A7600E-MNSE Hardware Design

LTE Module

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Version History

Date	Version	Description of change	Author
2020-07-07	1.00	Original version.	Gaochao.li Qingqing.fu
2020-09-03	1.01	1. Baseband current consumption data update (chapter 3.1) 2. Added RI and DTR function description (Chapter 3.2.1) 3. Delete the description of adaptive baud rate (chapter 3.2)	Zhongyou.chen
2020-10-09	1.02	1. Supplementary test data 2. Add GPS reference Design 3. Delete the remarks of the customized version of the handset interface	Gaochao.li

Contents

Table Index

Figure Index

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 A7600E-MNSE module to design and develop applications quickly. SIMcom provides a set of evaluation boards to facilitate A7600E-MNSE module testing and use. The evaluation board tools include an EVB board, a USB cable, an antenna, and other peripherals.

1.1 Product Outline

A7600E-MNSE module support GSM, LTE-TDD and LTE-FDD. Please refer to the following table for detailed frequency band Description:

Table 1: A7600E-MNSE Frequency Bands

STANDARD	BAND	A7600E-MNSE
GSM	EGSM900MHz	▻
	DCS1800MHz	▻
LTE-FDD	LTE-FDD B1	▻
	LTE-FDD B3	▻
	LTE-FDD B5	▻
	LTE-FDD B7	▻
	LTE-FDD B8	▻
	LTE-FDD B20	▻
LTE-TDD	LTE TDD B34	▻
	LTE TDD B38	▻
	LTE TDD B39	▻
	LTE TDD B40	▻
	LTE TDD B41	▻
GNSS*		▻
Category		CAT1

With a small physical dimension of 30 * 30 * 2.5 mm, which can meet the requirements of space size in almost all M2M applications, such as vehicle, metering, security, routing, wireless POS, mobile computing equipment, PDA, tablet computer, etc.

A7600E-MNSE provides 143 pins, including 87 LCC pins in the outer ring and 56 LGA pins in the inner ring. This document will introduce all the functional pins.

1.2 Hardware Interface Overview

A7600E-MNSE provides the following hardware interfaces.

- Power input
- USB 2.0 interface
- Two UART interfaces(one main serial port ,one debug serial port)， one GPS serial port
- SDC interfaces, one dedicated to EMMC / SD card and one dedicated to WIFI interface (* in development)
- USIM card interface
- General input and output interfaces (GPIO)
- Two ADC interfaces
- Power supply output
- Two audio interfaces, one MIC port and one Receiver port.
- Two I2C interfaces
- USB boot download and guidance interface
- Network status indication interface
- Antenna interfaces
- Module operation status indication interface
- Flight mode control interface
- 1 Line MIPI Camera interface

1.3 Hardware Block Diagram

The block diagram of the A7600E-MNSE module is shown in the figure below.

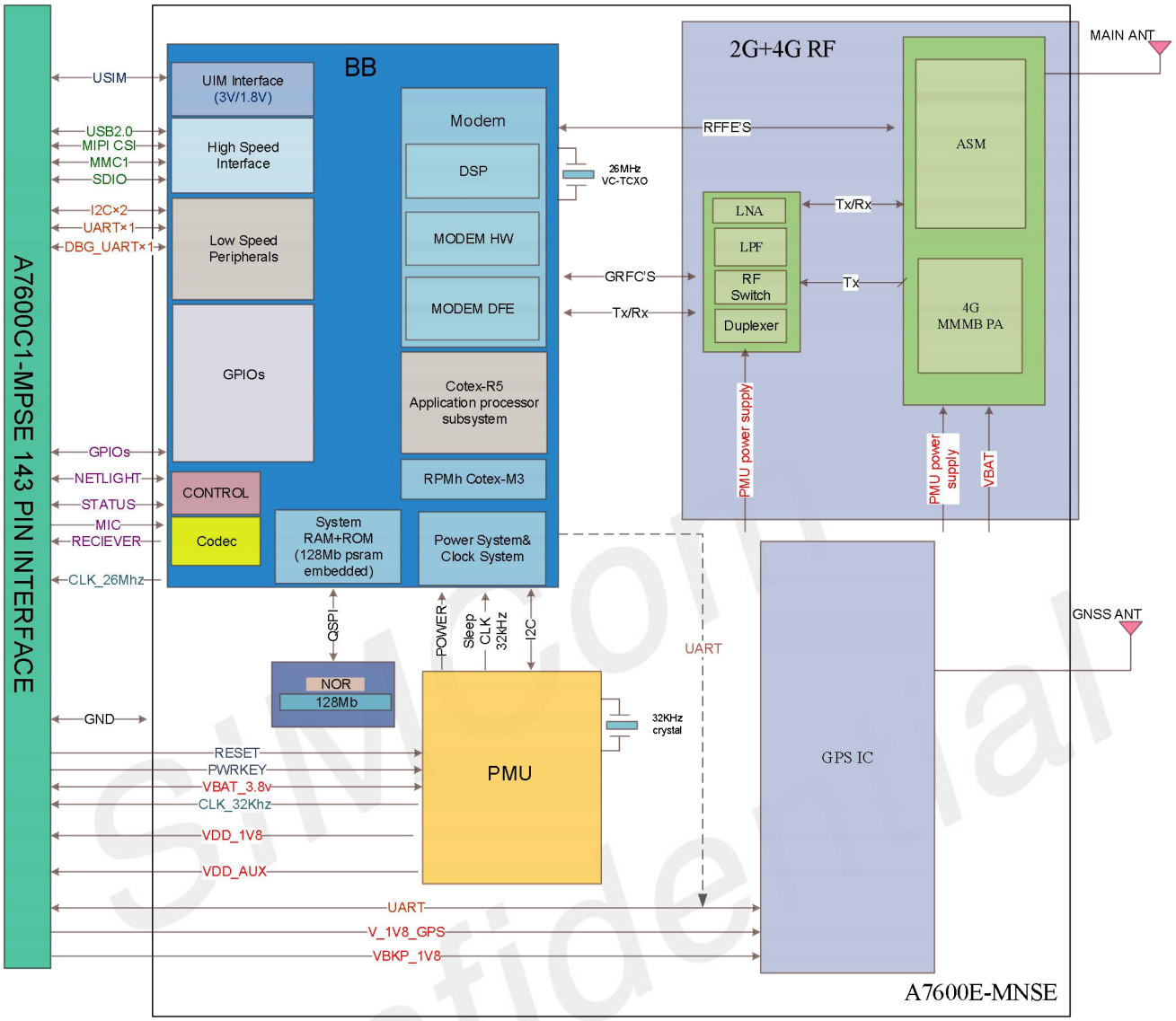

Figure 1: Block diagram

1.4 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	VBAT: 3.4V ~4.2V,Recommended VBAT: 3.8V
Power consumption	Current consumption in sleep mode: <3mA
BAND	Refer to Table 1
TX power	GSM/GPRS power level: -- GSM850/EGSM900: 4 (33dBm±2dB) --DCS1800/PCS1900: 1 (30dBm±2dB) 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 FDD-LTE category 1 : 10 Mbps (DL),5 Mbps (UL) TDD-LTE category 1 : 10 Mbps (DL),5 Mbps (UL)
Antenna interface	GSM/LTE Main antenna interface GNSS antenna interface
Short Message（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 Card interface	Support 1.8V/3V USIM card
USIM application toolkit	Support SAT class3, GSM 11.14 Release 99 Support USAT
Phonebook management	Support phonebook types : SM/FD/ON/AP/SDN
Audio feature	Support one analog MIC, one analog earpiece audio interface
UART interface	●Main serial port Baud rate support from 300bps to 3.6Mbps AT command and data can be sent through serial port Support RTS/CTS Hardware flow control ● UART3 Baud rate support from 4800bps to 921600bps Does not Support RTS/CTS Hardware flow control Default used as GPS port. ●Debug serial port Support debug usage
SD/SDIO	Support SDC interfaces, clock rate up to 200MHz Support SDIO interface
USB interface	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	Dimension: 30*30*2.5mm Weight: 4.75g
Temperature range	Operation temperature: -30℃ ~ +80℃ Extended operation temperature: -40℃ ~ +85℃* Storage temperature: -45℃ ~ +90℃

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 extended operating temperature range.

2 Package Information

2.1 Pin Assignment Overview

A7600E-MNSE provides 143 pins interface. The following Figure is the TOP view of the pin assignment of the MODULE.

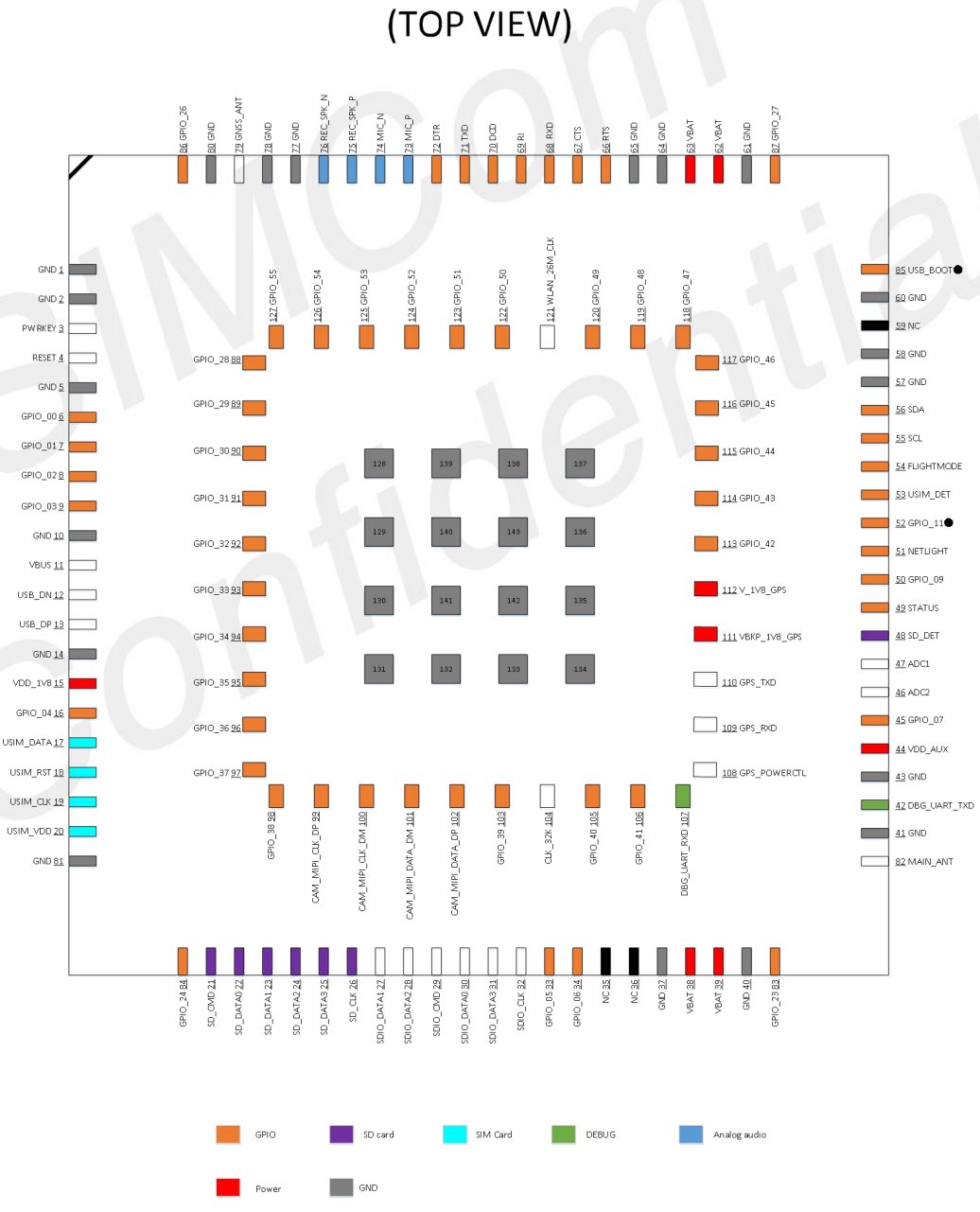

Figure 2: Module pin diagram (Top view)

NOTE

'USB_BOOT' Pin and 'GPIO_11' Pin cannot be pulled up before the module powered up, otherwise it will affect the normal start-up of the module.

Table 3: Pin Description

Pin No.	Pin name	Pin No.	Pin name
1	GND	2	GND
3	PWRKEY	4	RESET
5	GND	6	GPIO_00
7	GPIO_01	8	GPIO_02
9	GPIO_03	10	GND
11	VBUS	12	USB_DN
13	USB_DP	14	GND
15	VDD_1V8	16	GPIO_04
17	USIM_DATA	18	USIM_RST
19	USIM_CLK	20	USIM_VDD
21	SD_CMD	22	SD_DATA0
23	SD_DATA1	24	SD_DATA2
25	SD_DATA3	26	SD_CLK
27	SDIO_DATA1	28	SDIO_DATA2
29	SDIO_CMD	30	SDIO_DATA0
31	SDIO_DATA3	32	SDIO_CLK
33	GPIO_05	34	GPIO_06
35	NC	36	NC
37	GND	38	VBAT
39	VBAT	40	GND
41	GND	42	DBG_UART_TXD
43	GND	44	VDD_AUX
45	GPIO_07	46	ADC2
47	ADC1	48	SD_DET
49	STATUS	50	GPIO_09
51	NETLIGHT	52	GPIO_11●
53	USIM_DET	54	FLIGHTMODE
55	SCL	56	SDA
57	GND	58	GND
59	NC	60	GND
61	GND	62	VBAT

63	VBAT	64	GND
65	GND	66	RTS
67	CTS	68	RXD
69	RI	70	DCD
71	TXD	72	DTR
73	MIC_P	74	MIC_N
75	REC_SPK_P	76	REC_SPK_N
77	GND	78	GND
79	GNSS_ANT	80	GND
81	GND	82	MAIN_ANT
83	GPIO_23	84	GPIO_24
85	USB_BOOT●	86	GPIO_26
87	GPIO_27	88	GPIO_28
89	GPIO_29	90	GPIO_30
91	GPIO_31	92	GPIO_32
93	GPIO_33	94	GPIO_34
95	GPIO_35	96	GPIO_36
97	GPIO_37	98	GPIO_38
99	CAM_MIPI_CLK_DP	100	CAM_MIPI_CLK_DM
101	CAM_MIPI_DATA_DM	102	CAM_MIPI_DATA_DP
103	GPIO_39	104	CLK_32K
105	GPIO_40	106	GPIO_41
107	DBG_UART_RXD	108	GPS_POWERCTL
109	GPS _RXD	110	GPS _TXD
111	VBKP_1V8_GPS	112	V_1V8_GPS
113	GPIO_42	114	GPIO_43
115	GPIO_44	116	GPIO_45
117	GPIO_46	118	GPIO_47
119	GPIO_48	120	GPIO_49
121	WLAN_26M_CLK	122	GPIO_50
123	GPIO_51	124	GPIO_52
125	GPIO_53	126	GPIO_54
127	GPIO_55	128	GND
129	GND	130	GND
131	GND	132	GND
133	GND	134	GND
135	GND	136	GND
137	GND	138	GND
139	GND	140	GND
141	GND	142	GND
143	GND		

NOTE

'USB_BOOT' Pin and 'GPIO_11' Pin 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 4: IO parameters definition

Pin type	Description
PI	Power input
PO	Power output
AI	Analog input
AO	Analog output
I/O	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
OD	Open Drain

Table 5: 1.8V IO electrical 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=1.8V Typical				
	IIL	Input leakage current	-	-	10uA
	Input DC Operating Conditions (VCC = 1.8 V Typical)				
	VOH	Output high level range	VCC - 0.4	-	VCC
	VOL	Output low level	-	-	0.2V

		range			
	DCS[1:0]= 00 01 10 11	Maximum current driving capacity at high level output		IOH = (mA min) 1 mA 2 mA 4 mA 5 mA	

Table 6: I2C/USIM/SD IO electrical parameters definition

Power domain	Parameter	Description	Min	Typ.	Max
1.8V(I2C/USIM/SD)	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	-	25 KΩ	-
	Rpd	Pull down resistor	-	25 KΩ	-
3V(USIM/SD)	VCC=3V				
	VIH	High level input	VCC * 0.75	-	VCC + 0.4
	VIL	Low level input	-0.4	-	VCC * 0.25
	Rpu	Pull up resistor	-	50K	-
	Rpd	Pull down resistor	-	50K	-
1.8V(I2C/USIM/SD)	VCC = 1.8V Typical				
	IIL	Input leakage current	-	-	2uA
	Input DC Operating Conditions (VCC = 1.8 V Typical)				
	VOH	Output high level range	VCC - 0.4	-	VCC
	VOL	Output low level range	-	-	0.2V
	SR= 00 01 10 11	Maximum current driving capacity at high level output		IOH = (mA min) 1 mA 2 mA 3 mA 4 mA	
3V(USIM/SD)	VCC = 3V Typical				
	IIL	Input leakage current	-	-	2uA
	Input DC Operating Conditions (VCC = 3 V Typical)				
	VOH	Output high level range	VCC - 0.4	-	VCC
	VOL	Output low level range	-	-	0.3V
	SR= 00 01 10 11	Maximum current driving capacity at high level output		IOH = (mA min) 2 mA 4 mA 7 mA 9 mA	

Table 7: Pin description

Pin name	Pin No.	Pin parameter		Description	Note
		Power domain	Type		
Power supply					
VBAT	38,39,62,63	-	PI	A7600E-MNSE input voltage ranges from 3.4V to 4.2V, and the peak current value can reach 2A.	
VDD_AUX	44	-	PO	Output current limit: 400mA, Output voltage: 3V (default).	SD card power supply
VDD_1V8	15	-	PO	The internal 1.8V power output, the maximum output current is 50mA, can not supply power to high-power loads, can provide power for level conversion circuits, etc.	If unused, keep it open.
V_1V8_GPS	112	-	PI	GPS Vcore, VDDIO power supply, the input range is 1.75V~1.9V when 1.8V power supply. If 3.3V power supply, please contact SIMcom to confirm the plan	If unused, keep it open.
VBKP_1V8_GPS	111	-	PI	GPS backup power input, power supply range is 1.4~3.6V	If unused, keep it open.
GND	1,2,5,10,14,37,40,41,43,57,58,60,61,64,65,77,78,80,81,128~143	-	-	Ground	
System Control					
PWRKEY	3	-	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	4	-	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.
SDC interface					
SD_CMD	21	1.8/3.0V	I/O,PU	SDC bus command output	If unused, keep it open.
SD_DATA0	22	1.8/3.0V	I/O,PU	SDC bus data I/O	
SD_DATA1	23	1.8/3.0V	I/O,PU		
SD_DATA2	24	1.8/3.0V	I/O,PU		
SD_DATA3	25	1.8/3.0V	I/O,PU		
SD_CLK	26	1.8/3.0V	DO,PD	SDC bus clock output	
USIM interface					
USIM_DATA	17	1.8/3.0V	I/O,PU	USIM bus data, this pin has been pull-up with 4.7KΩ resistor to USIM_VDD.	
USIM_RST	18	1.8/3.0V	I/O,PU	USIM bus reset output.	
USIM_CLK	19	1.8/3.0V	I/O,PU	USIM bus clock output.	
USIM_DET	53	1.8V	DI	SIM card hot swap detection	
USIM_VDD	20	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.	
USB interface					
VBUS	11	-	AI	Valid USB detection input, active High Vmin=3.5V，Vmax=5.25V，Vnorm=5V	
USB_DN	12	-	I/O	Negative line of the differential, bi-directional USB signal.	
USB_DP	13	-	I/O	Positive line of the differential, bi-directional USB signal.	
MIPI CSI interface					
CAM_MIPI_CLK_DP	99	1.2V	AIO	Positive line of the differential, MIPI CSI CLK signal.	If unused, keep it open.
CAM_MIPI_CLK_DM	100	1.2V	AIO	Negative line of the differential, MIPI CSI CLK signal.	
CAM_MIPI_DATA_DM	101	1.2V	AIO	Negative line of the differential, MIPI CSI DATA bit0 signal.	
CAM_MIPI_DATA_DP	102	1.2V	AIO	Positive line of the differential, MIPI CSI DATA bit0 signal.	
Full function UART interface					
RTS	66	1.8V	DO	RTS output	If unused, keep it open.
CTS	67	1.8V	DI	CTS input	
RXD	68	1.8V	DI	Data input	
TXD	71	1.8V	DOH	Data output	
RI	69	1.8V	DO	Ringing indicator	
DCD	70	1.8V	DO	Carrier detection	
DTR	72	1.8V	DI	DTE Ready	
Debug UART					

DBG_UART_TXD	42	1.8V	DOH	CP_UART output	Default used as debug port.
DBG_UART_RXD	107	1.8V	DI	CP_UART input	
I2C interface					
I2C2_SCL	114	1.8V	DO	I2C clock output	If unused, keep it open. If you need to use it, use 15 PIN VDD_1V8 outside the module to connect to the power supply and pull up a 2.2K resistor
I2C2_SDA	113	1.8V	I/O	I2C data I/O	
I2C1_SCL	55	1.8V	DO	I2C clock output	
I2C1_SDA	56	1.8V	I/O	I2C data I/O	
SDIO interface					
SDIO_DATA1	27	1.8V	I/O	SDIO data bus byte 1	
SDIO_DATA2	28	1.8V	I/O	SDIO data bus byte 2	
SDIO_CMD	29	1.8V	I/O	SDIO bus command	
SDIO_DATA0	30	1.8V	I/O	SDIO data bus byte 0	
SDIO_DATA3	31	1.8V	I/O	SDIO data bus byte 3	
SDIO_CLK	32	1.8V	DO	SDIO bus clock	
Analog audio interface					
MIC1_P	73	1.8V	AIO	Audio microphone input positive	If unused, keep it open.
MIC1_N	74	1.8V	AIO	Audio microphone input negative	
REC_SPK_P	75	1.8V	AIO	Earpiece output positive	
REC_SPK_N	76	1.8V	AIO	Earpiece output negative	
GPIO					
GPIO_00	6	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_01	7	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_02	8	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_03	9	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_04	9	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_05	33	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_06	34	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_07	45	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_09	50	1.8V	IO,PD	General purple I/O	If unused, keep it

					open.
GPIO_11●	52	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_23	83	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_24	84	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_26	86	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_27	87	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_28	88	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_29	89	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_30	90	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_31	91	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_32	92	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_33	93	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_34	94	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_35	95	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_36	96	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_37	97	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_38	99	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_39	103	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_40	105	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_41	106	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_42	113	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_43	114	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_44	115	1.8V	IO,PD	General purple I/O	If unused, keep it open.

GPIO_45	116	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_46	117	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_47	118	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_48	119	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_49	120	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_50	122	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_51	123	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_52	124	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_53	125	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_54	126	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_55	127	1.8V	IO,PU	General purple I/O	If unused, keep it open.
ANT interface					
MAIN_ANT	79	-	AI	Main ANT interface	
GNSS_ANT	82	-	AIO	GNSS ANT interface	
Other pins					
STATUS	49	1.8V	DO	Power on status indicator	If unused, keep it open.
NETLIGHT	51	1.8V	DO	Network registration status indicator (LED). For more detail, please refer the chapter 3.12.	If unused, keep it open.
FLIGHTMODE	54	1.8V	DI	*Flight mode control input (in software development): High level (suspended): normal mode Low level: flight mode	
ADC1	47	-	AI	General Purpose ADC	If unused, keep it open.
ADC2	46	-	AI	General Purpose ADC	If unused, keep it open.
CLK_32KHZ	104	-	DO	32K CLK Buffered crystal output.	If unused, keep it open.
WLAN Function related pin					
WLAN_26M_CLK	121	1.8V	AO	WLAN reversed PIN: 26M CLK	

GPS Function related pin					
GPS_POWERCTL	108	1.8V	DI	GPS VCORE/VDDIO power supply enable	
GPS_RXD	109	1.8V	DI	GPS UART RX	Externally connect MCU TX or module UART3 TX
GPS_TXD	110	1.8V	DO	GPS UART TX	Externally connect to MCU RX or module UART3 RX

2.3 Mechanical Information

The following figure shows the package outline drawing of A7600E-MNSE module.

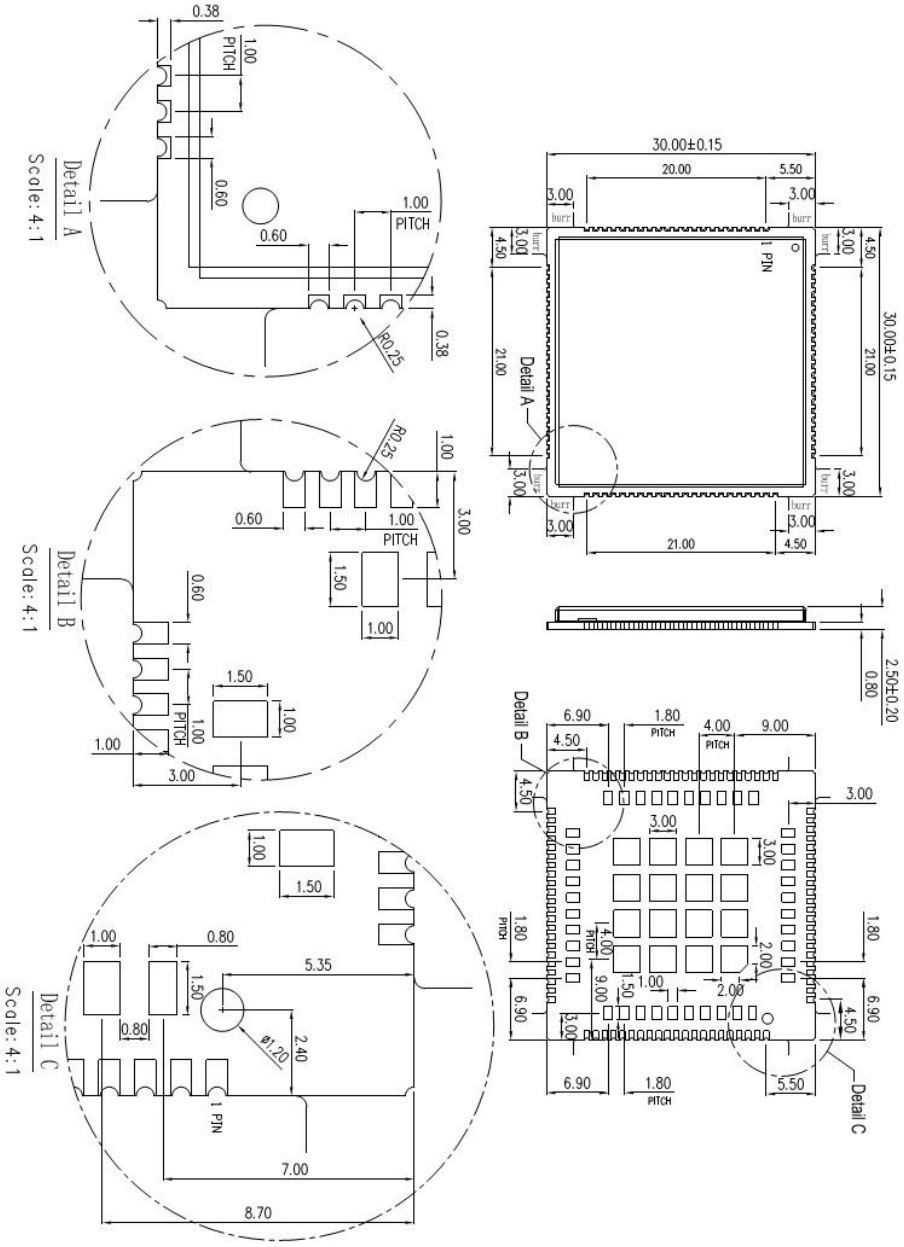

Figure 3: Dimension drawing (Unit: mm)

NOTE

The side length is 30.00 ± 0.15mm, excluding burr area.

2.4 Recommend PCB Footprint Dimension

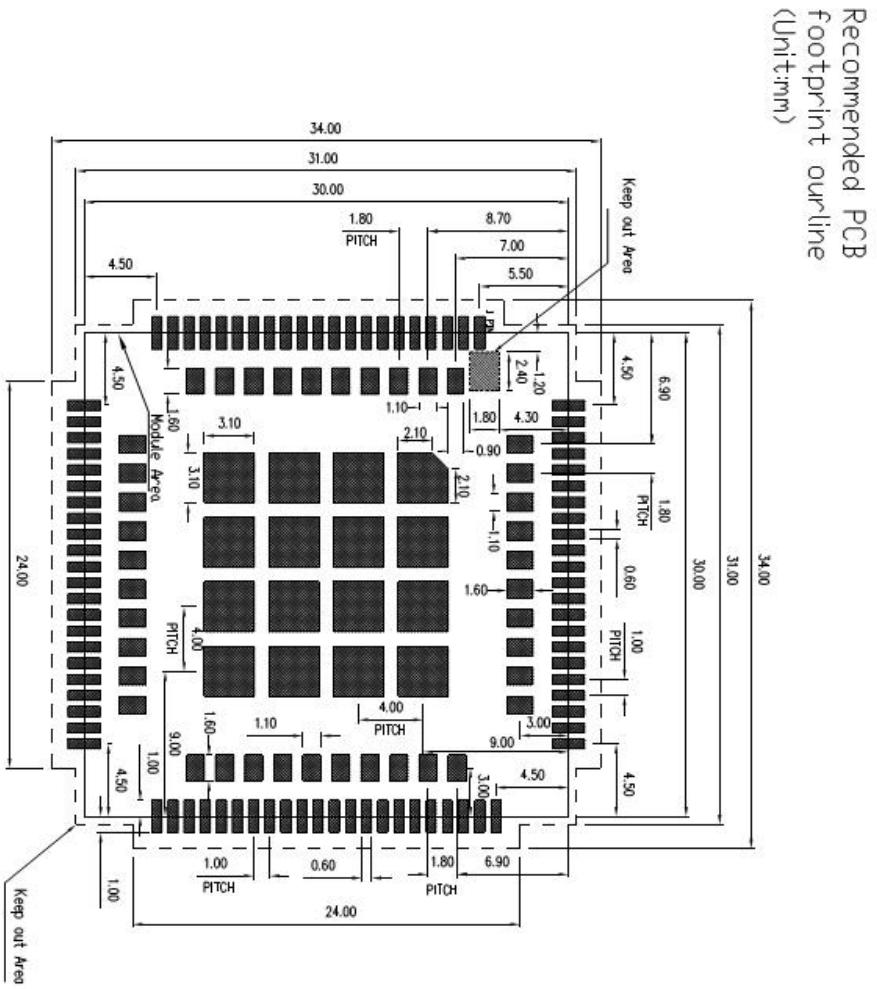

Figure 4: Recommend PCB footprint Dimension (Unit: mm)

2.5 Recommend Stencil Size

Recommend stencil thickness≥0.12mm and ≤0.15mm.

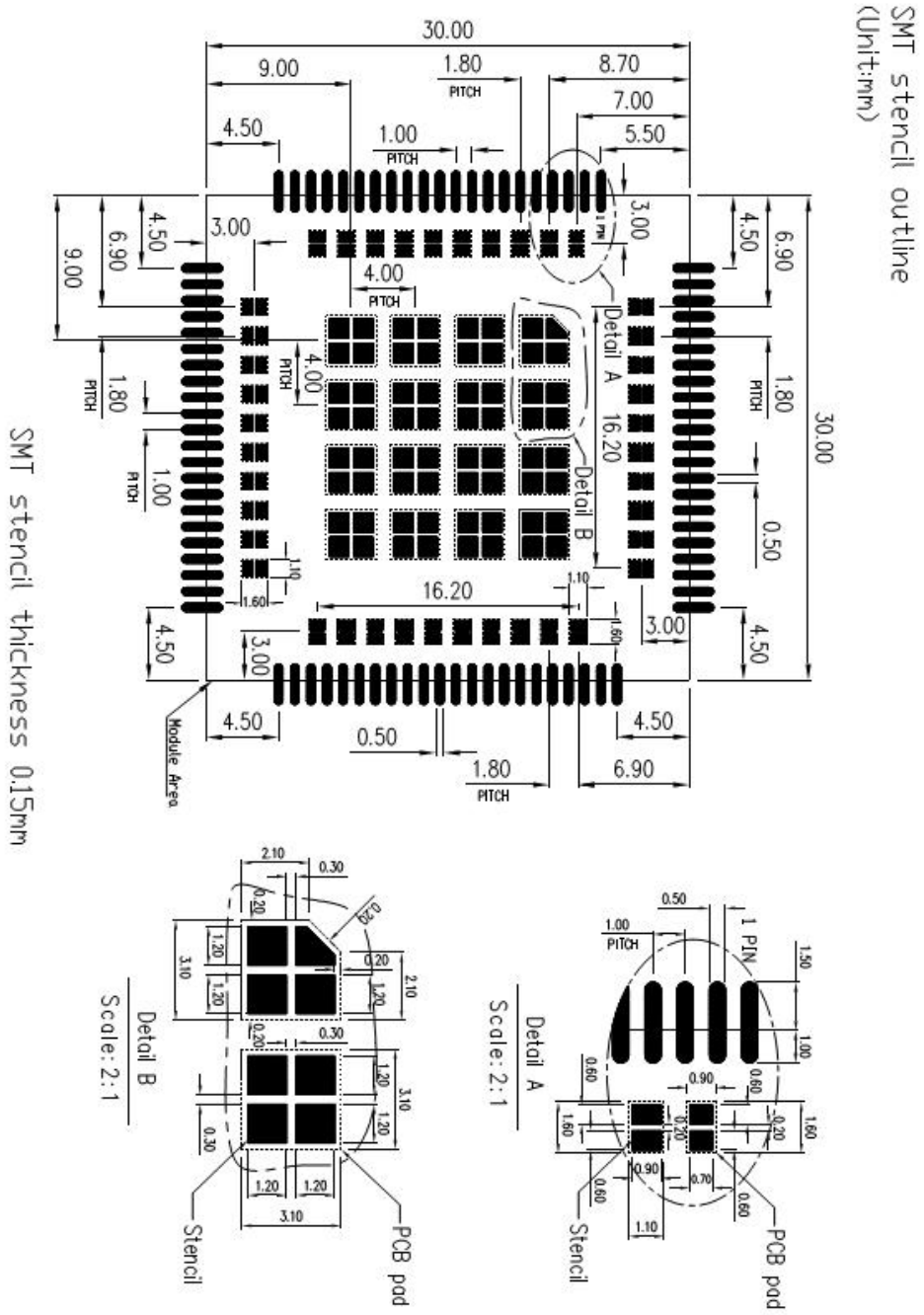

Figure 5: Recommend stencil dimension (Unit: mm)

3 Interface Application

3.1 Power Supply

A7600E-MNSE offers four power supply PINs (38, 39, 62, 63) as VBAT power input PIN. A7600E-MNSE use these four PINs supply the internal RF and baseband circuit. The recommended typical power supply voltage of GSM is 3.8V, and range from 3.4V to 4.2V.

If the customer adopts the double-layer board design, the power supply of the module can only connect 62, 63 pins, or only connect 38, 39 pins, because these four pins are connected together internally, so that the customer's PCB can get a better ground plane.

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.

The following figure shows the VBAT voltage drop.

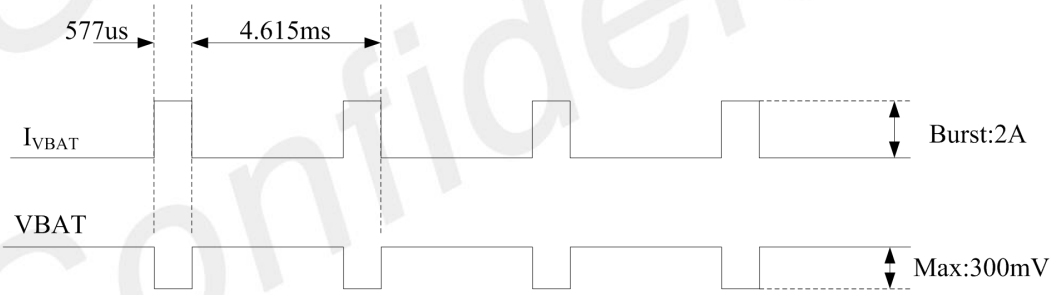

Figure 6: Burst current cause VBAT drop

NOTE

Test condition: VBAT power supply 3.8V, SIMcom EVB is used for test, add 300μF tantalum capacitor to VBAT power supply terminal.

Table 8: VBAT Pin electrical parameters

Parameter	Description	Min	Typ.	Max	Unit
VBAT	Module supply voltage	3.4	3.8	4.2	V
$I_{VBAT(peak)}$	Module consumption peak current	-	2	-	A
$I_{VBAT(average)}$	Module average consumption current (normal mode)	Refer to table 45			
$I_{VBAT(sleep)}$	Module average consumption current (sleep mode)				
$I_{VBAT(power-off)}$	Module average consumption current（off leakage current）	-		20	uA

3.1.1 Power Supply Reference Design

In the user's design, Make sure that the voltage on the VBAT pins will never drop below 3.4V even when the module current consumption reaches 2A. If the voltage drops below 3.4V, the RF performance of the module will be affected. 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 1000uf to ensure that the voltage drop on the VBAT pin at any time is not more than 300mV.

It is recommended to place four 0.1/1μF , 33/10pF 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.

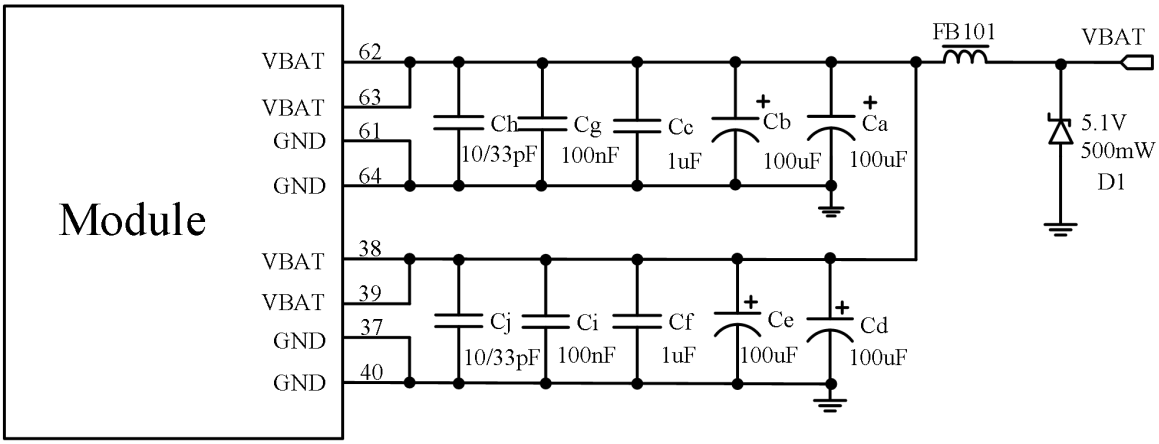

Figure 7: VBAT input reference circuit

In addition, in order to prevent the damage of A7600E-MNSE 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	V_{RWM}	Package
1	JCET	ESDBW5V0A1	5V	DFN1006-2L
2	Prisemi	PESDHC2FD4V5BH	4.5V	DFN1006-2L
3	WAYON	WS05DPF-B	5V	DFN1006-2L
4	WILL	ESD5611N	5V	DFN1006-2L
5	WILL	ESD56151W05	5V	SOD-323
6	WAYON	WS4.5DPV	4.5V	DFN1610-2L

NOTE

When selecting TVS, pay attention to the clamping voltage for surge protection, the clamping voltage should not be higher than 10V for 100V surge input.

3.1.2 Recommended Power Supply Circuit

The MCU must have the function to power off the module, but the module can not 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:

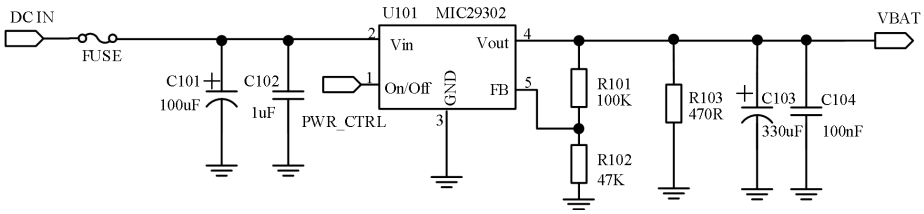

Figure 8: Recommended circuit for linear power supply

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

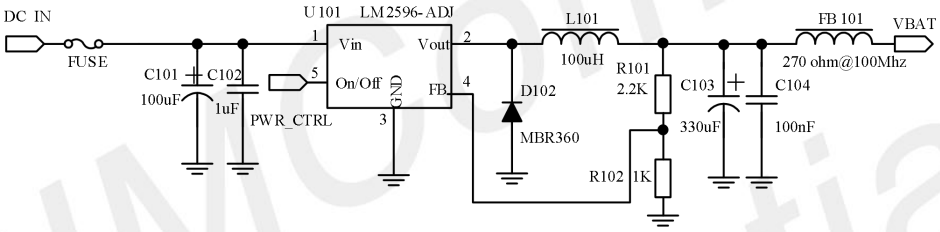

Figure 9: Recommended circuits for switching power supply

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 Module 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:

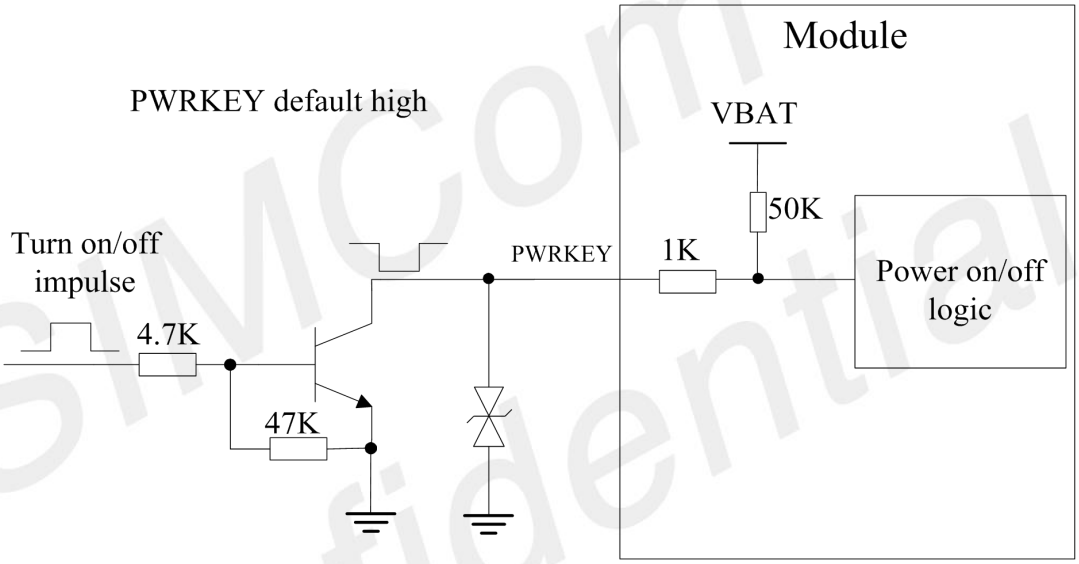

Figure 10: Power on/off reference circuit

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.

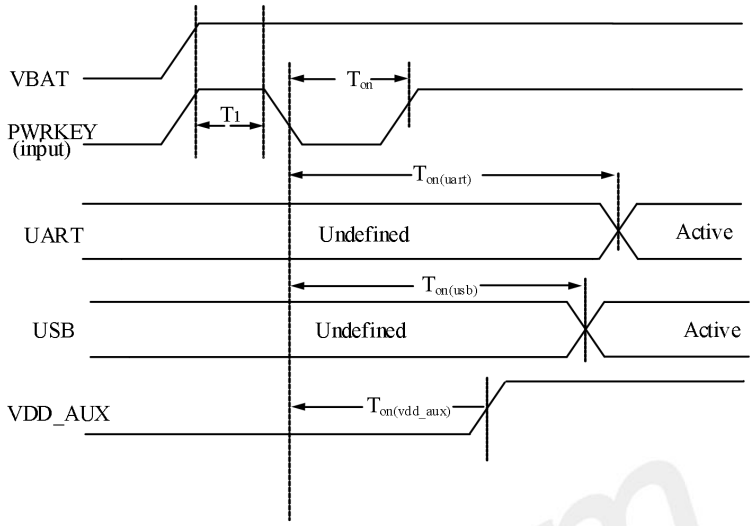

Figure 11: PWRKEY power on sequence

Table 10: Power on sequence parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_1	Power on anti-shake time	-	100	-	ms
T_{on}	Power on low level pulse width	-	50	-	ms
$T_{on(uart)}$	Power on time (according to UART interface)	-	9.2	-	s
$T_{on(vdd\_aux)}$	Power on time (according to VDD_AUX pin)	-	6.8	-	s
$T_{on(usb)}$	Power on time (according to USB interface)	-	7.8	-	s
V_{IH}	PWRKEY input high voltage level	2.94V	-	VBAT	
V_{IL}	PWRKEY input low voltage level	0	0	0.5V	

When the module is working, cutting off the power of the module will damage the flash. It is recommended to turn off the module through AT command or PWRKEY before disconnecting the power supply. When using the AT command to shut down, please ensure that the PWRKEY is at a high level; otherwise, the module will automatically power on again after the module completes the shutdown.

3.2.2 Module Power off

A7600E-MNSE 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, ‘AT+CPMVT’ set voltage range
- Over-temperature or under-temperature automatic power off.

It is strongly recommended that the customer use PWRKEY or ‘AT+CPOF’ to shut down, and 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 ℃, A7600E-MNSE will report warning information through AT port. When the temperature exceeds the range of - 40 ~ + 85 ℃, A7600E-MNSE 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:

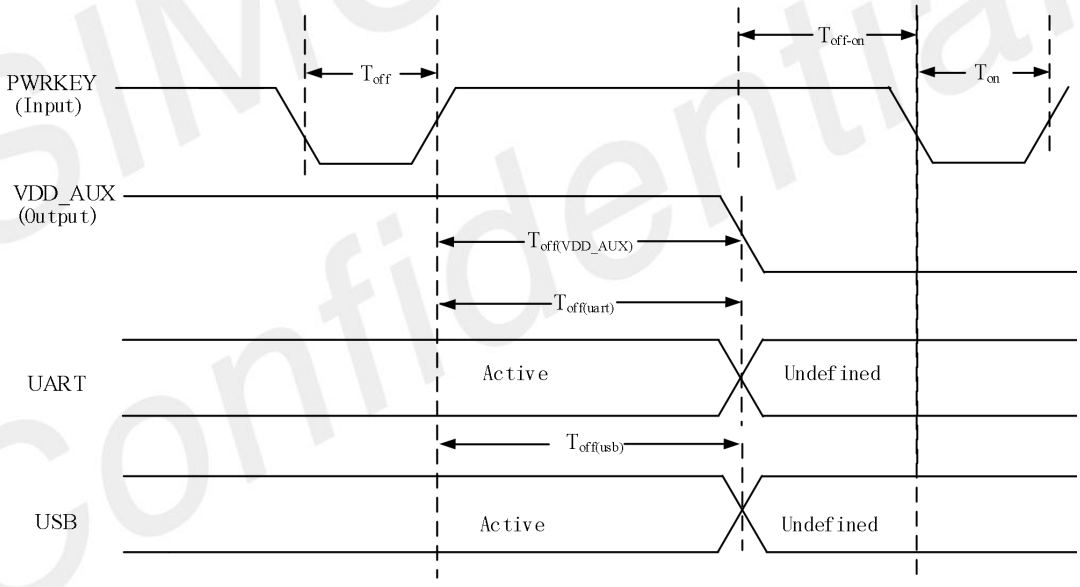

Figure 12: PWRKEY power off sequence

Table 11: Power off sequence parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{off}	Power off low level pulse width	2.5	-	-	s
$T_{off(uart)}$	Power off time(according to UART interface)	-	1.1	-	s

$T_{off(usb)}$	Power off time(according to USB interface)	-	1.1	-	s
$T_{off(VDD\_AUX)}$	Power off time(according to VDD_AUX pin)	-	1.1	-	s
T_{off-on}	Power off - power on buffer time	2	-	-	s

3.2.3 Module Reset

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:

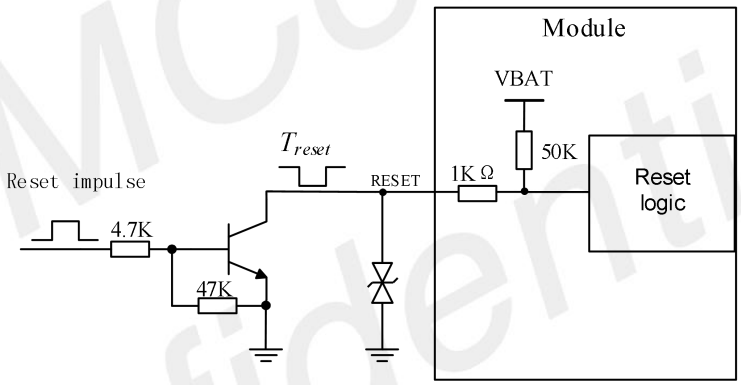

Figure 13: Reference reset circuit

Table 12: RESET electric parameter

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{reset}	Restart low level pulse width	-	1.5	-	S
V_{IH}	RESET pin input high voltage	2.94	-	VBAT	V
V_{IL}	RESET pin input low 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 1.5s.

3.3 UART

A7600E-MNSE provides two serial ports, the main communication serial port UART, and the log serial port CP_UART module is DCE (Data Communication Equipment) equipment.

When using the full function serial port, you can refer to the following connection mode:

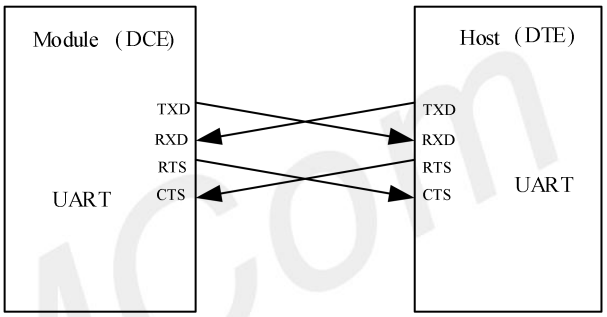

Figure 14: Serial port connection diagram (full function mode)

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

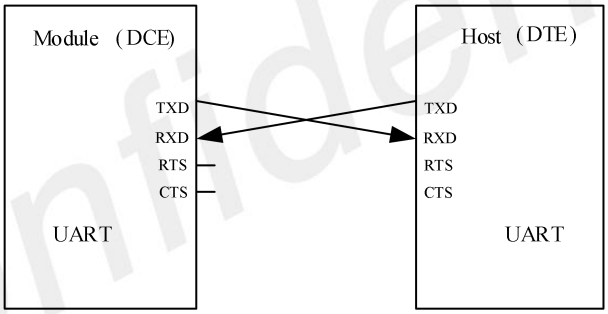

Figure 15: Serial port connection diagram (NULL mode)

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.

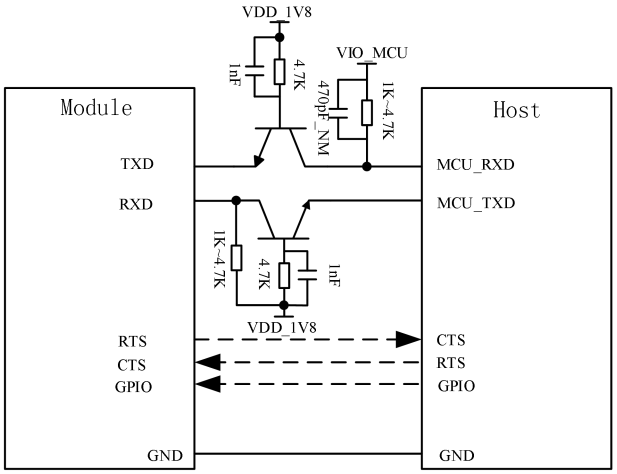

Figure 16: Triode level conversion circuit

NOTE

A7600E-MNSE supports the following baud rates: 0, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1842000, 3686400. The default baud rate is 115200bps.

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.

3.3.1 RI/DTR description

The RI pin can be used as an interrupt to wake up the host. Normally, it maintains a high voltage output. When a short message or URC report is received, RI outputs a low voltage for 120ms (SMS)/60ms (URC), and then returns to a high voltage state； RI will output low voltage. when receiving a telephone call as the called party, RI outputs low voltage, and then it will remain low voltage until the host accepts the call using the "ATA" command, or the caller stops calling RI will resume outputting high level.

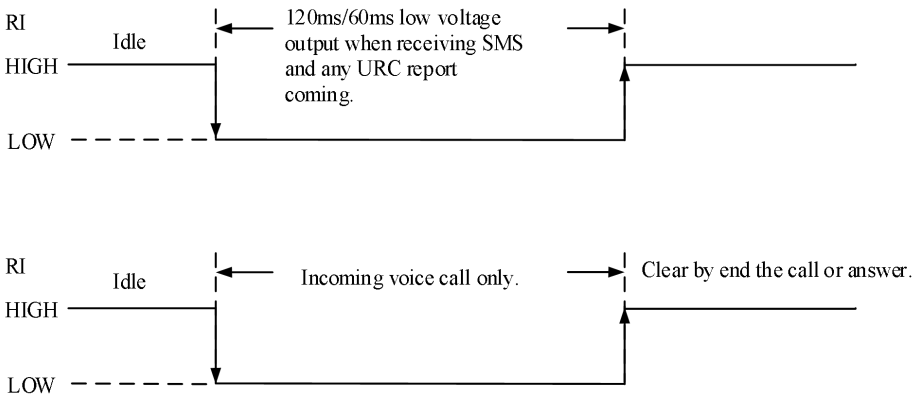

Figure 17: Level change on RI (SMS，URC，Incomming call)

DTR can be used as the sleep wake-up pin of the A7600E module. When the A7600E module enters the sleep mode, pull down DTR to wake up the A7600E module.

When the user sets ‘AT+CSCLK=1’ and pulls up the DTR pin, the module will enter the sleep mode. The serial port function cannot communicate. When the A7600E module enters sleep mode, pull DTR low to wake up.

In the mode of setting "AT+CSCLK=0", pull up the DTR pin, the normal communication of the serial port function will not be affected.

3.4 USB Interface

A7600E-MNSE 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.

Support high speed (480Mbps) and full speed (12Mbps). The interface can be used for AT command sending, data transmission, software debugging and upgrading. Map out ttyUSB1-ttyUSB2 under Linux or android system (refer to Linux or android debugging document for details).

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

A7600E-MNSE can be used as a USB slave device. The recommended connection circuit diagram is as follows:

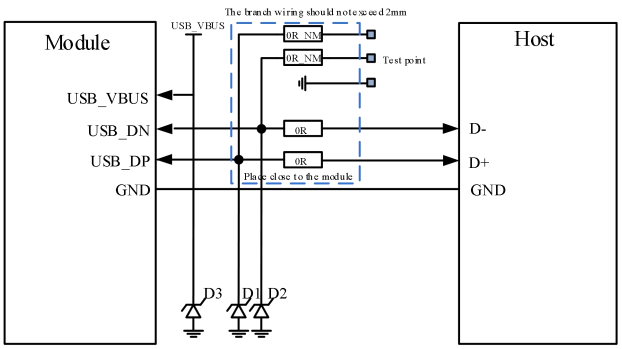

Figure 18: USB circuit diagram

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. A TVS tube can be placed. The recommended model is ESD5681N07.

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

A7600E-MNSE 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
85	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.

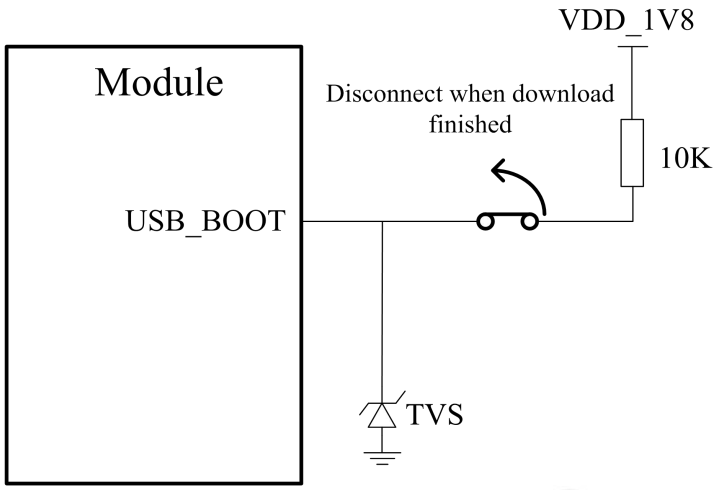

Figure 19: Reference USB_BOOT circuit

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

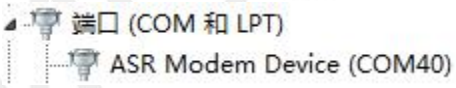

Figure 20: Force-download port

NOTE

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

3.5 USIM Interface

A7600E-MNSE 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	Power supply voltage output to USIM card	1.62	1.8	1.98	V
V_{IH}	High-level input voltage	0.7*USIM_VDD	-	USIM_VDD +0.4	V

V_{IL}	Low-level input voltage	-0.4	0	0.25*USIM_VDD	V
V_{OH}	High-level output voltage	USIM_VDD -0.4	-	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.2	V

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

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

3.5.1 USIM 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.

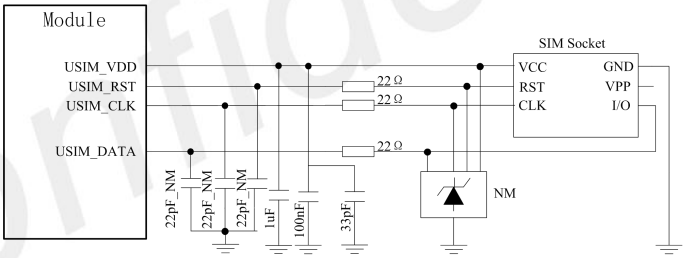

Figure 21: USIM interface reference circuit

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].

Because the SIM card circuit is susceptible to interference, causing the card not to be recognized or dropped, please follow the following principles when designing:

- During the PCB layout stage, keep the USIM card holder away from the main antenna.

- The USIM card wiring should be kept away from RF lines, VBAT and high-speed signal lines as much as possible, and the USIM card wiring should not be too long.
- The GND of the USIM card holder and the GND of the module maintain good connectivity, so that the GNDs of the two are equal in potential.
- To prevent USIM_CLK from interfering with other signals, it is recommended to protect USIM_CLK separately.
- It is recommended to place a 220nF capacitor on the USIM_VDD signal line close to the USIM card socket.
- Place a TVS close to the USIM card socket. The parasitic capacitance of the TVS should not be greater than 50pF, such as ESD9L5.0ST5G.
- Connecting a 22Ω resistor in series between the USIM card socket and the module can enhance the ESD protection performance.
- In order to make the wiring smooth, it is recommended to use a single-channel TVS, placed close to each pin of the card socket.
- The USIM_CLK signal is very important. Customers should ensure that the rising edge and falling edge time of the USIM_CLK signal are less than 40ns, otherwise, abnormal card recognition may occur.

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.

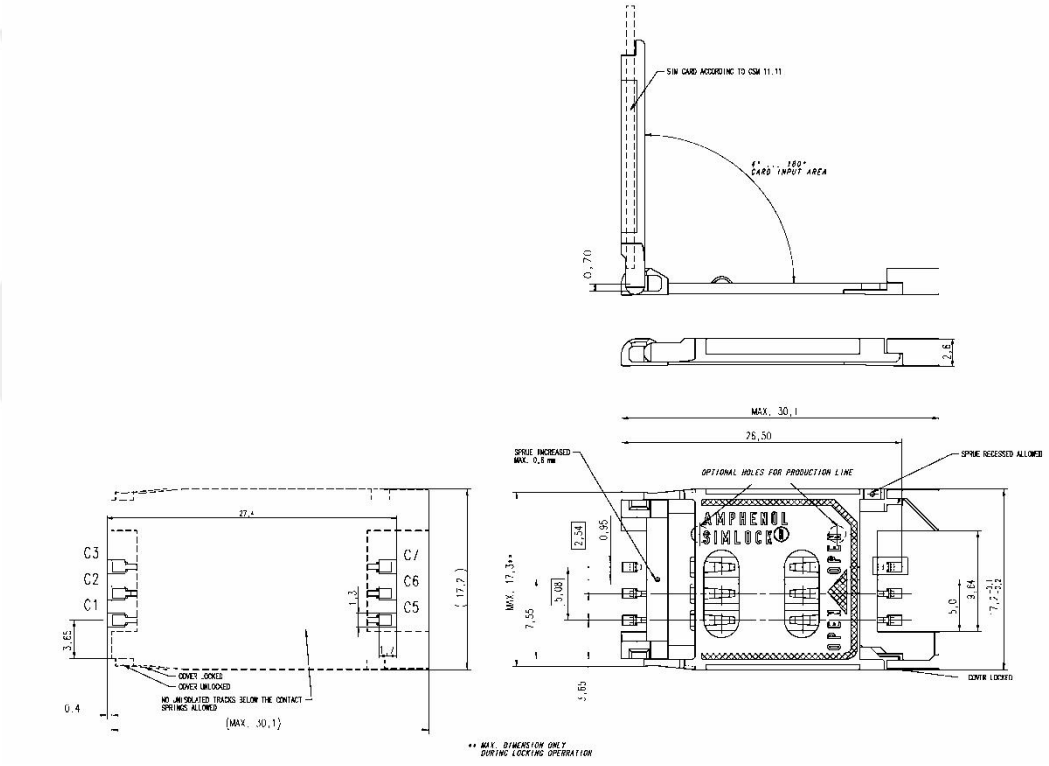

Figure 22: Amphenol C707 10M006 512 USIM card socket

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	
C7	USIM_DATA	USIM Card data I/O.

NOTE

When customers design in-vehicle products, please choose a more reliable SIM card holder with push-push structure.

3.6 Analog audio interface

A7600E-MNSE integrates audio codec and audio front-end, provides 1 set of MIC analog audio interface, 1 set of earpiece analog audio interface. customers can connect the 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 earpiece output

Table 17：Analog MIC input ADC parameter table

Parameter	Min.	Typ.	Max.	Unit
clock rate	-	6.144	-	MHz

Table 18：Analog audio output channel

parameter	conditions	Maximum power
DAC	RL=10KΩ	1.59Vp
Earpiece	MONO,32Ω,differential	37mW

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

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

3.6.1 Analog Audio Reference Design

The recommended circuit for analog audio is shown below:

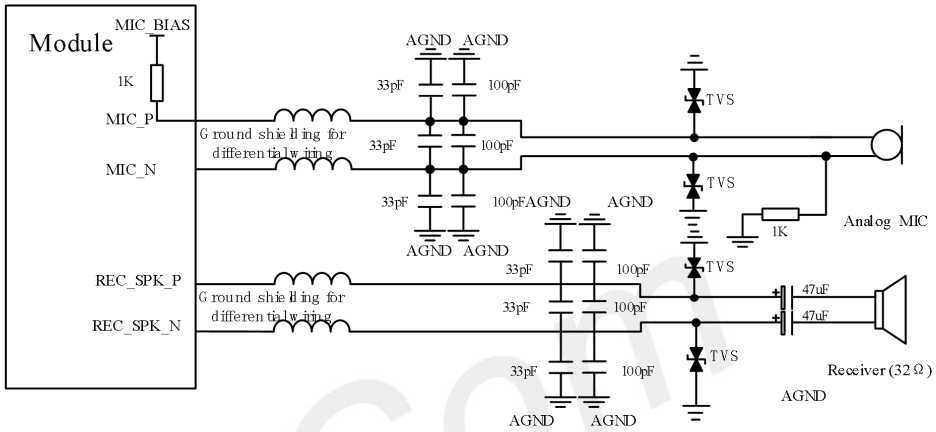

Figure 23: Analog audio interface reference circuit

3.7 GNSS interface

3.7.1 GNSS interface overview

A7600E-MNSE provides GNSS solution-The solution offers best-in-class acquisition and tracking sensitivity. GNSS provides 2 power input interfaces, 1 GNSS main power control switch, and 1 2-wire UART interface. Two solutions of 1.8V and 3.3V power supply are provided. Customers can choose according to their needs and application scenarios. The details are as follows.

GNSS NMEA outputs through serial port. The default baud rate is 9600bps. (Determined by firmware)

Table 19：GPS Function Pin Description

Pin name	Pin NO	I/O	Description	Remark
VBKP_1V8_GPS	112	PI	GNSS backup VRTC input	Option 1: 1.8V power supply Option 2: 3.3V power supply
V_1V8_GPS	111	PI	GNSS IO power supply, Vcore and VDD_IO power input	Option 1: 1.8V power supply Option 2: 3.3V power supply
GPS_PWR_CTRL	108	DI	GNSS Vcore and VDD_IO	Option 1: It is

			power supply enable control switch Pull low：Vcore and VDD_IO power supply Turn on Pull high：Vcore and VDD_IO power supply Turn off	recommended to connect the module GPIO_07 Option 2: Connect MCU GPIO
GPS_RXD	109	DI	GNSS IC UART serial port signal input in the module	Option 1: 1.8V power domain, connect to the module RTS pin Option 2: 3.3V power domain, connect to MCU UART_TX
GPS_TXD	110	DO	GNSS IC UART serial port signal input in the module	Option 1: 1.8V power domain, connect to the module CTS pin Option 2: 3.3V power domain, connect to MCU UART_RX

3.7.2 Reference scheme

Reference scheme 1:
The reference design of GNSS powered by the module and pass-through interface is as follows，where the RTS pin is multiplexed as UART3_TX, and the CTS pin is multiplexed as UART3_RXD:

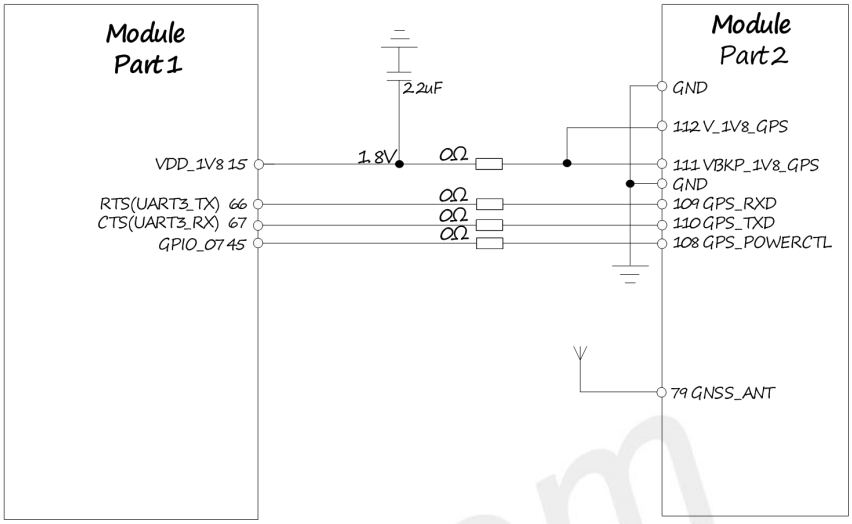

Figure 24: GNSS reference schematic diagram

Reference scheme 2:

The reference design of the GNSS powered by the MCU and pass-through interface is as follows. This wiring method is used in scenarios where the GNSS can work independently without the module being turned on:

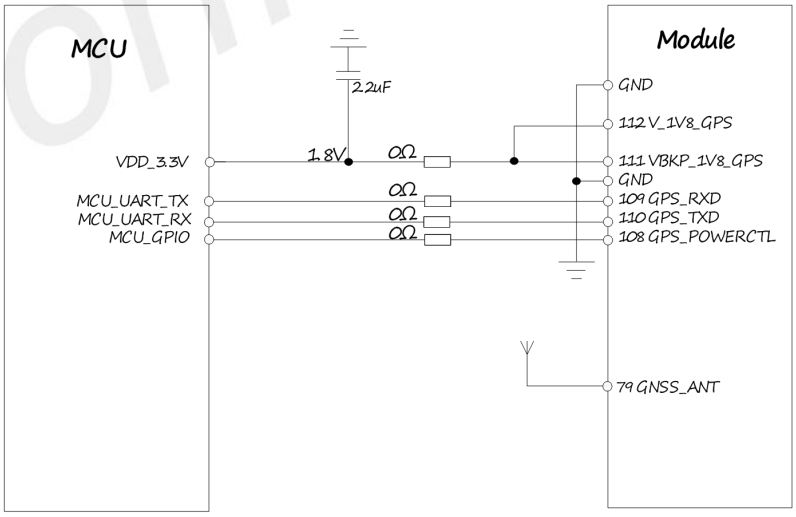

Figure 25: GNSS reference schematic diagram (working independently of the module)

3.7.3 Backup Power of GNSS

To support hot start positioning, VBKP_1V8_GPS can be powered separately to provide backup power for RTC and backup RAM when V_1V8_GPS is powered off.

It also can be connected a rechargeable 3V button battery. The chip has built-in trickle charging circuit and anti-reverse charging circuit. Note that the maximum rechargeable voltage of button battery or farad capacitor should be greater than VDD_ IO+0.3V.

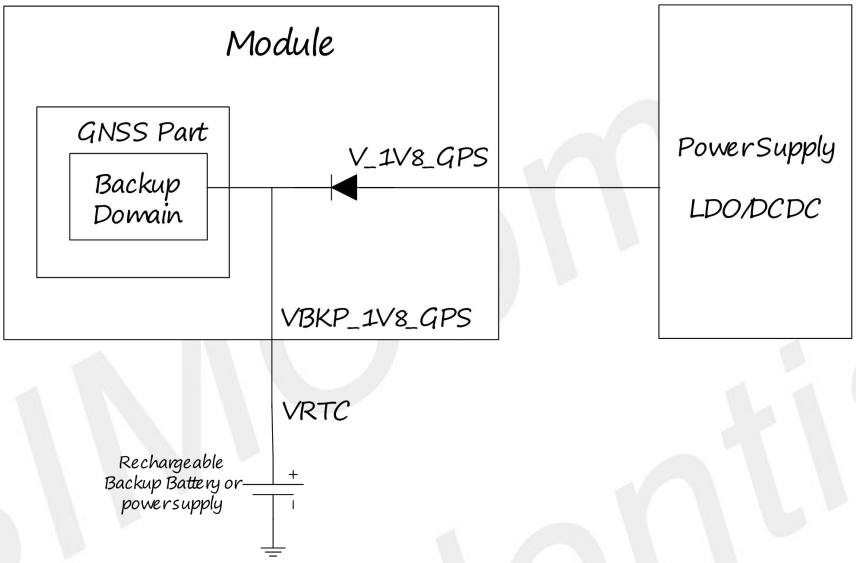

Figure 26: GNSS backup power reference circuit

Table 20: Digital I/O characteristics

Symbol	Min	Typ.	Max	Unit
V_{IL}	-0.3	0	0.25*V_1V8_GPS	V
V_{IH}	0.75*V_1V8_GPS	-	-	V
V_{OL}	-0.3	0	0.4	V
V_{OH}	0.75*V_1V8_GPS	V_1V8_GPS	-	V

Table 21: Power PINs electric parameter

Parameter	Min.	Typ.	Max.	Unit
V_1V8_GPS	1.8	1.8/3.3	3.6	V
VBKP_1V8_GPS	1.8	1.8/3.3	3.6	V

3.8 GPIO Interface

A7600E-MNSE module provides 42 GPIOs.

Table 22: GPIO Resource List

Pin No	Pin name	Interrupt wake-up function	Power domain	(Default: configurable)	Basic function	Remark
6	GPIO_00	▶	1.8V	DOWN	GPIO_00	
7	GPIO_01	▶	1.8V	DOWN	GPIO_01	
8	GPIO_02	▶	1.8V	DOWN	GPIO_02	
9	GPIO_03	▶	1.8V	DOWN	GPIO_03	
16	GPIO_04	▶	1.8V	UP	GPIO_04	
33	GPIO_05		1.8V	UP	GPIO_05	
34	GPIO_06	▶	1.8V	DOWN	GPIO_06	
45	GPIO_07	▶	1.8V	DOWN	GPIO_07	
50	GPIO_09	▶	1.8V	DOWN	GPIO_09	
52	GPIO_11	▶	1.8V	DOWN	GPIO_11	UART download
83	GPIO_23		1.8V	UP	GPIO_23	
84	GPIO_24		1.8V	DOWN	GPIO_24	
86	GPIO_26	▶	1.8V	DOWN	GPIO_26	
87	GPIO_27	▶	1.8V	UP	GPIO_27	
88	GPIO_28	▶	1.8V	DOWN	GPIO_28	
89	GPIO_29		1.8V	DOWN	GPIO_29	
90	GPIO_30	▶	1.8V	DOWN	GPIO_30	
91	GPIO_31	▶	1.8V	DOWN	GPIO_31	
92	GPIO_32	▶	1.8V	DOWN	GPIO_32	
93	GPIO_33	▶	1.8V	DOWN	GPIO_33	
94	GPIO_34	▶	1.8V	DOWN	GPIO_34	
95	GPIO_35	▶	1.8V	DOWN	GPIO_35	
96	GPIO_36	▶	1.8V	DOWN	GPIO_36	
97	GPIO_37	▶	1.8V	UP	GPIO_37	
98	GPIO_38	▶	1.8V	UP	GPIO_38	
103	GPIO_39	▶	1.8V	UP	GPIO_39	
105	GPIO_40	▶	1.8V	DOWN	GPIO_40	
106	GPIO_41	▶	1.8V	DOWN	GPIO_41	
113	GPIO_42	▶	1.8V	UP	GPIO_42	
114	GPIO_43	▶	1.8V	UP	GPIO_43	
115	GPIO_44	▶	1.8V	DOWN	GPIO_44	
116	GPIO_45	▶	1.8V	DOWN	GPIO_45	
117	GPIO_46	▶	1.8V	DOWN	GPIO_46	

118	GPIO_47	▶	1.8V	DOWN	GPIO_47	
119	GPIO_48	▶	1.8V	DOWN	GPIO_48	
120	GPIO_49	▶	1.8V	DOWN	GPIO_49	
122	GPIO_50	▶	1.8V	DOWN	GPIO_50	
123	GPIO_51	▶	1.8V	DOWN	GPIO_51	
124	GPIO_52	▶	1.8V	DOWN	GPIO_52	
125	GPIO_53	▶	1.8V	DOWN	GPIO_53	
126	GPIO_54	▶	1.8V	UP	GPIO_54	
127	GPIO_55	▶	1.8V	UP	GPIO_55	

3.9 SD Card Interface

A7600E-MNSE provides a 4-bit SD3.0/eMMC interface, only supports master mode, the clock rate can reach 200MHz SDR and 50MHZ DDR, and supports 1.8V/3V card types.

Following mode are supported: DS, HS, SDR12, SDR25, SDR50, SDR104, DDR50.

Table 23: SD card electrical parameter (SD_DATA0-SD_DATA3, SD_CLK and SD_CMD)

Symbol	Parameter	Min.	Typ.	Max.	Unit
1.8V power domain					
V_{IH}	High-level input voltage	1.62	1.8	1.98	V
V_{IL}	Low-level input voltage	-0.4	0	0.45	V
V_{OH}	High-level output voltage	1.62	1.8	1.98	V
V_{OL}	Low-level output voltage	0	0	0.45	V
3V power domain					
V_{IH}	High-level input voltage	2.7	3	3.3	V
V_{IL}	Low-level input voltage	-0.4	-	0.5	V
V_{OH}	High-level output voltage	2.7	3	3.3	V
V_{OL}	Low-level output voltage	0	-	0.5	V

NOTE

Customers choose SD3.0 card, and the power supply needs an external 800mA power supply.

3.9.1 Reference Design for External SD Card

The SD card in the figure below uses VDD_AUX for power supply by default, and the output is 3V.

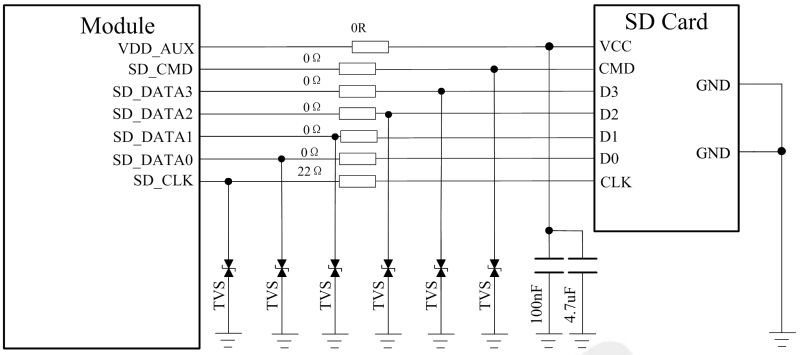

Figure 27: SD reference circuit

SD card layout guide lines:

- Protect other sensitive signals/circuits from SD card signals.
- Protect SD card signals from noisy signals (clocks, SMPS, etc.).
- Up to 200 MHz clock rate, 50 Ω nominal, ±10% trace impedance The routing needs to be controlled by 50 ohm impedance
- CLK to DATA/CMD length matching < 1 mm
- 15–24 Ω termination resistor on clock lines near module
- Total routing length < 50 mm recommended
- Spacing to all other signals = 2x line width
- Bus capacitance < 15 pF
- Recommended TVS model: ESD9L5.0ST5G.

3.10 I2C Bus

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

I2C is open-drain output, and the reference circuit is as follows:

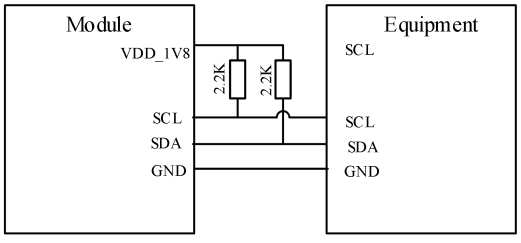

Figure 28: I2C reference circuit

NOTE

The SCL and SDA pins have no internal pull-up resistors, and the reserved pull-up power must be VDD_1V8 output by the module.

3.11 SDIO Interface

A7600E-MNSE provides one SDIO3.0 protocol interface.

Table 24: SDIO interface description

Pin No.	Pin name	I/O	Power domain	Description	Remark
27	SDIO_DATA1	IO	1.8V	SDIO bus data1	
28	SDIO_DATA2	IO	1.8V	SDIO bus data 2	
29	SDIO_CMD	IO	1.8V	SDIO bus command	
30	SDIO_DATA0	IO	1.8V	SDIO bus data 0	
31	SDIO_DATA3	IO	1.8V	SDIO bus data 3	
32	SDIO_CLK	DO	1.8V	SDIO bus clock	

Table 25: WIFI Reserved Clock interface

Pin No.	Pin name	I/O	Power domain	Description	Remark
121	WLAN_26M_CLK	AO	1.8V	WLAN reserved 26M CLK	

3.12 Network status

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

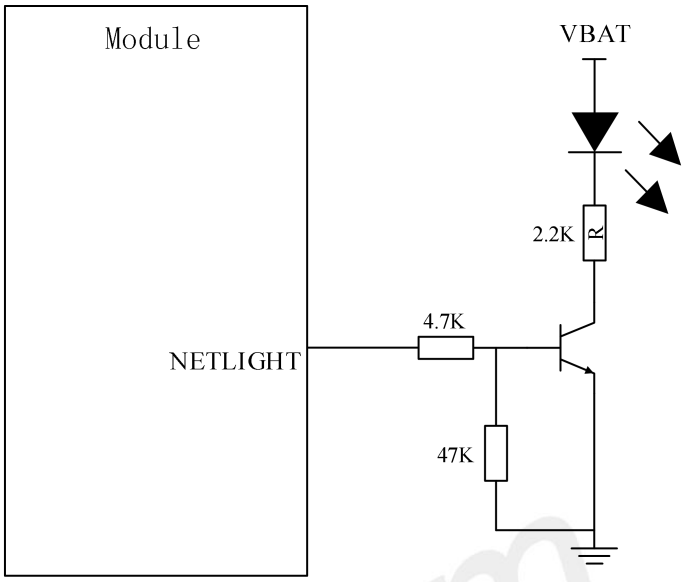

Figure 29: NETLIGHT reference circuit

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 26: 2G/3G 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 / AT+CSCLK=1, and DTR is pulled high.

Table 27: LTE mode NETLIGHT pin status

NETLIGHT pin status	Module status
Always On	Searching Network
200ms ON, 200ms OFF	Data Transmit/Registered
OFF	Power off / AT+CSCLK=1, and DTR is pulled high.

3.13 Flight Mode Control

The FLIGHTMODE pin can be used to control A7600E-MNSE to enter or exit flight mode. In flight mode, the RF circuit inside the A7600E-MNSE is turned off. The reference circuit of FLIGHTMODE multiplexing function is shown in the figure below:

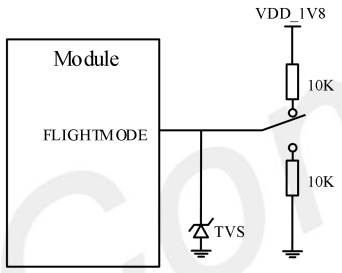

Figure 30: Flight mode switch reference circuit

Customers can use AT + CFUN command to control the module to enter or exit flight mode.

If the customer does not apply the switch circuit control in the figure above, but uses the MCU to control this pin, it is necessary to pay attention to the level matching. Please refer to the UART circuit section to use the transistor for level shifting.

Table 28: FLIGHTMODE pin control

FLIGHTMODE pin status	Module operation
Input Low Level	Flight Mode: RF is closed
Input High Level	AT command determines working mode AT+CFUN=0: RF is closed AT+CFUN=1: RF is working

3.14 Other interface

3.14.1 ADC

A7600E-MNSE has 2 dedicated ADC pins named ADC1 and ADC2. These electronic specifications are shown in the following table.

Table 29: ADC1 and ADC2 electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	12	–	bits
Input Range	0.1	–	1.3	V
Input serial resistance	1	–	–	MΩ

NOTE

'AT+CADC' and 'AT+CADC2' can be used to read the voltage of the ADC1 and ADC2 pins, for more details, please refer to document [1].

3.14.2 LDO

A7600E-MNSE has 2 LDO output, VDD_1V8 and VDD_AUX.

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.

VDD_AUX is an output LDO power supply. The output voltage is configurable. The default output voltage is 3 V，which supplies power to the SD card.

Table 30: 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.

Table 31: VDD_AUX Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{VDD_AUX}	Output voltage	-	3	-	V

I_O	Output current	-	-	400	mA

4 RF Specifications

4.1 GSM/LTE

Table 32: Conducted emission power

Frequency	power	Minimum power
EGSM900(GMSK)	33dBm ±2dB	5dBm ± 5dB
DCS1800(GMSK)	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 B3	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-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 33: 2G frequency band information

Frequency	DL	UL
EGSM900	925～960MHz	880～915 MHz
DCS1800	1805～1880 MHz	1710～1785 MHz

Table 34: 4G frequency band information

E-UTRA BAND	UL	DL	Duplex Mode
1	1920 ~1980 MHz	2110 ~2170 MHz	FDD

3	1710 ~1785 MHz	1805 ~1880 MHz	FDD
5	869 ~894 MHz	824 ~849 MHz	FDD
7	2500 ~2570 MHz	2620 ~2690 MHz	FDD
8	880 ~915 MHz	925 ~960 MHz	FDD
20	832 ~862 MHz	791 ~821 MHz	FDD
34	2010 ~2025 MHz	2010 ~2025 MHz	TDD
38	2570 ~2620 MHz	2570 ~2620 MHz	TDD
39	1880 ~1920 MHz	1880 ~1920 MHz	TDD
40	2300 ~2400 MHz	2300 ~2400 MHz	TDD
41	2496 ~2690 MHz	2496 ~2690 MHz	TDD

Table 35: 2G Conducted receive sensitivity

Frequency	Sensitivity (TYP)	Sensitivity (MAX)
EGSM900	< -109dBm	3GPP
DCS1800	< -109dBm	3GPP

Table 36: 4G Reference sensitivity (QPSK)

E-UTRA BAND	3GPP standard						Measured value	Duplex Mode
	1.4 MHz	3MHz	5MHz	10MHz	15 MHz	20 MHz	10 MHz	
1	-	-	-100	-97	-95.2	-94	-97	FDD
3	-101.7	-98.7	-97	-94	-92.2	-91	-97	FDD
5	-103.2	-100.2	-98	-95	-	-	-97	FDD
7	-	-	-98	-95	-93.2	-92	-98	FDD
8	-102.2	-99.2	-97	-94	-	-	-98	FDD
20	-	-	-97	-94	-92.2	-91	-98	FDD
34	-	-	-100	-97	-95.2	-	-97	TDD
38	-	-	-100	-97	-95.2	-94	-98	TDD
39	-	-	-100	-97	-95.2	-94	-97	TDD
40	-	-	-100	-97	-95.2	-94	-98	TDD
41	-	-	-98	-95	-93.2	-92	-98	TDD

4.2 GSM/ LTE Antenna Reference Design

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

in the following table.

Table 37: GSM/LTE antenna requirements

Parameter	Requirement
Operating Frequency	Reference frequency band information table
Direction	Omni Directional
Gain	> -3dBi (Avg)
Impedance	50 Ω
Efficiency	> 50 %
Max. Input Power	50W
VSWR	< 2
Isolation	>20dB
Cable Insertion Loss (<1GHz)	<1dB
Cable Insertion Loss (1GHz~2.2GHz)	<1.5dB
Cable Insertion Loss (2.3GHz~2.7GHz)	<2dB

4.3 GNSS RF parameters

Table 38: GNSS Frequency Bands

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

Table 39: GNSS Performance

GNSS	GPS	BeiDou	GLONASS
Tracking sensitivity	-160dBm	-159.5dBm	-153dBm
Capture sensitivity	-156dBm	-157dBm	-152dBm
Hot start TTFF	<1s		
cold start TTFF	<40s		
positioning accuracy	<2m		

4.4 GNSS Antenna Requirements

Table 40: GNSS Antenna Requirements

Antenna index	Index requirements
Operating Frequency	L1: 1559~1609MHZ
Direction	Hemisphere, face to sky
Impedance	50 Ω
Max. Input Power	50W
VSWR	< 2
Plan category	RHCP or Linear
Passive antenna gain	0dBi
Active antenna gain	-2dBi
Active antenna noise figure	< 1.5
LNA gain of internal antenna	20dB(Typ.)
Total antenna gain	< 18 dB
Coaxial insertion loss	<1.5dB

4.5 Antenna reference design

4.5.1 GSM/LTE/GNSS Passive Antenna

When designing the antenna circuit, the routing between the module and the antenna must ensure a 50Ω trace impedance.

It is recommended to add RF connector for calibration and test, and add RF matching circuit for antenna tuning. The recommended circuit is as follows:

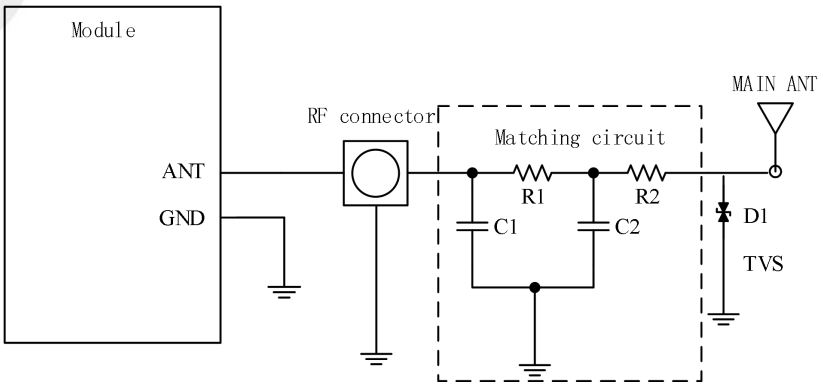

Figure 31: Passive antenna connection circuit

NOTE

GNSS adopts active antenna design scheme by default. If the customer uses a passive antenna solution, it is recommended that AT+CVAUXS=0 turn off the power supply of the active antenna to avoid chip damage caused by the installation of the passive antenna.

The specific values of R1, C1, C2 and R2 in the matching circuit usually provided by the antenna factory and determined by the antenna optimization. R1 and R2 are pasted 0 Ω by default, C1 and C2 are not pasted by default. D1 is a bidirectional TVS device, it is recommended to choose to paste, The capacitance value is required to be less than 0.2pf to avoid damage to the internal devices of the module. The recommended TVs models are as follows:

Table 41: TVS recommended part list

Package	Part	Vendor
0201	CE0201S05G01R	SOCAY
0402	PESD0402-03	PRISEMI

4.5.2 GNSS Active Antenna

The default output of GNSS active antenna power supply is 3V. The output voltage can be controlled by AT+CVAUXV, and the power supply voltage can be confirmed according to the customer's antenna selection. For example, through AT+CVAUXV=2800, set the output voltage to 2.8V. The AT command takes effect once set once.

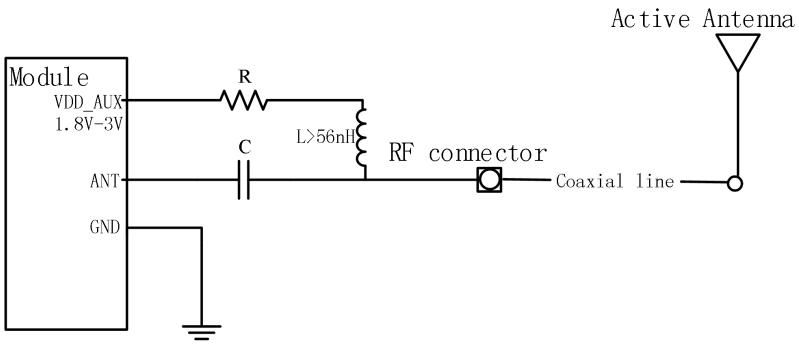

Figure 32: Active Antenna Connection Circuit

5 Electrical Specifications

5.1 Absolute Maximum Ratings

Absolute maximum rating for digital and analog pins of A7600E-MNSE are listed in the following table, Exceeding these limits may cause permanent damage to the module.

Table 42: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	-0.5	-	4.7	V
Voltage at VBUS	-0.5	-	5.4	V
Voltage at digital pins (GPIO,I2C,SPI,UART and PCM)	-0.3	-	2.1	V
Voltage at digital pins (USIM,SD)	-0.3	-	2.1	V
	-0.3	-	3.9	V
Voltage at PWRKEY、RESET	-0.3	-	4.7	V

5.2 Operating conditions

Table 43: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.4	3.8	4.2	V
Voltage at VBUS	3.0	5.0	5.25	V

Table 44: 1.8V Digital I/O characteristics*

Parameter	Description	Min.	Typ.	Max.	Unit
V_{IH}	High-level input voltage	1.35	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	-	0.45	V
V_{OH}	High-level output voltage	1.35	-	1.8	V
V_{OL}	Low-level output voltage	0	-	0.4	V
I_{OH}	High-level output current(no pull	1	-	5	mA

	down resistor)				
I_{OL}	Low-level output current(no pull up resistor)	-1	-	-5	mA
I_{IH}	Input high leakage current (no pull down resistor)	-	-	10	uA
I_{IL}	Input low leakage current(no pull up resistor)	-10	-	-	uA

NOTE

These parameters are for digital interface pins, such as GPIO , I2C, UART, PCM,SPI,SDIO 和 USB_BOOT.

Table 45: 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 A7600E-MNSE product.

Table 46: 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 .
	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, and the network configuration (e.g. multi-slot configuration).
Minimum functionality mode		AT command 'AT+CFUN=0' can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work and the 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 A7600E-MNSE enter into sleep mode:

- UART condition
- USB condition
- Software condition

5.3.3 Minimum functionality mode and Flight mode

The command "AT+CFUN=<fun>" can set the module to this mode. This command provides three options for setting different functions.

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

If A7600E-MNSE has been set to minimum functionality mode, the RF function and USIM card function will be closed. In this case, the serial port and USB are still accessible, but RF function and USIM card and some AT commands will be unavailable.

If A7600E-MNSE 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 and some AT commands will be unavailable.

When A7600E-MNSE is in minimum functionality or flight mode, it can return to full functionality by the AT command 'AT+CFUN=1'.

For detailed information about the "AT+CFUN" command, please refer to the document [1].

5.4 Current Consumption

The current consumption is listed in the table below.

Table 47: Current consumption on VBAT Pins (VBAT=3.8V)

GSM sleep/idle mode	
GSM/GPRS supply current (without USB connection)	Sleep mode @ BS_PA_MFRMS=2 Typical: 2.4mA Idle mode @ BS_PA_MFRMS=2 Typical: 16mA
LTE sleep/idle mode	
LTE supply current (without USB connection)	Sleep mode Typical: 2.5mA Idle mode Typical: 16mA
GSM Talk	
EGSM 900	@ power level #5 Typical: 260 mA
DCS1800	@ power level #0 Typical: 180 mA
GPRS data	
EGSM 900 (1 Rx,4 Tx)	@ power level #5 Typical: 460 mA
DCS1800 (1 Rx,4 Tx)	@ power level #0 Typical: 300 mA
EGSM 900 (3 Rx,2 Tx)	@ power level #5 Typical: 365 mA
DCS1800 (3 Rx,2 Tx)	@ power level #0 Typical: 245 mA
EDGE data	
EGSM 900 (1 Rx,4 Tx)	@ power level #8 Typical: 460 mA
DCS1800 (1 Rx,4 Tx)	@ power level #2 Typical: 300 mA
EGSM 900 (3 Rx,2 Tx)	@ power level #8 Typical: 250 mA
DCS1800 (3 Rx,2 Tx)	@ power level #2 Typical: 200 mA

LTE data			
LTE-FDD B1	@10MHz	23dBm	Typical: 650 mA
LTE-FDD B3	@10MHz	23dBm	Typical: 580 mA
LTE-FDD B5	@10MHz	23dBm	Typical: 450 mA
LTE-FDD B7	@10MHz	23dBm	Typical: TBD
LTE-FDD B8	@10MHz	23dBm	Typical: 500 mA
LTE-FDD B20	@10MHz	23dBm	Typical: TBD
LTE-TDD B34	@10MHz	23dBm	Typical: 360 mA
LTE-TDD B38	@10MHz	23dBm	Typical: 405 mA
LTE-TDD B39	@10MHz	23dBm	Typical: 348 mA
LTE-TDD B40	@10MHz	23dBm	Typical: 372 mA
LTE-TDD B41	@10MHz	23dBm	Typical: 362 mA

5.5 ESD Notes

A7600E-MNSE is an electrostatic sensitive device. Users must pay attention to electrostatic protection when producing, assembling and operating the module. The electrostatic performance parameters of the module are as follows:

Table 48: The ESD performance measurement table (Temperature: 25℃, Humidity: 45%)

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

NOTE

Test condition is module pasted on SIMcom Development board (With ESD components).

6 SMT Production Guide

6.1 Top and Bottom View of A7600E-MNSE

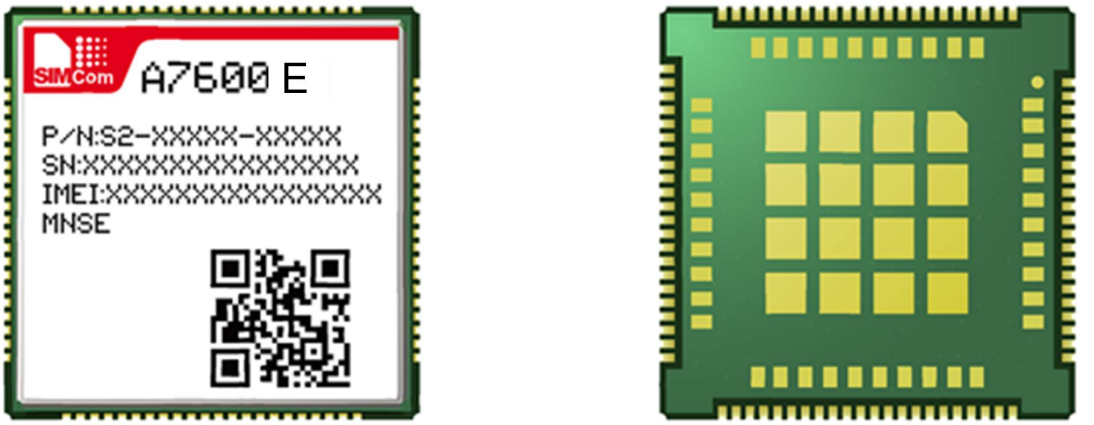

Figure 33: Top and bottom view of A7600E-MNSE

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

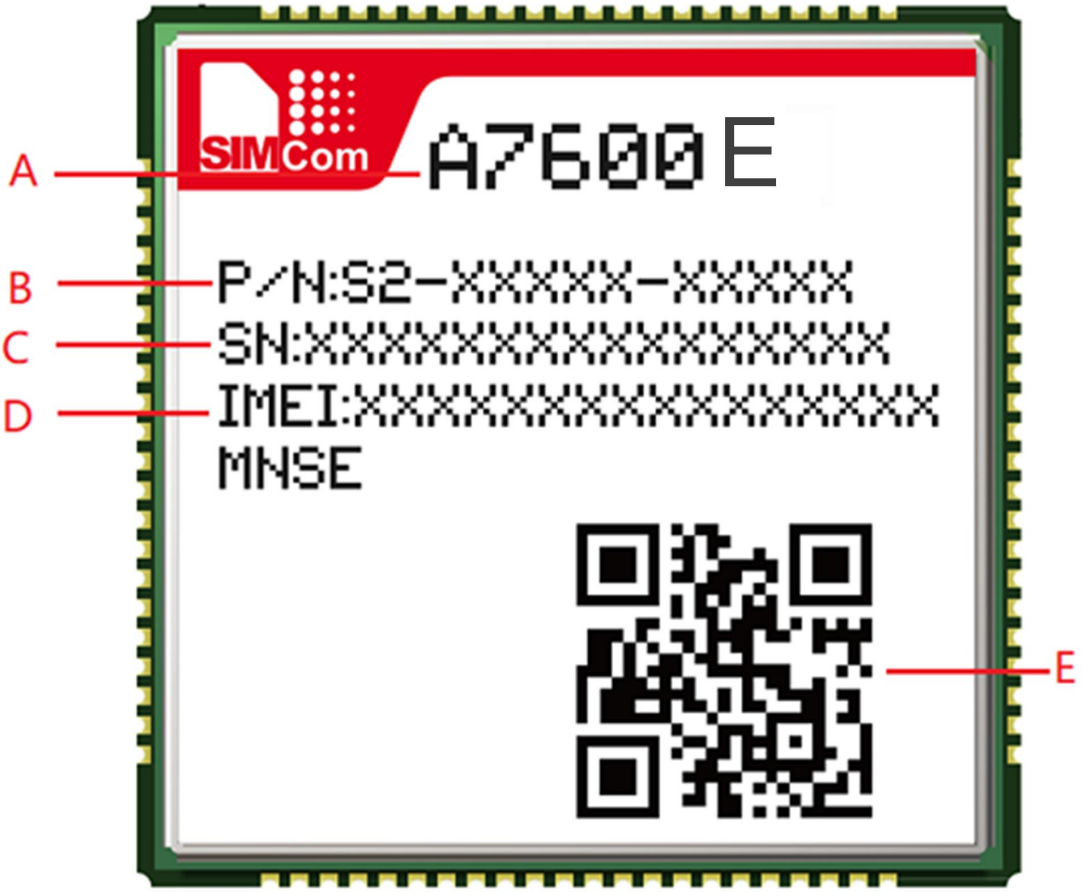

Figure 34: Label information

Table 49: The description of label information

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

6.3 Typical SMT Reflow Profile

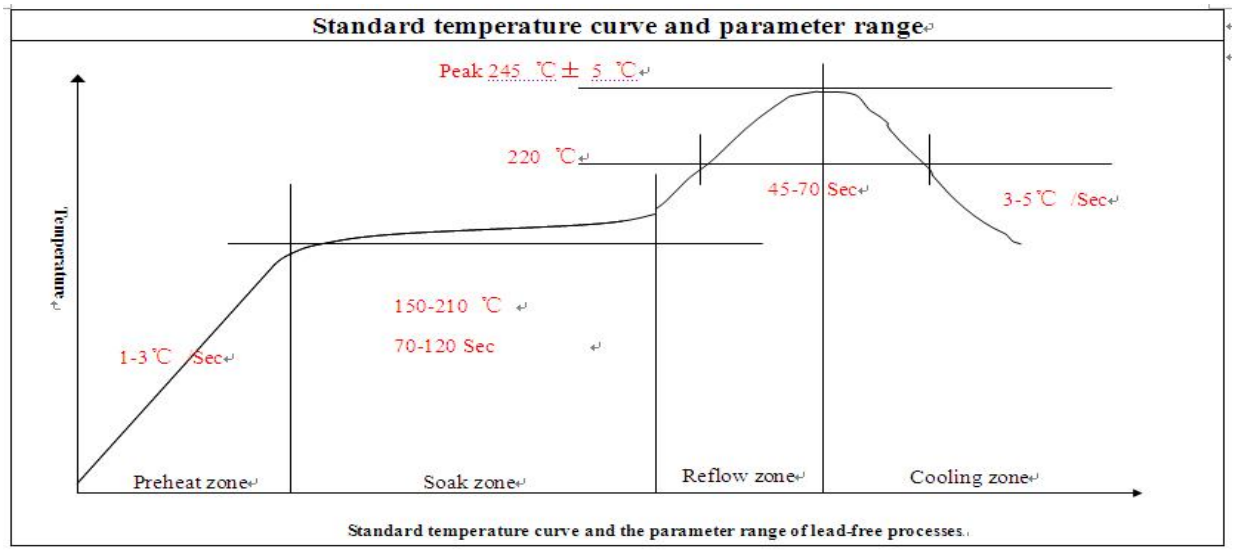

Figure 35: The ramp-soak-spike reflow profile of A7600E-MNSE

NOTE

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

6.4 Moisture Sensitivity Level (MSL)

A7600E-MNSE is qualified to Moisture Sensitivity Level (MSL) 3 in accordance with JEDEC J-STD-033.

In the following two cases, the A7600E-MNSE module should be fully baked before reflow soldering, otherwise the module may cause permanent damage during the reflow soldering process.

After unpacking or vacuum packaging is damaged and leaks, the A7600E-MNSE module needs to be SMT patched within 168 hours under environmental conditions of temperature <30 degrees and relative humidity <60%. If the above conditions are not met, bake is required.

If the vacuum packaging is not opened, but the shelf life has expired, baking is also required.

Bake conditions: users should bake modules for 192 hours in drying equipment (<5% RH) at 40+5/-0°C, or 72 hours at 85+5/-5°C. (If using a tray, please pay attention to whether the tray is resistant to thermal deformation).

Table 50: Moisture Sensitivity Level and Floor Life

Moisture Sensitivity Level (MSL)	Floor Life (out of bag) at factory ambient≤30°C/60% RH or as stated
1	Unlimited at ≦30℃/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.

NOTE

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

7 Packaging

A7600E-MNSE support tray packaging.

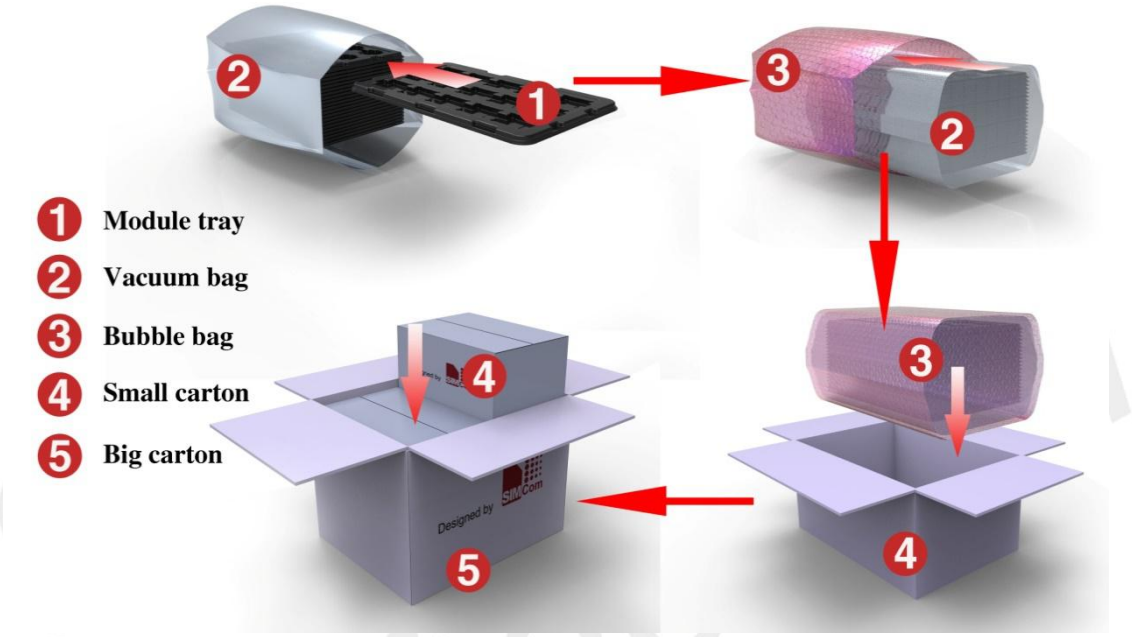

Figure 36: packaging diagram

Module tray drawing：

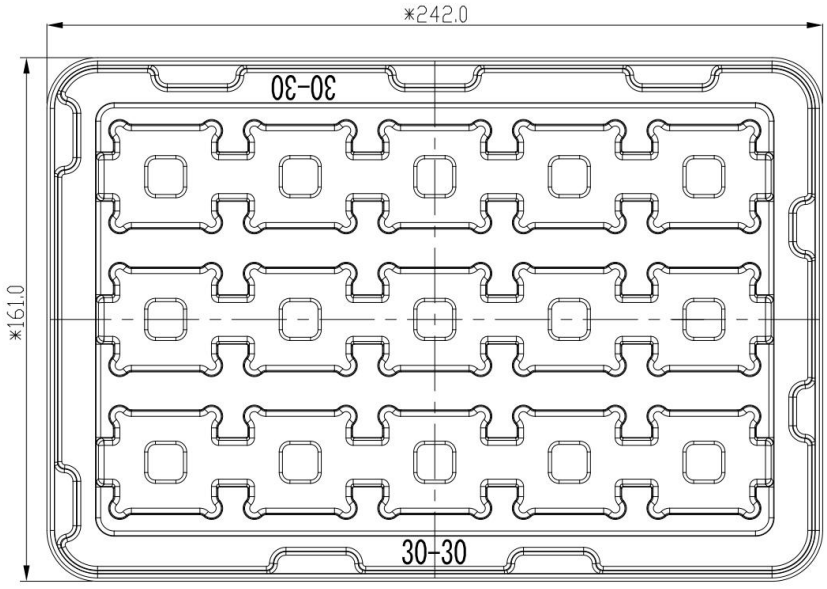

Figure 37: Tray drawing

Table 51: Tray size

Length (±3mm)	Width (±3mm)	number
242.0	161.0	15

Small carton drawing：

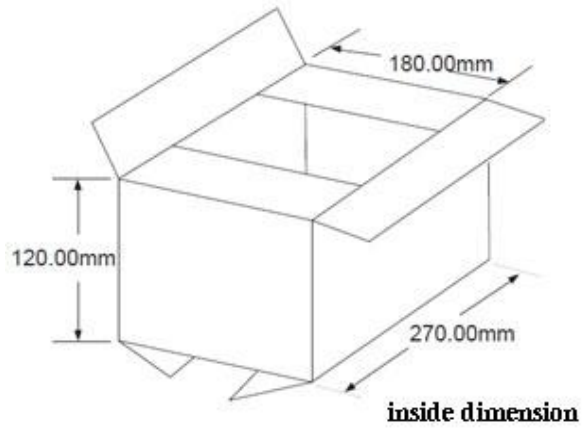

Figure 38: Small carton drawing

Table 52: Small Carton size

Length (±10mm)	Width (±10mm)	Height (±10mm)	number
270	180	120	15*20=300

Big carton drawing：

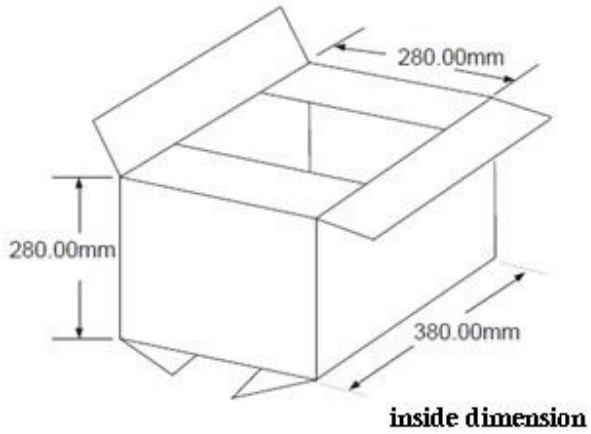

Figure 39: Big carton drawing

Table 53: Big Carton size

Length (±10mm)	Width (±10mm)	Height (±10mm)	number
380	280	280	300*4=1200

8 Appendix

8.1 Coding Schemes and Maximum Net Data Rates over Air Interface

Table 54: Coding Schemes and Maximum Net Data Rates over Air Interface

Multi slot definition (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
HSDPA device category	**Max data rate（peak）**		**Modulation type**

Category 1	1.2Mbps	16QAM,QPSK
Category 2	1.2Mbps	16QAM,QPSK
Category 3	1.8Mbps	16QAM,QPSK
Category 4	1.8Mbps	16QAM,QPSK
Category 5	3.6Mbps	16QAM,QPSK
Category 6	3.6Mbps	16QAM,QPSK
Category 7	7.2Mbps	16QAM,QPSK
Category 8	7.2Mbps	16QAM,QPSK
Category 9	10.2Mbps	16QAM,QPSK
Category 10	14.4Mbps	16QAM,QPSK
Category 11	0.9Mbps	QPSK
Category 12	1.8Mbps	QPSK
Category 13	17.6Mbps	64QAM
Category 14	21.1Mbps	64QAM
Category 15	23.4Mbps	16QAM
Category 16	28Mbps	16QAM
Category 17	23.4Mbps	64QAM
Category 18	28Mbps	64QAM
Category 19	35.5Mbps	64QAM
Category 20	42Mbps	64QAM
Category 21	23.4Mbps	16QAM
Category 22	28Mbps	16QAM
Category 23	35.5Mbps	64QAM
Category 24	42.2Mbps	64QAM
HSUPA device category	**Max data rate（peak）**	**Modulation type**
Category 1	0.96Mbps	QPSK
Category 2	1.92Mbps	QPSK
Category 3	1.92Mbps	QPSK
Category 4	3.84Mbps	QPSK
Category 5	3.84Mbps	QPSK
Category 6	5.76Mbps	QPSK
LTE-FDD device category (Downlink)	**Max data rate（peak）**	**Modulation type**
Category 1	10Mbps	QPSK/16QAM/64QAM
Category 2	50Mbps	QPSK/16QAM/64QAM
Category 3	100Mbps	QPSK/16QAM/64QAM
Category 4	150Mbps	QPSK/16QAM/64QAM
LTE-FDD device category (Uplink)	**Max data rate（peak）**	**Modulation type**
Category 1	5Mbps	QPSK/16QAM
Category 2	25Mbps	QPSK/16QAM

Category 3	50Mbps	QPSK/16QAM
Category 4	50Mbps	QPSK/16QAM

8.2 Related Documents

Table 55: 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

8.3 Terms and Abbreviations

Table 56: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
IMEI	International Mobile Equipment Identity
Li-ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated

PAP	Password Authentication Protocol
PBCCH	Packet Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
RX	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
PB abbreviation	
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 57: 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.