A7670 Series Hardware Design

LTE Module

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Date	Version	Description of change	Author
2020-06-09	1.00	Original	Zhongyi.liu Peilin.yue
2020-08-31	1.01	Baseband current consumption data update (section 3.1/ section 5.4); Switch timing diagram update (Section 3.2); Serial port description update (Section 3.3); CTS/RTS flow control update (Section 3.3); RF data update (section 4.1)	Zhongyi.liu Peilin.yue
2020-01-27	1.02	Add the description for A7670C-LAAE 、A7670C-LAAL、A7670C-LAAS、A7670C-LNSC ; Modify the pulse width for RESET (Chapter3.2) Modify the reference design for USIM(Chapter3.5) Modify the RF frequency Modify the Antenna requirements Modify the Current Consumption	Zhongyou.chen Xuefeng.liu
2021-03-03	1.03	Delete the illustration of customize REC_SPK for external power amplifier.	Gaochao.li

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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 A7670 module to design and develop applications quickly. SIMCom provides a set of evaluation boards to facilitate A7670 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	A7670C	A7670C-LAAE	A7670C-LAAL	A7670C-LAAS	A7670C-LNSC	A7670E	A7670SA
GSM	GSM850MHz							✓
	EGSM900MHz	✓	✓			✓	✓	✓
	DCS1800MHz	✓	✓			✓	✓	✓
	PCS1900MHz							✓
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	CAT1	CAT1	CAT1	CAT1

With a small physical dimension of 24*24*2.5 mm and with the functions integrated, the module can meet almost any space requirement in users' applications, such as smart phone, PDA, industrial handhold, machine-to-machine and vehicle application, etc.
A7670 provides 88 pins, including 68 LGA pins in the outer ring and 20 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
- ADC Interface
  A7670C/A7670E/A7670SA/A7670C-LNSC：Support one ADC interface
  A7670C/LAAE/A7670C-LAAL/A7670C-LAAS：Support two ADC interfaces
- 4*4 matrix keyboard
  A7670C/A7670E/A7670SA/A7670C-LNSC：Not support
  A7670C/LAAE/A7670C-LAAL/A7670C-LAAS：Support
- Analog audio MIC input interface
  A7670C/A7670E/A7670SA/A7670C-LNSC：Not support
  A7670C/LAAE/A7670C-LAAL/A7670C-LAAS：Support
- Analog audio SPK output interface
  A7670C/A7670E/A7670SA/A7670C-LNSC：Not support
  A7670C/LAAE/A7670C-LAAL/A7670C-LAAS：Support
- LDO Power Output
- PCM Interface
- I2C Interface
- General input and output interfaces (GPIO)
- Antenna Interface
- USB_BOOT interface
- Network status indication interface
- Module operation status indication interface

Table 2: Hardware interface list

Interface	A7670C	A7670C-LAAE	A7670C-LAAL	A7670C-LAAS	A7670C-LNSC	A7670E	A7670SA
Power input	✓	✓	✓	✓	✓	✓	✓
USB2.0	✓	✓	✓	✓	✓	✓	✓

Full function serial port	✓	✓	✓	✓	✓	✓	✓
Ordinary serial port	✓	✓	✓	✓	✓	✓	✓
DEBUG serial port	✓	✓	✓	✓	✓	✓	✓
USIM	✓	✓	✓	✓	✓	✓	✓
GPIO	✓	✓	✓	✓	✓	✓	✓
ADC	1	2	2	2	1	1	1
4*4 matrix keyboard		✓	✓	✓			
Analog audio MIC input interface		✓	✓	✓			
Analog audio SPK output interface		✓	✓	✓			
Power output	✓	✓	✓	✓	✓	✓	✓
PCM	✓	✓	✓	✓	✓	✓	✓
I2C	✓	✓	✓	✓	✓	✓	✓
USB_BOOT	✓	✓	✓	✓	✓	✓	✓
NETLIGHT indication	✓	✓	✓	✓	✓	✓	✓
STATUS indication	✓	✓	✓	✓	✓	✓	✓
Antenna	✓	✓	✓	✓	✓	✓	✓

1.3 Hardware Block Diagram

The block diagram of the A7670 module is shown in the figure below.

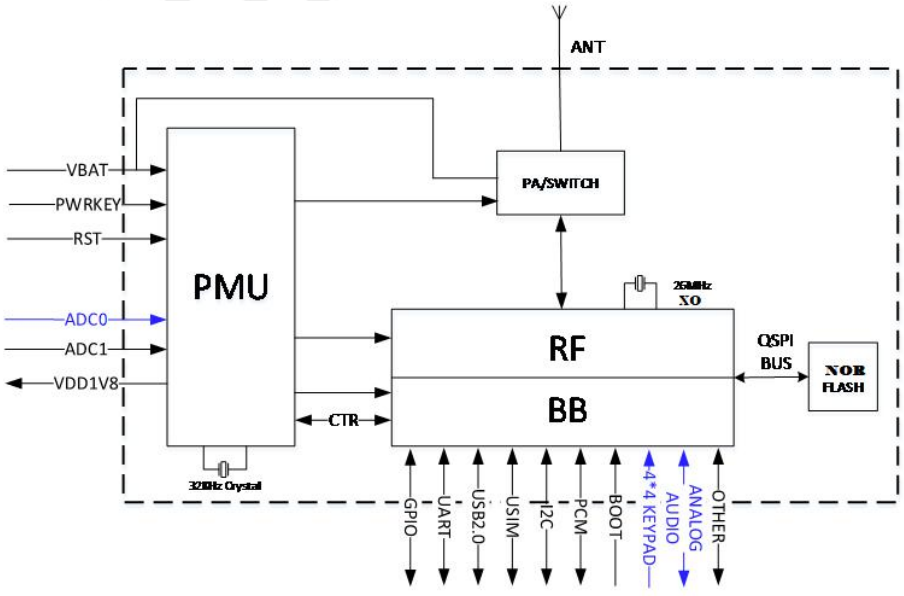

Figure 1: A7670 block diagram

NOTE

Only A7670C-LAAE/A7670C-LAAL/A7670C-LAAS modules are supported for the blue highlighted circuits in the block diagram

1.4 Functional Overview

Table 3: General features

Feature	Implementation
Power supply	VBAT: 3.4V ~4.2V,Recommended VBAT: 3.8V
Power saving	Current in sleep mode :<2.5mA
Radio frequency bands	Please refer to the table 1
Transmitting power	GSM/GPRS power class: ●EGSM900: 4 (33dBm±2dB) ●DCS1800: 1 (30dBm±2dB) EDGE power class: ●EGSM900: E2 (27dBm±3dB) ●DCS1800 : E1 (26dBm+3dB/-4dB) LTE power class: 3 (23dBm±2.7dB)
Data Transmission Throughput	GPRS multi-slot class 12 EDGE multi-slot class 12 LTE-FDD CAT1 : 10 Mbps (DL) , 5 Mbps (UL) LTE-TDD CAT1 : 8.96Mbps (DL) , 3.1 Mbps (UL)
Antenna	GSM/LTE Main antenna interface
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	PCM Digital Audio interface Analog audio MIC input interface(A7670C-LAAE/A7670C-LAAL/A7670C-LAAS support only) Analog audio SPK output

	interface(A7670C-LAAE/A7670C-LAAL/A7670C-LAAS support only)
UART interface	●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	USB 2.0 compliant, host mode not supported. This interface can be used for AT command sending, data transmission, software debugging and upgrading.
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size:24*24*2.5m Weight:3.08g(Typical)
Temperature range	Normal operation temperature: -30°C to +80°C Extended operation temperature: -40°C to +85°C* Storage temperature -45°C to +90°C

NOTE

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

2 Package Information

2.1 Pin Assignment Overview

All functions of the module will be provided through 88 pads that will be connected to the customers' platform. The following Figure is a high-level view of the pin assignment of the module for A7670C/A7670E/A7670SA/A7670C-LNSC.

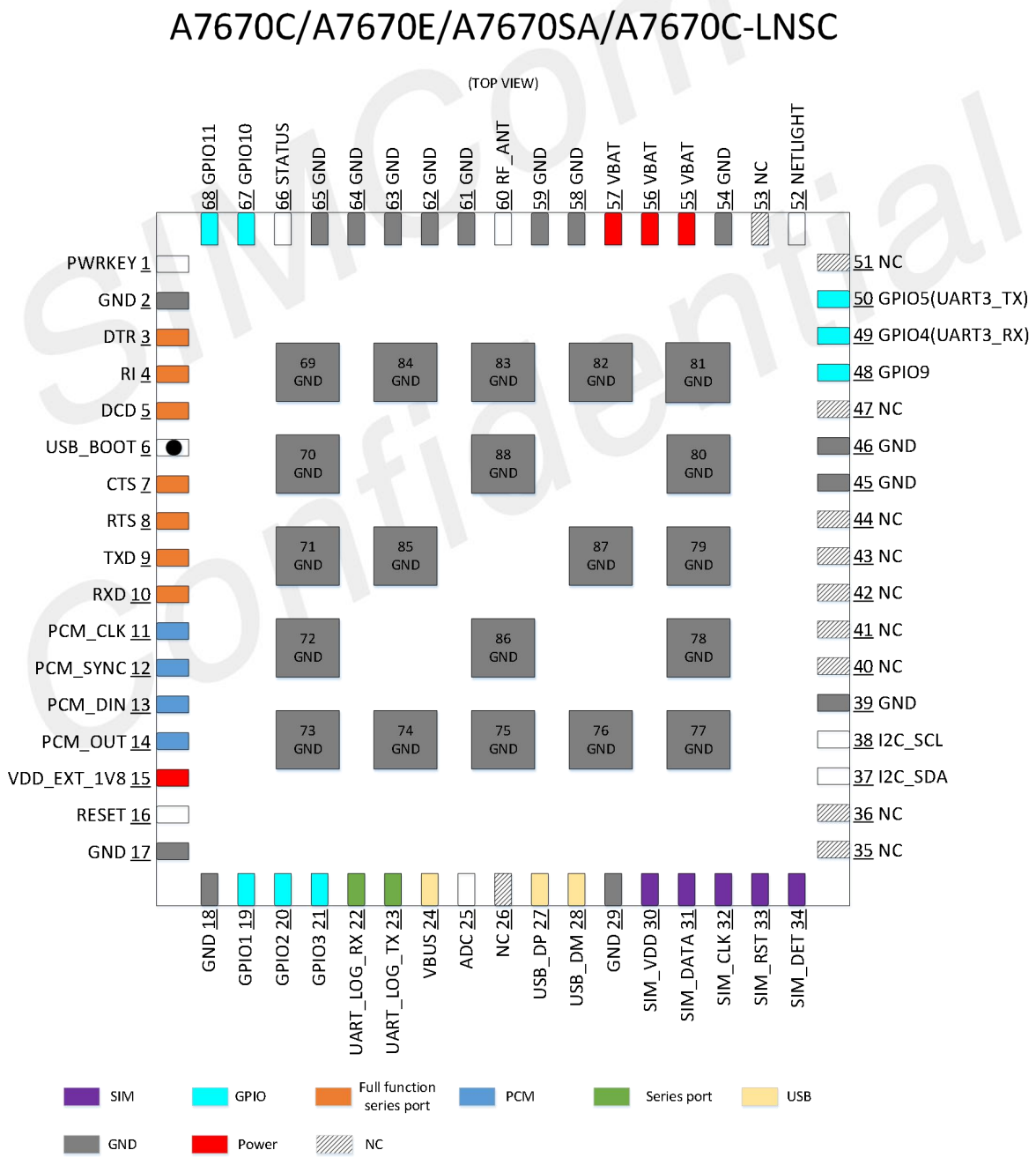

Figure 2: Pin assignment overview for A7670C/A7670E/A7670SA/A7670C-LNSC

The following Figure is a high-level view of the pin assignment of the module for A7670C-LAAE/A7670C-LAAL/A7670C-LAAS.

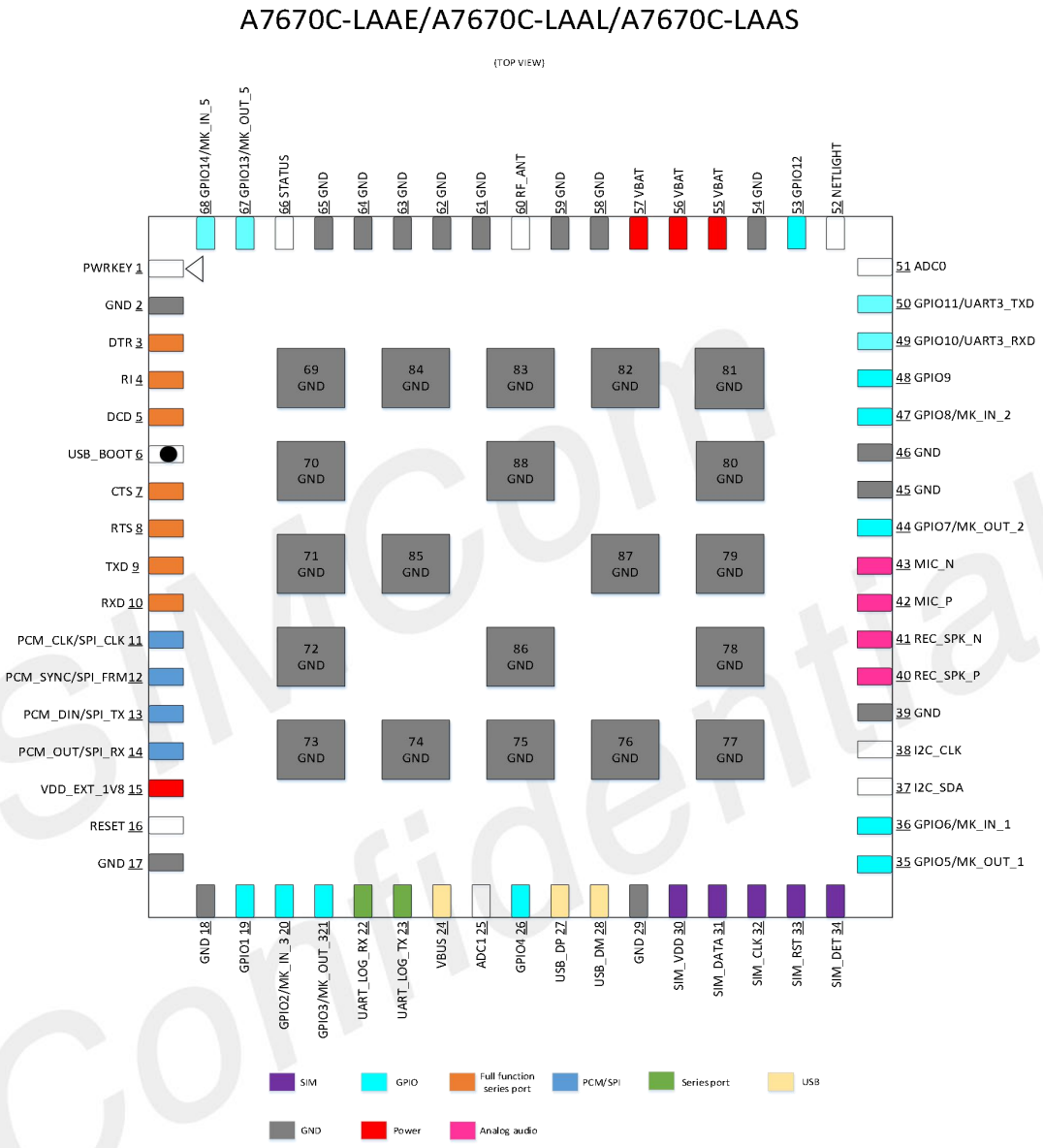

Figure 3: Pin assignment overview for A7670C-LAAE/A7670C-LAAL/A7670C-LAAS

Table 4: Pin Description

A7670C/A7670E/A7670SA/A7670C-LNSC				A7670C-LAAE/A7670C-LAAL/A7670C-LAAS			
PIN NO	PIN NAME	PIN NO	PIN NAME	PIN NO	PIN NAME	PIN NO	PIN NAME
1	PWRKEY	2	GND	1	PWRKEY	2	GND
3	DTR	4	RI	3	DTR	4	RI
5	DCD	6	USB_BOOT●	5	DCD	6	USB_BOOT●
7	CTS	8	RTS	7	CTS	8	RTS

9	TXD	10	RXD	9	TXD	10	RXD
11	PCM_CLK	12	PCM_SYNC	11	PCM_CLK	12	PCM_SYNC
13	PCM_DIN	14	PCM_OUT	13	PCM_DIN	14	PCM_OUT
15	VDD_1V8	16	RESET	15	VDD_1V8	16	RESET
17	GND	18	GND	17	GND	18	GND
19	GPIO1	20	GPIO2	19	GPIO1	20	GPIO2/MK_IN_3
21	GPIO3	22	UART_LOG_RX	21	GPIO3/MK_OUT_3	22	UART_LOG_RX
23	UART_LOG_TX	24	VBUS	23	UART_LOG_TX	24	VBUS
25	ADC	26	NC	25	ADC1	26	GPIO4
27	USB_DP	28	USB_DM	27	USB_DP	28	USB_DM
29	GND	30	SIM_VDD	29	GND	30	SIM_VDD
31	SIM_DATA	32	SIM_CLK	31	SIM_DATA	32	SIM_CLK
33	SIM_RST	34	SIM_DET	33	SIM_RST	34	SIM_DET
35	NC	36	NC	35	GPIO5/MK_OUT_1	36	GPIO6/MK_IN_1
37	I2C_SDA	38	I2C_SCL	37	I2C_SDA	38	I2C_SCL
39	GND	40	NC	39	GND	40	REC_SPK_P
41	NC	42	NC	41	REC_SPK_N	42	MIC_P
43	NC	44	NC	43	MIC_N	44	GPIO7/MK_OUT_2
45	GND	46	GND	45	GND	46	GND
47	NC	48	GPIO9	47	GPIO8/MK_IN_2	48	GPIO9
49	GPIO4 (UART3_RX)	50	GPIO5 (UART3_TX)	49	GPIO10 (UART3_RX)	50	GPIO11 (UART3_TX)
51	NC	52	NETLIGHT	51	ADC0	52	NETLIGHT
53	NC	54	GND	53	GPIO12	54	GND
55	VBAT	56	VBAT	55	VBAT	56	VBAT
57	VBAT	58	GND	57	VBAT	58	GND
59	GND	60	RF_ANT	59	GND	60	RF_ANT
61	GND	62	GND	61	GND	62	GND
63	GND	64	GND	63	GND	64	GND
65	GND	66	STATUS	65	GND	66	STATUS
67	GPIO10	68	GPIO11	67	GPIO13/MK_OUT_5	68	GPIO14/MK_IN_5
69	GND	70	GND	69	GND	70	GND
71	GND	72	GND	71	GND	72	GND
73	GND	74	GND	73	GND	74	GND
75	GND	76	GND	75	GND	76	GND
77	GND	78	GND	77	GND	78	GND
79	GND	80	GND	79	GND	80	GND
81	GND	82	GND	81	GND	82	GND
83	GND	84	GND	83	GND	84	GND
85	GND	86	GND	85	GND	86	GND
87	GND	88	GND	87	GND	88	GND

NOTE

'USB_BOOT' cannot be pulled up before the module powered up, otherwise it will affect the normal start-up of the module.

2.2 Pin Description

Table 5: Pin parameter abbreviation

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

Table 6: IO parameters definition

Power domain	Parameter	Description	Min	Typ.	Max
1.8V	VCC=1.8V				
	VIH	High level input	VCC * 0.7	1.8V	VCC + 0.4
	VIL	Low level input	-0.4	0V	VCC *0.25
	Rpu	Pull up resistor	-	100 KΩ	-
	Rpd	Pull down resistor	-	100 KΩ	-
1.8V	VCC = 1.8				
	IIL	Input leakage current	-	-	10uA
	Output DC Operating Conditions (VCC = 1.8 V Typical)				
	VOH	Output level range	VCC - 0.4	-	VCC
	VOL	Output low range	-	-	0.2V
	MFPR[DCS]= 1 0	Maximum current driving capacity at high level output	IOH = (mA min) 2 mA		

			4 mA

Table 7: I2C/USIM parameters definition

Power Domain	Parameter	Description	Min	Typ.	Max
1.8V (I2C/USIM)	Condition (VCC=1.8V)				
	VIH	High level input	VCC * 0.7	1.8V	VCC + 0.4
	VIL	Low level input	-0.4	0V	VCC *0.25
	VOH	Output level range	VCC - 0.4	-	VCC
	VOL	Output low range	-	-	0.2V
	Rpu	Pull up resistor	-	25 KΩ	-
	Rpd	Pull down resistor	-	25 KΩ	-
	IIL	Input leakage current	-	-	2uA
3V(USIM)	Condition (VCC=3V)				
	VIH	High level input	VCC * 0.75	-	VCC + 0.4
	VIL	Low level input	-0.4	-	VCC * 0.25
	VOH	Output level range	VCC - 0.4	-	VCC
	VOL	Output low range	-	-	0.3V
	Rpu	Pull up resistor	-	50K	-
	Rpd	Pull down resistor	-	50K	-
	IIL	Input leakage current	-	-	2uA

Table 8: Pin description

Pin name	Pin No.	Pin parameter		Description	Note
		Power domain	Type		
Power supply					
VBAT	55,56,57	-	PI	A7670 input voltage ranges from 3.4V to 4.2V, and the peak current value can reach 2A.	
VDD_1V8	15	-	PO	1.8V power output, output current up to 50 mA. It is on by default.	If unused, keep it open.
GND	2,17,18,29,39,45,46,54,58,59,61,62,63,64,65,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,8	-	-	Ground	

	7,88				
System Control					
PWRKEY	1	-	DI,PU	Power ON/OFF input, active low. VIH: 0.7*VBAT VIL: 0.5V	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: 0.5V	RESET has been pulled-up to VBAT with 50KΩ (typical) resistor, default high.
USIM interface					
SIM_DATA	31	1.8/3.0V	I/O,PU	USIM bus data, this pin has been pull-up with 4.7KΩ resistor to USIM_VDD.	
SIM_RST	33	1.8/3.0V	I/O,PU	USIM bus reset output.	
SIM_CLK	32	1.8/3.0V	I/O,PU	USIM bus clock output.	
SIM_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.	
SIM_DET	34	1.8V	I/O,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.	
USB_DN	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	If unused, keep it open.
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	
Debug UART					
UART_LOG_TXD	23	1.8V	DOH	Log output	Default used as debug port.
UART_LOG_R	22	1.8V	DI	Log input	

XD					
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. These pins have been Internally pull-up to VDD_1.8 on A7670C/A7670E/ A7670SA/A7670C -LNSC，and not been pulled-up on A7670C-LAAE/A7670C-LAAL/A7670C-LAAS. External power supply cannot be used to pull up these pin, pull up with VDD_1V8 offered by module if needed， otherwise there will be voltage leakage.
I2C_SDA	37	1.8V	I/O	I2C data I/O	
PCM interface					
PCM_OUT	14	1.8V	DO,PD	PCM data output	If unused, keep it open.
PCM_IN	13	1.8V	DI,PD	PCM data input	
PCM_SYNC	12	1.8V	I/O,PD	PCM SYNC signal	
PCM_CLK	11	1.8V	DO,PU	PCM clock output	
Analog audio interface（A7670C-LAAE/A7670C-LAAL/A7670C-LAAS）					
REC_SPK_P	40	1.8V	AIO	SPK output positive	If unused, keep it open.
REC_SPK_N	41	1.8V	AIO	SPK output negative	
MIC_P	42	1.8V	AIO	MIC input positive	
MIC_N	43	1.8V	AIO	MIC input negative	
GPIO（A7670C/A7670E/A7670SA/A7670C-LNSC）					
GPIO1	19	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO2	20	1.8V	IO,PD	General purple I/O	If unused, keep it

					open.
GPIO3	21	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO4	49	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO5	50	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO9	48	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO10	67	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO11	68	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO（A7670C-LAAE/A7670C-LAAL/A7670C-LAAS）					
GPIO1	19	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO2	20	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO3	21	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO4	26	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO5	35	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO6	36	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO7	44	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO8	47	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO9	48	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO10	49	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO11	50	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO12	53	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO13	67	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO14	68	1.8V	IO,PU	General purple I/O	If unused, keep it open.
ANT interface					
RF_ANT	60	-	AIO	Main ANT interface	

Other pins					
ADC1	25,(51)	-	AI	General Purpose 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	DI	Module status indicator (LED).	
USB_BOOT	6	1.8V	DI	Firmware download guide control input. when pull-up to 1.8V and press PWRKEY,A7670 will access in USB download mode.	Do place 2 test points for debug. Do not pull up 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 ofA7670.

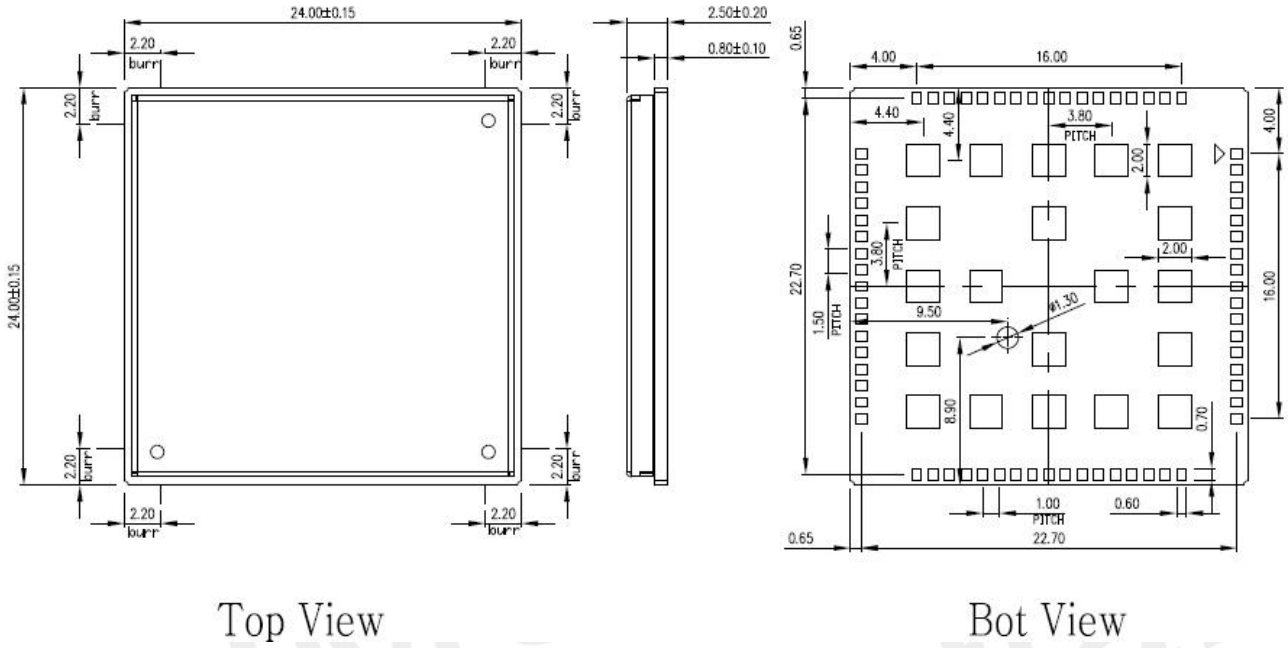

Figure 4: Dimensions (Unit: mm)

NOTE

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

2.4 Footprint Recommendation

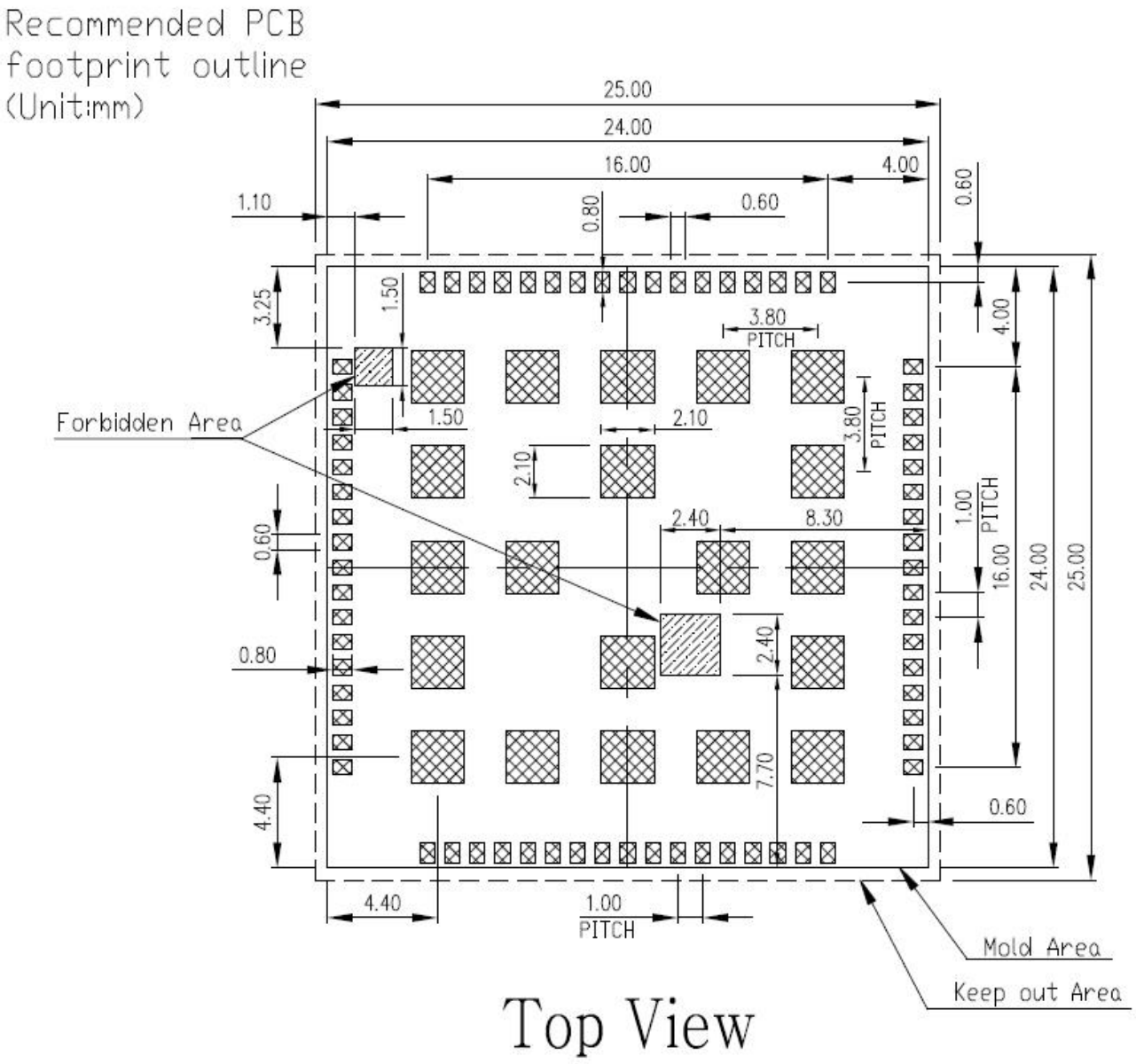

Figure 5: Footprint recommendation (Unit: mm)

2.5 Recommend Stencil Size

Recommend stencil thickness≥0.15mm and <0.18mm.

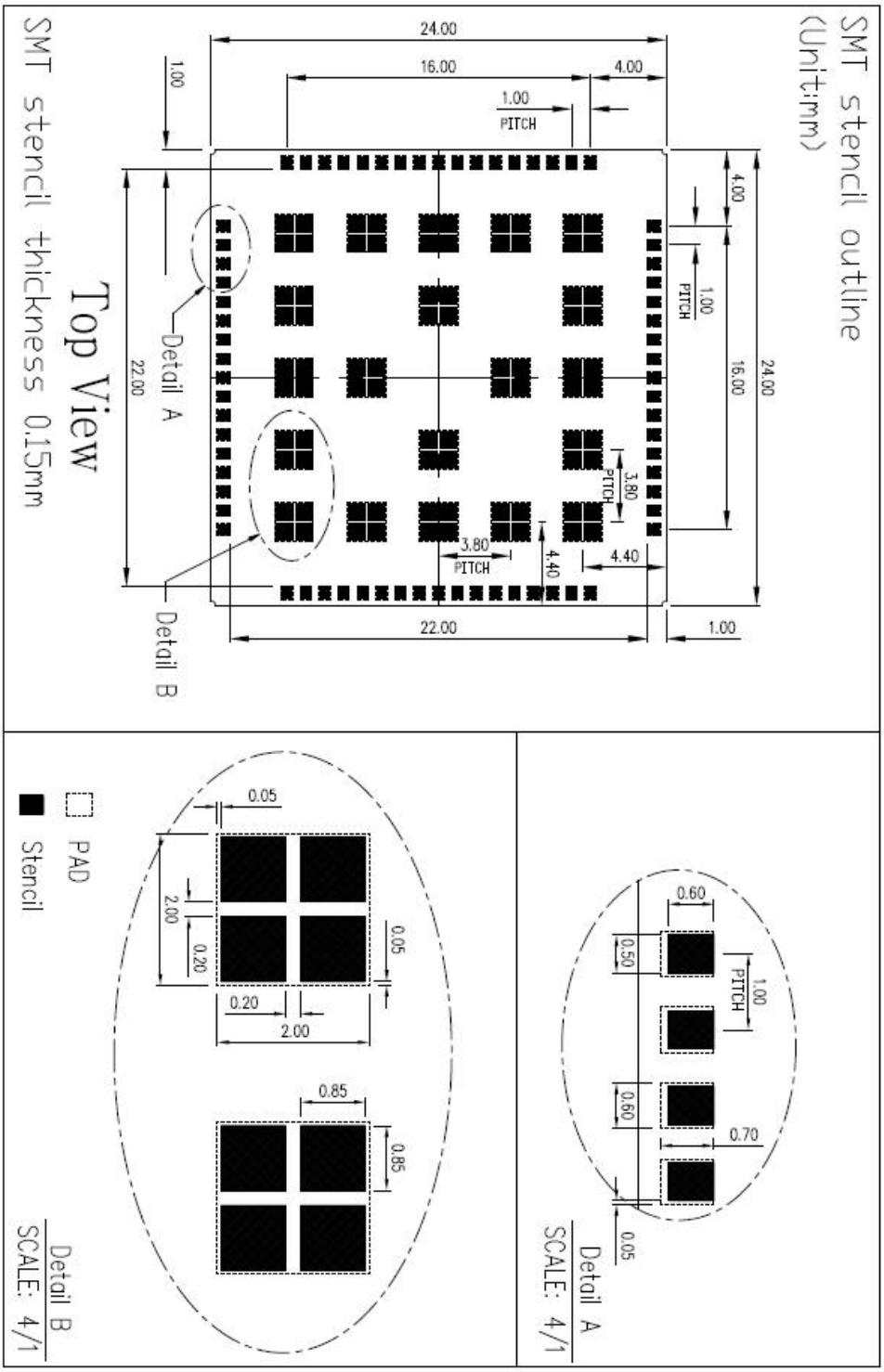

Figure 6: Recommend stencil dimension (Unit: mm)

3 Interface Application

3.1 Power Supply

A7670 offers 3 power supply pins (55, 56, 57) as VBAT power input pin.A7670 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.

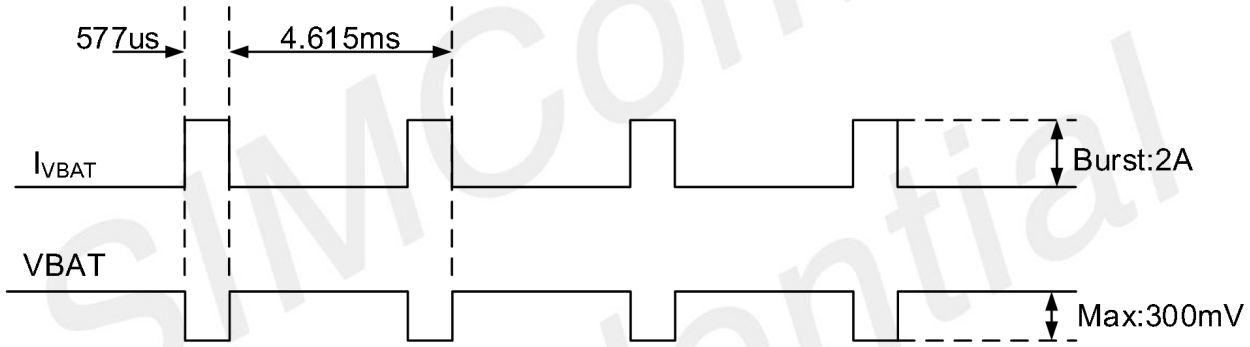

Figure 7: VBAT voltage drop during burst emission (EDGE/GPRS)

NOTE

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

Table 9: 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 40			
IVBAT(sleep)	Module average consumption current (sleep mode)				
IVBAT(power-	Module average consumption current(off leakage	-	-	20	uA

off)	current)				

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 four33PF/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 2mm. 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.

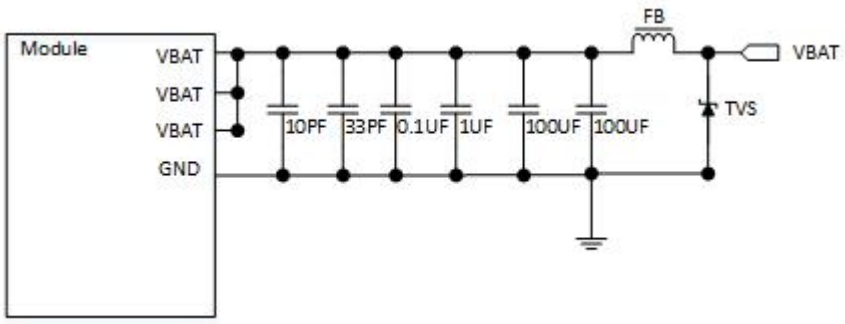

Figure 8: Power supply application circuit

In addition, in order to prevent the damage of A7670 caused by surge and overvoltage, it is recommended to parallel one TVS on the Vbat pin of the module.

Table 10: 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

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. 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:

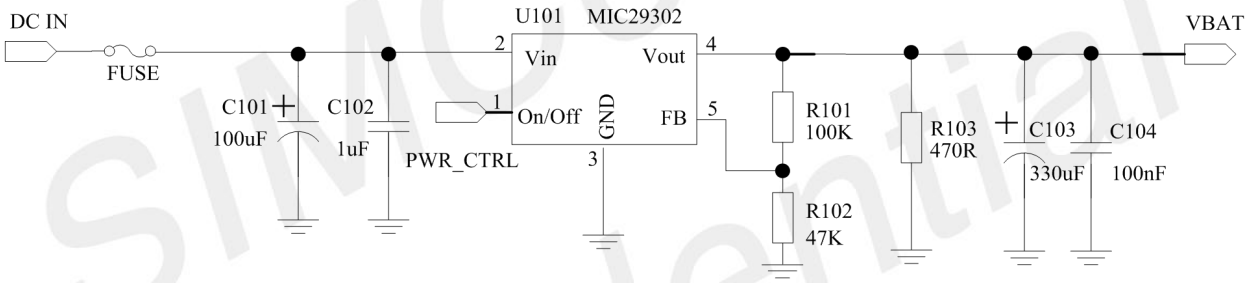

Figure 9: Linear regulator reference circuit

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

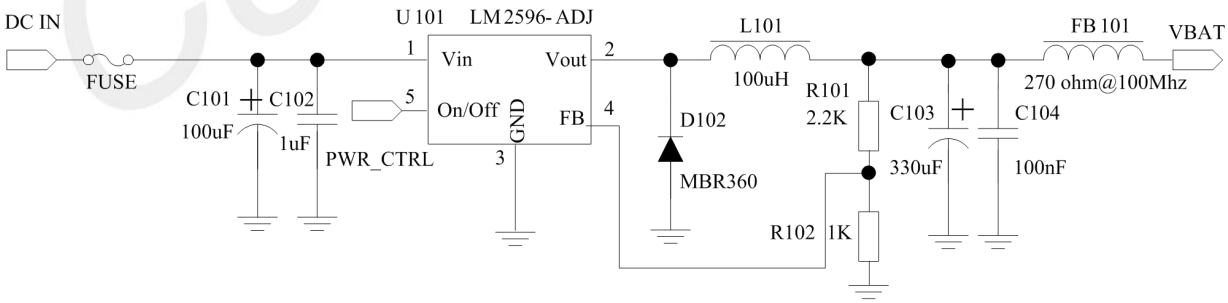

Figure 10: power supply reference circuit

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

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:

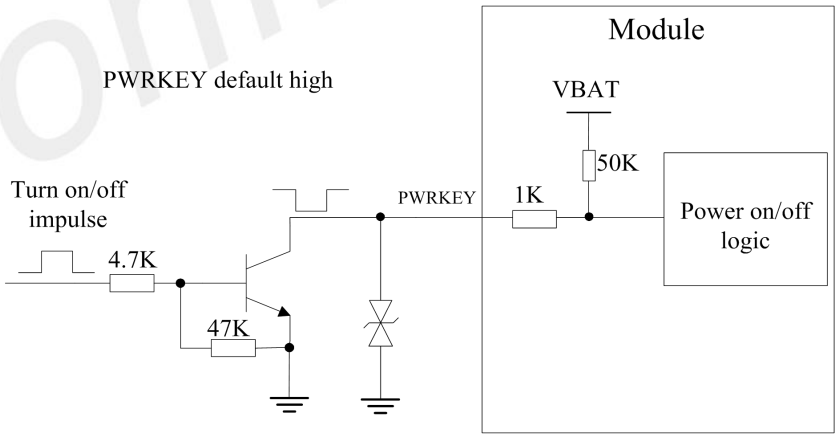

Figure 11: Reference power on/off circuit

NOTE

Do not parallel capacitors which the value is exceed 10 n F 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.

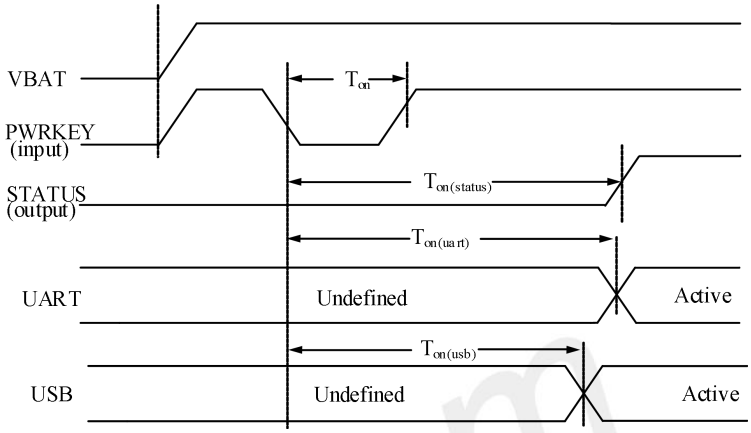

Figure 12: Power on timing sequence

Table 11: 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)	-	11.2	-	s
Ton(uart)	The time from power-on issue to UART port ready	-	11.1	-	s
Ton(usb)	The time from power-on issue to USB port ready	-	9	-	s
VIH	Input high level voltage on PWRKEY pin	2.94	-	VBAT	V
VIL	Input low level voltage on PWRKEY pin	0	0	0.5	V

3.2.2 Power off

A7670 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 ~ + 80 ℃, A7670 will report warning information through AT port. When the temperature exceeds the range of - 40 ~ + 85 ℃, A7670 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:

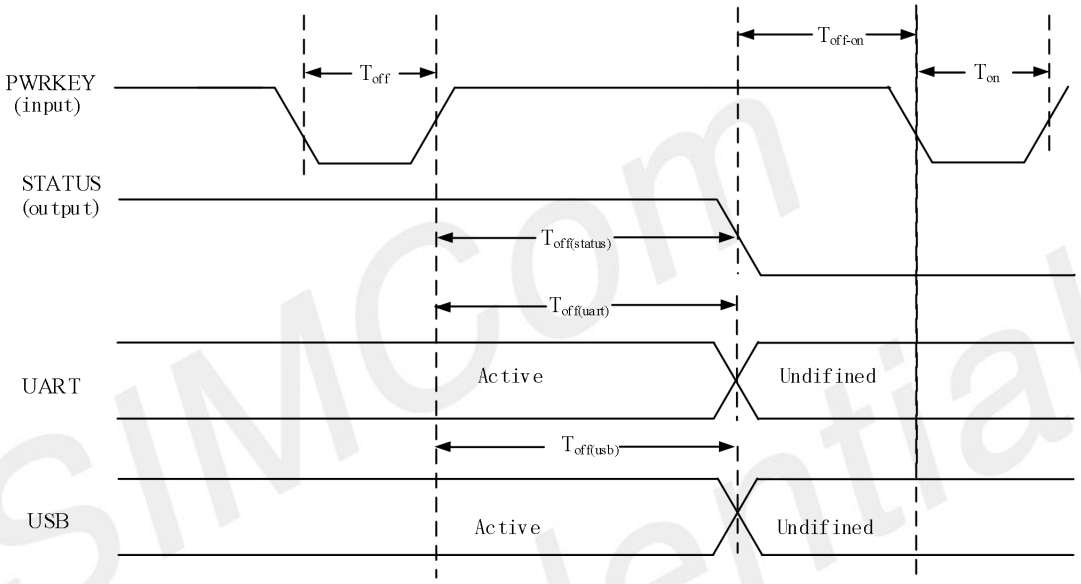

Figure 13: Power off timing sequence

Table 12: 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

A7670 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 50K Ω 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:

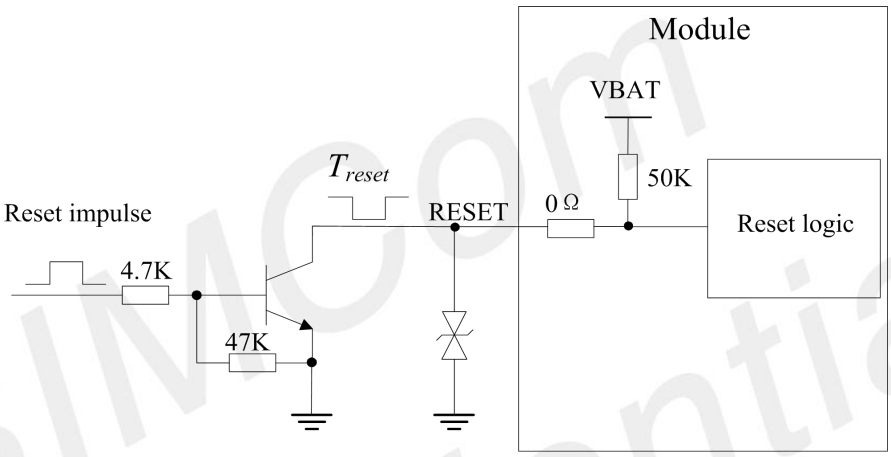

Figure 14: Reference reset circuit

Table 13: 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	2.94	-	VBAT	V
VIL	Input low level voltage	0	0	0.5	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

A7670 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:

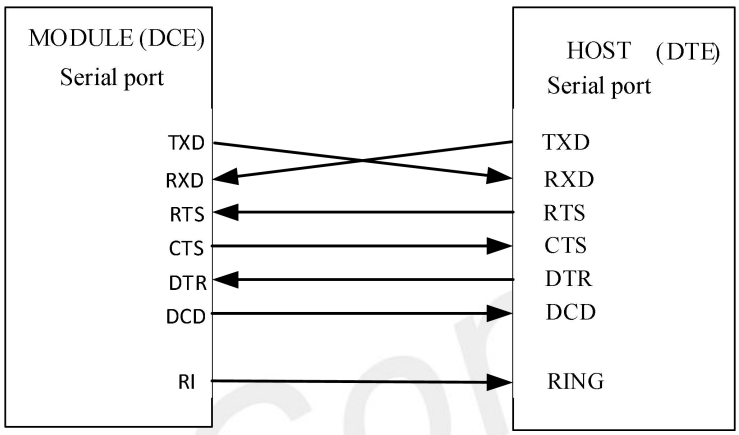

Figure 15: Serial port connection diagram (full-function mode)

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

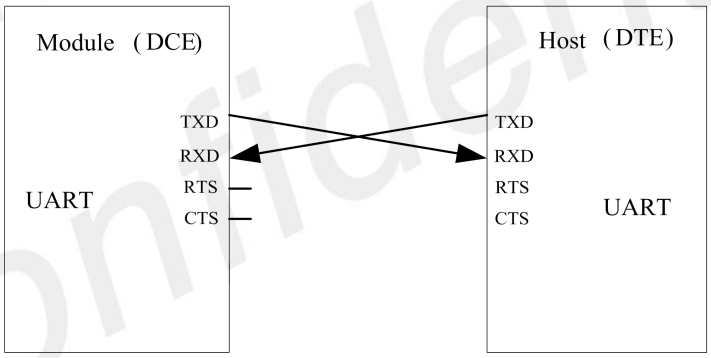

Figure 16: Serial port connection diagram (NULL mode)

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.

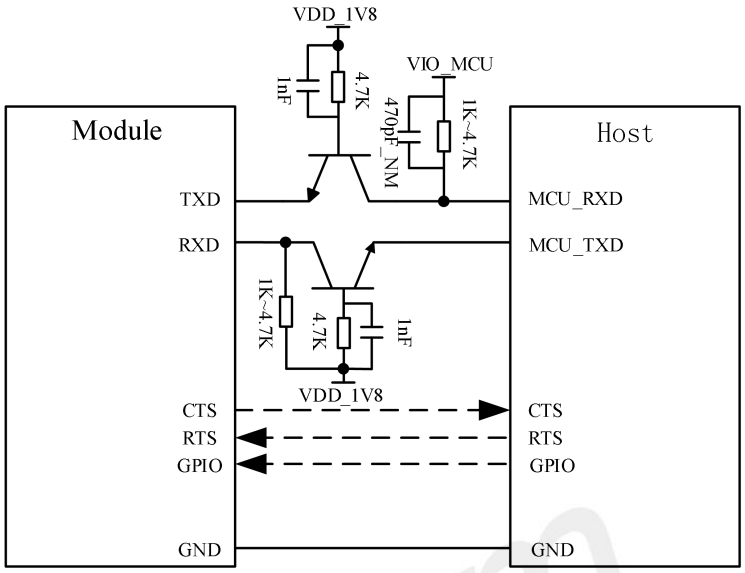

Figure 17: Triode level conversion circuit

NOTE

1. The CTS of the module (DCE) is connected to the CTS of the main control (DTE), and the RTS of the module (DCE) is connected to the RTS of the main control (DTE).
2. A7670 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.
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.

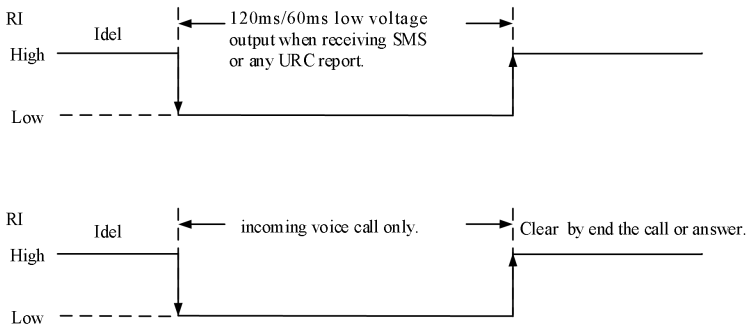

Figure 18: RI behaviour (SMS and URC report)

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 A7670 enters sleep mode, pulling down DTR can wakeup module.
After setting the AT command “AT+CSCLK=0”, A7670 Series will do nothing when the DTR pin is pulling up.

3.4 USB Interface

The A7670 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, 0R resistors must be reserved for switching external test points during design, as shown in the figure below.

3.4.1 USB Reference Design

A7670 can be used as a USB slave device. The recommended connection circuit diagram is as follows:

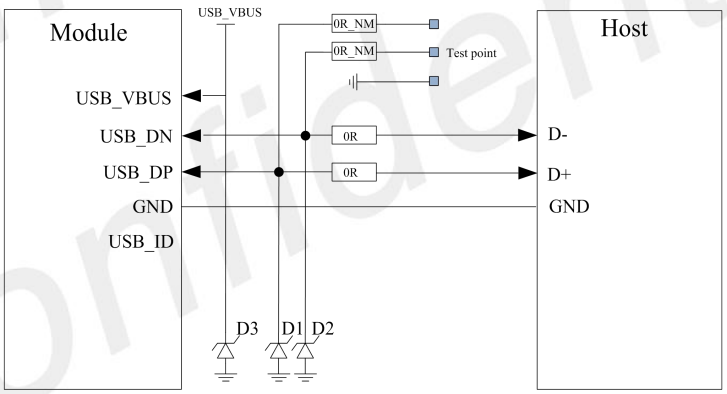

Figure 19: USB circuit diagram

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 90Ω +/- 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

A7670 provides one forced download boot interface 'USB_BOOT'.

Table 14: USB_BOOT description

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

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 1.8V, 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.

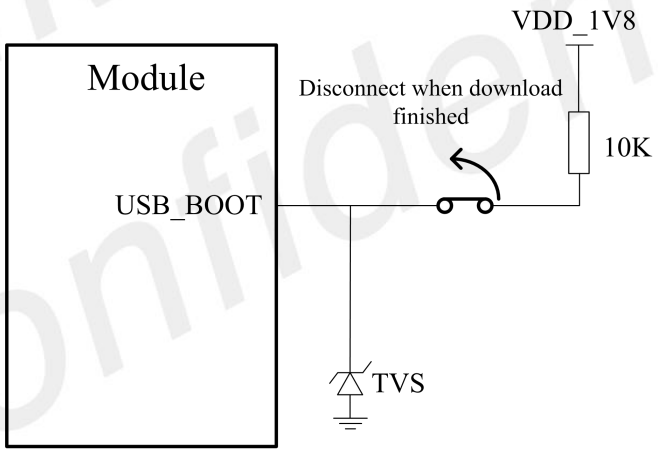

Figure 20: Reference USB_BOOT circuit

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

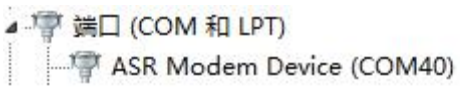

Figure 21: Force-download port

NOTE

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

3.5 SIM Interface

A7670 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 15: 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*USIM_VDD	-	USIM_VDD +0.4	V
VIL	Low-level input voltage	-0.4	0	0.25*USIM_VDD	V
VOH	High-level output voltage	USIM_VDD -0.4	-	USIM_VDD	V
VOL	Low-level output voltage	0	0	0.2	V

Table 16: 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*USIM_VDD	-	USIM_VDD +0.4	V
VIL	Low-level input voltage	-0.4	0	0.25*USIM_VDD	V
VOH	High-level output voltage	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.

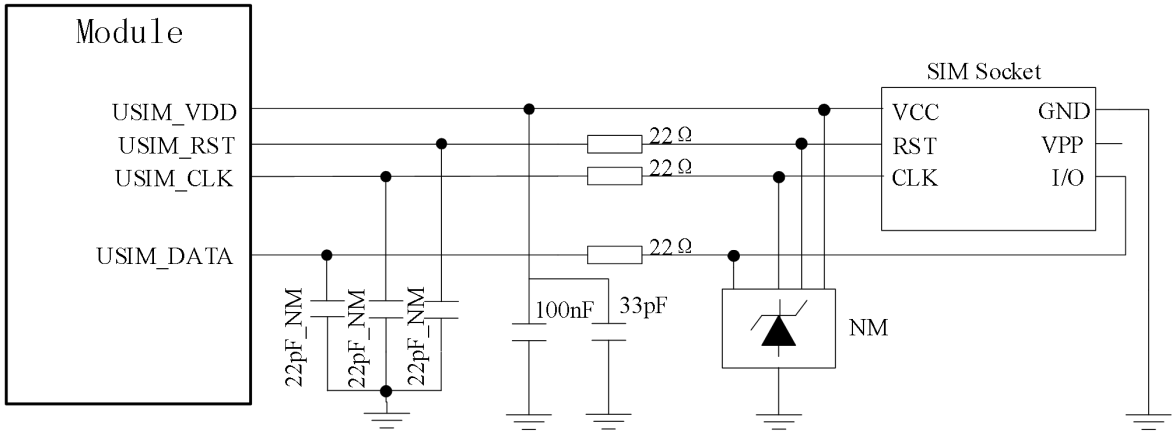

Figure 22: SIM interface reference circuit

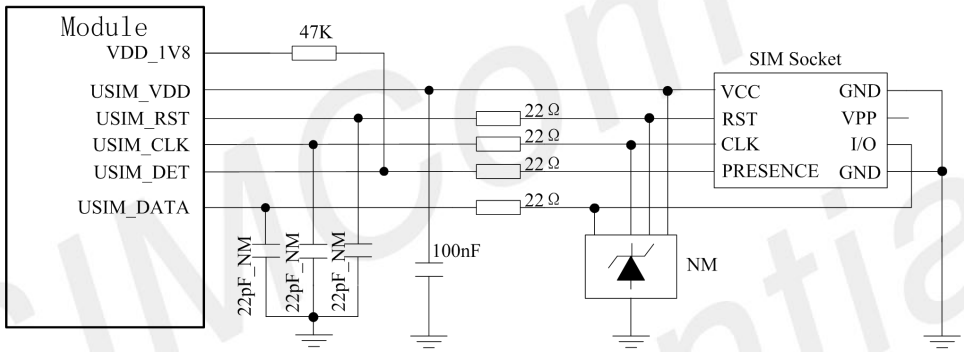

Figure 23: SIM interface reference circuit (8PIN)

NOTE

USIM_DATA has been pulled up with a 4.7KΩ resistor to USIM_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].USIM_CLK is very important signal, the rise time and fall time of USIM_CLK

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.

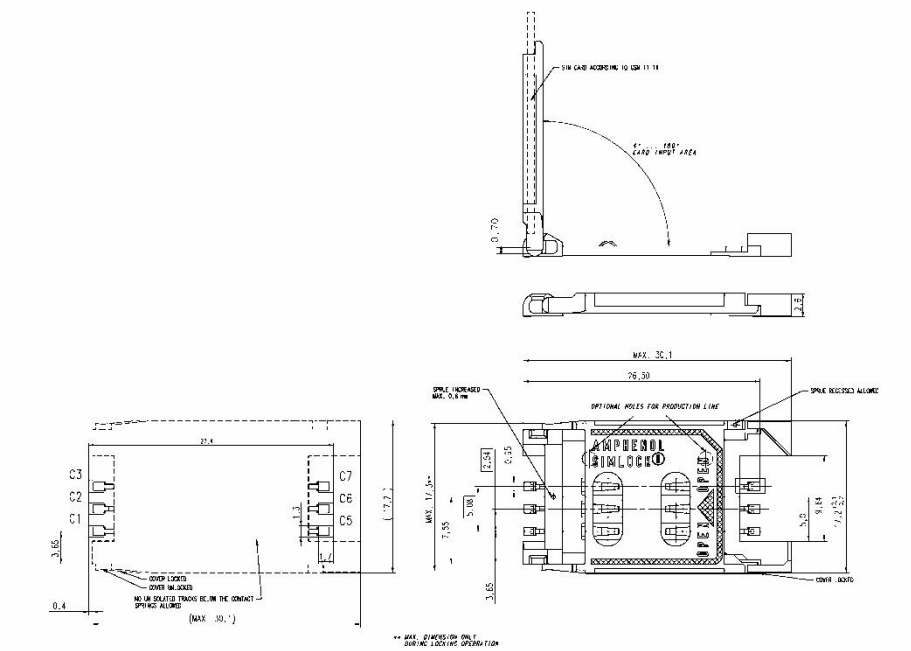

Figure 24: Amphenol C707 10M006 512 USIM card socket

Table 17: 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

A7670C-LAAE and A7670C-LAAL 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,16bit

--DAC: 90db SNR@20~20KHz

--Class-G: THD<-90dB@32-ohm load

--Class-AB: THD<-90dB@32-ohm load

--REC_SPK_P 、REC_SPK_N support the handset by default.

Table 18: MIC input ADC parameter list

Parameter	MIN	Type	MAX	Unit
Clock frequency	-	6.144	-	MHz

Table 19: Analog audio output channel

Parameter	Condition	MAX Power
DAC	RL=10KΩ	1.59Vp
RECEIVER	Mono,32Ω, Differential	37mW

Audio playback supports formats: AMR-NB(.amr;.3gp)、MP3(.mp3)、MIDI(.mid)

Audio recording supports formats: AMR-NB (.amr)

3.6.1 Analog audio reference design

The analog audio recommendation circuit is as follows:

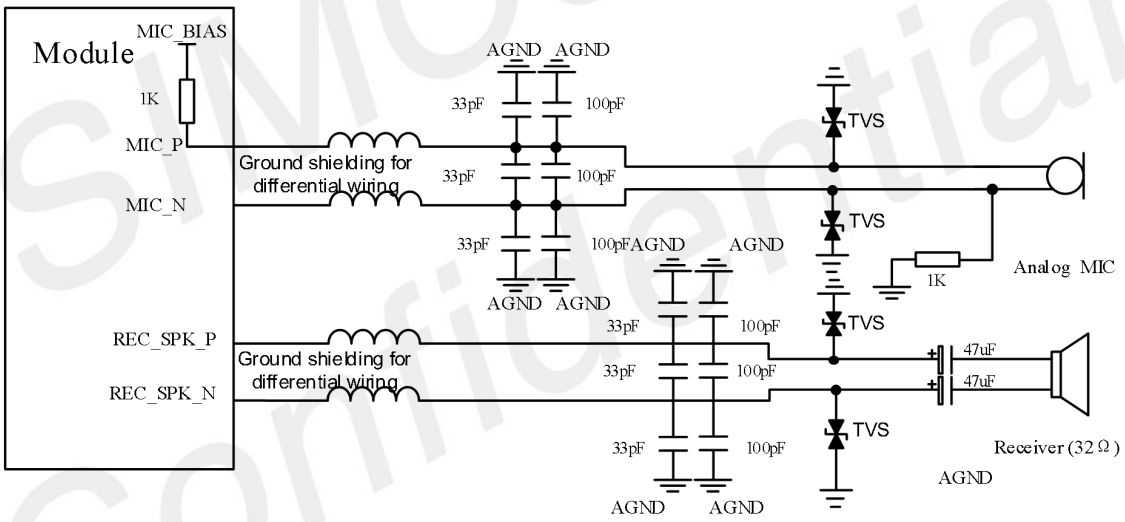

Figure 25: Analog audio interface reference circuit

3.7 PCM Interface

A7670 provides a PCM interface for external codec, which can be used in master mode with short sync and 16 bits linear format. A7670 support voice function, customers can add codec on PCM for voice call. For specific parameters and matters, please refer to the relevant software manuals.

Table 20: PCM format

Characteristics	Specification
Line Interface Format	Linear(Fixed)
Data length	16bits(Fixed)
PCM Clock/Sync Source	Master Mode(Fixed)
PCM Clock Rate	8KHz/16KHz
PCM Sync Format	Short sync(Fixed)
Data Ordering	MSB

3.7.1 PCM Sequence

The related PCM timing is shown in the following figure:

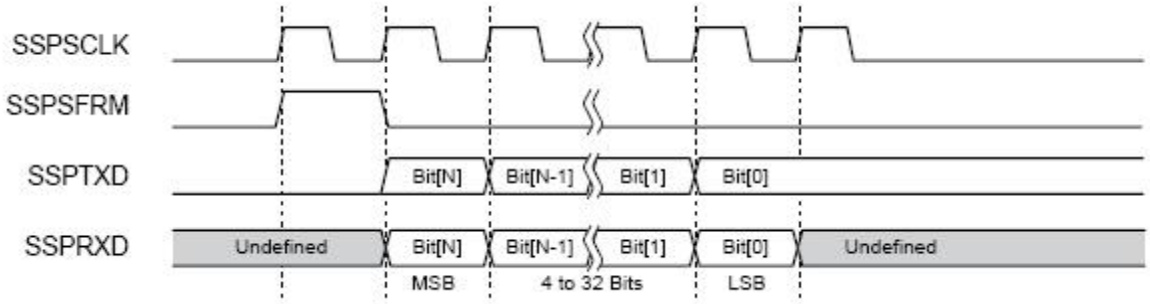

Figure 26: PCM sequence

3.7.2 PCM Reference Design (Software development)

The following figure shows the external codec reference design.

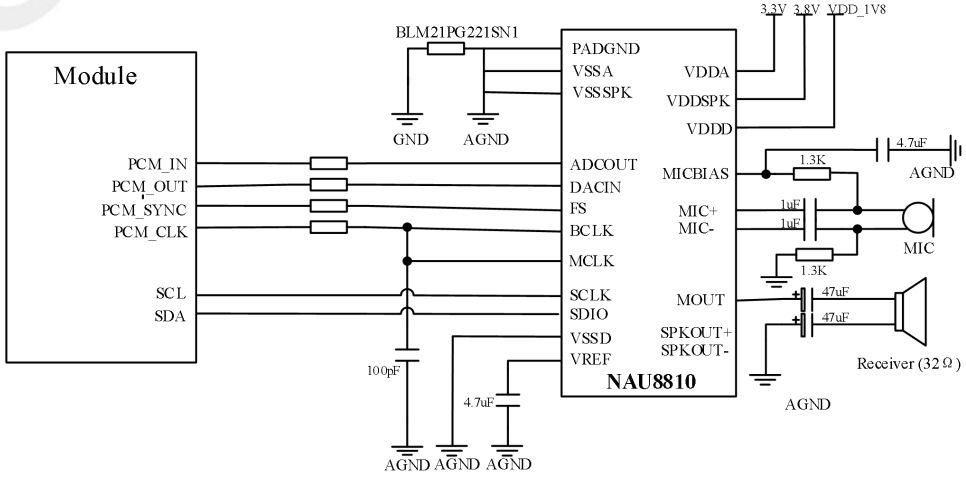

Figure 27: PCM reference circuit

NOTE

Please reserve 0R serial resistance on the PCM channel.

3.8 Keyboard interface

The module provides a set of 4 x 4 keyboard input interface.

Table 21: Keyboard Resources

PIN NAME	Function	PIN NO	I/O	Description	NOTE
GPIO6	MK_IN1	36	IO	Keyboard input signal	
GPIO8	MK_IN2	47	IO		
GPIO2	MK_IN3	20	IO		
GPIO14	MK_IN5	68	IO		
GPIO5	MK_OUT1	35	IO	Keyboard output signal	
GPIO7	MK_OUT2	44	IO		
GPIO3	MK_OUT3	21	IO		
GPIO13	MK_OUT5	67	IO		

Keyboard interface reference design:

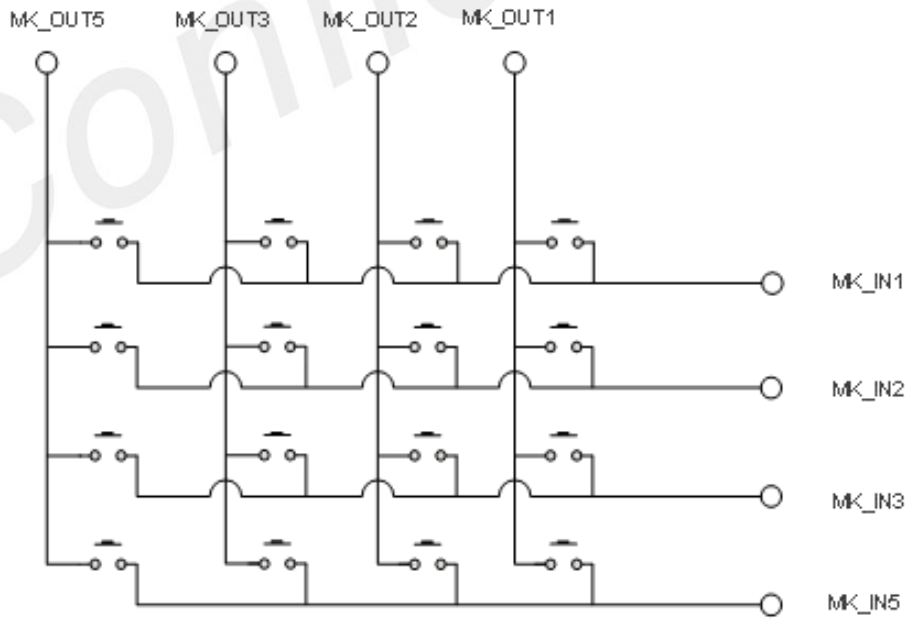

Figure 28: Keyboard interface reference circuit

3.9 GPIO Interface

A7670 module provides multiple GPIOs.

Table 22: Standard GPIO Resources of A7670C/A7670E/A7670SA/A7670C-LNSC

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
20	GPIO2	GPIO2	IO	1.8V	PD	Yes
21	GPIO3	GPIO3	IO	1.8V	PU	Yes
49	GPIO4	GPIO4	IO	1.8V	PU	Yes
50	GPIO5	GPIO5	IO	1.8V	PU	Yes
48	GPIO9	GPIO9	IO	1.8V	PD	Yes
67	GPIO10	GPIO10	IO	1.8V	PU	Yes
68	GPIO11	GPIO11	IO	1.8V	PU	Yes

Table 23: Standard GPIO Resources of A7670C-LAAE/A7670C-LAAL/A7670C-LAAS

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
20	GPIO2	GPIO2	IO	1.8V	PD	Yes
21	GPIO3	GPIO3	IO	1.8V	PD	Yes
26	GPIO4	GPIO4	IO	1.8V	PU	Yes
35	GPIO5	GPIO5	IO	1.8V	PD	Yes
36	GPIO6	GPIO6	IO	1.8V	PD	Yes
44	GPIO7	GPIO7	IO	1.8V	PD	Yes
47	GPIO8	GPIO8	IO	1.8V	PD	Yes
48	GPIO9	GPIO9	IO	1.8V	PD	Yes
49	GPIO10	GPIO10	IO	1.8V	PU	Yes
50	GPIO11	GPIO11	IO	1.8V	PU	Yes
53	GPIO12	GPIO12	IO	1.8V	PU	Yes
67	GPIO13	GPIO13	IO	1.8V	PU	Yes
68	GPIO14	GPIO14	IO	1.8V	PU	Yes

3.10 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.

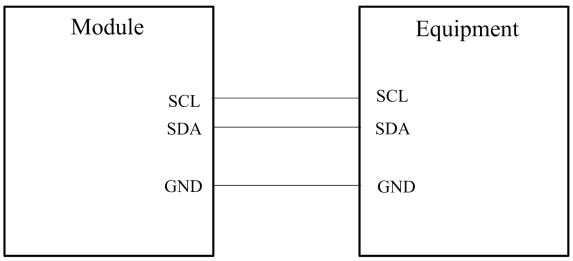

Figure 29: I2C reference circuit

NOTE

SCL and SDA have pull-up resistor inside for A7670C/A7670E/A7670SA/A7670C-LNSC, external resistor is not needed.
SCL and SDA have no pull-up resistor inside for A7670C-LAAE/A7670C-LAAL/A7670C-LAAS, external resistor is needed and the pulled power source must be VDD_1V8 output from the module.

3.11 Network status

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

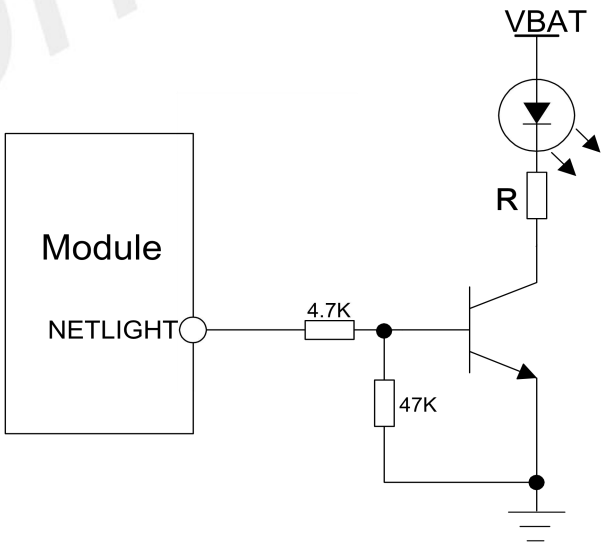

Figure 30: NETLIGHT reference circuit

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 24: 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 25: 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

3.12 Other interface

3.12.1 ADC

A7670C/A7670E/A7670SA/A7670C-LNSC has 1 dedicated ADC pin.
A7670C-LAAE/A7670C-LAAL/A7670C-LAAS have 2 dedicated ADC pins. They are available for digitizing analog signals such as battery voltage and so on. These electronic specifications are shown in the following table.

Table 26: ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	12	-	Bits
Input Range	0	-	1.3	V
Input serial resistance	1	–	–	MΩ

NOTE

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

[1].

3.12.2 LDO

A7670 has 1 LDO output, VDD_1V8.
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.

Table 27: VDD_1V8 Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{VDD_1V8}	Output voltage	-	1.8	-	V
I_O	Output current	-	-	50	mA

NOTE

This power supply 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 RF Specifications

Table 28: Conducted transmission power

Frequency	Power	Min.
GSM850	33dBm ±2dB	5dBm ± 5dB
EGSM900	33dBm ±2dB	5dBm ± 5dB
DCS1800	30dBm ±2dB	0dBm ± 5dB
PCS1900	30dBm ±2dB	0dBm ± 5dB
GSM850 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
EGSM900 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
DCS1800 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
PCS1900 (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

NOTE

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

Table 29: 2G/3G frequency band information

Frequency	DL	UL
GSM850	869~894 MHz	824~849MHz
EGSM900	925~960MHz	880~915 MHz
DCS1800	1805~1880 MHz	1710~1785 MHz
PCS1900	1850~1910MHz	1930~1990MHz

Table 30: 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	869～894 MHz	824～849MHz	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	2110~2180MHz	FDD
34	2010～2025MHz	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 31: Conducted receive sensitivity

Frequency	Receive sensitivity(Typical)	Receive sensitivity(MAX)
EGSM900	< -108dBm	3GPP
GSM850	< -108dBm	3GPP
DCS1800	< -108dBm	3GPP
PCS1900	< -108dBm	3GPP
LTE FDD/TDD	Refer to table 32	3GPP

Table 32: Reference sensitivity (QPSK)

E-UTRA Band	3GPP standard						Actual	Duplex Mode
	1.4 MHz	3MHz	5MHz	10MHz	15 MHz	20 MHz	10 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	-104.7	-101.7	-100	-97	-95.2	-94	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

NOTE

The measured value is the main antenna under 10 MHz.

4.2 GSM/LTE Antenna Design Guide

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

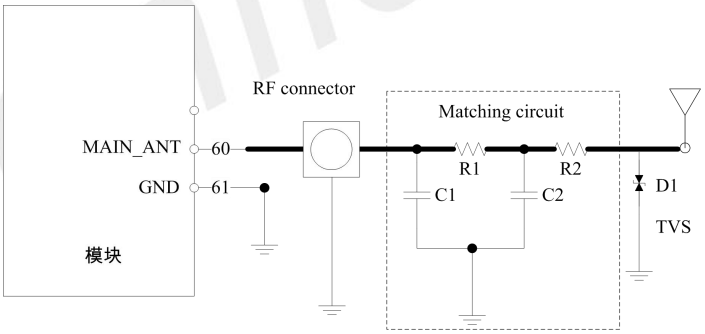

Figure 31: Antenna matching circuit (MAIN_ANT)

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

The RF test connector is used for the conducted RF performance test, and should be placed as close as to the module's MAIN_ANT pin. The traces impedance between A7670 and antenna must be controlled in 50

Ω.

Two TVS are recommended in the table below.

Table 33: Recommended TVS

Package	Part Number	Vender
0201	CE0201S05G01R	SOCAY
0402	PESD0402-03	PRISEMI

4.3 Antenna Requirements

The following table shows the requirements on GSM/LTE antennas.

Table 34: GSM/LTE antennas

Parameter	Requirement
Operating Frequency	See Table 29&30 for each antenna
Direction	Omni Directional
Gain	> -3dBi (Avg.)
Impedance	50 Ω
Efficiency	>50 %
Max. Input Power	50W
VSWR	< 2
Isolation	20dB is preferred
Cable Insertion Loss<1GHz	<0.5dB
Cable Insertion Loss 1GHz~2.2GHz	<0.9dB
Cable Insertion Loss 2.3GHz~2.7GHz	<1.2dB

5 Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of A7670 are listed in the following table, exceeding these limits may cause permanent damage to the module.

Table 35: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage on VBAT	-0.5	-	4.7	V
Voltage on USB_VBUS	-0.5	-	5.4	V
Voltage at digital pins (GPIO,I2C,UART,PCM)	-0.3	-	2.1	V
Voltage at IO pins	-0.3	-	2.1	V
(USIM)	-0.3	-	3.9	V
Voltage at PWRKEY, RESET	-0.3	-	4.7	V

5.2 Operating conditions

Table 36: 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 37: 1.8V Digital I/O characteristics*

Parameter	Description	Min.	Typ.	Max.	Unit
VIH	High-level input voltage	1.35	1.8	2.1	V
VIL	Low-level input voltage	-0.3	-	0.45	V
VOH	High-level output voltage	1.35	-	1.8	V
VOL	Low-level output voltage	0	-	0.4	V
IOH	High-level output current(no pull down resistor)	2	-	4	mA
IOL	Low-level output current(no pull up resistor)	-2	-	-4	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 PCM.

The operating temperature of A7670 is listed in the following table.

Table 38: Operating temperature

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

NOTE

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

5.3 Operating Mode

5.3.1 Operating Mode Definition

The table below summarizes the various operating modes of A7670 product.

Table 39: 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 is not accessible.

5.3.2 Sleep mode

In sleep mode, the current consumption of module will be reduced to the minimal level, and module can still receive paging message and SMS.
Several hardware and software conditions must be satisfied together in order to let A7670 enter into 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 A7670 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 A7670 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 A7670 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 40: Current consumption on VBAT Pins (VBAT=3.8V)

GSM sleep/idle mode	
GSM supply current (GNSS off，without USB connection)	Sleep mode@BS_PA_MFRMS=2Typical: 2.4mA Idle mode@BS_PA_MFRMS=2Typical: 23mA
LTE sleep/idle mode	
LTE supply current (GNSS off，without USB connection)	Sleep mode@DRX=0.32STypical: 2.5mA Idle mode @DRX=0.32STypical: 24mA
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	@5MHz @10MHz	23dBm 23dBm	Typical :600 mA Typical :600 mA
LTE-FDD B2	@5MHz @10MHz	23dBm 23dBm	Typical :TBD Typical :TBD
LTE-FDD B3	@5MHz @10MHz	23dBm 23dBm	Typical :620 mA Typical :600 mA
LTE-FDD B4	@5MHz @10MHz	23dBm 23dBm	Typical :TBD Typical :TBD
LTE-FDD B5	@5MHz @10MHz	23dBm 23dBm	Typical :570 mA Typical :580 mA
LTE-FDD B7	@5MHz @10MHz	23dBm 23dBm	Typical :540mA Typical :540mA
LTE-FDD B8	@5MHz @10MHz	23dBm 23dBm	Typical :520mA Typical :520mA
LTE-FDD B20	@5MHz @10MHz	23dBm 23dBm	Typical :540mA Typical :540mA
LTE-FDD B28	@5MHz @10MHz	23dBm 23dBm	Typical :TBD Typical :TBD
LTE-FDD B66	@5MHz @10MHz	23dBm 23dBm	Typical :TBD Typical :TBD
LTE-TDD B34	@5MHz @10MHz	23dBm 23dBm	Typical :260mA Typical :260mA
LTE-TDD B38	@5MHz @10MHz	23dBm 23dBm	Typical :340 mA Typical :340 mA
LTE-TDD B39	@5MHz @10MHz	23dBm 23dBm	Typical :260 mA Typical :260 mA
LTE-TDD B40	@5MHz @10MHz	23dBm 23dBm	Typical :340mA Typical :340mA
LTE-TDD B41	@5MHz @10MHz	23dBm 23dBm	Typical :340mA Typical :340mA

5.5 ESD Notes

A7670 is sensitive to ESD in the process of storage, transporting, and assembling. WhenA7670 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 A7670 ESD measurement performance without any external ESD component.

Table 41: The ESD performance measurement table (Temperature: 25℃, 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 A7670

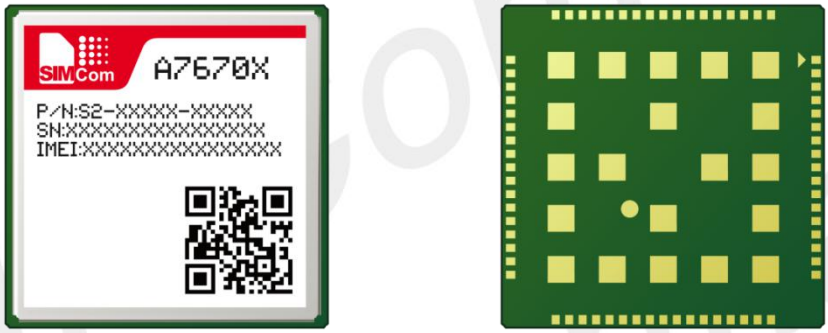

Figure 32: Top and bottom view of A7670

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

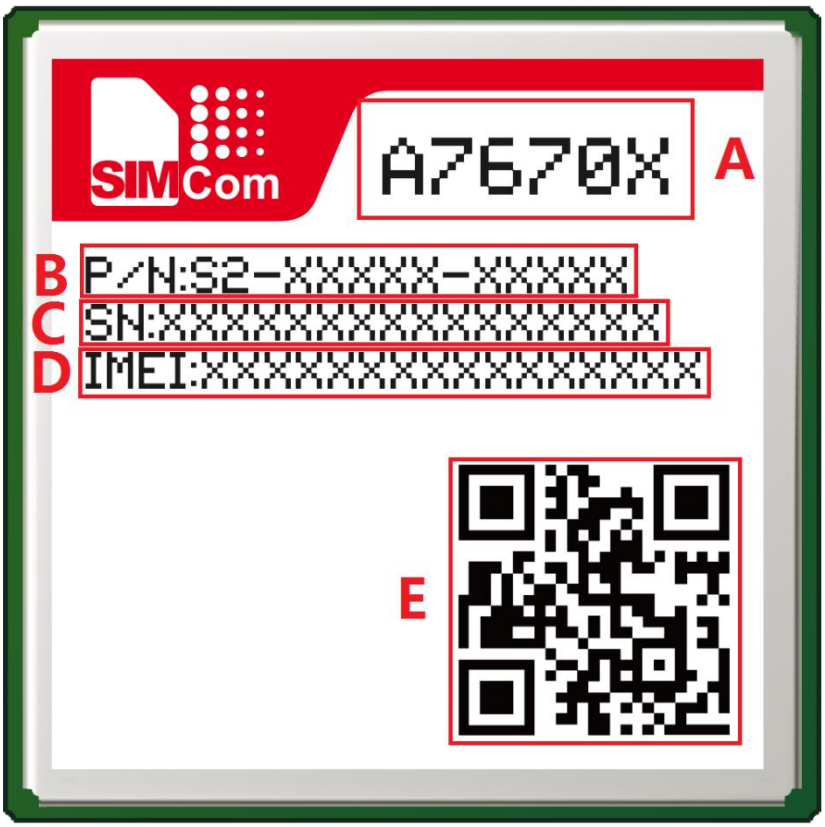

Figure 33: Label information

Table 42: The description of label information

No.	Description
A	Project name
B	Part number
C	Serial number
D	International mobile equipment identity
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.

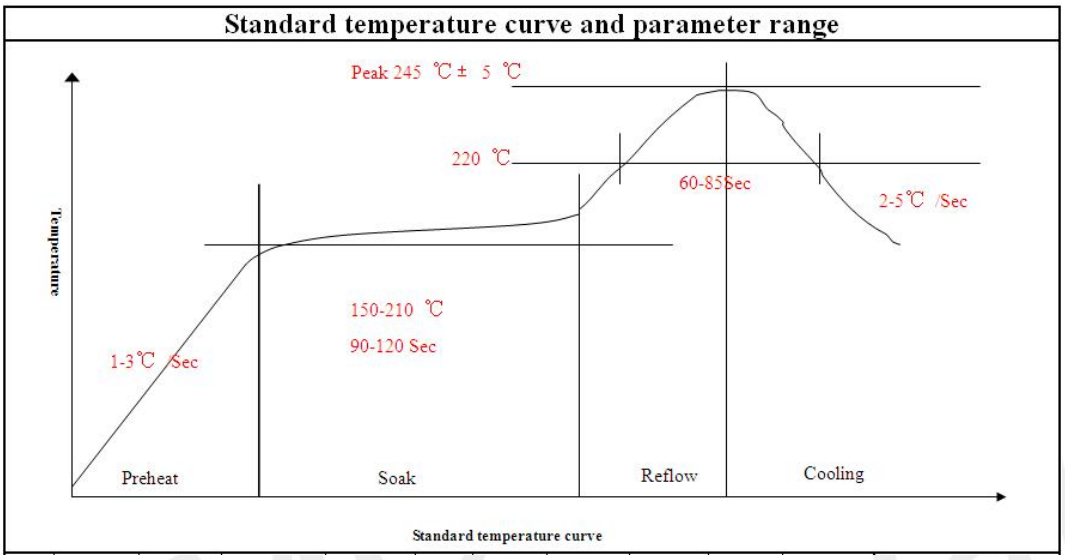

Figure 34: The ramp-soak-spike reflow profile of A7670

NOTE

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

6.4 Moisture Sensitivity Level (MSL)

A7670 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 43: Moisture Sensitivity Level and Floor Life

Moisture Sensitivity Level (MSL)	Floor Life (out of bag) at factory ambient≤30°C/60% RH or as stated
1	Unlimited at ≦30℃/85% RH
2	1 year at≦30℃/60% RH
2a	4 weeks at ≦30℃/60% RH
3	168 hours at ≦30℃/60% RH
4	72 hours at ≦30℃/60% RH

5	48 hours at ≦30℃/60% RH
5a	24 hours at ≦30℃/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-033standard must be followed for production and storage.

7 Packaging

7.1 Tray packaging

A7670 module support tray packaging.

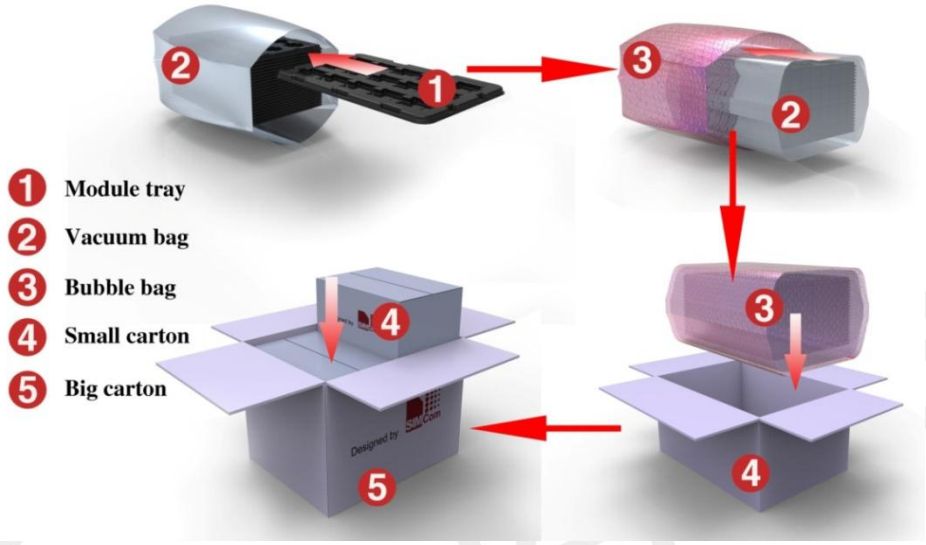

Figure 35: packaging diagram

Module tray drawing：

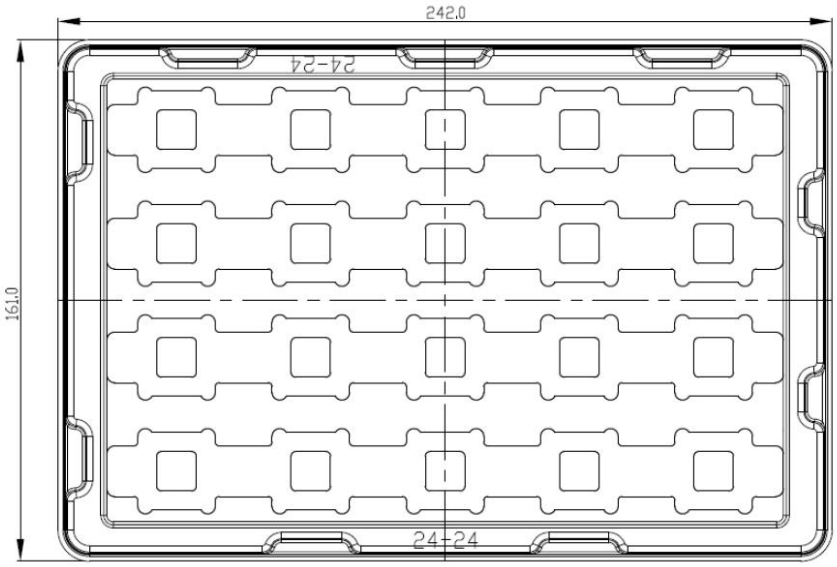

Figure 36: Tray drawing

Table 44: Tray size

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

Small carton drawing：

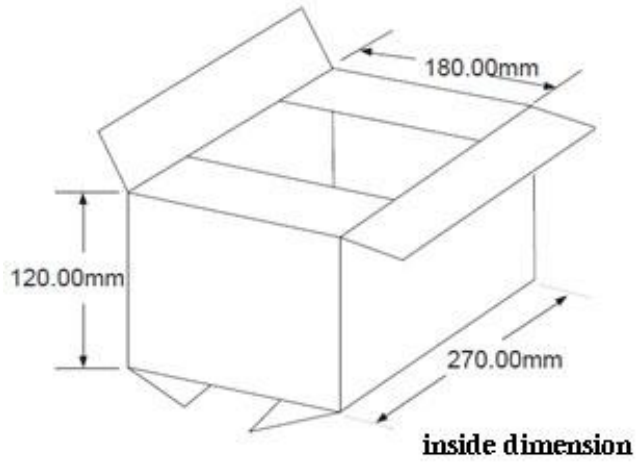

Figure 37: Small carton drawing

Table 45: Small Carton size

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

Big carton drawing：

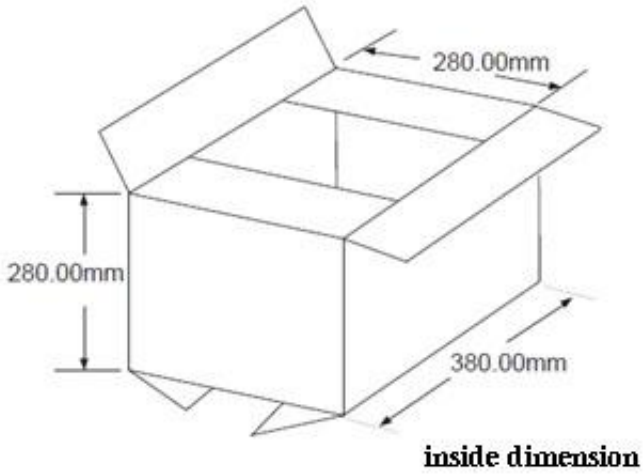

Figure 38: Big carton drawing

Table 46: Big Carton size

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

8 Appendix

8.1 Coding Schemes and Maximum Net Data Rates over Air Interface

Table 47: 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 rata（4 slots）**		**Modulation type**
CS 1 = 9.05 kb/s / time slot	36.2 kb/s		GMSK
CS 2 = 13.4 kb/s / time slot	53.6 kb/s		GMSK
CS 3 = 15.6 kb/s / time slot	62.4 kb/s		GMSK
CS 4 = 21.4 kb/s / time slot	85.6 kb/s		GMSK
EDGE coding scheme	**Max data rata（4 slots）**		**Modulation type**
MCS 1 = 8.8 kb/s/ time slot	35.2 kb/s		GMSK
MCS 2 = 11.2 kb/s/ time slot	44.8 kb/s		GMSK
MCS 3 = 14.8 kb/s/ time slot	59.2 kb/s		GMSK
MCS 4 = 17.6 kb/s/ time slot	70.4 kb/s		GMSK
MCS 5 = 22.4 kb/s/ time slot	89.6 kb/s		8PSK
MCS 6 = 29.6 kb/s/ time slot	118.4 kb/s		8PSK
MCS 7 = 44.8 kb/s/ time slot	179.2 kb/s		8PSK
MCS 8 = 54.4 kb/s/ time slot	217.6 kb/s		8PSK
MCS 9 = 59.2 kb/s/ time slot	236.8 kb/s		8PSK
LTE-FDD device category	**Max data rate（peak）**		**Modulation type**

(Downlink)		
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 48: 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	Antenna design guidelines for diversity receiver system
[24]	A7600 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 49: 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 50: 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.