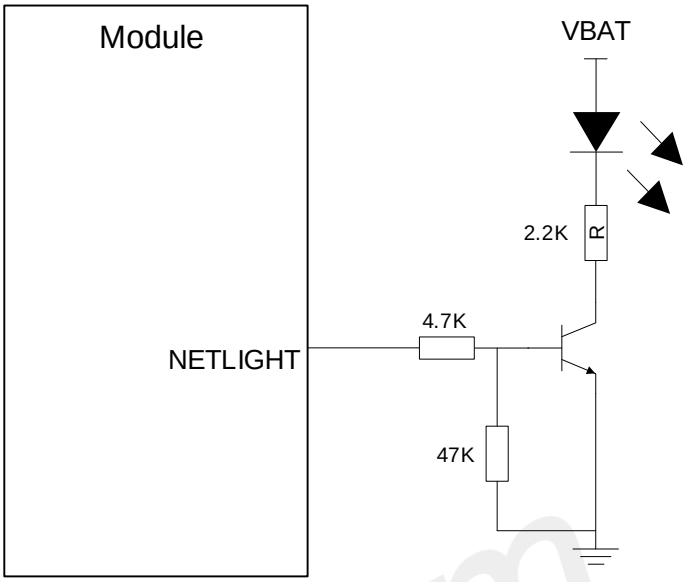

Figure 26: NETLIGHT reference circuit

※ NOTE

The resistance value of R in the figure above depends on the specific parameters of VBAT and LED.

The NETLIGHT signal is used to control the LED lights that indicate the status of the network. The working status of this pin is shown in the table below:

Table 33: LTE mode NETLIGHT pin status

NETLIGHT Pin Status	Module Status
Always On	Searching Network
200ms ON, 200ms OFF	Data Transmit/Registered
OFF	Power off, or condition AT+CSCLK=1, and DTR is pulled up.

3.12 Module operating status indication

STATUS indicates the running status of the module and is used to determine whether the module is powered on. When the module is powered on and initialization is complete, the STATUS pin output is high; otherwise, it will remain low.

Table 34: STATUS interface definition

Pin Name	Pin No.	I/O	Description	Note
STATUS	66	DO	Module operating status indication	If unused, keep it open.

The reference circuit is shown below：

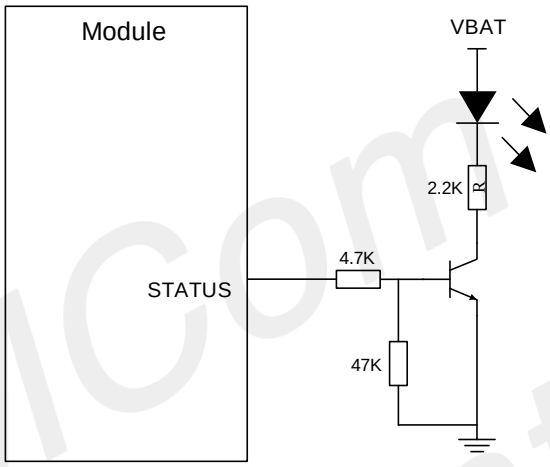

Figure 27: STATUS reference circuit

※ Note

The resistance value of resistance R in the figure above depends on the specific parameters of VBAT and LED.

3.13 GNSS interface

Module supports GNSS function interface. The module ports provide an alternate power input, a UART port, a pulse-synchronised clock signal port, and a GNSS antenna port.

- It supports GPS, BeiDou, and GLONASS navigation systems.
- The GNSS function is turned off by default. Send AT commands' AT+CGNSSPWR=1 'and' AT+CGNSSTST=1 'to turn on the GNSS function and obtain NMEA data.

Table 35: GNSS interface description

Pin Name	Pin No	I/O	Description	Note
GNSS_VBKP	116	PI	GNSS backup power input	Power supply ranges from 1.4V to 3.6V. This pin must be connected.
GNSS_RXD	96	DI	GNSS UART RX	1.8V power domain.
GNSS_TXD	95	DO	GNSS UART TX	1.8V power domain.
1PPS	100	DO	GNSS pulse synchronous clock signal	Second pulse signal, can be used for accurate timing, about 30 seconds after successful positioning began to output pulse signal.
GNSS_ANT	90	AI	GNSS_ANT Input	Refer to Section 4.6 for antenna design

GNSS reference design is as follows:

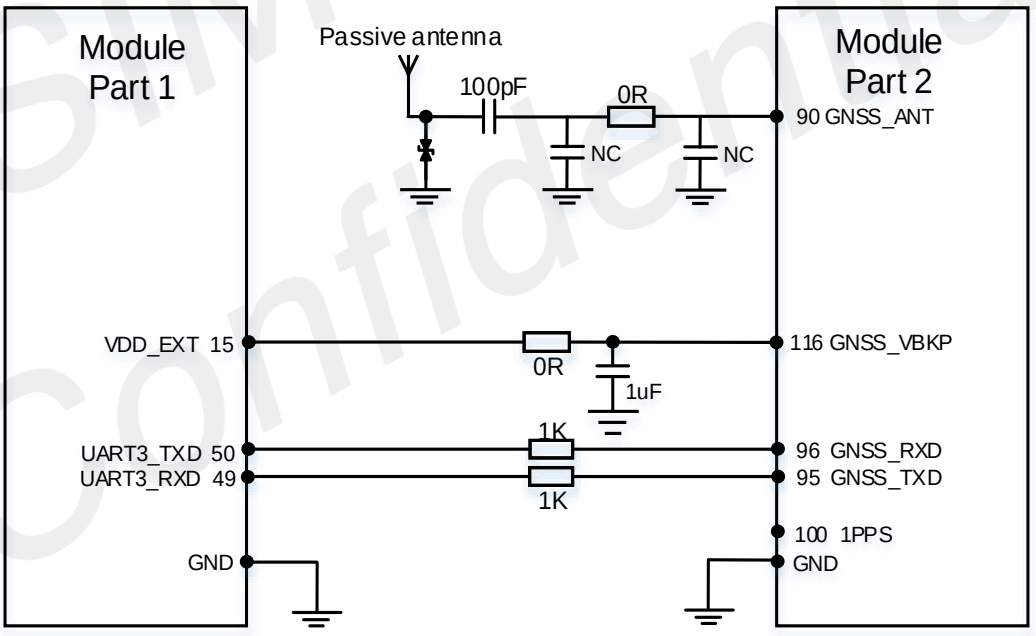

Figure 28: GNSS reference design

Common GNSS instructions are shown in the table below:

Table 36: Common GNSS instructions list

Command	Function
AT+CGNSSPWR	=1 Open GNSS =0 Close GNSS
AT+CGNSSTST	=1 The positioning data is transmitted to the UART3, and the positioning data can be obtained in the NMEA port in the USB port
AT+CGPSCOLD	Cold start GPS
AT+CGPSWARM	Warm start GPS
AT+CGPSHOT	Hot start GPS
AT+CGPSINFO	Get GPS location information
AT+CGNSSINFO	Get GNSS location information.

※ NOTE

1. For more detailed information on GNSS AT operation, see the reference document [1]
2. Please series in 1K resistors for serial communication lines with GNSS to prevent leakage current to the serial ports of the GNSS chip.
3. GNSS_VBKP can be powered via VDD_EXT. This pin must be connected.
4. When GNSS is working, the module cannot enter sleep mode, and the module can only enter sleep after turning off GNSS.
5. The GNSS reference circuit uses a passive antenna design, and the GNSS active antenna design can be found in Section 4.5.2

3.14 MMC interface

The module provides a 4-bit SD/MMC interface, only supports the host mode, clock frequency up to 208MHz SDR and 50MHZ DDR, and maximum capacity support of 128GB.

The supported modes are DS, HS, HS200, SDR12, SDR25, SDR50, SDR104, and DDR50.

Conforming to specifications:

SDIO Card Specification, version 3.0

eMMC Specification, version 4.5

Table 37: MMC interface description

Pin Name	Pin No	I/O	Description	Note
MMC_DAT3	115	DIO	MMC/SD data 3	If unused, keep it open.
MMC_DAT2	114	DIO	MMC/SD data 2	
MMC_DAT1	113	DIO	MMC/SD data 1	
MMC_DAT0	128	DIO	MMC/SD data 0	
MMC_CLK	129	DO	MMC/SD clock	
MMC_CMD	130	DIO	MMC/SD command	
VDD_SDIO	125	PO	The DATA digitally pulls up the power supply	

Table 38: Electrical parameters of the MMC interface (MMC_DAT0-MMC_DAT3, MMC_CLK and MMC_CMD)

Parameter	Description	Min.	Typ.	Max.	Unit
VDD_SD	SD card power supply voltage, requires external power supply	2.7	3.0	3.3	V
1.8V Voltage Domain					
V_{IH}	Input high level voltage	VCC*0.7	1.8	VCC+0.2	V
V_{IL}	Input low level voltage	-0.3	0	0.3*VCC	V
V_{OH}	Output high level voltage	VCC-0.2V	1.8	-	V
V_{OL}	Output low level voltage	0	0	0.2V	V
3.0V Voltage Domain					
V_{IH}	Input high level voltage	2	-	VCC+0.3	V
V_{IL}	Input low level voltage	-0.3	0	0.8	V
V_{OH}	Output high level voltage	2.4	-	-	V
V_{OL}	Output low level voltage	0	-	0.4	V

The following figure shows the reference circuit diagram of the SD card. The SD card uses 3V power supply, and external VDD_SD power supply is required.

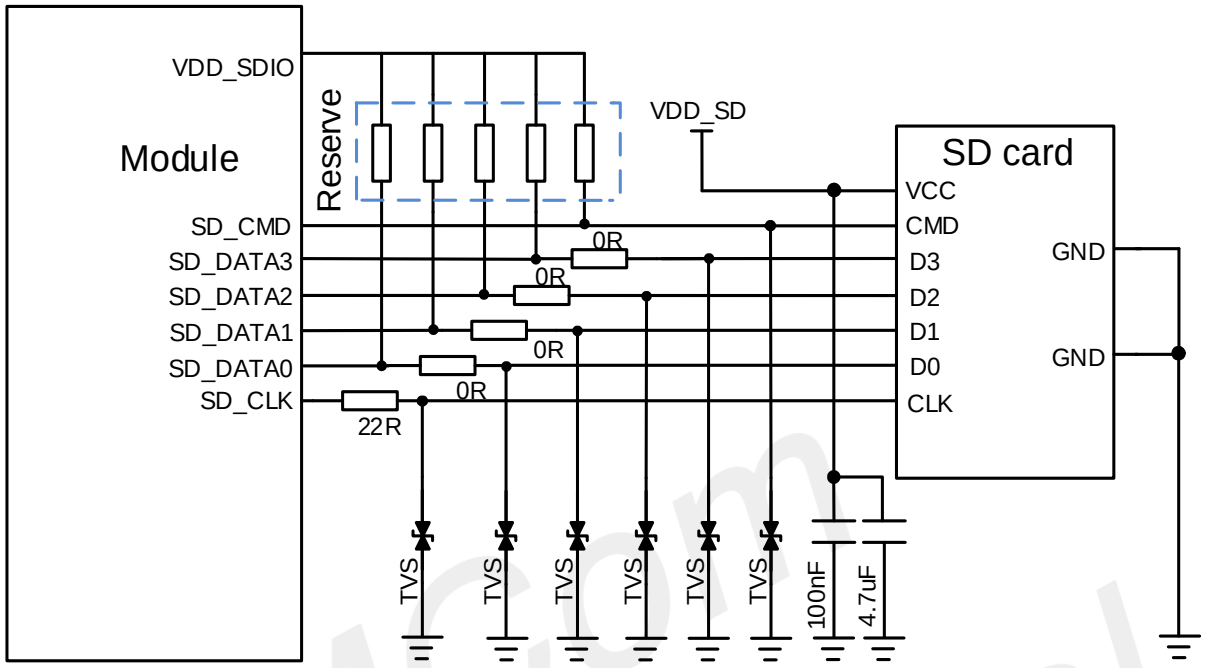

Figure 29: SD card reference circuit diagram

※ NOTE

VDD_SD needs to be provided externally by the customer, and the continuous flow capacity of 350mA needs to be guaranteed.

Precautions for SD card cabling:

- Protect other sensitive signal cables away from SD card signals.
- Protect SD card signal line away from other signals that may cause interference (e.g., clock signal, switching power supply light).
- The clock frequency of the SD card is up to 200MHZ, and 50 ohm impedance control is required for wiring.
- The difference between the length of the CLK signal of the SD card and the length of the DATA/CMD signal must be less than 1mm.
- Connect a 22-ohm resistor in series with the clock signal near the end of the module.
- The cable length should be less than 50mm.
- The distance between signal cables must be twice the cable width.
- The load capacitance of signal cables must be less than 15pf.

3.15 Other interfaces

3.15.1 Analog to digital converter (ADC)

Module provides two general purpose ADC interfaces. The input voltage of ADC ranges from 0 to 1.2V. Its electrical characteristics are as follows:

Table 39: ADC interface description

Pin Name	Pin No	I/O	Description	Note
ADC1	25	AI	Universal analog-to-digital converter channel 1	If unused, keep it open.
ADC2	51	AI	Universal analog-to-digital converter channel 2	

Table 40: ADC Electrical characteristics

Characteristics	Min.	Typ.	Max.	Unit
ADC resolution	–	12	–	bits
Input voltage range	0	–	1.2	V
Input impedance		Hi-Z		

※ NOTE

1. “AT+CADC=2” can be used to read the voltage of the ADC1 pin.
2. “AT+CADC2=2” can be used to read the voltage of the ADC2 pin.
3. “AT+CBC” can be used to read the voltage of the VBAT.
4. For more details, please refer to document [1].

3.15.2 LDO

Module provides three power outputs: VDD_EXT, VDD_AUX, and VDD_SDIO.

VDD_EXT is the module's system IO power supply, which can only provide a current capacity of 50mA. It cannot be used as a high current drive source.

VDD_AUX is the adjustable voltage output power supply of the module, the default output is 3V, can only provide 50mA current capacity, cannot be used as a large current driver source; It can provide power

for other peripherals such as active antenna and LCD.

VDD_SDIO is the voltage domain power supply for the digital IO port of the MMC interface, which can only be used as the pull-up power supply for the SD/MMC data line, and the output voltage is set to 1.8V or 3.0V according to the software.

Table 41: LDO interface description

Pin Name	Pin No	I/O	Description	Note
VDD_EXT	15	PO	System I/O power	If unused, keep it open.
VDD_AUX	99	PO	Internal LDO power supply	
VDD_SDIO	125	PO	MMC port I/O Pull up the power supply	

Table 42: VDD_EXT Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{EXT}	Output voltage	-	1.8	-	V
I_{EXT}	Output current	-	-	50	mA

The following figure shows the peripheral reference circuit of module VDD_EXT pin:

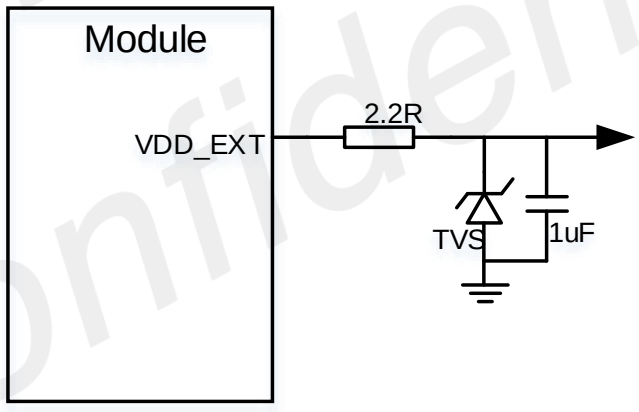

Figure 30: VDD_EXT reference circuit diagram

※ NOTE

1. It is recommended that a TVS protection tube be connected in parallel near the module VDD_EXT pin for ESD protection. The recommended model is shown in the following table.
2. It is recommended that a 2.2R resistor be connected in series near the module VDD_EXT pin for surge absorption. Since the resistor will produce a voltage drop, if the current flowing on the VDD_EXT is large, the resistance value should be appropriately reduced.

Table 43: List of recommended TVS models for VDD_EXT

No.	Manufacturer	Part number	V_{RWM}	V_C(max)	Ppp(max)	C_J(max)	Package
1	WILL	ESD9X5VU	5V	8V	NA	0.9pF	WBFBP-02C
2	LRC	LESD9L5.0T5G	5V	9.8V	NA	0.9pF	SOD-923
3	ON	ESD9L5.0ST5G	5V	9.8V	NA	0.9pF	SOD−923

Table 44: VDD_AUX Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{AUX}	Output voltage	2.5	3.0	3.0	V
I_{AUX}	Output current	-	-	50	mA

※ NOTE

1. VDD_AUX is the adjustable voltage output, the default output is 3.00V.The adjustable voltage values are: 2.50V, 2.60V, 2.70V, 2.80V, 2.90V, 3.00V.
2. VDD_AUX cannot be turned off. Pay attention to the application scenario.
3. For the voltage output regulation method, please refer to the document [1].

Table 45: VDD_SDIO Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{SDIO}	Output voltage	-	1.8/3.0	-	V
I_{SDIO}	Output current	-	-	20	mA

※ NOTE

VDD_SDIO is the pull-up power supply for the digital I/O port of the MMC, not the main power supply for SD card.

4 RF Specifications

4.1 LTE radio frequency parameters

Table 46: Conducted transmission power

Frequency	Power	Min.
LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23dBm +/-2.7dB	<-40dBm
LTE-FDD B5	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm
LTE-TDD B34	23dBm +/-2.7dB	<-40dBm
LTE-TDD B38	23dBm +/-2.7dB	<-40dBm
LTE-TDD B39	23dBm +/-2.7dB	<-40dBm
LTE-TDD B40	23dBm +/-2.7dB	<-40dBm
LTE-TDD B41	23dBm +/-2.7dB	<-40dBm

Table 47: E-UTRA operating bands

E-UTRA Band	UL Freq.	DL Freq.	Duplex Mode
1	1920~1980 MHz	2110~2170 MHz	FDD
3	1710~1785 MHz	1805~1880 MHz	FDD
5	824～849 MHz	869～894MHz	FDD
8	880~915 MHz	925~960 MHz	FDD
34	2010～2025 MHz	2010～2025 MHz	TDD
38	2570 ~2620 MHz	2570 ~2620 MHz	TDD
39	1880 ~1920 MHz	1880 ~1920 MHz	TDD
40	2300 ~2400 MHz	2300 ~2400 MHz	TDD
41	2535 ~2655 MHz	2535 ~2655 MHz	TDD

Table 48: Reference sensitivity (QPSK)

E-UTRA	3GPP Standard						Actual	Duplex Mode
	1.4 MHz	3MHz	5MHz	10MHz	15MHz	20MHz	10MHz	
1			-100	-97	-95.2	-94	-98	FDD
3	-101.7	-98.7	-97	-94	-92.2	-91	-98	FDD
5	-103.2	-100.2	-98	-95			-98.5	FDD
8	-102.2	-99.2	-97	-94			-99	FDD
34			-100	-97	-95.2		-101	TDD
38			-100	-97	-95.2	-94	-98.5	TDD
39			-100	-97	-95.2	-94	-101	TDD
40			-100	-97	-95.2	-94	-100	TDD
41			-98	-95	-93.2	-92	-98.5	TDD

4.2 LTE Antenna Requirements

Table 49: LTE antenna requirements

Passive	Recommended Standard
operating band	See table 46 and 47
Direction	Omni Directional
Gain	> -3dBi (Avg)
Input impedance	50 Ω
Efficiency	>50 %
Maximum input power	50W
VSWR	< 2
Isolation	>20dB
PCB insertion loss(<1GHz)	<0.5dB
PCB insertion loss(1GHz~2.2GHz)	<1dB
PCB insertion loss(2.3GHz~2.7GHz)	<1.5dB

4.3 GNSS Specifications

Table 50: GNSS operating bands

Type	Frequency
GPS	1575.42±1.023MHz
GLONASS	1597.5~1605.8MHz
BeiDou	1561.098±2.046MHz

Table 51: GNSS performance

GNSS	GPS	BeiDou	GLONASS
Tracking sensitivity	-160dBm	-161dBm	TBD
Capture sensitivity	-146.5dBm	-145dBm	TBD
Quick start TTFF	3s		
Cold start TTFF	<40s		
Accuracy	<2m		

※ NOTE

The GNSS quick start TTFF is 3s, which is the RMS value, and it is affected by the injection time of AGNSS and LBS.

4.4 GNSS Antenna Requirements

Table 52: Recommended Antenna Characteristics (GNSS)

Passive	Recommended Standard
operating band	L1: 1559~1609MHZ
Direction	Hemisphere, face to sky
Input impedance	50 Ω
Maximum input power	50W
VSWR	< 2
Plan category	RHCP or Linear
Passive antenna gain	0dBi
Active antenna gain	-2dBi
Active antenna noise figure	< 1.5
Built-in antenna LNA gain	20dB(Typ.)
Total antenna gain	< 18 dB
Coaxial insertion loss	<1.5dB

4.5 Antenna Reference Design

4.5.1 Passive Antenna for LTE/GNSS

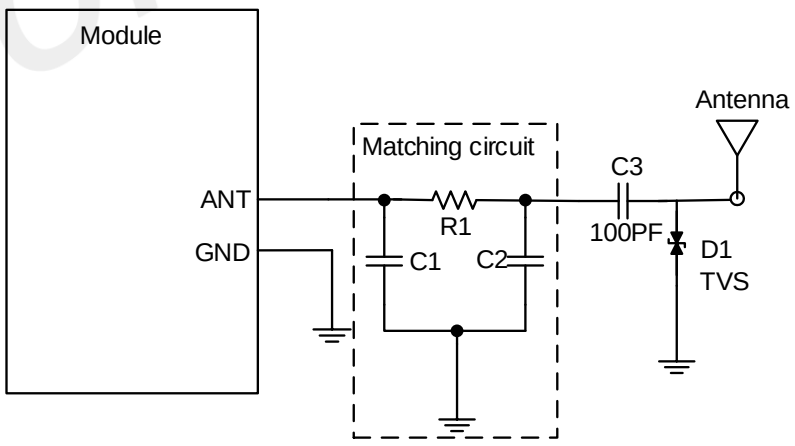

Figure 31: Passive antenna reference

The matching circuit R1 is labeled 0Ω by default, and C1 and C2 are reserved by default, and the

specific value is determined by the antenna optimization, usually provided by the antenna manufacturer.

The antenna port is easy to introduce static electricity, to avoid the internal components of the module being damaged by static electricity, C3 is pasted with a 100pF capacitor by default to enhance ESD protection capability.

It is recommended that D1 choose a suitable two-way TVS protection device placed close to the antenna. It especially needs to pay attention to the influence of TVS junction capacitance value on RF signals. Recommended TVS models are as follows:

Table 53: TVS for RF LTE antenna part number list

No.	manufacturer	Part number	V_{RWM}	V_C(max)	Ppp(max)	C_J(Typ.)	Package
1	BILLSEMI	BLE5V0CR05UB	5V	40V	NA	0.05pF	DFN1006-2

Table 54: TVS for GNSS antenna part number list

No.	manufacturer	Part number	V_{RWM}	V_C(max)	Ppp(max)	C_J(Typ.)	Package
1	WAYON	WE05DGCF-B	5V	23V	70W	0.3pF	DFN1006-2

4.5.2 Active Antenna for GNSS

The module VDD_AUX can be used as a power supply for GNSS active antennas, and AT+CVAUXV can control the output voltage value. For example, with AT+CVAUXV=2800, set the output voltage to 2.8V. The AT command set takes effect once, and this voltage output cannot be turned off.

The GNSS active antenna reference circuit is shown below:

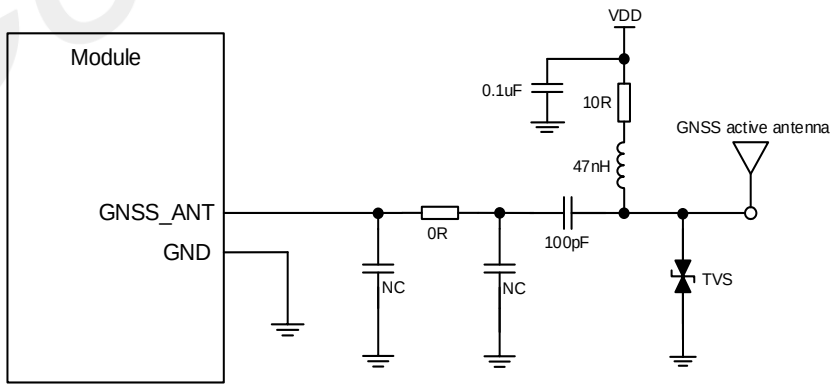

Figure 32: Active antenna reference

※ NOTE

1. VDD_AUX default output voltage and voltage adjustment function are subject to the actual software version.
2. GNSS adopts the active antenna design scheme by default, and C uses 100pF.
3. For customers using the passive antenna scheme, it is recommended to disconnect the power supply path to avoid chip damage caused by passive antenna installation.
4. There may be parallel inductance at the antenna inside the module, showing a similar short circuit phenomenon, which is normal. Please consult SIMCom if you have any doubts about this

4.6 PCB layout

When routing the PCB, the user should pay attention to the impedance design of the PCB trace from the module ANT port to the antenna connection base, and the trace length is recommended to be controlled within 20mm, and away from interference signals such as power clocks.

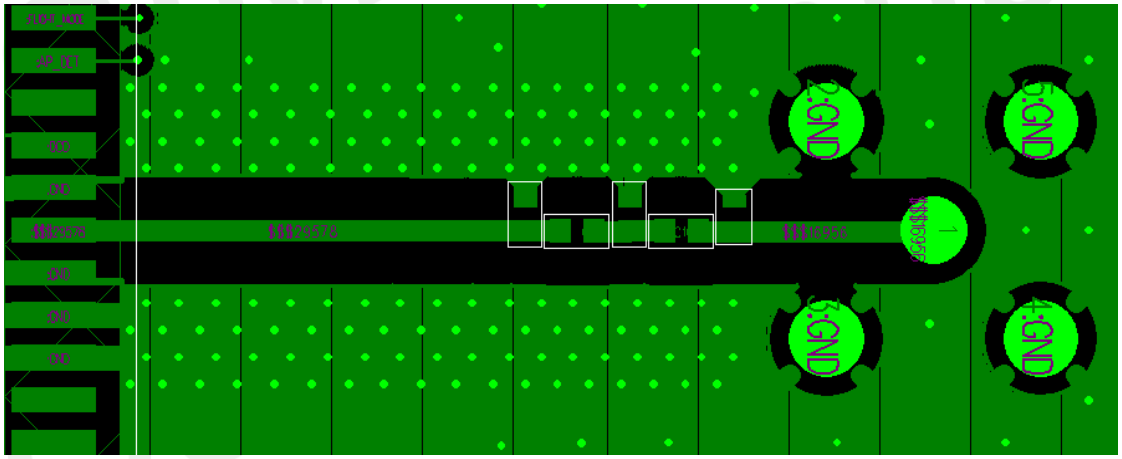

Figure 33: Reference PCB layout

5 Electrical Specifications

5.1 Absolute maximum ratings

The following table shows the absolute maximum in the case of abnormal operation. Exceeding these limits may result in permanent module damage.

Table 55: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage on VBAT	-0.5	-	4.8	V
Voltage on USB_VBUS	-0.5	-	5.4	V
Voltage at digital pins GPIO, UART	-0.3	-	2.0	V
Voltage at IO pins	-0.3	-	2.0	V
USIM	-0.3	-	3.9	V
PWRKEY\RESET	-0.3	-	4.8	V

5.2 Operating conditions

Table 56: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.4	3.8	4.2	V
Voltage at USB_VBUS	3.0	5.0	5.2	V

Table 57: Module operating temperature

Parameter	Min.	Typ.	Max.	Unit
Normal operating temperature	-30	25	75	℃
Extended operating temperature	-40		85	℃
Storage temperature	-40		90	℃

※ NOTE

1. When operating in the normal operating temperature range, the relevant performance of the module meets the requirements of 3GPP standards.
2. When the operating temperature range is extended, the module can maintain the normal working state, with voice, short message, data transmission, emergency calls and other functions. There will be no unrecoverable failure; The radio frequency spectrum and network are unaffected. Only the values of individual indicators, such as output power, may be outside the range of the 3GPP standard. When the temperature returns to the normal operating temperature range, the hands of the module still meet the 3GPP standard.

5.3 Operating Mode

5.3.1 Operating Mode Definition

The following table briefly describes the various working modes that will be mentioned in subsequent sections.

Table 58: Operating mode Definition

Mode		Function
Normal operation	LTE Sleep	In this case, the current module consumption will be reduced to a minimal level and the module can still receive paging message and SMS.
	LTE Idle	Software is active. The module is registered to the network and ready to communicate.
	LTE Talk	Two customers are connected. In this case, the module's power consumption depends on the network and module configuration.
	LTE Data transmission	The data is being transmitted. In this case, the power consumption depends on the network condition (for example, the power control level), the data rates of the upstream and downstream data links, and the network configuration (for example, using a multi-slot configuration).
Minimum functionality mode		AT commands 'AT+CFUN=0',' AT+CSCLK=1' can 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 , the USIM card will not be accessible and UART does not work properly. At this time, the power consumption is extremely low.
Flight mode		AT command 'AT+CFUN=4' or pulling down the FLIGHTMODE

	pin 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 and USB ports are still accessible. The power consumption in this mode is lower than in normal mode.
Power off	The module can go into power-off mode by sending the AT command 'AT+CPOF' or pull down the PWRKEY pin, normally. The power management unit shuts down the power supply in this mode, and software is inactive. The serial port and USB are is not accessible.

5.3.2 Sleep mode

Sleep mode can reduce the current module consumption to a minimal level, and the module can still receive paging messages and SMS.

Module automatically enters sleep mode when the following software and hardware conditions are met:

- UART condition
- USB condition
- Software condition

Refer to the documentation [17] for more information on sleep modes.

5.3.3 CFUN mode

You can do this by running the command "AT+CFUN=<fun>" To set the module to this mode, this command provides three options for setting different functions.

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

Setting AT+CFUN=0 puts the module into minimum functionality mode and turns RF and USIM card functionality off. The serial port and USB can still be used in this case, but RF and USIM card-related functions and some AT commands cannot be used.

After setting "AT+CFUN=4", the module enters Flight Mode and turns off RF functions. The module's serial port and USB can still be used in this case, but RF-related functions and some AT commands cannot be used.

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

Refer to the documentation for details on the "AT+CFUN" command [1].

5.3.4 PSM mode

The module can configure the PSM function through the "AT+CPSMS" command, and the module will automatically enter the PSM mode when the conditions are met. The primary purpose of PSM is to reduce module power consumption and extend battery power supply time.

The PSM process is as follows:

The module is initially in the RRC Connect state, and after the end call, the module enters the Idle state and T3324/T3412 starts timing. When the T3324 timer expires, the module enters the PSM state. In the state of PSM, unless there are external factors to wake up actively, you can only wait for the end of the T3412 timer, the end of the PSM phase. The module will enter the TAU state (tracking area update), then continue a cycle from RRC Connect to RRC Release to idle, starting the second cycle.

Set the PSM instructions as follows:
AT*COMCFG=1,,,,,254 Enable 1bis
AT+CFUN=0
AT+CPSMS=1,,,"01100101","00000101"// Enable PSM
AT+MEDCR=0,103,1// Start hardware psm
AT+MEDCR=0,71,2// Set the wake time to 2min
AT+CFUN=1 Enables the network

When the module enters PSM mode, the network connection is terminated, and the module cannot respond to the user's request. If the customer needs to issue commands to the module after the PSM phase (T3412 timer timeout) or pull PWRKEY to wake up the module, send commands AT+CPSMS=0, and the module will exit the PSM mode.

5.4 Current Consumption of VBAT

Table 59: Current consumption of VBAT in each mode
(VBAT=3.8V, GNSS off, without USB connection)

PSM Mode	
PSM mode consumption	Typical values: 141uA
Flight Mode Sleep	
Flight mode sleep consumption (Without USB connection)	Flight mode @AT+CFUN=0, AT+CSCLK=1 Typical values: 1mA
LTE Sleep/Idle Mode	
LTE supply current	Sleep Mode @DRX=0.32S Typical values：2mA Sleep Mode @DRX=0.64S Typical values：1.5mA Sleep Mode @DRX=1.28S Typical values：1.5mA Sleep Mode@DRX=2.56S Typical values：1mA Idle mode Typical values：17mA

LTE Cat1		
LTE-FDD B1	@5MHz	23.0dBm Typical values：624mA
LTE-FDD B3	@5MHz	23.0dBm Typical values：600mA
LTE-FDD B5	@5MHz	23.0dBm Typical values：665mA
LTE-FDD B8	@5MHz	23.0dBm Typical values：607mA
LTE-TDD B34	@5MHz	23.0dBm Typical values：575mA
LTE-TDD B38	@5MHz	23.0dBm Typical values：655mA
LTE-TDD B39	@5MHz	23.0dBm Typical values：604mA
LTE-TDD B40	@5MHz	23.0dBm Typical values：559mA
LTE-TDD B41	@5MHz	23.0dBm Typical values：657mA

5.5 Current Consumption of GNSS operation

Table 60: VBAT current consumption during GNSS operation
(VBAT=3.8V, @AT+CFUN=0, without USB connection)

Mode	Positioning system	Condition	Typical value (mA)
GNSS signal generator	GPS	-130dBm/Tracking	29.93
		-145dBm/Tracking	29.06
		-130dBm/ Cold start	53.03
		-145dBm/ Cold start	52.26
		Loss of positioning	53.43
GNSS signal generator	GPS+BD	-130dBm/Tracking	29.46
		-145dBm/Tracking	29.26
		-130dBm/ Cold start	52.86
		-145dBm/ Cold start	52.28
		Loss of positioning	52.05
Real network passive antenna	GPS	Acquisition	53.80
		Tracking	29.69
		Loss of positioning	52.81
Real network passive antenna	GPS+BD	Acquisition	53.93
		Tracking	29.77
		Loss of positioning	53.06

5.6 ESD Notes

The module is electrostatic sensitive. Therefore, customers must take ESD protection precautions

when producing, assembling, and operating the module. The following table describes the electrostatic performance parameters of the module:

Table 61: The ESD performance measurement table (Temperature: 25℃, Humidity: 45%.)

Part	Contact Discharge	Air Discharge
VBAT, GND	+/-4K	+/-8K
Antenna port	+/-4K	+/-8K
USB interface	+/-4K	+/-6K
UART interface	+/-3K	+/-6K
Other PINS	+/-1K	+/-2K

※ NOTE

Test conditions: The module is on the SIMCom EVB (the EVB has the necessary ESD protection devices), not single module test data.

6 Manufacturing

6.1 Top and Bottom View of Module

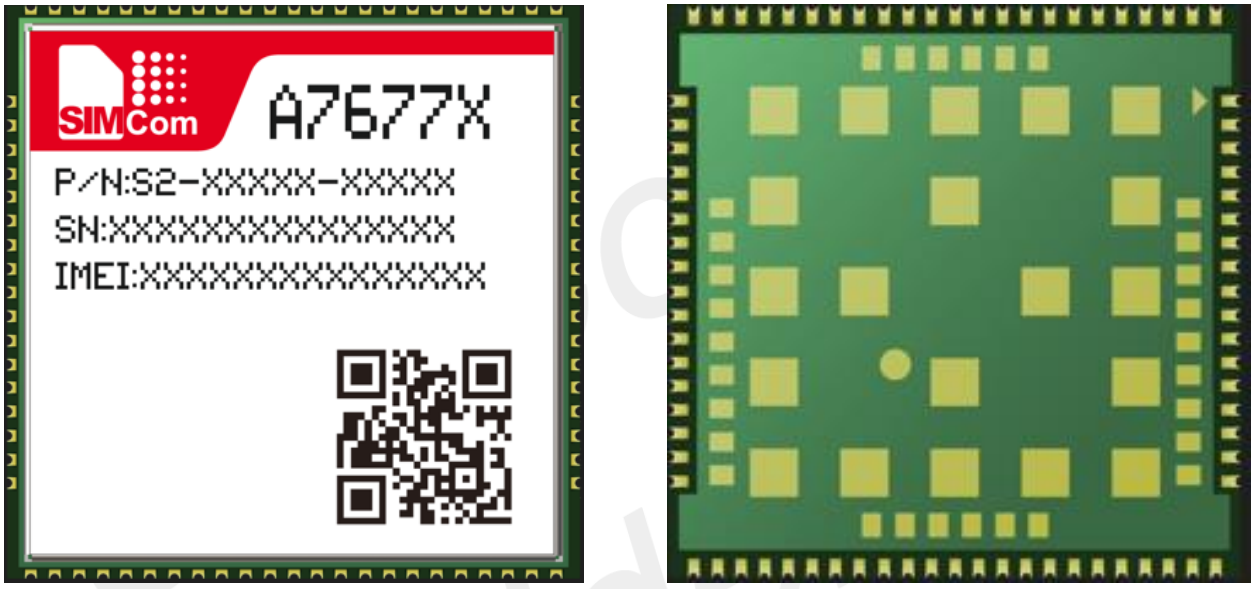

Figure 34: Top and bottom view of A7677S-MANS/MANV/LANS/LANV

6.2 Label Information

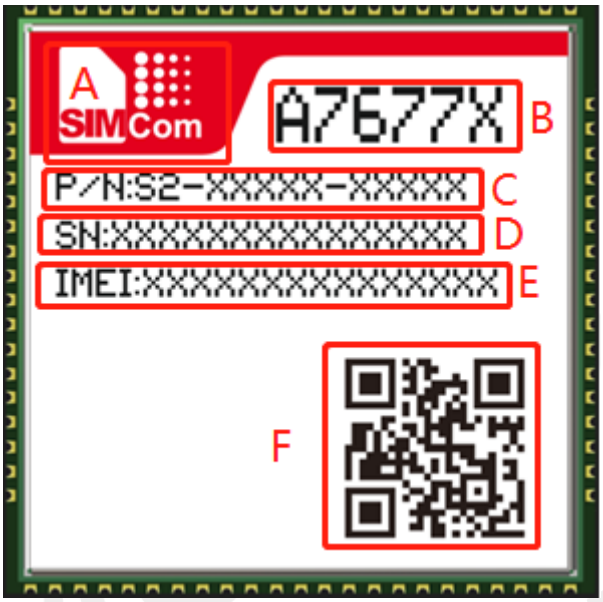

Figure 35: Label information for A7677S

Table 62: The description of label information

No.	Description
A	Logo
B	Project name
C	Product P/N Number
D	Serial number
E	International mobile equipment identity
F	QR code

※ NOTE

The above is the design effect diagram of the module for reference. The actual appearance is subject to the actual product.

6.3 Recommended reflow furnace temperature curve

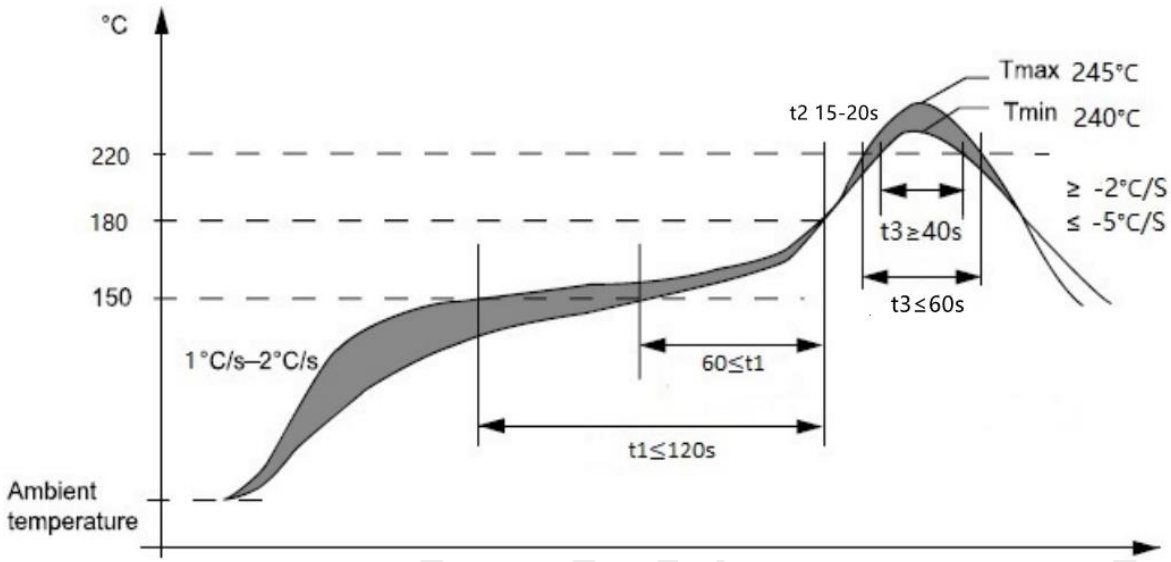

Figure 36: The ramp-soak-spike reflow profile of the module

Table 63: Motherboard Reflow Temperature Profile Requirements (Pb-free)

Zone	Time	Parameter
Preheat Zone (Room temperature~150℃)	NA	Heating rate: 1~2℃/s
T1 (150~180℃)	60~120s	/
T2 (180~220℃)	15~20s	/
T3 (≥220℃)	40~60s	Peak temperature: 240~245℃
Cooling Zone	NA	Cooling rate: -2~-5℃/s

※ NOTE

- The maximum times of refluxes for the module is once.
- Recommended lead-free process.
- In the table above, the temperature testing location includes the solder mask of the module MCU pins, bottom LGA pins, and external LCC pins.
- The actual welding temperature is affected by other external factors, such as the presence of furnace carriers, solder paste, size and thickness of the substrate, and component resistance. Thermal requirements and panel design, etc. Please confirm with our engineering and technical personnel in time if the recommended parameters cannot be reached. Otherwise, the module may be damaged.
- It is recommended to use board supported by furnace carrier or high Tg to prevent warping and PCB when heated. Deformation, thus affecting module welding.
- After the module is welded, X-ray and optical inspection methods shall be used to check the welding quality. For specific standards, please refer to relevant standards of IPC-A-610H.
- For more information about shipping and manufacturing, please refer to “Module Secondary SMT Process User Guide”.
- Due to the complexity of the SMT process, in case of uncertainty or processes not mentioned in this document (such as selective wave soldering, ultrasonic welding), please contact SIMCom support team before SMT process starts.

6.4 Moisture Sensitivity Level and Storage conditions

Modules are shipped in vacuum-sealed aluminum foil bag bags, vacuum packaging according to IPC/JEDEC standard J-STD-020C specification.

- Recommended storage conditions: temperature 23℃± 5℃, and relative humidity 35%~60%.
- Storage period: 12 months (Under recommended storage conditions and in sealed vacuum packaging).

The module meets the humidity sensitivity level 3 (MSL-3), and the storage period after unpacking is shown in table below.

The out-of-bag floor life of the module with MSL-3 is 168 hours. If the workshop temperature is 23℃ ±5℃ and the relative humidity is less than 60%, the module needs to be unpacked within 168 hours of reflux production or other high temperature operations. Otherwise, the module shall be stored in an environment with relative humidity less than 10% (for example, a moisture-proof cabinet) to keep the product dry.

Table 64: MSL levels

MSL	Out-of-bag floor life	Comment
1	Unlimited	≤+30℃/85% RH
2	1 year	≤+30℃/60% RH
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.	

Before use, it is necessary to confirm whether the package is in good condition; After unpacking, check the status of humidity indicator card in vacuum bag (Figure 33). The module needs to be baked before use if any of the following conditions occur.

- Explanation Humidity indicator card: 30%, 40%, and 50% of any indicator circle has discolouring
- The module has been un-packed and the module exceeds the humidity sensitivity level corresponding to the exposed workshop time. For example, MSL=3 is 168.
- Packed，but the Shelf Life exceeds 12 months；
- Exceeds the Floor Life；
- Unable to track and determine the status of the module.

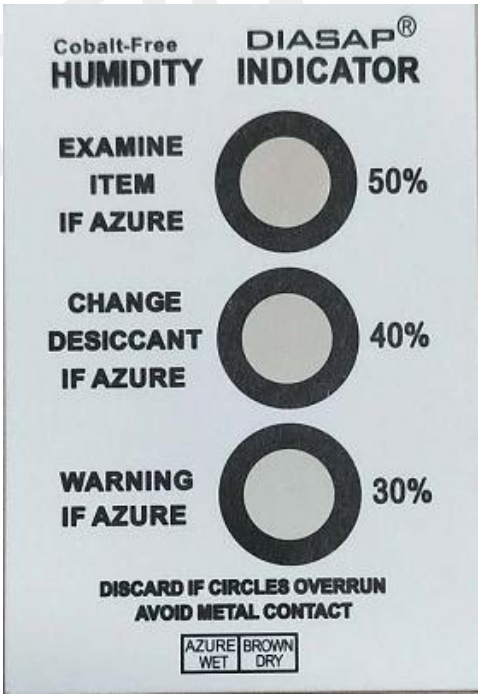

Figure 37: Humidity card

The following conditions also need to be pre-baked.

- The storage temperature and humidity do not meet the recommended storage conditions.
- Vacuum sealed bag leak, bulk materials
- Before repairing the module.
- After unpacking, the module failed to complete production or storage under the control of humidity sensitive level 3.

6.5 Baking Requirements

If baking is required, proceed according to the requirements in the table below. Preferentially choose a nitrogen-filled oven.

Table 65: Baking Requirements

Baking conditions	Baking time	Comment
120°C±5°C, <5% RH	8 hours	Not applicable to original packaging pallets

NOTE

- In order to prevent and reduce the occurrence of poor welding caused by moisture, such as foaming and delamination, the module should be strictly controlled. It is not recommended to expose the module to air for a long time after unpacking the vacuum package。
- Before baking, it is necessary to remove the module from the package and place the bare module on the high temperature resistant device to avoid high temperature damage to the plastic tray or coil; The modules for secondary baking must be welded within 24 hours after baking, otherwise they need to be stored in vacuum packaging or in a drying oven.
- Please pay attention to ESD protection when unpacking and placing modules, such as wearing anti-static gloves.

7 Packaging

Module support tray packaging.

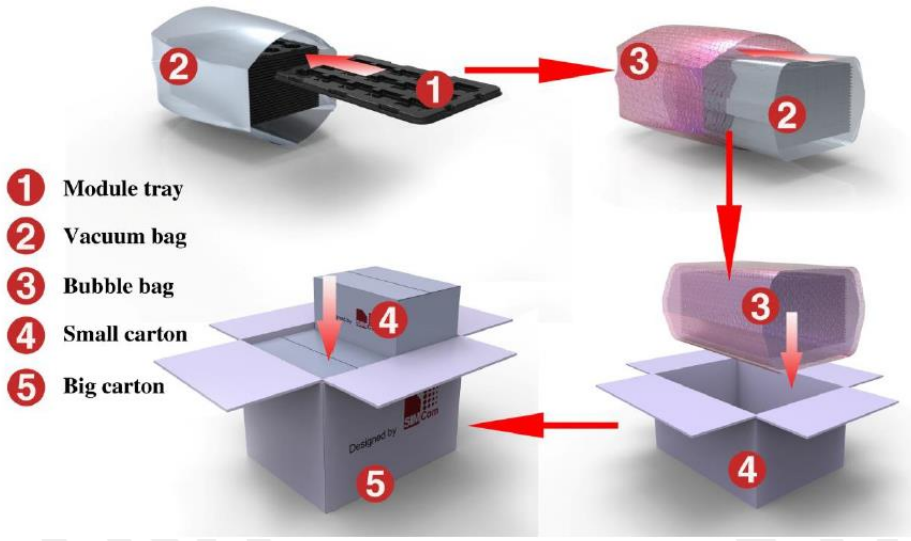

Figure 38: Packaging diagram

Module tray drawing:

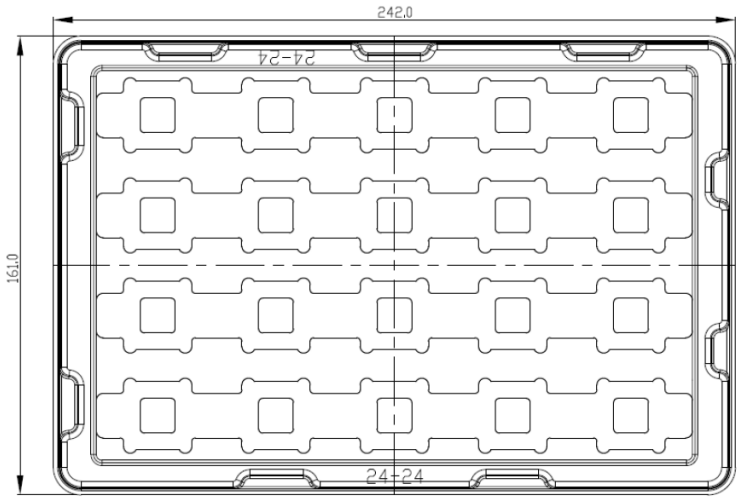

Figure 39: Tray drawing

Table 66: Tray size

Length (±3mm)	Width (±3mm)	Module number
242.0	161.0	20

Small carton drawing:

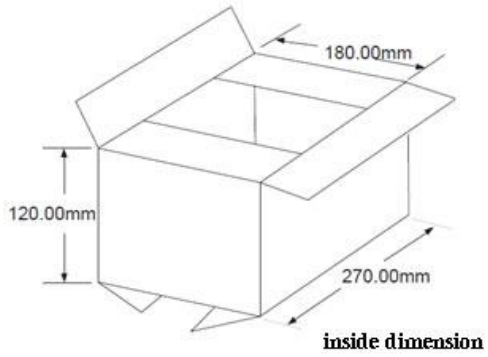

Figure 40: Small carton drawing

Table 67: Small Carton size

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

Big carton drawing:

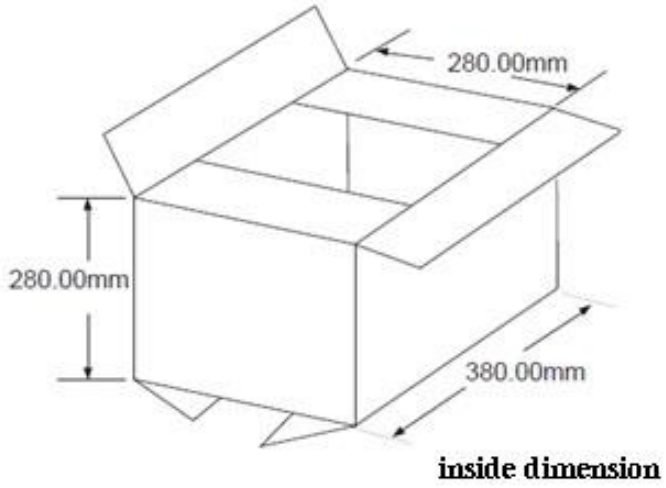

Figure 41: Big carton drawing

Table 68: Big Carton size

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

8 Appendix

8.1 Encoding method and maximum data rate

Table 69: Encoding method and maximum data rate

Multislot Definition (GPRS/EDGE)			
Slot Class	**DL Slot Number**	**UL Lot Number**	**Active Slot Number**
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5
LTE-FDD Device Category (Downlink)	**Max Data Rate (peak)**		**Modulation Type**
Category 1	10Mbps		QPSK/16QAM/64QAM
Category 2	50Mbps		QPSK/16QAM/64QAM
Category 3	100Mbps		QPSK/16QAM/64QAM
Category 4	150Mbps		QPSK/16QAM/64QAM
LTE-FDD Device Category (Uplink)	**Max Data Rate (peak)**		**Modulation Type**
Category 1	5Mbps		QPSK/16QAM
Category 2	25Mbps		QPSK/16QAM
Category 3	50Mbps		QPSK/16QAM
Category 4	50Mbps		QPSK/16QAM

8.2 Reference Documents

Table 70: Reference Documents

No.	Title	Description
[1]	A1602 & 1606 Series_AT Command Manual	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]	A76XX Series_UART_Application Note	This document describes how to use UART interface of SIMCom modules.
[16]	Antenna design guidelines for diversity receiver system	Antenna design guidelines for diversity receiver system
[17]	A76XX Series_Sleep Mode_Application Note	Sleep Mode Application Note
[18]	A76XX Series_UIM HOT SWAP_Application Note	This document introduces UIM card detection and UIM hot swap.
[19]	Module Secondary SMT Process User Guide_V1.01	This paper mainly introduces the SMT process of module production, the requirements of steel mesh production, reflow welding, welding and repair

8.3 Terms and Abbreviations

Table 71: 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
USIM	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
Abbreviation of telephone book	
FD	USIM fix dialing phonebook
LD	USIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ON	USIM (or ME) own numbers (MSISDNs) list
RC	Mobile Equipment list of received calls
SM	USIM phonebook
NC	Not connect

8.4 Safety Caution

Pay attention to the following safety precautions when using or repairing any terminal or cell phone containing modules. The terminal device shall inform the customer of the following safety information. Otherwise, SIMCom will not be liable for any consequences arising from the customer's failure to act on these warnings.

Table 72: 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 operating 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.