



A7672X Series Hardware Design

LTE Module

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1 Introduction

This document describes the hardware interface of the module, which can help users quickly understand the interface definition, electrical performance and structure size of the module. Combined with this document and other application documents, users can understand and use A7672X module to design and develop applications quickly. SIMCom provides a set of evaluation boards to facilitate A7672X module testing and use. The evaluation board tools include an EVB board, a USB cable, an antenna, and other peripherals.

1.1 Product Outline

Aimed at the global market, the module supports GSM, LTE-TDD and LTE-FDD. Users can choose the module according to the wireless network configuration. The supported radio frequency bands are described in the following table.

Table 1: Module frequency bands

Standard	Frequency	A7672S	A7672E	A7672SA
GSM	900MHz	✓	✓	✓
	1800MHz	✓	✓	✓
LTE-FDD	LTE-FDD B1	✓	✓	✓
	LTE-FDD B2			✓
	LTE-FDD B3	✓	✓	✓
	LTE-FDD B4			✓
	LTE-FDD B5	✓	✓	✓
	LTE-FDD B7		✓	✓
	LTE-FDD B8	✓	✓	✓
	LTE-FDD B20		✓	
	LTE-FDD B28			✓
	LTE-FDD B66			✓
LTE-TDD	LTE TDD B34	✓		
	LTE TDD B38	✓		
	LTE TDD B39	✓		
	LTE TDD B40	✓		
	LTE TDD B41	✓		
Category		CAT1	CAT1	CAT1
GNSS		Optional	Optional	Optional
BlueTooth		Optional	Optional	Optional

With a small physical dimension of 24*24*2.4mm and with the functions integrated, the module can meet almost any space requirement in users' applications, such as smart phone, PDA, industrial handheld, machine-to-machine and vehicle application, etc.

A7672X provides 124 pins, including 80 LCC pins in the outer ring and 44 LGA pins in the inner ring. This document will introduce all the functional pins.

1.2 Hardware Interface Overview

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

- Power Supply
- USB 2.0 Interface
- Three UART Interface, one full function serial port, one ordinary serial port and one debug serial port
- USIM Interface
- General ADC Interface
- VBAT ADC Interface
- 4*4 matrix keyboard
- Analog audio MIC input interface
- Analog audio SPK output interface
- SPI Interface
- LDO Power Output
- I2C Interface
- General input and output interfaces (GPIO)
- SPI LCD Interface
- SPI Camera Interface
- Antenna Interface
- USB_BOOT interface
- Network status indication interface
- Module operation status indication interface

1.3 Hardware Block Diagram

The block diagram of the A7672X module is shown in the figure below.

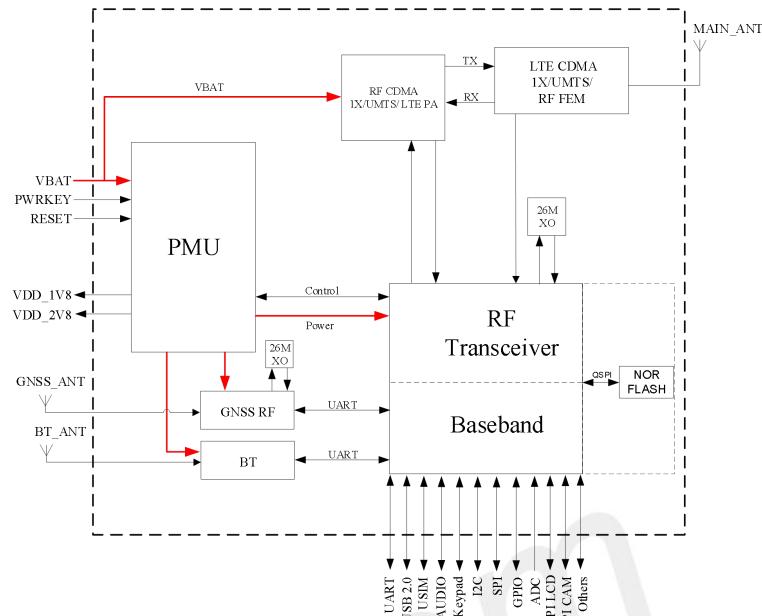


Figure 1: A7672X block diagram

1.4 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	VBAT: 3.4V ~4.2V, Recommended VBAT: 3.8V
Power saving	Current in sleep mode: TBD
Radio frequency bands	Please refer to the table 1 GSM/GPRS power level: -- EGSM900: 4 (33dBm±2dB) -- DCS1800: 1 (30dBm±2dB)
Transmitting power	EDGE power level: -- EGSM900: E2 (27dBm±3dB) -- DCS1800 : E1 (26dBm+3dB/-4dB) LTE power level: 3 (23dBm±2.7dB)
Data Transmission Throughput	GPRS Multiple time slot level 12 EDGE Multiple time slot level 12 TDD/FDD-LTE category 1 : 10 Mbps (DL),5 Mbps (UL)
Antenna	GSM/LTE antenna interface GNSS antenna interface(optional) Bluetooth antenna interface(optional)
SMS	MT, MO, CB, Text, 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
USIM application toolkit	Support SAT class 3, GSM 11.14 Release 98 Support USAT
Phonebook management	Support phonebook types: SM/FD/ON/AP/SDN
Audio feature	Support analog audio interface
UART interface	<ul style="list-style-type: none"> • Full function serial port Baud rate support from 300bps to 3686400bps AT command and data can be sent through serial port Support RTS/CTS Hardware flow control Support serial port multiplexing function conforming to GSM 07.10 protocol • Debug serial port Support debug usage • UART3 serial port Ordinary serial port
USB	<p>USB 2.0 compliant, host mode not supported.</p> <p>This interface can be used for AT command sending, data transmission, software debugging and upgrading.</p>
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	<p>Size:24*24*2.4m</p> <p>Weight:2.8±0.1g</p>
Temperature range	<p>Normal operation temperature: -30°C to +80°C</p> <p>Extended operation temperature: -40°C to +85°C*</p> <p>Storage temperature -45°C to +90°C</p>

NOTE

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

2 Package Information

2.1 Pin Assignment Overview

The following Figure is a high-level view of the pin assignment of the module for A7672X.

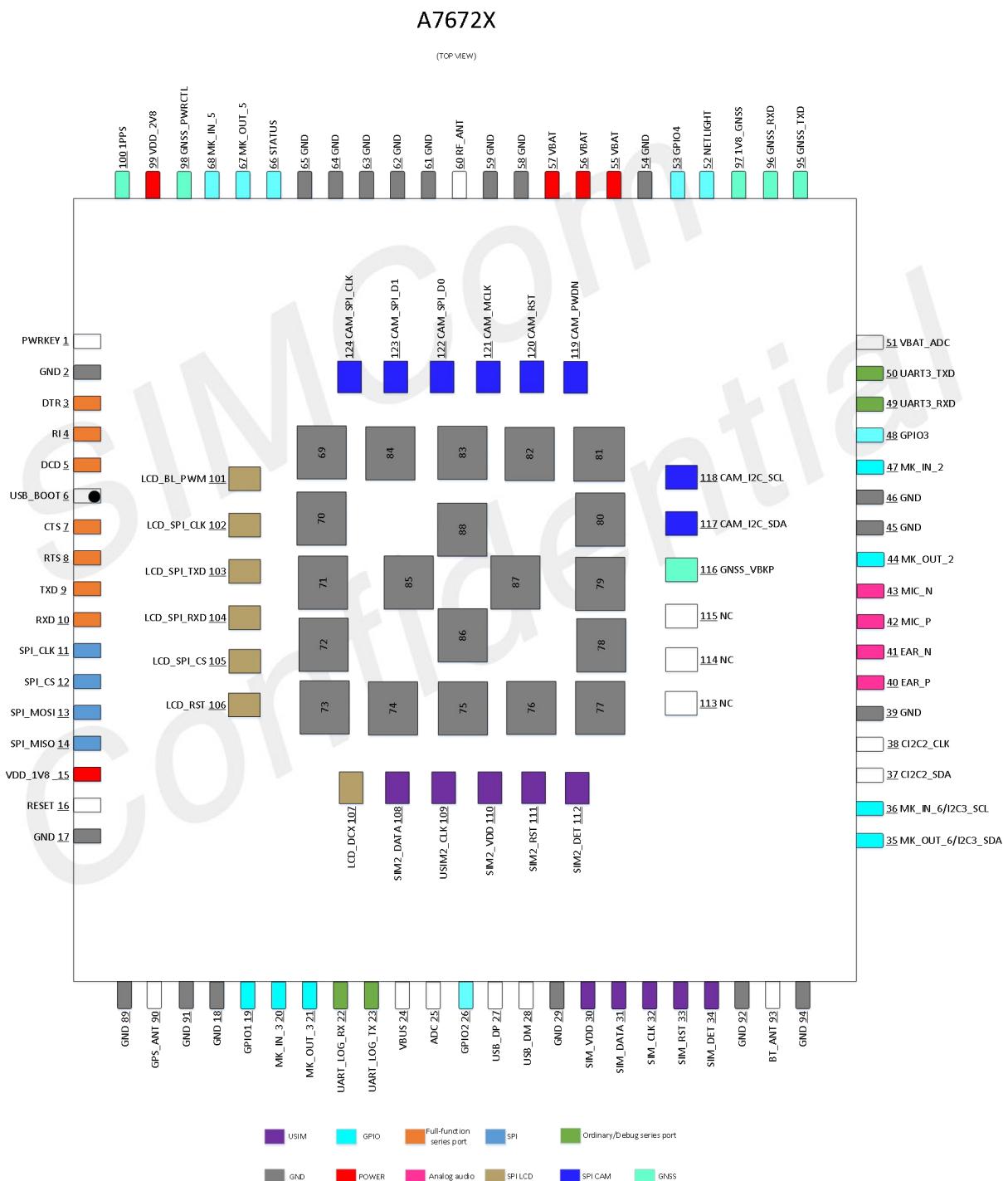


Figure 2: Pin assignment overview for A7672X

Table 3: 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_1V8	16	RESET
17	GND	18	GND
19	GPIO1	20	MK_IN_3
21	MK_OUT_3	22	UART_LOG_RX
23	UART_LOG_TX	24	VBUS
25	ADC	26	GPIO2
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/I2C3_SDA	36	MK_IN_6/I2C3_SCL
37	I2C_SDA	38	I2C_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	GPIO3
49	UART3_RXD	50	UART3_TXD
51	VBAT_ADC	52	NETLIGHT
53	GPIO4	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	BT_ANT	94	GND
95	GNSS_TXD	96	GNSS_RXD
97	1V8_GNSS	98	GNSS_PWRCTL
99	VDD_2V8	100	1PPS
101	LCD_BL_PWM	102	LCD_SPI_CLK
103	LCD_SPI_TXD	104	LCD_SPI_RXD
105	LCD_SPI_CS	106	LCD_RST
107	LCD_DCX	108	USIM2_DATA
109	USIM2_CLK	110	USIM2_VDD
111	USIM2_RST	112	USIM2_DET
113	NC	114	NC
115	NC	116	GNSS_VBKP
117	CAM_I2C_SDA	118	CAM_I2C_SCL
119	CAM_PWDN	120	CAM_RST
121	CAM_MCLK	122	CAM_SPI_D0
123	CAM_SPI_D1	124	CAM_SPI_CLK

NOTE

'•' Indicates that these Pins cannot be pulled down before the module powered up, otherwise it will affect the normal start-up of the module.

2.2 Pin Description

Table 4: Pin parameter abbreviation

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: 1.8V IO parameters definition

Power Domain	Parameter	Description	Min	Typ.	Max
	VIH	High level input	VCC * 0.7	1.8V	VCC + 0.2
	VIL	Low level input	-0.3V	0V	VCC * 0.3
	Rpu	Pull up resistor	55KΩ	79 KΩ	121 KΩ
	Rpd	Pull down resistor	51 KΩ	87 KΩ	169 KΩ
	IIL	Input leakage current	-	-	10uA
	VOH	Output level range	VCC - 0.2	-	-
	VOL	Output low range	-	-	0.2V
	IOL	Maximum current driving capacity at low level output	-	-	13mA
	IOH	Maximum current driving capacity at high level output Vpad=VCC-0.2V	-	-	11mA

Table 6: 3.3V IO parameters definition

Power Domain	Parameter	Description	Min	Typ.	Max
3.3V	VIH	High level input	2V	1.8V	VCC + 0.3
	VIL	Low level input	-0.3V	0V	0.8V
	Rpu	Pull up resistor	26KΩ	47 KΩ	72 KΩ
	Rpd	Pull down resistor	27 KΩ	54 KΩ	267 KΩ
	IIL	Input leakage current	-	-	10uA
	VOH	Output level range	2.4V	-	-
	VOL	Output low range	-	-	0.4V
	IOL	Maximum current driving capacity at low level output	-	-	7mA
	IOH	Maximum current driving capacity at high level output Vpad=VCC-0.5V	-	-	7mA

Table 7: Pin description

Pin name	Pin No.	Pin parameter		Description	Note
		Power domain	Type		
Power supply					
VBAT	55,56, 57	-	PI	Module input voltage ranges from 3.4V to 4.2V, Typical values is 3.8V. and the peak current value can reach 2A.	
VDD_1V8	15	-	PO	1.8V power output, output current up to 50 mA. Cannot provide to high power load, can provide power for level conversion circuit, etc.	Can provide 1V8 power supply for GNSS. If unused, keep it open.
VDD_2V8	99	-	PO	Internal 2.8V power output, output current up to 50 mA. Cannot provide to high power load.	Can provide 2V8 power supply for LCD VCC_2V8. If unused, keep it open.
GND	2,17,1 8, 29,39, 45,46, 54,58, 59,61, 62,63, 64,65, 69,70, 71,72, 73,74, 75,76, 77,78, 79,80, 81,82, 83,84, 85,86, 87,88, 89,91, 92,94	-	-	Ground	
System Control					
PWRKEY	1	-	DI,PU	Power ON/OFF input, active low. VIH: 0.7*VBAT VIL: 0.3*VBAT	PWRKEY has been internally pulled-up to VBAT with 50KΩ resistor, default high.
RESET	16	-	DI,PU	System reset control input, active low. VIH: 0.7*VBAT VIL: 0.3*VBAT	RESET has been pulled-up to VBAT with 50KΩ (typical) resistor, default high.

USIM interface

USIM1_DATA	31	1.8/3.0V	I/O,PU	USIM bus data, this pin has been pull-up with 4.7KΩ resistor to USIM1_VDD.	
USIM1_RST	33	1.8/3.0V	I/O,PU	USIM bus reset output.	
USIM1_CLK	32	1.8/3.0V	I/O,PU	USIM bus clock output.	
USIM1_VDD	30	1.8/3.0V	PO	USIM card power supply output, supports 1.8v/3.0v output according to the card type, its output current is up to 50mA.	
USIM1_DET	34	1.8V	I/O,PU	USIM insert detect, it can be set to high/low active with the AT command, refer to Document [25]	
USIM2_DATA	108	1.8/3.0V	I/O,PU	USIM bus data, this pin need pull-up with 4.7KΩ resistor to USIM2_VDD externally.	
USIM2_RST	111	1.8/3.0V	I/O,PU	USIM bus reset output.	
USIM2_CLK	109	1.8/3.0V	I/O,PU	USIM bus clock output.	
USIM2_VDD	110	1.8/3.0V	PO	USIM card power supply output, supports 1.8v/3.0v output according to the card type, its output current is up to 50mA.	
USIM2_DET	112	1.8V	DI,PD	USIM insert detect, it can be set to high/low active with the AT command, refer to Document [25]	

USB interface

VBUS	24	-	AI	Valid USB detection input. Active high, Vmax(valid)=3.0V, Vmax(detection)=5.2V	
USB_DM	28	-	I/O	Negative line of the differential, bi-directional USB signal.	
USB_DP	27	-	I/O	Positive line of the differential, bi-directional USB signal.	

Full function UART interface

RTS	8	1.8V	DI	RTS input	
CTS	7	1.8V	DO	CTS output	
RXD	10	1.8V	DI	Data input	
TXD	9	1.8V	DOH	Data output	
RI	4	1.8V	DO	Ringing indicator	
DCD	5	1.8V	DO	Carrier detection	
DTR	3	1.8V	DI	DTE Ready	

If unused, keep it open.

Debug UART

UART_LOG_TXD	23	1.8V	DOH	Log output	
UART_LOG_RXD	22	1.8V	DI	Log input	Default used as debug port.

Serial Port UART3

UART3_TXD	50	1.8V	DOH	Log output	Two-wire serial port
UART3_RXD	49	1.8V	DI	Log input	
I2C interface					
I2C_SCL	38	1.8V	DO	I2C clock output	If unused, keep it open. Need pull up to VDD_1V8 externally.
I2C_SDA	37	1.8V	I/O	I2C data I/O	
SPI interface					
SPI_CLK	11	1.8V	I/O,PD	SPI clock	
SPI_CS	12	1.8V	I/O,PD	SPI chip selection	
SPI_MOSI	13	1.8V	DO,PD	SPI Main output slave input	
SPI_MISO	14	1.8V	DI,PD	SPI Main input slave output	
Analog audio interface					
EAR_P	40	1.8V	AIO	Earphone output positive	
EAR_N	41	1.8V	AIO	Earphone output negative	
MIC_P	42	1.8V	AIO	MIC input positive	
MIC_N	43	1.8V	AIO	MIC input negative	
GPIO					
GPIO1	19	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO2	26	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO3	48	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO4	53	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GNSS Interface					
GNSS_PWRCTL	98	1.8V	DI	The enable control PIN of GNSS power supply.	Active high.
1V8_GNSS	97	-	PI	The power input for GNSS, the input voltage must not be less than 1.8V.	Module VDD_1V8 (PIN 15) can be used for this power supply
GNSS_VBKP	116	-	PI	GNSS VRTC power input, input voltage 1.4V~3.6V	If unused, keep it open.
1PPS	100	1.8V	DO	1PPS signal output	If unused, keep it open.
GNSS_RXD	96	1.8V	DI	GNSS UART RX	Connect to MCU UART_TX; Or use 10K resistors in series in module

					UART3_TX (pin 50).
GNSS_TXD	95	1.8V	DO	GNSS UART TX	Connect to MCU UART_RX; Or use 10K resistors in series in module UART3_RX (pin 49).

SPI LCD Interface

LCD_BL_PWM	101	1.8V	DO	LCD backlight adjusting PWM	
LCD_SPI_CLK	102	1.8V	DO	SPI clock	
LCD_SPI_TXD	103	1.8V	DI, DO	SPI DATA(Bidirectional)	
LCD_SPI_RXD	104	1.8V	DI	SPI DATA	
LCD_SPI_CS	105	1.8V	DO	SPI CS	
LCD_RST	106	1.8V	DO	LCD Reset	
LCD_DCX	107	1.8V	DO	Command/parameter selection	

SPI CAMERA Interface

CAM_I2C_SDA	117	1.8V	DI, DO	Camera I2C data	
CAM_I2C_SCL	118	1.8V	DO	Camera I2C clock	
CAM_PWDN	119	1.8V	DO	Camera power down	
CAM_RST	120	1.8V	DO	Camera reset	
CAM_MCLK	121	1.8V	DO	Camera main clock	
CAM_SPI_D0	122	1.8V	DI	Camera SPI D0	
CAM_SPI_D1	123	1.8V	DI	Camera SPI D1	
CAM_SPI_CLK	124	1.8V	DO	Camera SPI clock	

ANT interface

RF_ANT	60	-	AIO	Main antenna	
GNSS_ANT	90	-	AIO	GNSS antenna	
BT_ANT	93	-	AIO	Bluetooth antenna	

Other pins

ADC	25	-	AI	General Purpose ADC	If unused, keep it open.
VBAT_ADC	51	-	AI	VBAT ADC	If unused, keep it open.
NETLIGHT	52	1.8V	DO	Network registration status indicator (LED). For more detail, please refer the chapter 3.12.	
STATUS	66	1.8V	DO	Module status indicator (LED).	
USB_BOOT	6	1.8V	DI	Firmware download guide	Do place 2 test

			control input. when pull-up to GND and press PWRKEY, module will access in USB download mode.	points for debug. Do not pull down USB_BOOT during normal power up !
--	--	--	---	---

NOTE

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

2.3 Mechanical Information

The following figure shows the package outline drawing of A7672X.

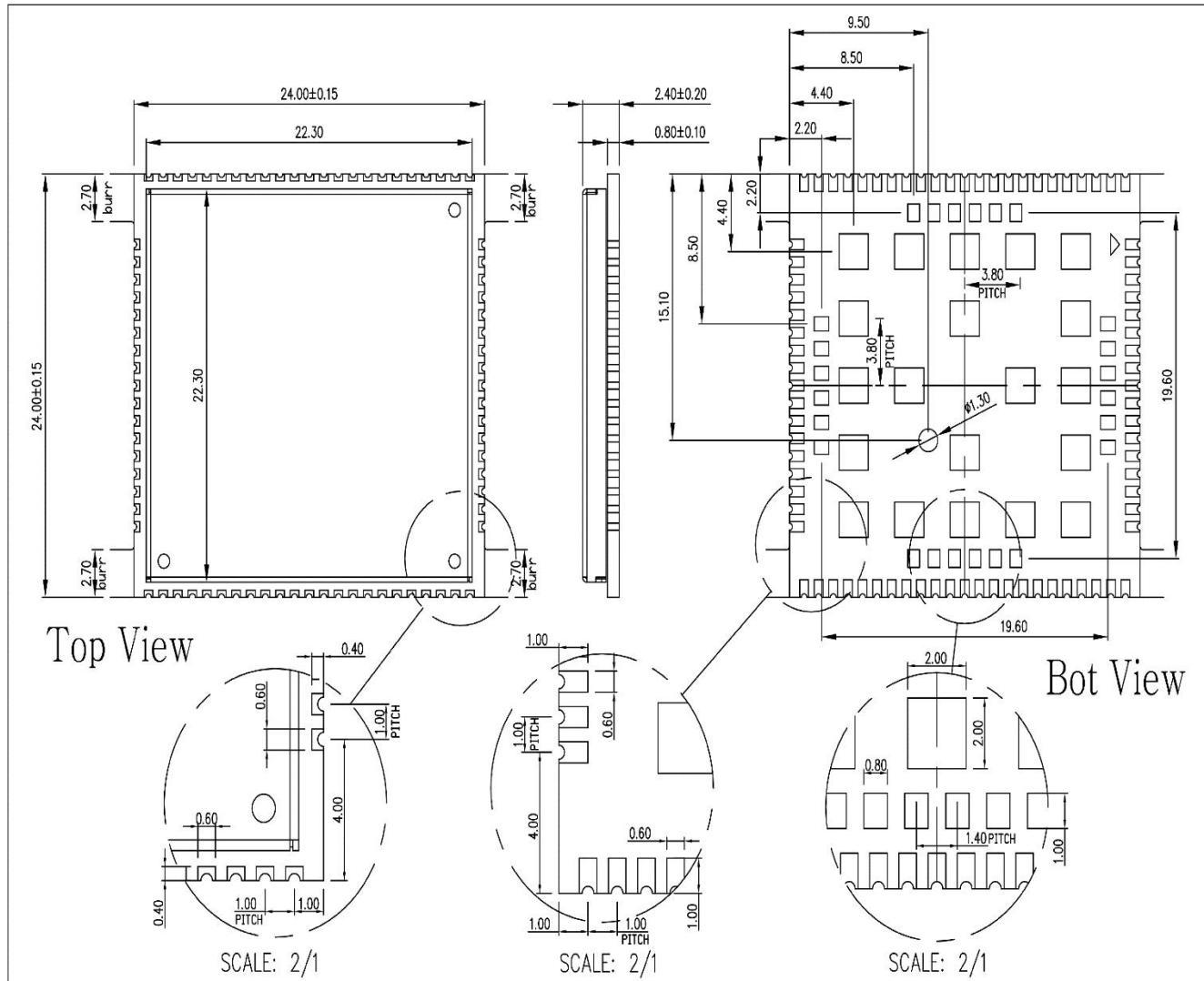


Figure 3: Dimensions (Unit: mm)

NOTE

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

2.4 Footprint Recommendation

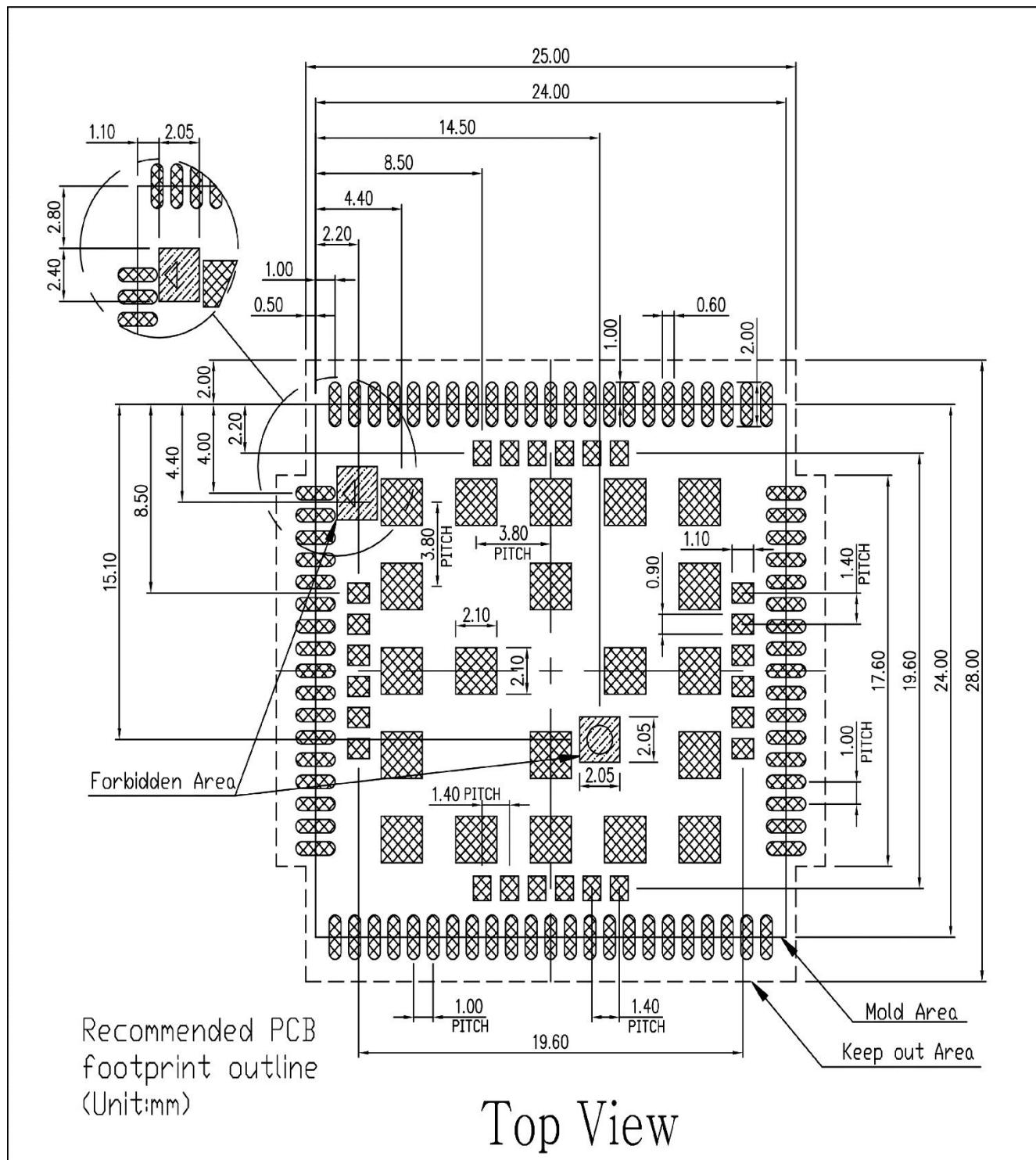


Figure 4: Footprint recommendation (Unit: mm)

2.5 Recommend Stencil Size

Recommend stencil thickness \geq 0.12mm and $<$ 0.15mm.

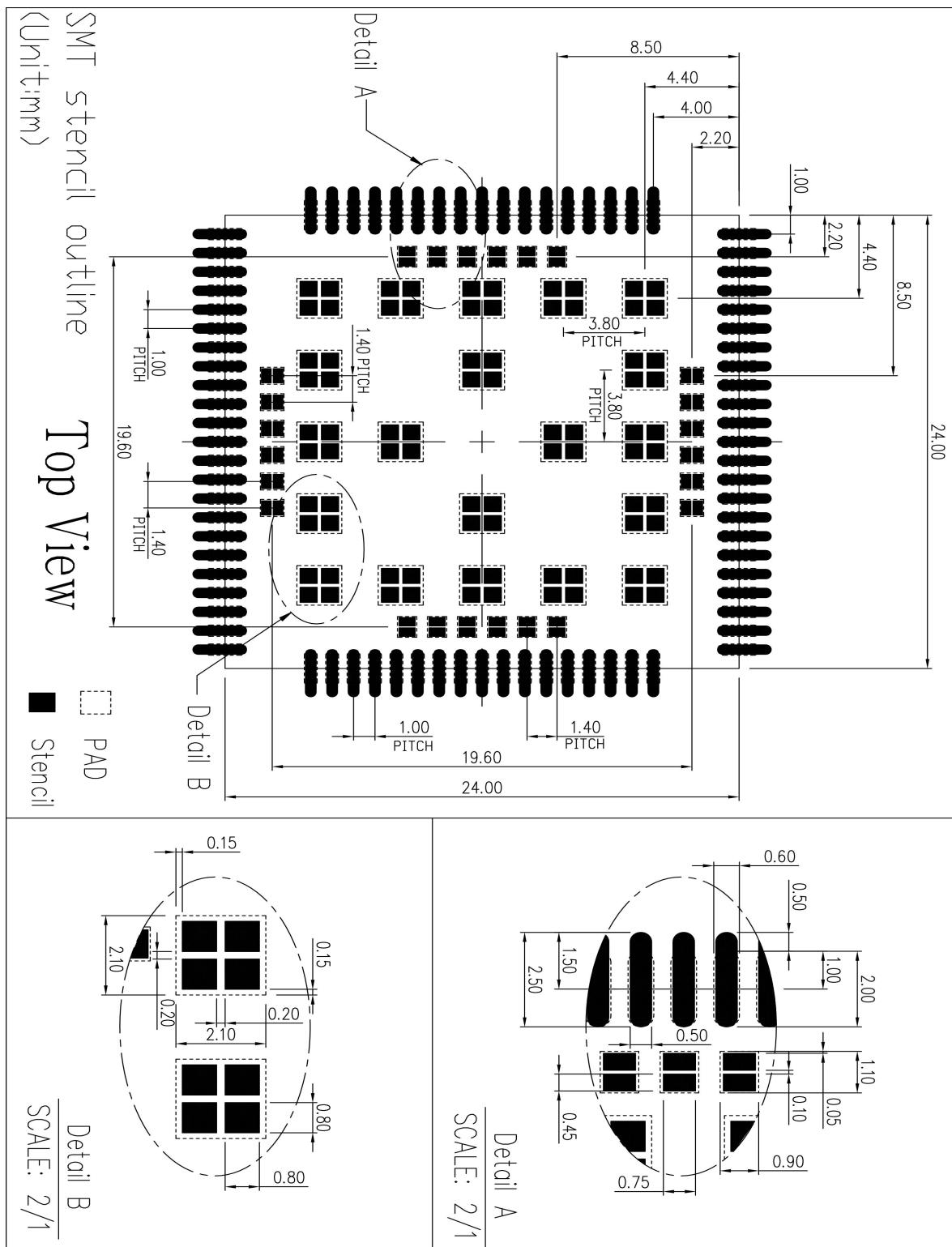


Figure 5: Recommend stencil dimension (Unit: mm)

3 Interface Application

3.1 Power Supply

A7672X offers 3 power supply pins (55, 56, 57) as VBAT power input pin. A7672X use these three pins supply the internal RF and baseband circuit.

When the module is at the maximum power in GSM TX mode, the peak current can reach 2A (peak current), which results in a large voltage drop on Vbat. In order to ensure that the voltage drop is less than 300mV, the power supply capacity of external power supply must be no less than 2A.

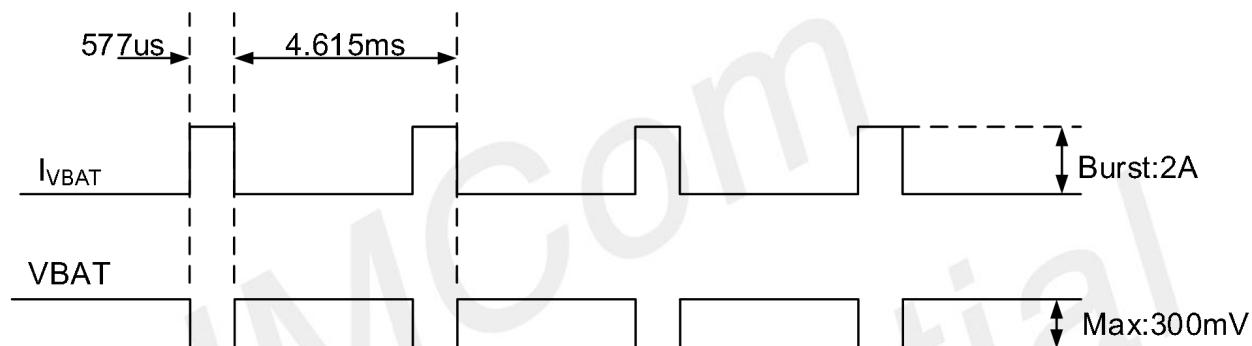


Figure 6: VBAT voltage drop during burst emission (EDGE/GPRS)

NOTE

Test condition: VBAT power supply 3.8V, the module is tested on EVB board, and the power input has a 330UF tantalum capacitor.

Table 8: VBAT pins electronic characteristic

Parameter	Description	Min	Typ.	Max	Unit
VBAT	Module supply voltage	3.4	3.8	4.2	V
IVBAT (peak)	Module consumption peak current	-	2	-	A
IVBAT (average)	Module average consumption current (normal mode)				Refer to Table 46
IVBAT (sleep)	Module average consumption current (sleep mode)				
IVBAT (power-off)	Module average consumption current (off leakage current)	-	20	-	uA

3.1.1 Power Supply Design Guide

In the user'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. It is recommended to select an LDO or DC-DC chip with an enable pin, and the enable pin is controlled by the MCU.

NOTE

When the power supply can provide a peak current of 2A, the total capacity of the external power supply capacitance is recommended to be no less than 300uF. If the peak current of 2A cannot be provided, the total capacity of the external capacitance is recommended to be no less than 600uf to ensure that the voltage drop on the Vbat pin at any time is not more than 300mV.

It is recommended to place four 33pF/10pF/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, it is recommended to add magnetic beads for filtering. The recommended types of magnetic beads are BLM21PG300SN1D and MPZ2012S221A.

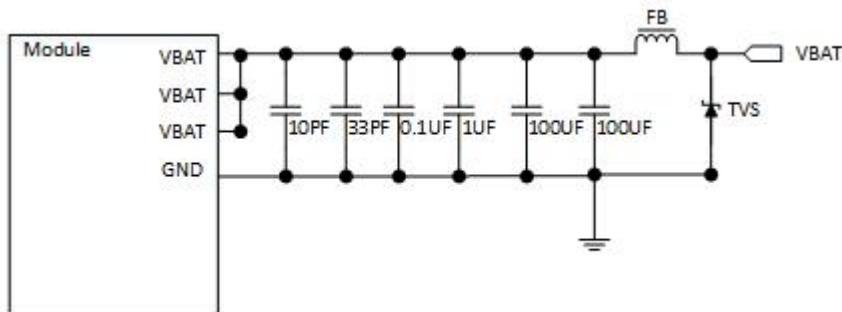


Figure 7: Power supply application circuit

In addition, in order to prevent the damage of A7672X caused by surge and overvoltage, it is recommended to parallel one TVS on the Vbat pin of the module.

Table 9: Recommended TVS diode list

No.	Manufacturer	Part Number	VRWM	Package
1	JCET	ESDBW5V0A1	5V	DFN1006-2L
2	WAYON	WS05DPF-B	5V	DFN1006-2L
3	WILL	ESD5611N	5V	DFN1006-2L

4

WILL

ESD56151W05

5V

SOD-323

NOTE

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

3.1.2 Recommended Power Supply Circuit

The MCU must have the function to power off the module, but the module cannot be shut down or restarted normally. Only when the module is abnormal and cannot be shut down or restarted normally can the module be powered off. When the input power is greater than 9V, the DCDC chip is recommended. When the input is less than 9V, it is recommended to use LDO power supply. If you use the module's OPEN LINUX secondary development function, because there is no MCU, you can add a low-cost single-chip microcomputer to play the role of hardware watchdog to pull POWERKEY to boot and can be powered off. It is recommended that a switching mode power supply or a linear regulator power supply is used. The following figure shows the linear regulator reference circuit:

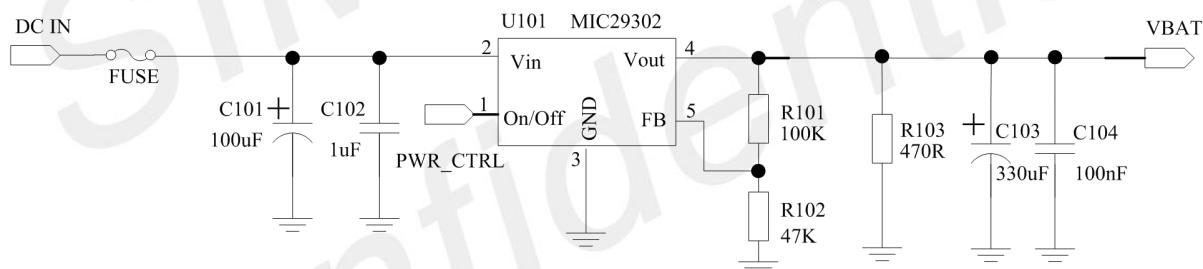


Figure 8: Linear regulator reference circuit

The following figure shows the DC-DC regulator reference circuit:

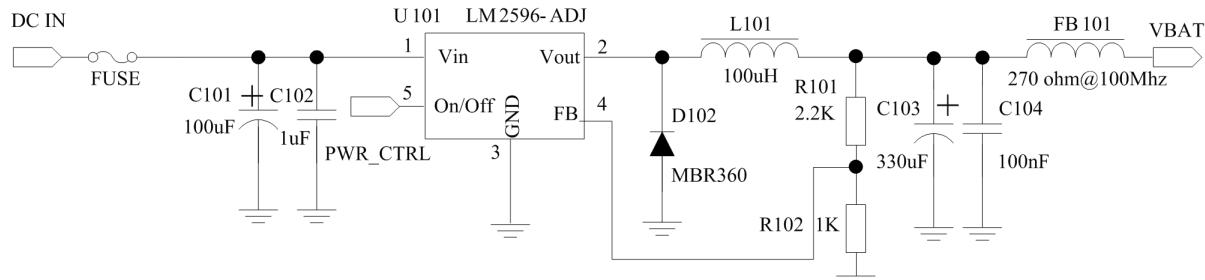


Figure 9: power supply reference circuit

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 alarm, When the actual voltage exceeds the preset range, a warning message will be reported through the AT port.

AT command 'AT+CPMVT' can be used to set high/low voltage power off, When the actual voltage exceeds the preset range, the module will shut down automatically.

NOTE

Voltage monitor function under debugging, Overvoltage alarm and overvoltage 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

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

It is recommended that when using the module, adding TVS diode at the module pin can effectively enhance the ESD performance.

The recommended circuit is as follows:

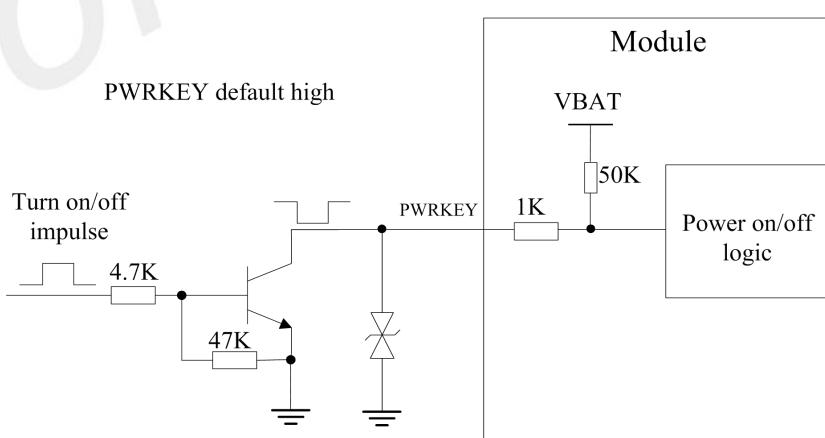


Figure 10: Reference power on/off circuit

NOTE

Do not parallel capacitors which the value is exceed 100nF on PWRKEY or RESET pin. It will cause module power on automatically when VBAT powered.

It is forbidden to pull down both RESET key and PWRKEY to power on the module at the same time.

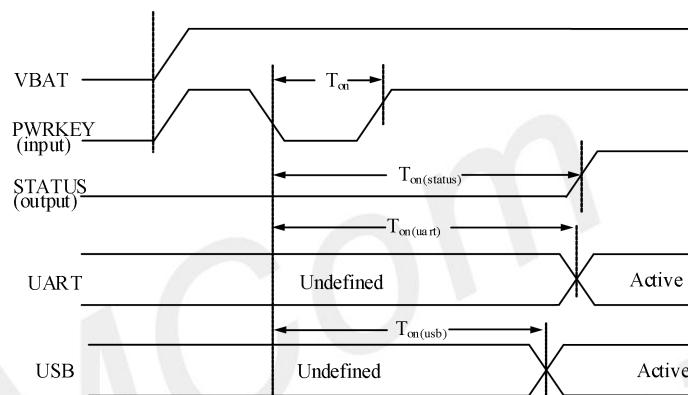


Figure 11: Power on timing sequence

Table 10: Power on timing and electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
Ton	The time of active low-level impulse of PWRKEY pin to power on module	-	50	-	ms
Ton(status)	The time from power-on issue to STATUS pin output high level (indicating power up ready)	-	6	-	s
Ton uart)	The time from power-on issue to UART port ready	-	8	-	s
Ton(usb)	The time from power-on issue to USB port ready	-	9	-	s
VIH	Input high level voltage on PWRKEY pin	0.7* VABT	-	VBAT	V
VIL	Input low level voltage on PWRKEY pin	0	0	0.3* VBAT	V

3.2.2 Power off

A7672X 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.
- Over-temperature or under-temperature automatic power off.

It is strongly recommended that the customer use PWRKEY or ‘AT+CPOF’ to shut down, and then 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 flash.

NOTE

when the temperature exceeds the range of $-30 \sim +80^{\circ}\text{C}$, A7672X will report warning information through AT port. When the temperature exceeds the range of $-40 \sim +85^{\circ}\text{C}$, A7672X will shut down automatically. For a detailed description of 'AT+ CPOF' and 'AT+ CPMVT', please refer to document [1].

PWRKEY can be used to power off the module, power off sequence see the following figure:

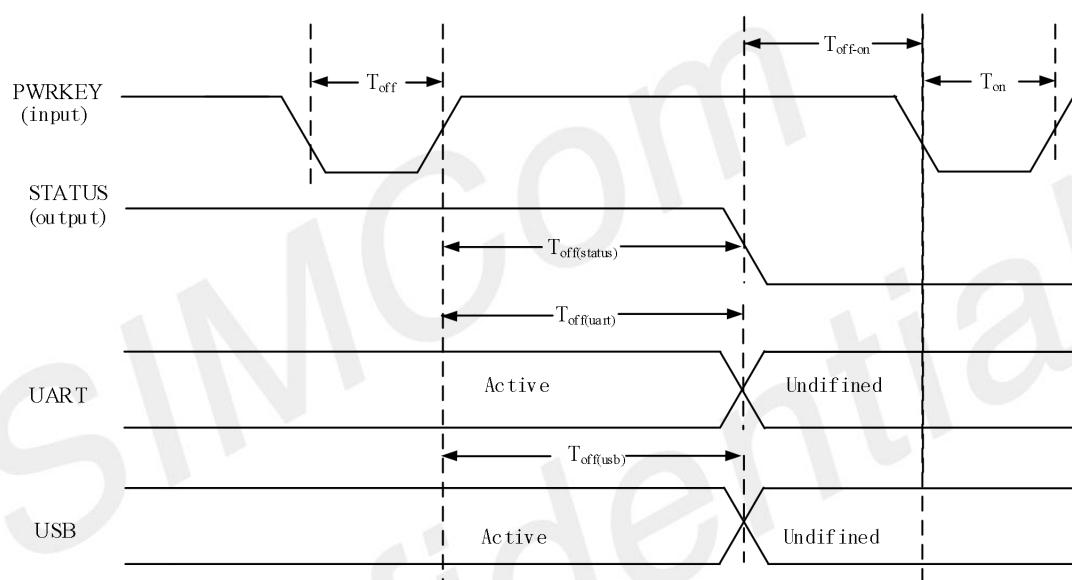


Figure 12: Power off timing sequence

Table 11: Power off sequence parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
Toff	Power off low level pulse width	2.5	-	-	s
Toff(status)	Power off time (according to status interface)	-	2	-	s
Toff uart	Power off time (according to UART interface)	-	2	-	s
Toff usb	Power off time (according to USB interface)	-	2	-	s
Toff-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 Function

A7672X can restart the module by pulling down the reset pin of the module. Reset pin also has the function of power on when PMU first time be given a valid supply voltage (active low, but this key has no shutdown function). After first time power on, some register of this pin will be written then it will lose this function, so it is recommended to use PWRKEY to power on the module and RESET key only used as reset function.

A $50\text{ k}\Omega$ resistor is used to pull-up to VBAT inside the module, so it is no need to add pull-up resistor outside. The recommended circuit is showed as follows:

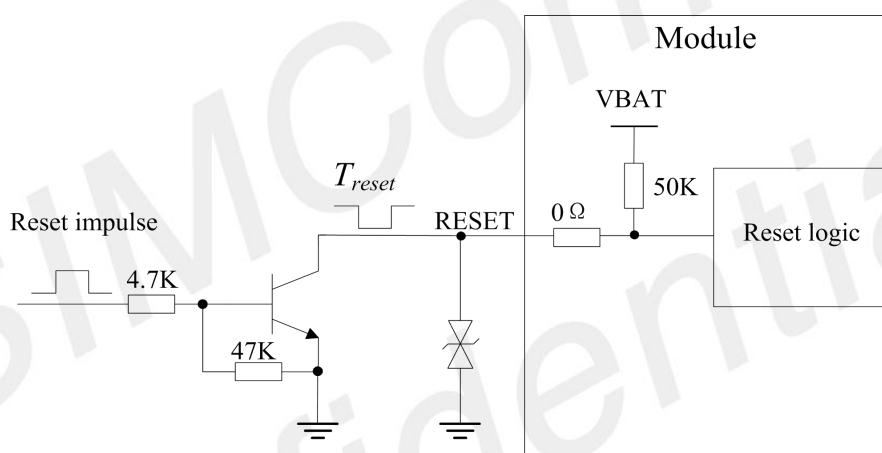


Figure 13: Reference reset circuit

Table 12: RESET pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
Treset	The active low level time impulse on RESET pin to reset module	2	2.5	-	s
VIH	Input high level voltage	0.7*	-	VBAT	v
VIL	Input low level voltage	0	0	0.3*	v

NOTE

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.

3.3 UART Interface

A7672X provides three serial ports, the main communication serial port is UART, one ordinary serial port, and the UART_LOG dedicate to printing log.

3.3.1 UART Design Guide

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

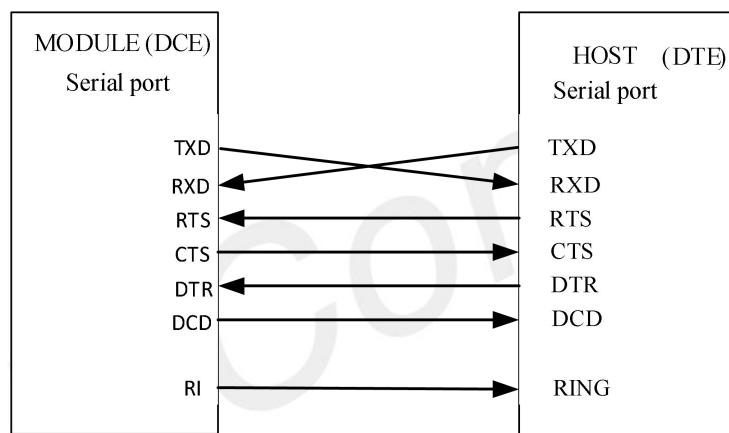


Figure 14: Serial port connection diagram (full-function mode)

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

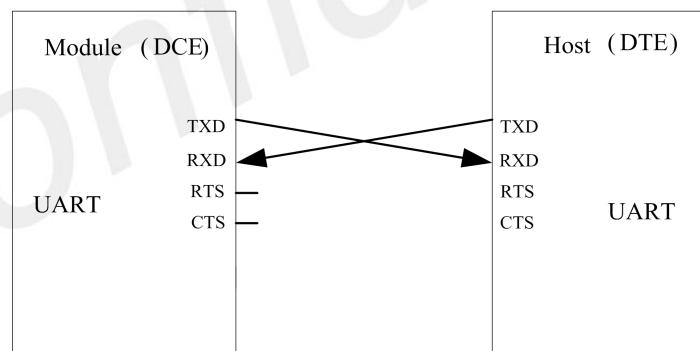


Figure 15: Serial port connection diagram (NULL mode)

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

The recommended triode model is MMBT3904.

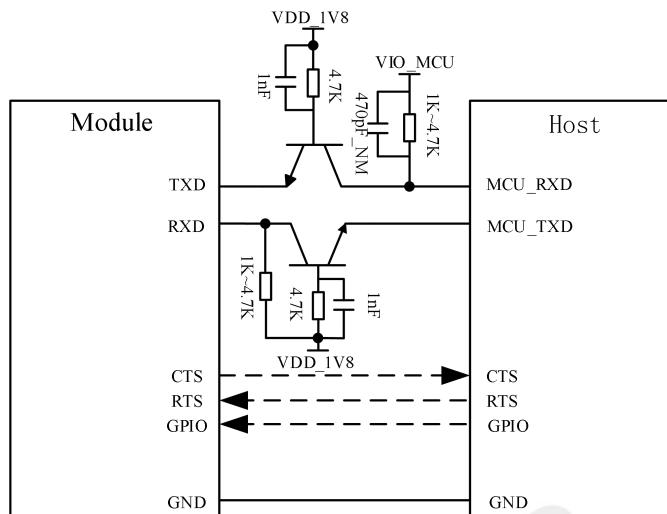


Figure 16: Triode level conversion circuit

NOTE

1. Main UART supports the following baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1842000, 3686400. The default baud rate is 115200bps.
2. The maximum baud rate supported by A7672X ordinary serial port is 921600.
3. 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 and DTR Behavior

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; RI will output a low level, when receiving a phone call as the called party. After outputting low level, RI will remain low until the host accepts the call using the "ATA" command or the caller stops calling RI, in the end, it will become high level.

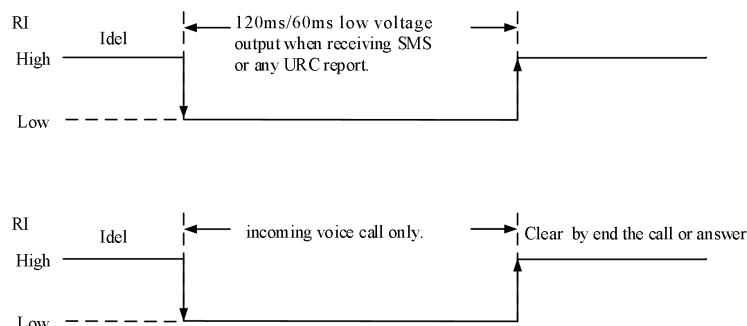


Figure 17: RI behaviour (SMS and URC report)

After setting the AT command "AT+CSCLK=1", and then pulling up the DTR pin, Module will enter sleep

mode when module is in idle mode. In sleep mode, the UART is unavailable. When A7672X enters sleep mode, pulling down DTR can wakeup module.

After setting the AT command “AT+CSCLK=0”, A7672X Series will do nothing when the DTR pin is pulling up.

3.4 USB Interface

The A7672X contains a USB interface compliant with the USB2.0 specification as a peripheral, but does not support USB charging function and does not support USB HOST mode.

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, OR resistors must be reserved for switching external test points during design, as shown in the figure below.

3.4.1 USB Reference Design

A7672X can be used as a USB slave device. The recommended connection circuit diagram is as follows:

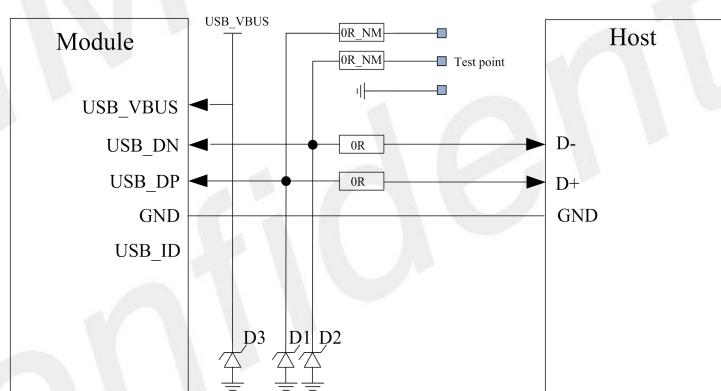


Figure 18: USB circuit diagram

Because of the high bit rate on USB bus, more attention should be paid to the influence of the junction capacitance of the ESD component on USB data lines. On USB_VBUS line, customers should pay attention to the selection of the D3 device when using it. It is recommended to choose an anti-static and anti-surge two-in-one device.

NOTE

1. The USB data cable must be strictly routed in $90\Omega \pm 10\%$ differential. The TVS devices D1 and D2 on the data line must be selected with equivalent capacitance less than 1pF. The TVS device should be placed near the USB connector or test point, recommended models ESD73011N and WS05DUCFM.
2. The detection of USB2.0 speed is determined automatically by the USB protocol. The customer does

not need to pull up the DP external, otherwise it may affect the device USB enumeration.

3.4.2 USB_BOOT Interface

A7672X provides one forced download boot interface ‘USB_BOOT’.

Table 13: USB_BOOT description

Pin number	Pin name	I/O	Description	Power domain	Default state	Remark
6	USB_BOOT	DI	Force downloads boot port	1.8V	B-PU	

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, then apply VBAT power to the module, and press RESET to enter the download mode. After entering the download mode, you need to release USB_BOOT and remove the pull-up.

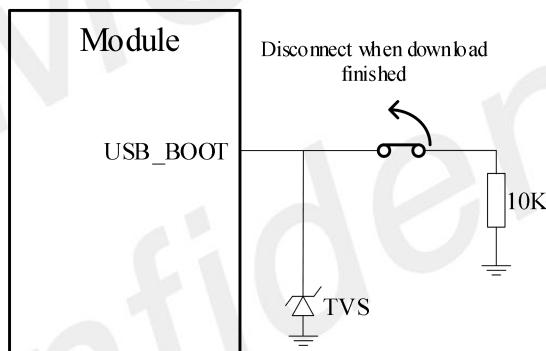


Figure 19: Reference USB_BOOT circuit

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

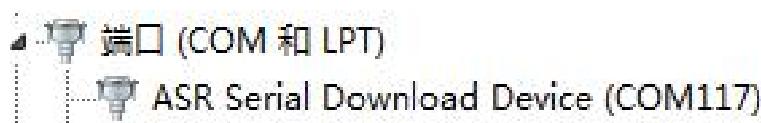


Figure 20: Force-download port

NOTE

USB_BOOT only has the function of forcing download and booting before booting (it cannot be pulled down).

3.5 USIM Interface

A7672X 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 14: USIM electronic characteristic in 1.8V mode (USIM_VDD=1.8V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	1.62	1.8	1.98	V
VIH	High-level input voltage	$0.7 * \text{USIM_VDD}$	-	$\text{USIM_VDD} + 0.4$	V
VIL	Low-level input voltage	-0.4	0	$0.25 * \text{USIM_VDD}$	V
VOH	High-level output voltage	$\text{USIM_VDD} - 0.4$	-	USIM_VDD	V
VOL	Low-level output voltage	0	0	0.2	V

Table 15: USIM electronic characteristic 3.0V mode (USIM_VDD=3V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	2.7	3	3.3	V
VIH	High-level input voltage	$0.7 * \text{USIM_VDD}$	-	$\text{USIM_VDD} + 0.4$	V
VIL	Low-level input voltage	-0.4	0	$0.25 * \text{USIM_VDD}$	V
VOH	High-level output voltage	$\text{USIM_VDD} - 0.45$	-	USIM_VDD	V
VOL	Low-level output voltage	0	0	0.3	V

3.5.1 SIM Application Guide

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

The following figure shows the 6-pin SIM card holder reference circuit.

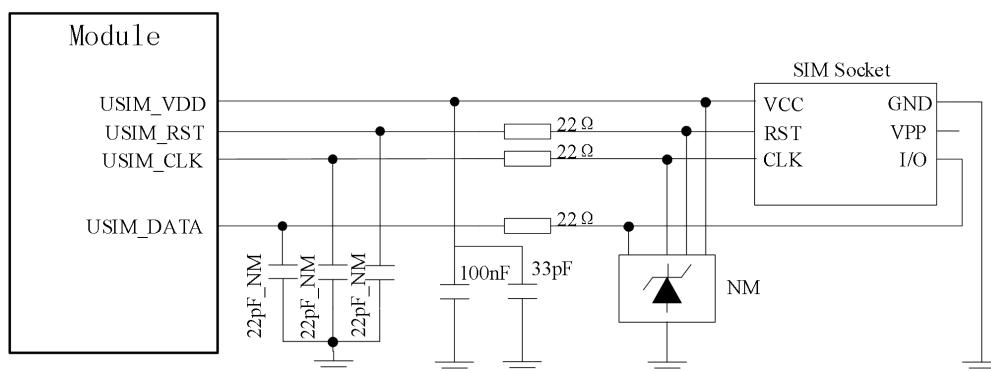


Figure 21: SIM interface reference circuit

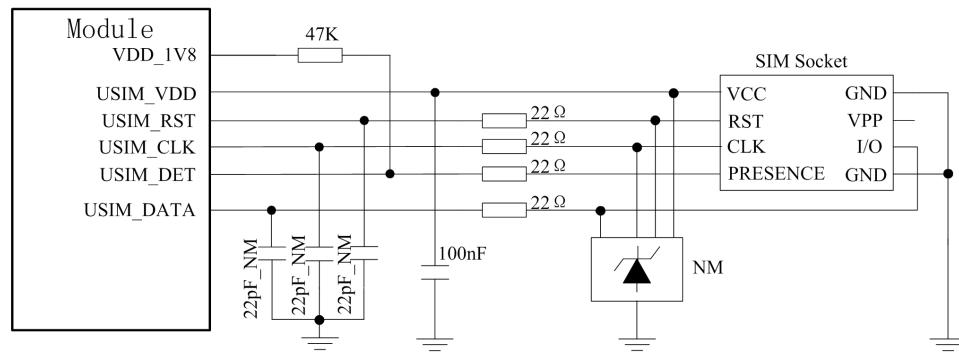


Figure 22: SIM interface reference circuit (8PIN)

NOTE

1. USIM1_DATA has been pulled up with a 4.7KΩ resistor to USIM1_VDD in module. A 100nF capacitor on USIM_VDD is used to reduce interference. For more details of AT commands about USIM, please refer to document [1].
2. USIM2_DATA has no pull resistor, need to add 4.7KΩ resistor pulled up to USIM2_VDD externally.

3.5.2 Recommend USIM Card Holder

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

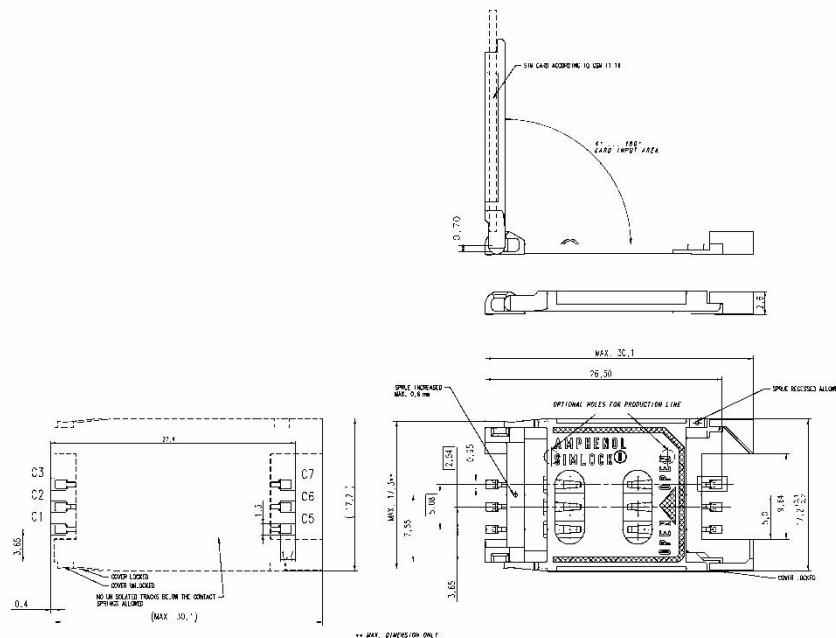


Figure 23: Amphenol C707 10M006 512 USIM card socket

Table 16: Amphenol USIM socket pin description

Pin	Signal	Description
C1	USIM_VDD	USIM Card Power supply.
C2	USIM_RST	USIM Card Reset.
C3	USIM_CLK	USIM Card Clock.
C5	GND	Connect to GND.
C6	VPP	NC
C7	USIM_DATA	USIM Card data I/O.

3.6 Analog audio interface

A7672X modules integrate audio codec and audio front end, provide 1 channel of analog audio MIC input interface and 1 channel of analog audio SPK output interface, customers can connect to the external phone handle for voice calls.

ADC: 90dB SNR@20~20kHz

DAC: 95dB SNR@20~20kHz

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

Table 17: MIC input ADC parameter list

Parameter	MIN	Type	MAX	Unit
Clock frequency	-	6.144	-	MHz

Table 18: Analog audio Parameter

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

3.6.1 Analog audio reference design

The analog audio recommendation circuit is as follows:

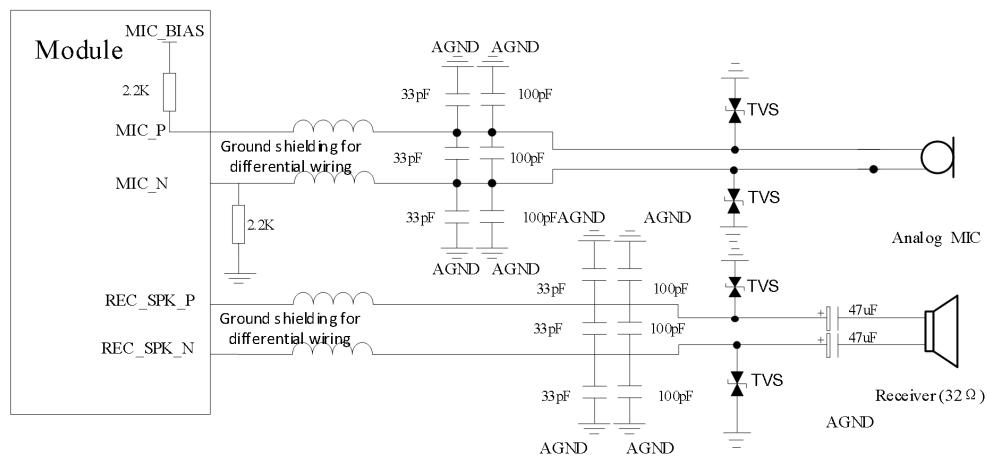


Figure 24: Analog audio interface reference circuit

3.7 Matrix keyboard interface

A7672X provides a 4*4 matrix keyboard interface.

Table 19: matrix keyboard PIN description

PIN Name	Multiplex Function	PIN NO.	I/O	描述
GPIO8	MK_IN2	47	DI	Matrix keyboard input
GPIO3	MK_IN3	20	DI	
GPIO10	MK_IN5	68	DI	
GPIO6	MK_IN6	36	DI	
GPIO7	MK_OUT2	44	DO	Matrix keyboard output
GPIO4	MK_OUT3	21	DO	
GPIO9	MK_OUT5	67	DO	
GPIO5	MK_OUT6	35	DO	

The matrix keyboard interface recommendation circuit is as follows:

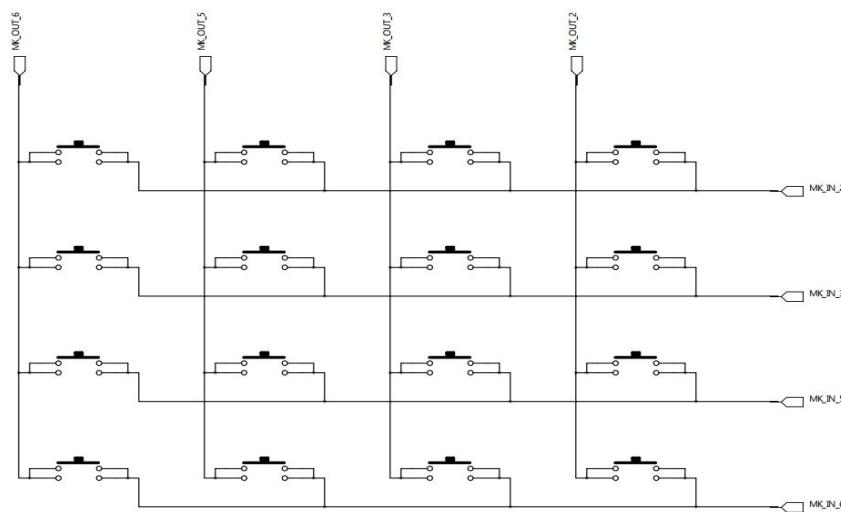


Figure 25: Matrix keyboard interface reference circuit

3.8 GPIO Interface

A7672X module provides multiple GPIOs.

Table 20: Standard GPIO Resources of A7672X

Pin No.	Pin name	AT command operation GPIO number	Pin typ.	Power domain	Default function	Pad Edge wakeup
19	GPIO1	GPIO1	IO	1.8V	PU	Yes
26	GPIO2	GPIO2	IO	1.8V	PD	Yes
48	GPIO3	GPIO3	IO	1.8V	PD	No
53	GPIO4	GPIO4	IO	1.8V	PU	Yes

3.9 I2C Bus

The module provides two sets of I2C interfaces, support standard speed clock frequency 100Kbps, support high speed clock frequency 400Kbps, its operation voltage is 1.8V.

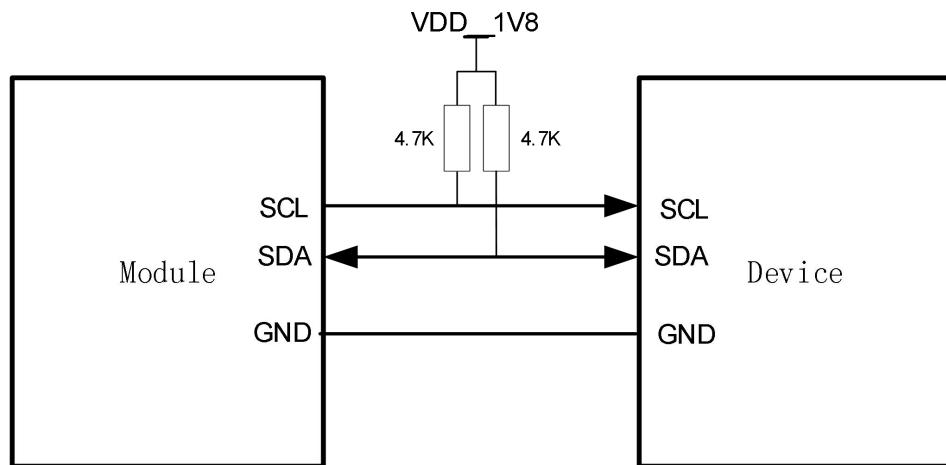


Figure 26: I2C reference circuit

NOTE

SCL and SDA have no pull-up resistor inside, external resistor is needed and the pulled power source must be VDD_1V8 output from the module.

3.10 Network status

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

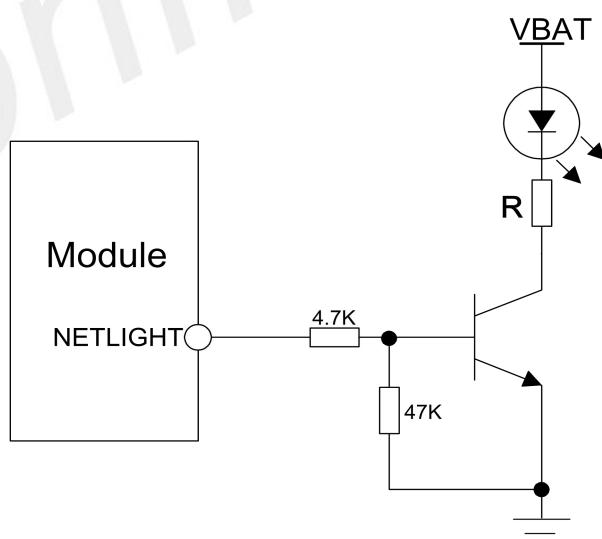


Figure 27: NETLIGHT reference circuit

NOTE

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

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 21: 2G mode NETLIGHT pin status

NETLIGHT pin status	Module status
Always On	Searching Network
200ms ON, 200ms OFF	Data Transmit
800ms ON, 800ms OFF	Registered network
OFF	Power off / Sleep

Table 22: LTE mode NETLIGHT pin status

NETLIGHT pin status	Module status
Always On	Searching Network
200ms ON, 200ms OFF	Data Transmit/Registered
OFF	Power off / Sleep

3.11 GNSS interface

A7672X support GNSS function interface. GNSS provides 2 power supply input interfaces, 1 GNSS power enable control switch, 1 UART interface and 1 pulse synchronous clock signal interface, which are described in detail as follows.

Table 23: GNSS interface description

PIN Name	PIN NO	I/O	Description	Note
GNSS_VBKP	116	PI	GNSS backup power input	Power supply range 1.4V~3.6V。
1V8_GNSS	97	PI	GNSS Vcore、VDDIO input	The supply voltage shall not be less than 1.8V, and routing width should more than 0.5mm.
GNSS_PWRCTL	98	DI	GNSS Vcore、VDDIO power enable control	Active high. Solution 1 : Connect to

				GPIO , recommend use MK_IN_3(PIN20). Solution 2 :Connect to MCU GPIO。
GNSS_RXD	96	DI	GNSS UART RX	1.8V power domain. Solution 1 :Use 10K resistor to connect UART3_TXD (PIN50) of the module in series. Solution2:Connect to MCU UART_TX.
GNSS_TXD	95	DO	GNSS UART TX	1.8V power domain. Solution 1 :Use 10K resistor to connect UART3_RXD (PIN49) of the module in series. Solution2 : Connect to MCU UART_RX
1PPS	100	DO	GNSS pulse synchronous clock signal	If unused, keep it open.

GNSS recommended reference design solution 1:

A7672X module itself provides power, power enable and UART transmission to GNSS, the recommended reference design as follow:

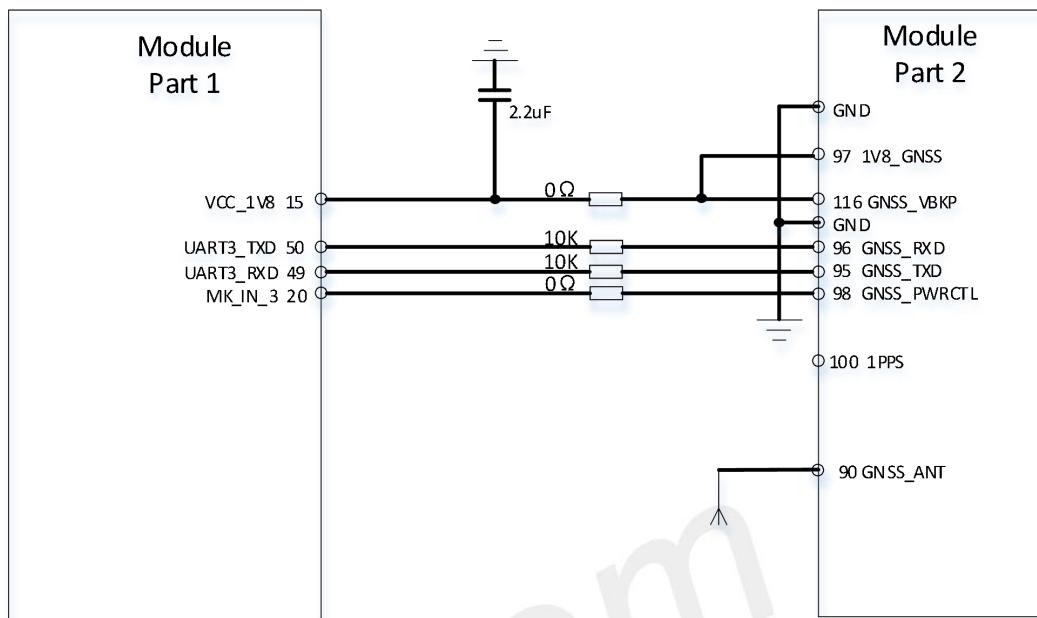


Figure 28: GNSS reference design (Non-standalone GNSS solution)

GNSS recommended reference design solution 2:

The external MCU provides power, power enable and UART transmission to GNSS, this solution is used for scenarios where GNSS can work standalone without the module powering up. The recommended reference design as follow:

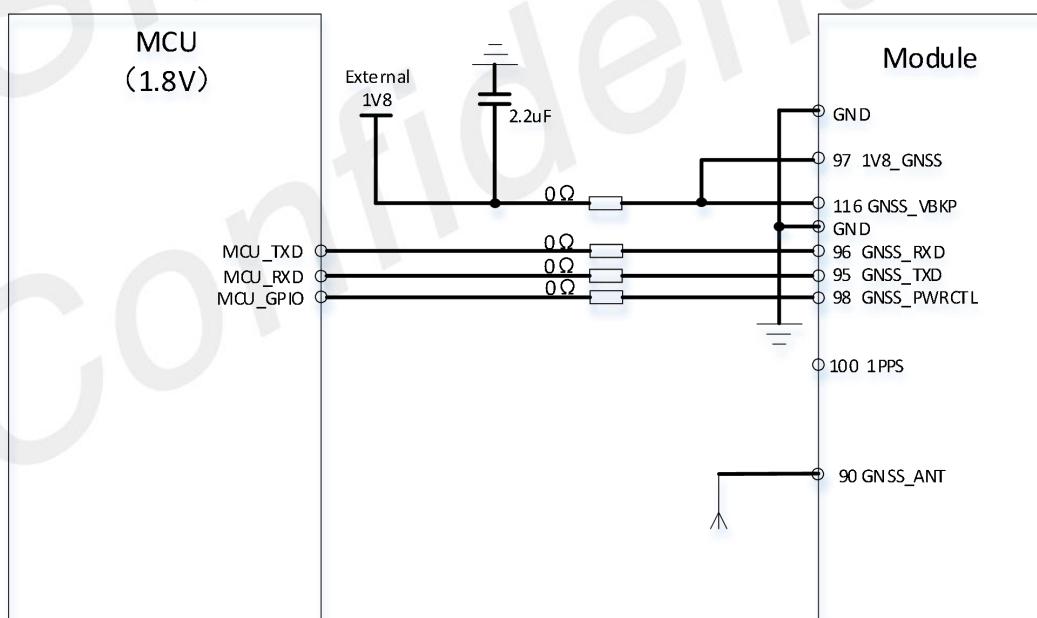


Figure 29: GNSS reference design (standalone GNSS solution)

NOTE

1. Please series in 10K resistors for serial communication lines with non-standalone GNSS solution to prevent leakage current to the serial ports of GNSS chip.

2. The standalone GNSS reference design is only applicable to 1.8V power domain MCU. If the MCU is not 1.8V power domain, a level shift circuit should be added.
3. The Vcore power for GNSS 1V8_GNSS has higher requirements for power supply, PCB routing should be as short as possible, and the routing width is required to be at least 0.5mm

3.12 SPI LCD interface

A7672X module provides a set of SPI LCD interface, which only supports LCD module of 1 data line. The LCD interface of the module does not have specified LCD_TE signal pin. If necessary, you can choose GPIO to simulate the use of LCD_TE signal. It is recommended to use module pin 44 (MK_OUT_2) as the LCD_TE signal.

It is recommended to reserve decoupling capacitor on the power supply for LCD, and reserve $0\ \Omega$ resistor in series for debugging. At the same time, $0\ \Omega$ in series is reserved on the data line to facilitate the adjustment of signal quality and prevent signal reflection, overshoot.

Table 24: LCD interface description

PIN Name	PIN NO	I/O	Description	Note
LCD_BL_PWM	101	DO	LCD backlight PWM signal	
LCD_SPI_CLK	102	DO	SPI clock	
LCD_SPI_TXD	103	DO, DI	SPI data (Bidirectional)	
LCD_SPI_RXD	104	DI	SPI data	
LCD_SPI_CS	105	DO	SPI CS	
LCD_RST	106	DO	LCD reset	
LCD_DCX	107	DO	LCD command/parameter selection	

The recommended reference design of SPI LCD as follow:

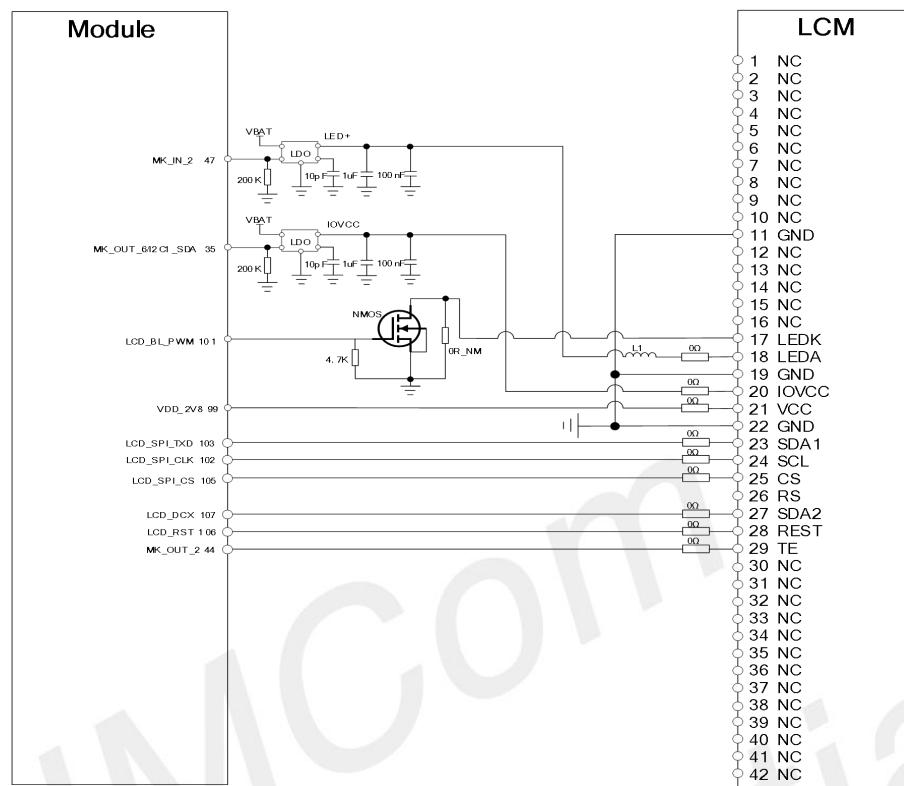


Figure 30: SPI LCD reference design

3.13 SPI camera interface

A7672X only supports SPI camera interface, supports up to 0.3MP pixel encoding, does not support video mode.

Table 25: SPI camera interface description

PIN NAME	PIN NO	I/O	DESCRIPTION	NOTE
CAM_I2C_SDA	117	DI, DO	CAM I2C data	
CAM_I2C_SCL	118	DO	CAM I2C clock	
CAM_PWDN	119	DO	CAM power down	
CAM_RST	120	DO	CAM reset	
CAM_MCLK	121	DO	CAM main clock	
CAM_SPI_D0	122	DI	CAM SPI DATA 0	
CAM_SPI_D1	123	DI	CAM SPI DATA 1	
CAM_SPI_CLK	124	DO	CAM SPI clock	

The recommended reference design of SPI camera as follow:

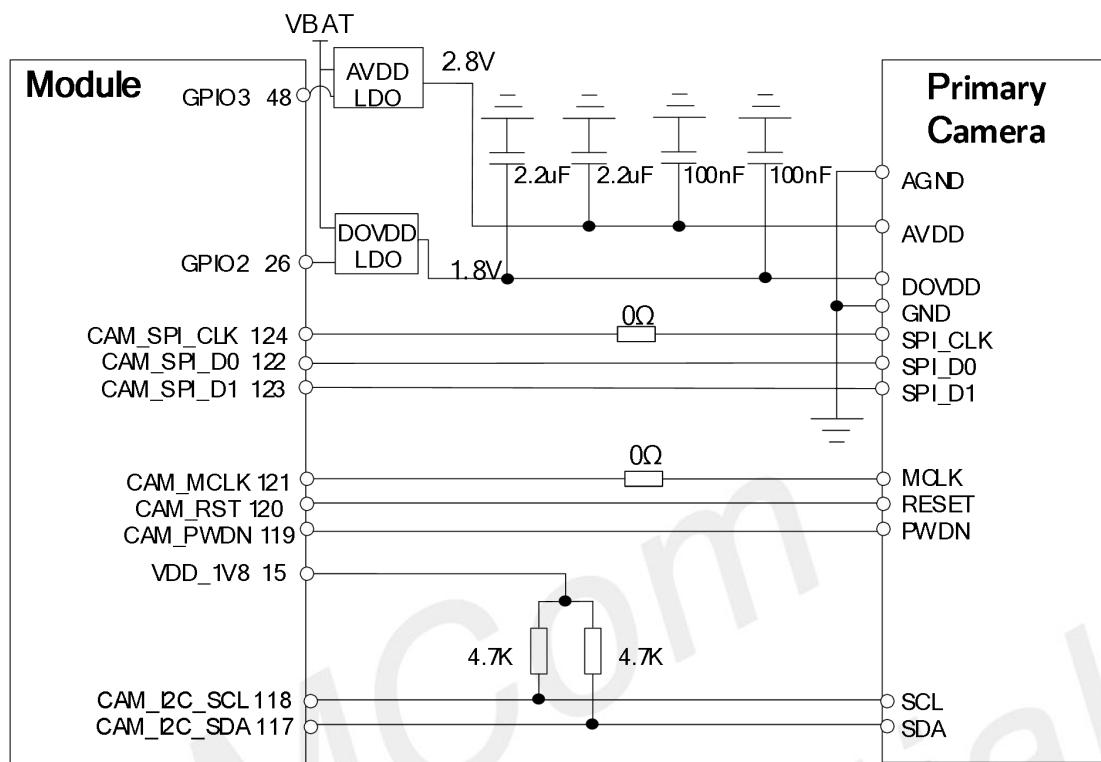


Figure 31: SPI camera reference design

3.14 Bluetooth interface

A7672X module has integrated Bluetooth function inside, and only one BT antenna is left on the module interface. A7672X Support BT5.0 protocol specification, compatible with BLE low power mode and traditional BT mode; It only supports Bluetooth data transmission and does not support VoiceOverPCM & VoHCI.

3.15 Another interface

3.15.1 ADC

A7672X have 1 general ADC and 1 dedicated VBAT_ADC pins. VABT_ADC just available for digitizing battery voltage. These electronic specifications are shown in the following table.

Table 26: General ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	-	9	-	Bits
Input Range	0	-	1.8	V

Table 27: VBAT_ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	-	9	-	Bits
Input Range	0	-	1.8	V

NOTE

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

The recommended reference design of VBAT_ADC as follow:

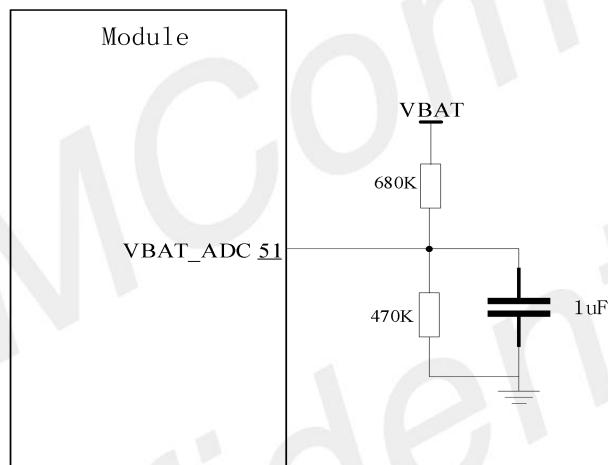


Figure 32: VBAT_ADC reference design

3.15.2 LDO

A7672X has 2 LDO outputs : VDD_1V8 and VDD_2V8.

VDD_1V8 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. It can be used as a power supply for module 1V8_GNSS (PIN97).

VDD_2V8 is the module 2.8V LDO power output, which can only provide a current capacity of 50mA. It cannot be used as a high current drive source. It can be used as a power supply for LCD VCC_2V8.

Table 28: VDD_1V8 Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{VDD_1V8}	Output voltage	-	1.8	-	V

I _o	Output current	-	-	50	mA
----------------	----------------	---	---	----	----

Table 29: VDD_2V8 Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V _{VDD_2V8}	Output voltage	-	2.8	-	V
I _o	Output current	-	-	50	mA

NOTE

VDD_1V8 is the system power supply. If the damage will affect the system startup, it is recommended that customers add TVS protection. The recommended model is ESD56051N.

4 RF Specifications

4.1 GSM/LTE Specifications

Table 30: Conducted transmission power

Frequency	Power	Min.
EGSM900	33dBm ±2dB	5dBm ± 5dB
DCS1800	30dBm ±2dB	0dBm ± 5dB
EGSM900 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
DCS1800 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
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 B7	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm
LTE-FDD B20	23dBm +/-2.7dB	<-40dBm
LTE-FDD B28	23dBm +/-2.7dB	<-40dBm
LTE-FDD B66	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 31: GSM Operating bands

Frequency	Receiving	Transmission
EGSM900	925~960MHz	880~915 MHz
DCS1800	1805~1880 MHz	1710~1785 MHz

Table 32: E-UTRA operating bands

E-UTRA	UL Freq.	DL Freq.	Duplex Mode
1	1920~1980 MHz	2110~2170 MHz	FDD
2	1850~1910MHz	1930~1990MHz	FDD
3	1710~1785 MHz	1805~1880 MHz	FDD

4	1710~1755MHz	2110~2155MHz	FDD
5	824 ~ 849 MHz	869 ~ 894MHz	FDD
7	2500~2570MHz	2620~2690MHz	FDD
8	880~915 MHz	925~960 MHz	FDD
20	832~862MHz	791~821MHz	FDD
28	703~748MHz	758~803MHz	FDD
66	1710~1780MHz	2110~2200MHz	FDD
34	2010~2025MHz	2010~2025MHz	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 33: Conducted receive sensitivity

Frequency	Receive sensitivity(Typical)	Receive sensitivity(MAX)
EGSM900	< -109dBm	3GPP
DCS1800	< -108dBm	3GPP
LTE FDD/TDD	See table 34.	3GPP

Table 34: Reference sensitivity (QPSK)

E-UTRA Band	3GPP standard						Actual	Duplex Mode
	1.4 MHz	3MHz	5MHz	10MHz	15 MHz	20 MHz		
1	-	-	-100	-97	-95.2	-94	-98.5	FDD
2	-102.7	-99.7	-98	-95	-93.2	-92	TBD	FDD
3	-101.7	-98.7	-97	-94	-92.2	-91	-98.1	FDD
4	-104.7	-101.7	-100	-97	-95.2	-94	TBD	FDD
5	-103.2	-100.2	-98	-95	-	-	-98.6	FDD
7			-98	-95	-93.2	-92	-98	FDD
8	-102.2	-99.2	-97	-94	-	-	-98.1	FDD
20			-97	-94	-91.2	-90	-99	FDD
28		-100.2	-98.5	-95.5	-93.7	-91	TBD	FDD
66	-104.2	-101.2	-99.5	-96.5	-94.7	-93.5	TBD	FDD
34	-	-	-100	-97	-95.2	-	-97.5	TDD
38	-	-	-100	-97	-95.2	-94	-98.6	TDD
39	-	-	-100	-97	-95.2	-94	-97.8	TDD
40	-	-	-100	-97	-95.2	-94	-98.2	TDD
41	-	-	-98	-95	-93.2	-92	-98.6	TDD

4.2 GSM/LTE Antenna Requirements

For better overall performance, it is recommended that the antenna design refer to the index requirements in the following table.

Table 35: GSM/LTE antenna requirements

Passive	Recommended standard
Operating band	See table 31 and table 32
Direction	omnidirectional
Gain	> -3dBi (Avg)
Input impedance	50 ohm
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 36: GNSS operating bands

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

Table 37: GNSS performance

GNSS	GPS	BeiDou	GLONASS
------	-----	--------	---------

Tracking sensitivity	-160dBm	-159.5dBm	-153dBm
Capture sensitivity	-154dBm	-154dBm	-152dBm
Hot start TTFF	<1s		
Cold start TTFF	<40s		
Accuracy	<2m		

4.4 GNSS Antenna Requirements

Table 38: Recommended Antenna Characteristics (GNSS)

Passive	Recommended standard
operating band	L1: 1559~1609MHZ
Direction	Hemisphere, face to sky
Input impedance	50 ohm
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 Bluetooth specifications

A7672X Support BT5.0 protocol specification, compatible with BLE low power mode and traditional BT mode.

Table 39: Bluetooth performance

Frequency	2.402GHz~2.483GHz			
TX performance	DH5	2DH5	3DH5	dBm
TX Power	6	TBD	TBD	
RX performance				

RX sensitivity	DH5	2DH5	3DH5	
	-93	-93	-87	dBm

4.6 Antenna Reference Design

4.6.1 Passive Antenna for GSM/LTE/GNSS/Bluetooth

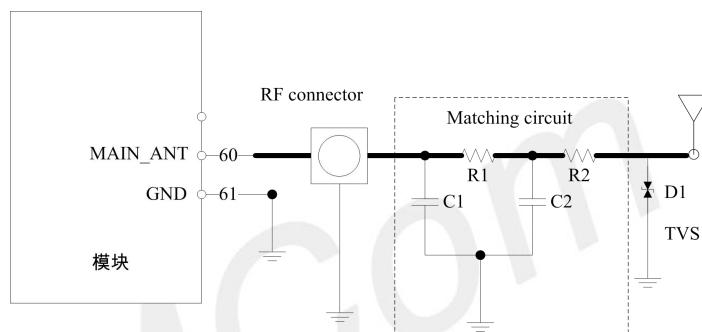


Figure 33: Passive antenna reference

NOTE

GNSS active antenna design is default solution. Strongly suggest to cut off GNSS active antenna supply by AT+CVAUXS=0, if customer design is passive antenna for GNSS.

In above figure, the component R1/R2/C1/C2 is reserved for antenna matching, the value of components can only be got after the antenna tuning, usually provided by the antenna factory. Among them, R1 and R2 paste 0Ω, C1 and C2 do not paste by default. The component D1 is a Bidirectional ESD Protection device, which is suggested to add to protection circuit, the recommended Part Numbers of the TVS are listed in the following table:

Table 40: TVS part number list

Package	Type	Supplier
0201	CE0201S05G01R	SOCAY
0402	PESD0402-03	PRISEMI

4.6.2 Active Antenna for GNSS

Default power supply value is controlled by AT+CVAUXV, default is 3V, which should meet the antenna requirement. For example, “AT+CVAUXV=2800” sets power supply 2.8V.

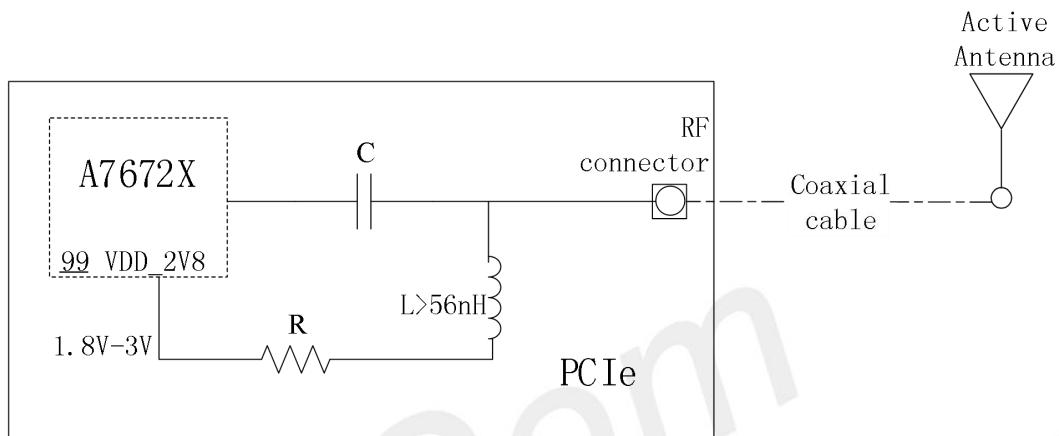


Figure 34: Active antenna reference

4.7 PCB layout

Users should pay attention to the impedance design of PCB layout from the module ANT port to the antenna connector, **and the length of the PCB trace should be within 20 mm, and far away from interference signals such as power & clock.** It is recommended to reserve RF Switch Connector for conduction test. The reference model of RF Switch Connector is: ECT 818011998.

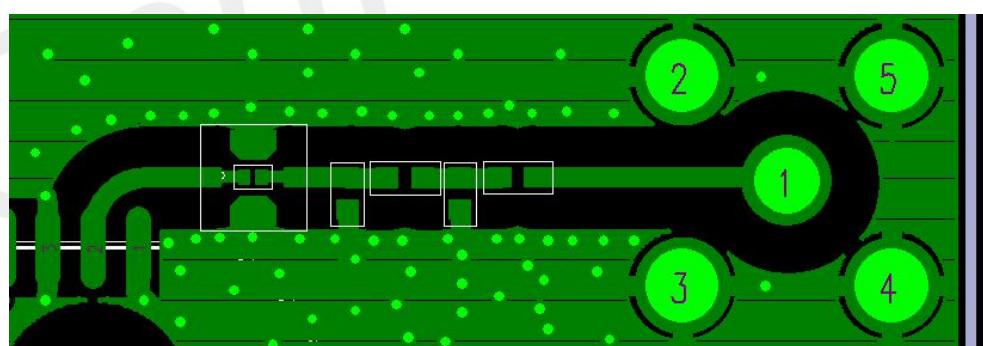


Figure 35: Reference PCB layout

5 Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of A7672X are listed in the following table, exceeding these limits may cause permanent damage to the module.

Table 41: 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, I2C, UART,PCM)	-0.3	-	2.0	V
Voltage at IO pins (USIM)	-0.3	-	3.9	V
Voltage at PWRKEY, RESET	-0.3	-	4.8	V

5.2 Operating conditions

Table 42: 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	5.4	V

Table 43: 1.8V Digital I/O characteristics*

Parameter	Description	Min.	Typ.	Max.	Unit
VIH	High-level input voltage	VCC*0.7	1.8	VCC+0.2	V
VIL	Low-level input voltage	-0.3	0	VCC*0.3	V
VOH	High-level output voltage	VCC-0.2	-	-	V
VOL	Low-level output voltage	0	-	0.2	V
IOH	High-level output current (no pull down resistor)	-	-	13	mA
IOL	Low-level output current (no pull up resistor)	-	-	13	mA
IIH	Input high leakage current (no pull-down resistor)	-	-	10	uA
IIL	Input low leakage current (no pull up resistor)	-10	-	-	uA

NOTE

These parameters are for digital interface pins, such as GPIO, I2C, UART, and USB_BOOT.

The operating temperature of A7672X is listed in the following table.

Table 44: Operating temperature

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

NOTE

The performance will be reduced slightly from the 3GPP specifications if the temperature is outside the normal operating temperature range and still within the extreme operating temperature range.

5.3 Operating Mode

5.3.1 Operating Mode Definition

The table below summarizes the various operating modes of A7672X product.

Table 45: Operating mode Definition

Mode	Function
Normal operation	GSM/ 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.
	GSM/LTE Idle Software is active. Module is registered to the network, and the module is ready to communicate.
	GSM/ LTE Talk Connection between two subscribers is in progress. In this case, the power consumption depends on network settings such as DTX off/on, FR/EFR/HR, hopping sequences, and antenna.
	GSM/LTE Standby Module is ready for data transmission, but no data is currently sent or received. In this case, power consumption depends on

	network settings.
GPRS/EDGE/LTE Data transmission	There is data transmission in progress. In this case, power consumption is related to network settings (e.g., power control level); uplink/downlink data rates, etc.
Minimum functionality mode	AT command 'AT+CFUN=0' AT+CSCLK=1 can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work and the USIM 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' 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 port and USB port are still accessible. The power consumption in this mode is lower than normal mode.
Power off	Module will go into power off mode by sending the AT command 'AT+CPOF' or pull down the PWRKEY pin, normally. In this mode the power management unit shuts down the power supply, and software is not active. The serial port and USB are 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 A7672X enter sleep mode:

- USB condition
- Software condition
- UART condition

NOTE

Before designing, pay attention to how to realize sleeping/waking function and refer to Document [24] for more details.

5.3.3 Minimum functionality mode and Flight mode

Minimum functionality mode ceases 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 A7672X 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 A7672X 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 A7672X is in minimum functionality or flight mode, it can return to full functionality by the AT command “AT+CFUN=1”.

5.4 Current Consumption

The current consumption is listed in the table below.

Table 46: Current consumption on VBAT Pins (VBAT=3.8V)

GSM sleep/idle mode		
Current under CFUN=0, CSCLK=1	TBD	
GSM supply current (GNSS off, without USB connection)	Sleep mode@BS_PA_MFRMS=2 Typical: TBD Idle mode@BS_PA_MFRMS=2 Typical: TBD	2.5mA 29mA
LTE sleep/idle mode		
LTE supply current (GNSS off, without USB connection)	Sleep mode@DRX=0.32STypical: TBD Idle mode @DRX=0.32STypical: TBD	3.5mA 28.5mA
GSM Talk		
EGSM 900	@power level #5 Typical: 320 mA	
DCS1800	@power level #5 Typical: 262 mA	
GPRS		
EGSM900(2 Rx,4 Tx)	@power level #5 Typical: 630mA	
DCS1800(2 Rx,4 Tx)	@power level #0Typical:395mA	
EGSM900(3Rx, 2 Tx)	@power level #5 Typical:370mA	
DCS1800(3Rx, 2 Tx)	@power level #0Typical:275mA	
EDGE		
EGSM900(2 Rx,4 Tx)	@power level #8Typical:460mA	
DCS1800(2 Rx,4 Tx)	@power level #2Typical:300mA	
EGSM900(3Rx, 2 Tx)	@power level #8Typical: 336mA	
DCS1800(3Rx, 2 Tx)	@power level #2Typical:208mA	

LTE Cat1

LTE-FDD B1	@10MHz	23dBm	Typical :600 mA
LTE-FDD B2	@10MHz	23dBm	Typical :TBD
LTE-FDD B3	@10MHz	23dBm	Typical :600 mA
LTE-FDD B4	@10MHz	23dBm	Typical :TBD
LTE-FDD B5	@10MHz	23dBm	Typical :580 mA
LTE-FDD B7	@10MHz	23dBm	Typical :540mA
LTE-FDD B8	@10MHz	23dBm	Typical :520mA
LTE-FDD B20	@10MHz	23dBm	Typical :540mA
LTE-FDD B28	@10MHz	23dBm	Typical :TBD
LTE-FDD B66	@10MHz	23dBm	Typical :TBD
LTE-TDD B34	@10MHz	23dBm	Typical :260mA
LTE-TDD B38	@10MHz	23dBm	Typical :340 mA
LTE-TDD B39	@10MHz	23dBm	Typical :260 mA
LTE-TDD B40	@10MHz	23dBm	Typical :340mA
LTE-TDD B41	@10MHz	23dBm	Typical :340mA

5.5 ESD Notes

A7672X is sensitive to ESD in the process of storage, transporting, and assembling. When A7672X is mounted on the users' mother board, the ESD components should be placed beside the connectors which human body may touch, such as SIM card holder, audio jacks, switches, keys, etc. The following table shows the A7672X ESD measurement performance without any external ESD component.

Table 47: The ESD performance measurement table (Temperature: 25°C, Humidity: 45%).

Part	Contact discharge	Air discharge
VBAT, GND	+/-5K	+/-10K
Antenna port	+/-5K	+/-10K
USB interface	+/-4K	+/-8K
UART interface	+/-4K	+/-6K
Other PADs	+/-1K	+/-2K

NOTE

Test conditions: The module is on the SIMCom development board (the development board has the necessary ESD protection devices)

6 SMT Production Guide

6.1 Top and Bottom View of A7672X

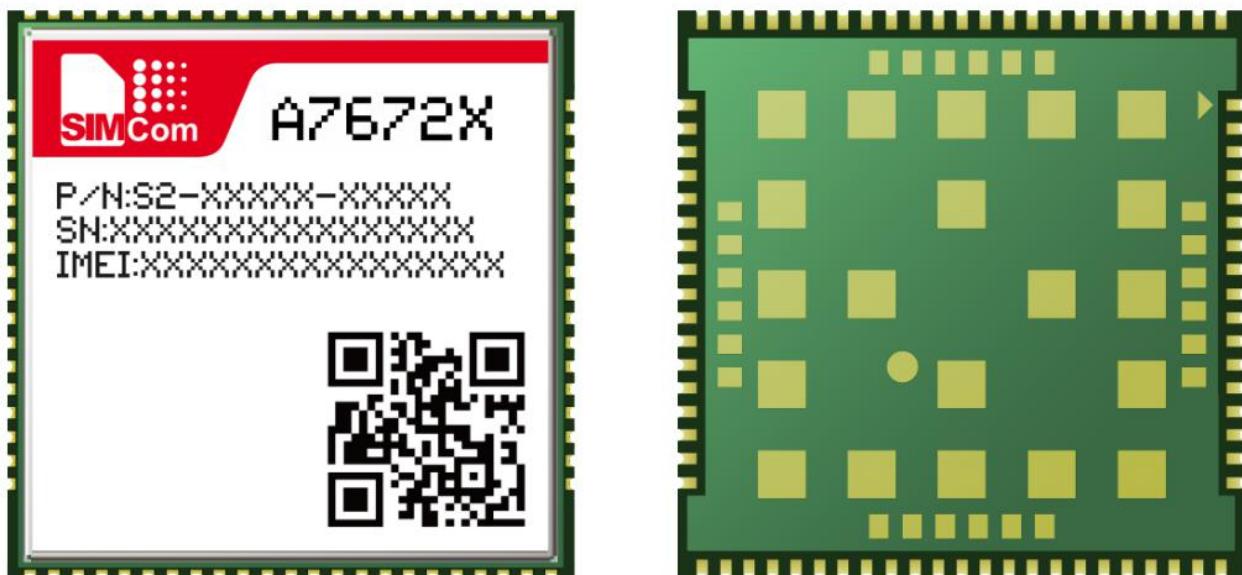


Figure 36: Top and bottom view of A7672X

NOTE

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

6.2 Label Information



Figure 37: Label information for A7672X

Table 48: The description of label information

No.	Description
A	Project name
B	Part number
C	Serial number
D	IMEI number
E	QR code

6.3 Typical SMT Reflow Profile

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

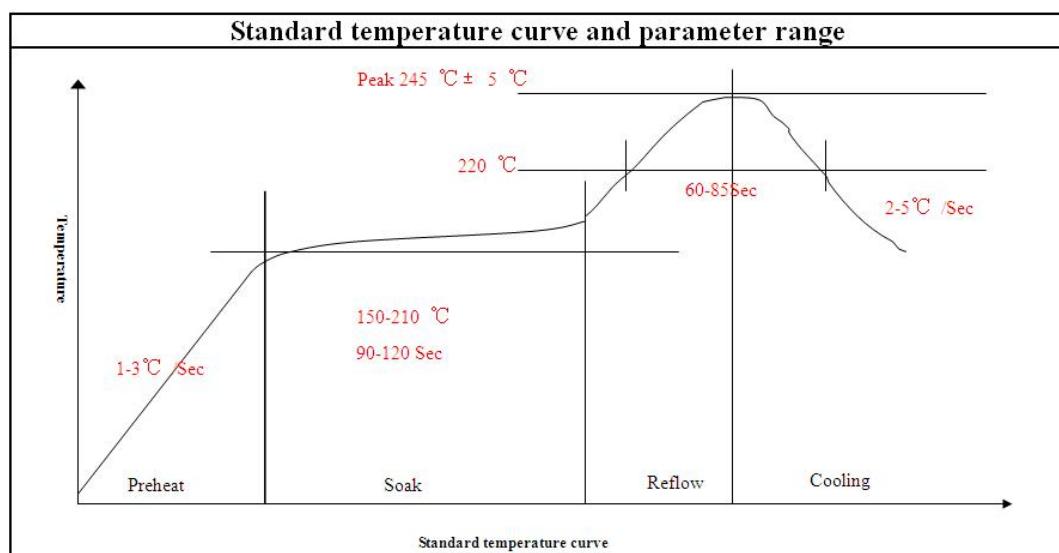


Figure 38: The ramp-soak-spike reflow profile of A7672X

NOTE

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

6.4 Moisture Sensitivity Level (MSL)

A7672X is qualified to Moisture Sensitivity Level (MSL) 3 in accordance with JEDEC J-STD-033.

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

Table 49: Moisture Sensitivity Level and Floor Life

Moisture Sensitivity Level (MSL)	Floor Life (out of bag) at factory ambient $\leq 30^{\circ}\text{C}/60\% \text{ RH}$ or as stated
1	Unlimited at $\leq 30^{\circ}\text{C}/85\% \text{ RH}$
2	1 year at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
2a	4 weeks at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
3	168 hours at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$
4	72 hours at $\leq 30^{\circ}\text{C}/60\% \text{ RH}$

5	48 hours at $\leq 30^{\circ}\text{C}/60\%$ RH
5a	24 hours at $\leq 30^{\circ}\text{C}/60\%$ RH
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.

NOTE

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

7 Packaging

A7672X module support tray packaging.

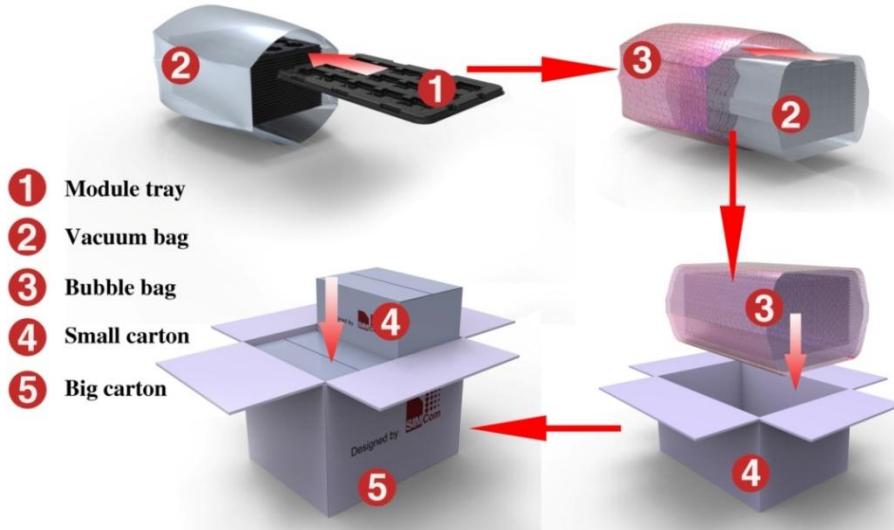


Figure 39: packaging diagram

Module tray drawing:

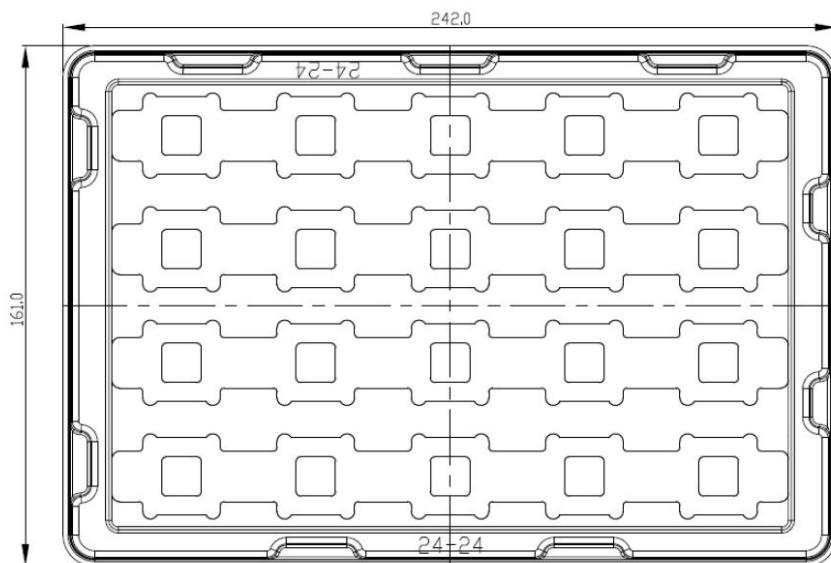


Figure 40: Tray drawing

Table 50: Tray size

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

Small carton drawing:

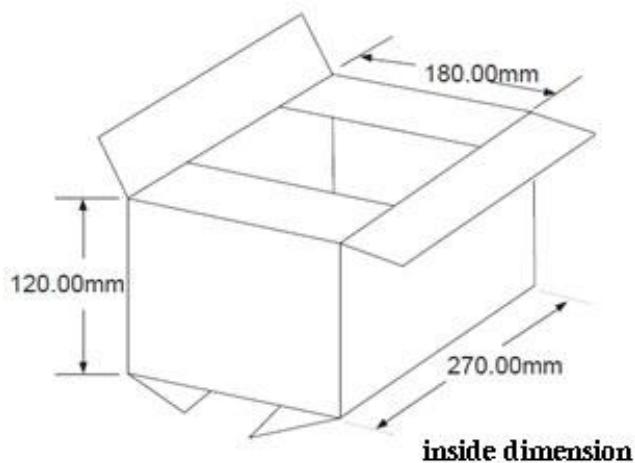


Figure 41: Small carton drawing

Table 51: Small Carton size

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

Big carton drawing:

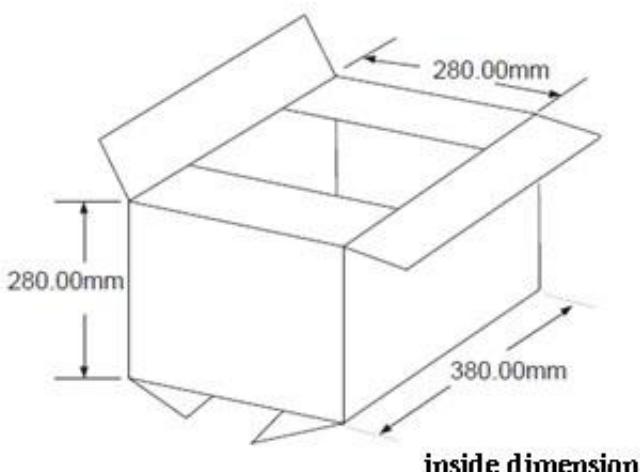


Figure 42: Big carton drawing

Table 52: Big Carton size

Length ($\pm 10\text{mm}$)	Width ($\pm 10\text{mm}$)	Height ($\pm 10\text{mm}$)	Module number
380	280	280	400*4=1600

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8 Appendix

8.1 Coding Schemes and Maximum Net Data Rates over Air Interface

Table 53: Coding Schemes and Maximum Net Data Rates over Air Interface

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

Category M1	1Mbps	QPSK/16QAM
LTE-FDD device category (Uplink)	Max data rate (peak)	Modulation type
Category M1	375kbps	QPSK/16QAM

8.2 Related Documents

Table 54: Related Documents

NO.	Title	Description
[1]	A7600 Series AT Command Manual _V1.00.04	AT Command Manual
[2]	ITU-T Draft new recommendationV.25ter	Serial asynchronous automatic dialing and control
[3]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[4]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[5]	GSM 07.05	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[6]	GSM 11.14	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[7]	GSM 11.11	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[8]	GSM 03.38	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[9]	GSM 11.10	Digital cellular telecommunications system (Phase 2) ; Mobile Station (MS) conformance specification ; Part 1: Conformance specification
[10]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[11]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[12]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[13]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[14]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[15]	EN 301 908-02 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000. Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive
[16]	EN 301 489-24 V1.2.1	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for

		IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
[17]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[18]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[19]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[20]	2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
[21]	Module secondary-SMT-UGD-V1.xx	Module secondary SMT Guidelines
[22]	A7600Series_UART_Application Note_V1.xx	This document describes how to use UART interface of SIMCom modules.
[23]	Antenna design guidelines for diversity receiver system A7600	Antenna design guidelines for diversity receiver system
[24]	Series_SleepMode_Application Note_V1.xx	Sleep Mode Application Note
[25]	A7600 Series_UIM HOT SWAP_Application Note_V1.00	This document introduces UIM card detection and UIM hot swap.

8.3 Terms and Abbreviations

Table 55: Terms and Abbreviations

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

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

8.4 Safety Caution

Table 56: 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.