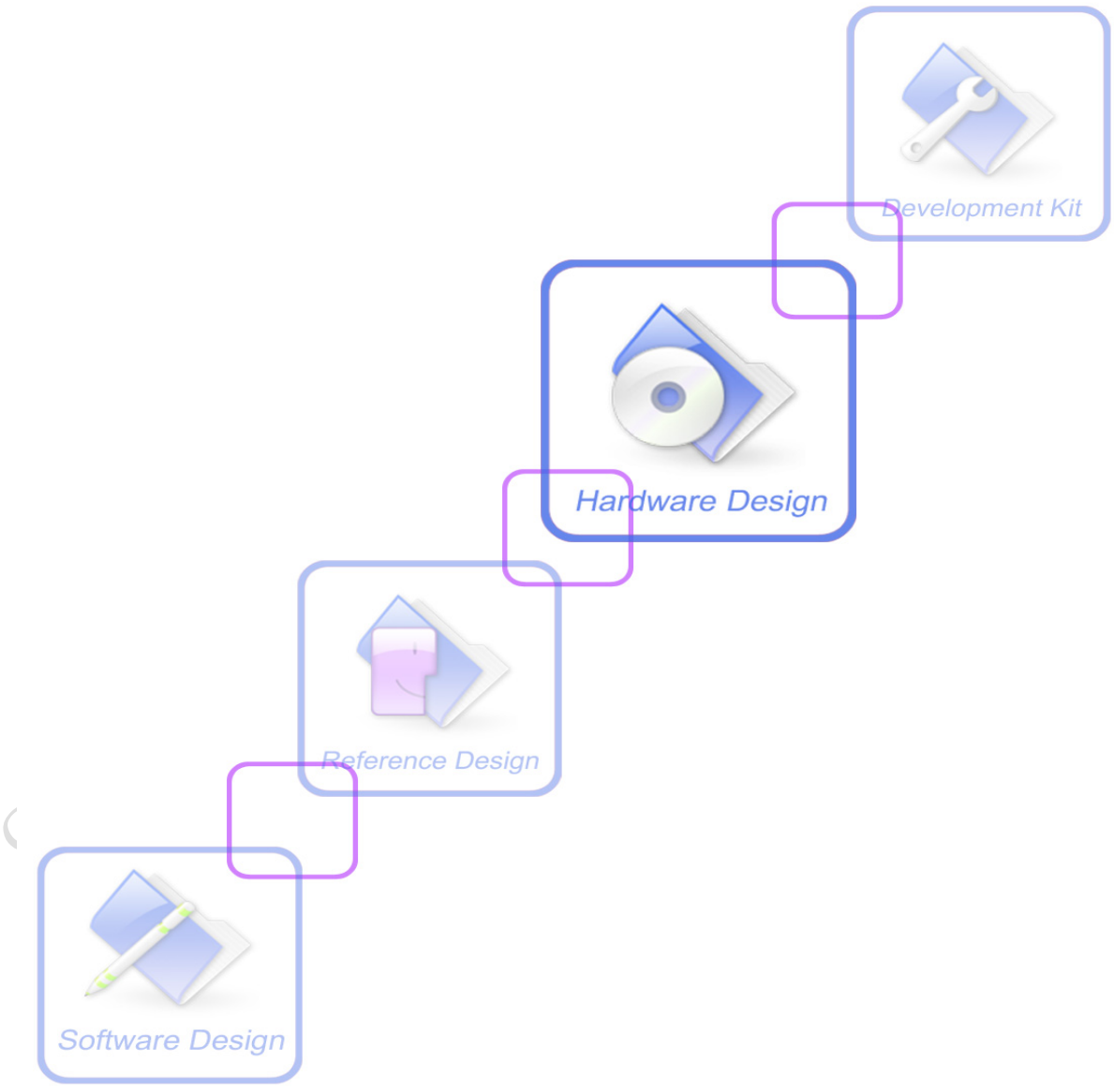
A7600E_Hardware Design_V1.00



Document Title	A7600E_Hardware Design_V1.00
Version	1.00
Date	2020-02-25
Status	Released
Document Control ID	A7600E_Hardware Design_V1.00

General Notes

Thank you for using the A7600E module provided by SIMCom. This product has a standard AT command interface, which can provide voice (* in development), data, SMS and other services. Please read the user manual carefully before use, you will appreciate its perfect functions and simple operation methods.

This module is mainly used for voice (* in development) or data communication. SIMCom does not assume the responsibility for property loss or personal injury caused by the abnormal operation of users. Users are requested to develop corresponding products according to the technical specifications and reference design in the manual. At the same time, pay attention to the general safety issues that should be paid attention to when using mobile products.

Before the declaration, SIMCom has the right to modify the contents of this manual according to the needs of technological development.

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Revision History

Date	Version	Description of change	Author
2019-02-25	1.00	Original version.	Gaochao.li Qingqing.fu

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 module to design and develop applications quickly.

1.1 Product Outline

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

Table 1: A7600E frequency bands

STANDARD	BAND	A7600E
GSM	EGSM900MHz	✓
	DCS1800MHz	✓
LTE-FDD	LTE-FDD B1	✓
	LTE-FDD B3	✓
	LTE-FDD B5	✓
	LTE-FDD B7	✓
	LTE-FDD B8	✓
	LTE-FDD B20	✓
	LTE-FDD B28A LTE-FDD B28B	✓ ✓
LTE-TDD	LTE TDD B38	✓
	LTE TDD B40	✓
	LTE TDD B41	✓
Category		CAT1

With a small physical dimension of 30 * 30 * 2.7 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 provides 119 pins, including 87 LCC pins in the outer ring and 32 LGA pins in the inner ring. This document will introduce all the functional pins.

1.1. Hardware Interface Overview

A7600E provides the following hardware interfaces.

- Power input
- USB 2.0 interface
- Two UART interfaces, one full function serial port and one debug 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)
- ADC interfaces
- Power supply output
- PCM digital audio interface
- I2C interfaces
- USB boot download and guidance interface
- SPI interface
- Network status indication interface
- Antenna interfaces
- Module operation status indication interface
- Flight mode control interface

1.2. Hardware Block Diagram

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

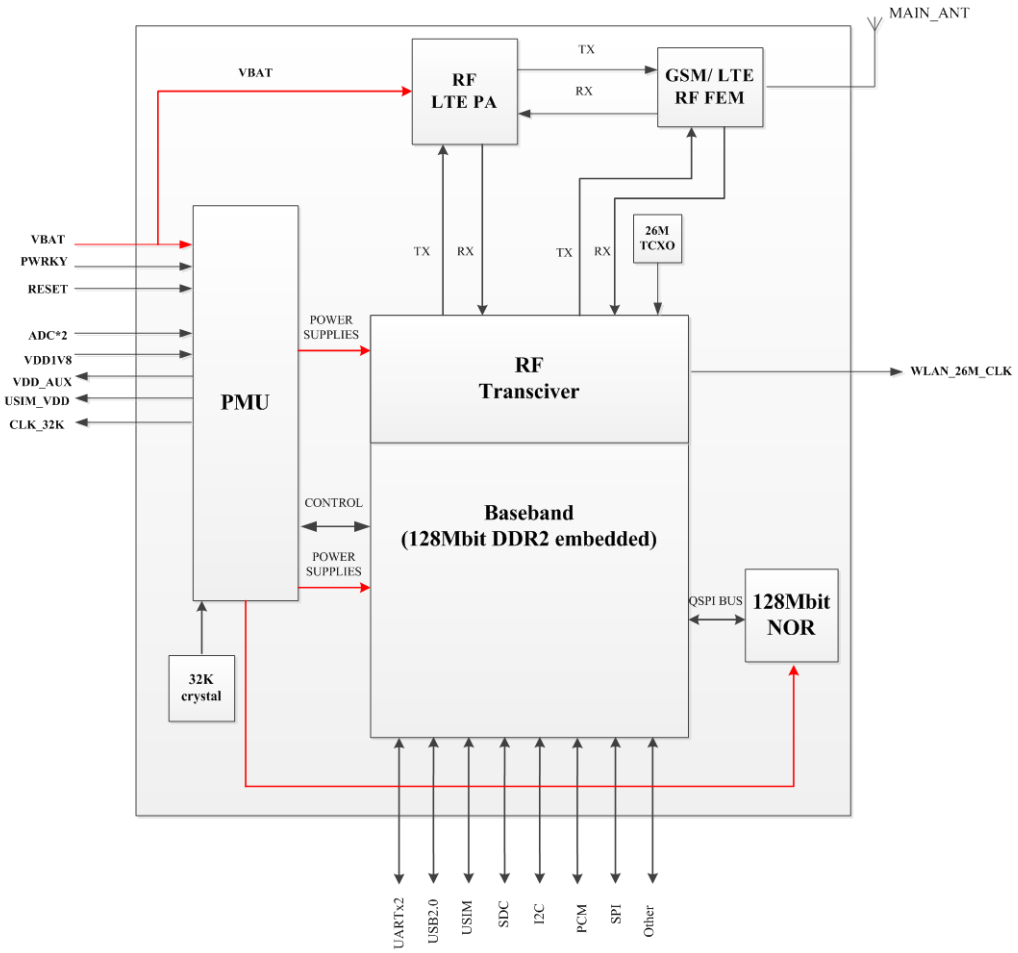

Figure 1: Block diagram

1.2 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: <3.8mA
BAND	Refer to Table 1
TX power	GSM/GPRS power level: -- EGSM900: 4 (2W) -- DCS1800: 1 (1W) EDGE power level: -- EGSM900: E2 (0.5W) -- DCS1800 : E1 (0.4W) LTE power level: 3 (0.25W)
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
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	PCM Digital Audio interface（in developing）
UART interface	●Full function serial port Baud rate support from 9600bps to 3.6Mbps 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
SD/SDIO	Support SDC interfaces, clock frequency up to 200MHz *SDIO interface supports WLAN scheme(*WIFI function is in development)
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*2.7mm Weight: TBD
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 provides 119 pins interface.All functions of the MODULE will be provided through 119 pads that will be connected to the customers' platform. The following Figures is the TOP view of the pin assignment of the MODULE.

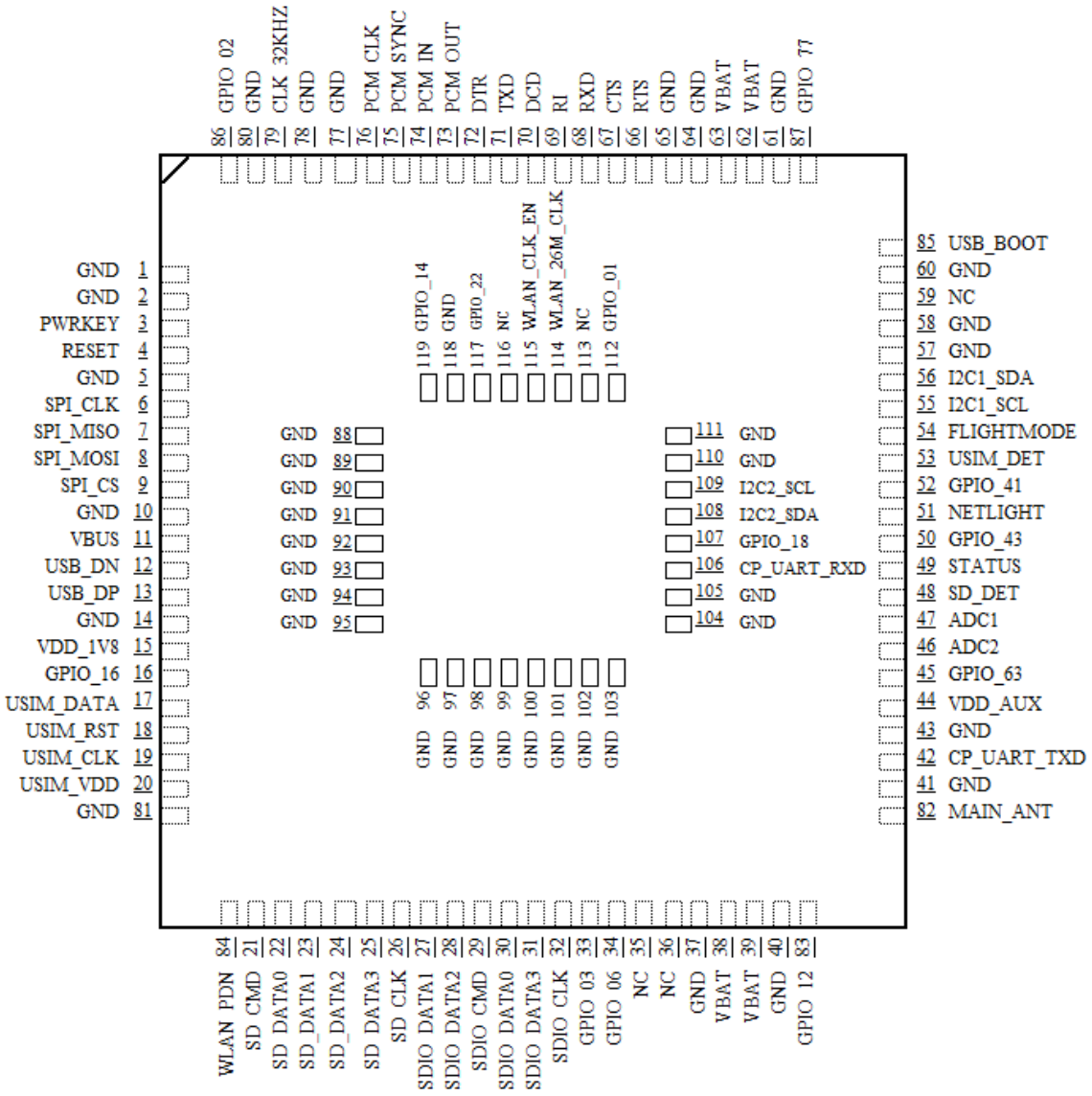

Figure 2: Module pin diagram (Top view)

Table 3: Pin Description

Pin No.	Pin name	Pin No.	Pin name
1	GND	2	GND
3	PWRKEY	4	RESET
5	GND	6	SPI_CLK
7	SPI_MISO	8	SPI_MOSI
9	SPI_CS	10	GND
11	VBUS	12	USB_DN
13	USB_DP	14	GND
15	VDD_1V8	16	GPIO_16
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_03	34	GPIO_06
35	NC	36	NC
37	GND	38	VBAT
39	VBAT	40	GND
41	GND	42	CP_UART_TXD
43	GND	44	VDD_AUX
45	GPIO_63	46	ADC2
47	ADC1	48	SD_DET
49	STATUS	50	GPIO_43
51	NETLIGHT	52	GPIO_41
53	USIM_DET	54	FLIGHTMODE
55	I2C1_SCL	56	I2C1_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	PCM_OUT	74	PCM_IN
75	PCM_SYNC	76	PCM_CLK
77	GND	78	GND
79	CLK_32KHZ	80	GND
81	GND	82	MAIN_ANT
83	GPIO_12	84	WLAN_PDN
85	USB_BOOT	86	GPIO_02
87	GPIO_77	88	GND
89	GND	90	GND
91	GND	92	GND
93	GND	94	GND
95	GND	96	GND
97	GND	98	GND
99	GND	100	GND
101	GND	102	GND
103	GND	104	GND
105	GND	106	CP_UART_RXD
107	GPIO_18	108	I2C2_SDA
109	I2C2_SCL	110	GND
111	GND	112	GPIO_01
113	NC	114	WLAN_26M_CLK
115	WLAN_CLK_EN	116	NC
117	GPIO_22	118	GND
119	GPIO_14		

Note: 'USB_BOOT' 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
	Output DC Operating Conditions (VCC = 1.8 V Typical)				
	VOH	Output high level range	VCC - 0.4	-	VCC
	VOL	Output low level range	-	-	0.2V
	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/U	VCC = 1.8V Typical				

SIM/SD)	IIL	Input leakage current	-	-	2uA
	Output 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
	Output DC Operating Conditions (VCC = 1.8 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 input voltage ranges from 3.4V to 4.2V, and the peak current value can reach 2.8A.	
VDD_AUX	44	-	PO	Output current limit: 400mA, Output voltage: 3V (default).	SD card power supply
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	1,2,5,10,14,37,40,41,43,57,58,60,61,64,65,77,78,80,81,88~105,110,111,	-	-	Ground	

	118				
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_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.	
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.	
Full function UART interface					
RTS	66	1.8V	DI	RTS output	If unused, keep it open.
CTS	67	1.8V	DO	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	
SPI interface					

SPI_CLK	6	1.8V	DO	Clock signal	If unused, keep it open.
SPI_MISO	7	1.8V	DI	Master device data input, slave device data output	
SPI_MOSI	8	1.8V	DO	Master device data output, slave device data input	
SPI_CS	9	1.8V	DO	Chip Select	
Debug UART					
CP_UART_TXD	42	1.8V	DOH	Log output	Default used as debug port.
CP_UART_RXD	106	1.8V	DI	Log input	
I2C interface					
I2C2_SCL	109	1.8V	DO	I2C clock output	If unused, keep it open. These pins have been Internally pull-up to VDD_1.8. External power supply cannot be used to pull up these pins, otherwise there will be voltage leakage。
I2C2_SDA	108	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	
PCM interface					
PCM_OUT	73	1.8V	DO,PD	PCM data output	If unused, keep it open.
PCM_IN	74	1.8V	DI,PD	PCM data input	
PCM_SYNC	75	1.8V	I/O,PD	PCM SYNC signal	
PCM_CLK	76	1.8V	DO,PU	PCM clock output	
GPIO					
GPIO_16	16	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_03	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_63	45	1.8V	IO,PD	General purple I/O	If unused, keep it open.

GPIO_43	50	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_41	52	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_12	83	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_02	86	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_77	87	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO_18	107	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_01	112	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_22	117	1.8V	IO,PD	General purple I/O	If unused, keep it open.
GPIO_14	119	1.8V	IO,PD	General purple I/O	If unused, keep it open.
ANT interface					
MAIN_ANT	82	-	AIO	Main ANT interface	
Other Pins					
ADC1	47	-	AI	General Purpose ADC	If unused, keep it open.
ADC2	46	-	AI	General Purpose ADC	If unused, keep it open.
CLK_32KHZ	79	-	DO	32K CLK Buffered crystal output.	If unused, keep it open.
NETLIGHT	51	1.8V	DO	Network registration status indicator (LED). For more detail, please refer the chapter 3.12.	
FLIGHTMODE	54	1.8V	DI	*Flight mode control input (in software development): High level (suspended): normal mode Low level: flight mode	
USB_BOOT	85	1.8V	DI	Firmware download guide control input. when pull-up to 1.8V and press PWRKEY,A7600E will access in USB download mode.	Do place 2 test points for debug. DO NOT PULL UP USB_BOOT DURING NORMAL POWER UP!
WLAN Function related pin (in function development)					
WLAN_PDN	84	1.8V	DO	WLAN full power down control	
WLAN_CLK_EN	115	1.8V	DI	RF858 WLAN reversed PIN:	

				clock 1 enable	
WLAN_26M_CLK	114	-	AO	WLAN reversed PIN: 26M CLK	
GPIO_41	52	1.8V	DI	GPIO_41/WIFI wake up multiplexer PIN	

2.3. Mechanical Information

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

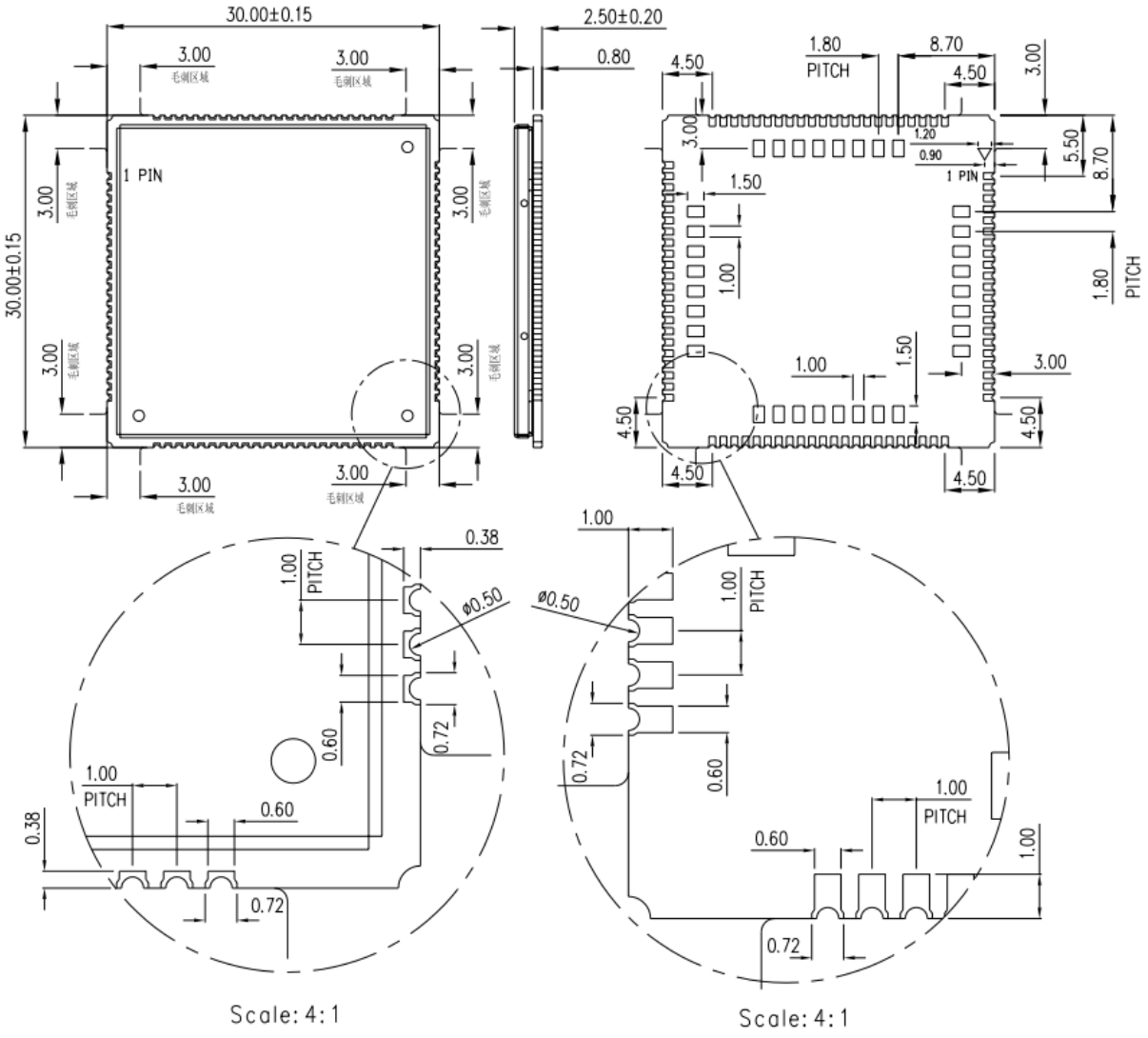

Figure 3: Dimension drawing (Unit: mm)

2.4. Recommend PCB Footprint Dimension

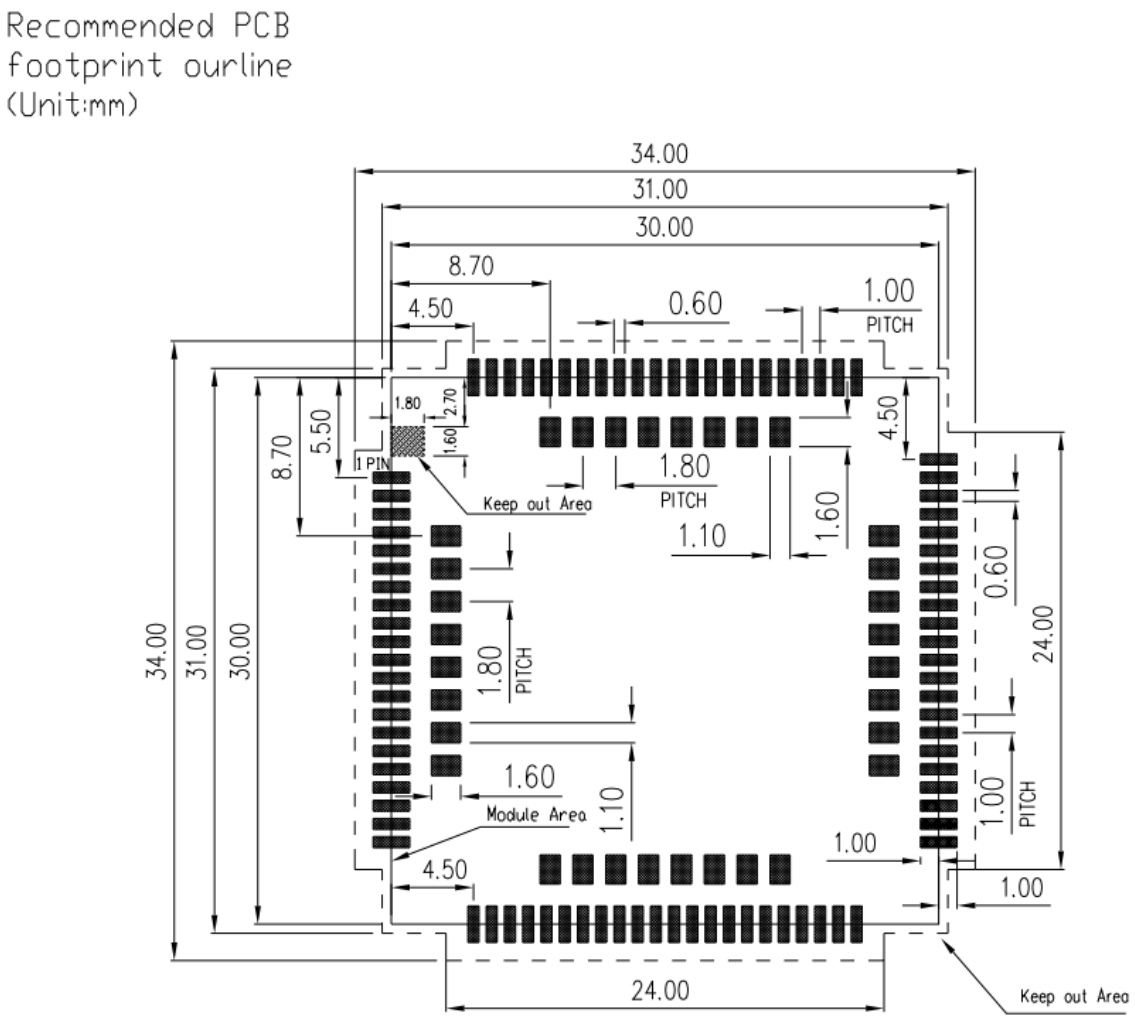

Figure 4: Recommend PCB footprint Dimension (Unit: mm)

2.5. Recommend Stencil Size

Recommend stencil thickness≥0.15mm,<0.18mm.

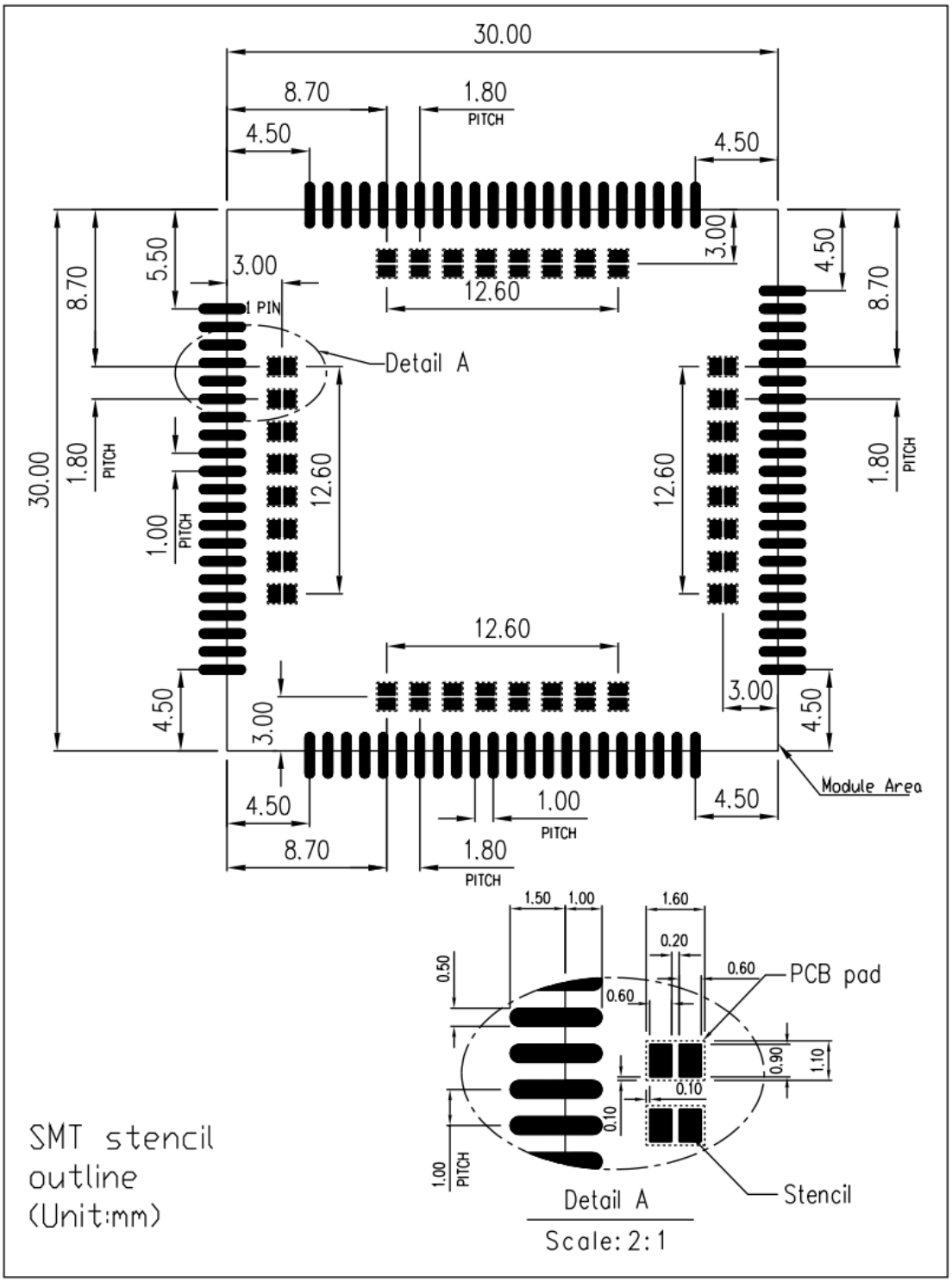

Figure 5: Recommend stencil dimension (Unit: mm)

3. Interface Application

3.1. Power Supply

A7600E offers four power supply PINs (38, 39, 62, 63) as VBAT power input PIN.A7600E use these four PINs supply the internal RF and baseband circuit.

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 2.7A (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 2.7A.

The following figure shows the Vbat voltage drop.

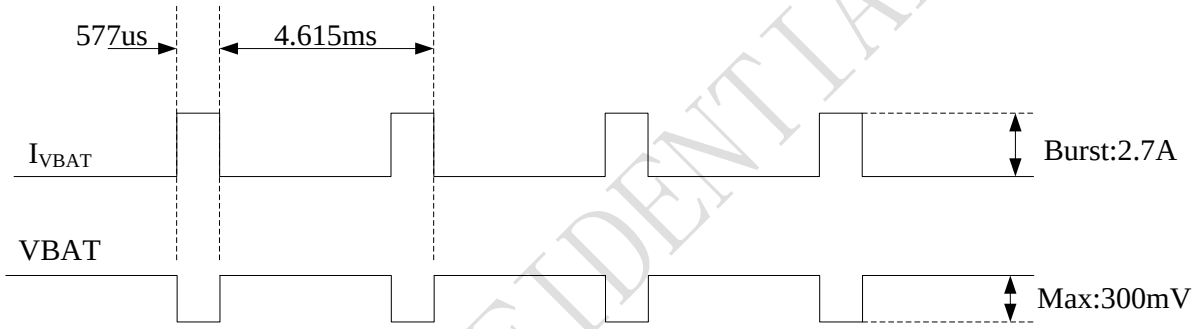

Figure 6: Burst current cause VBAT drop

Note: test condition: Vbat power supply 3.8V, Cd = 100 μ f tantalum capacitance (ESR equal to 0.7 Ω), CF = 100nF. (Refer to figure 7 for circuit)

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	-	2.7	-	A
$I_{VBAT(average)}$	Module average consumption current (normal mode)	Refer to figure 40			
$I_{VBAT(sleep)}$	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 2.7A. If the voltage drops below 3.4V, the RF performance of the module will be affected.

Note: when the power supply can provide a peak current of 2.7A, the total capacity of the external power supply capacitance is recommended to be no less than 300uf. If the peak current of 2.7A 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 two 0.1 / 1 μ f 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.

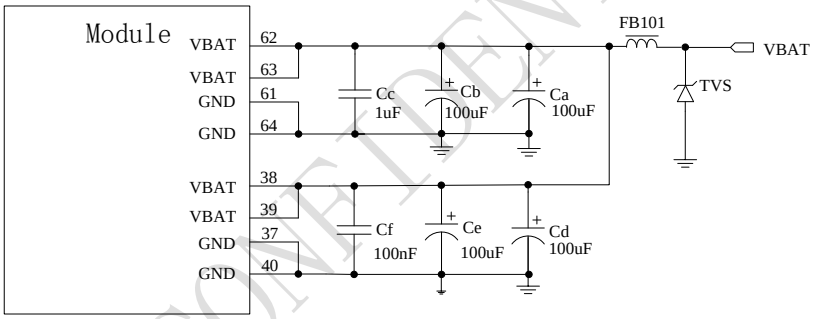

Figure 7: VBAT input reference circuit

In addition, in order to prevent the damage of A7600E 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

3.1.2. Recommended Power Supply Circuit

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:

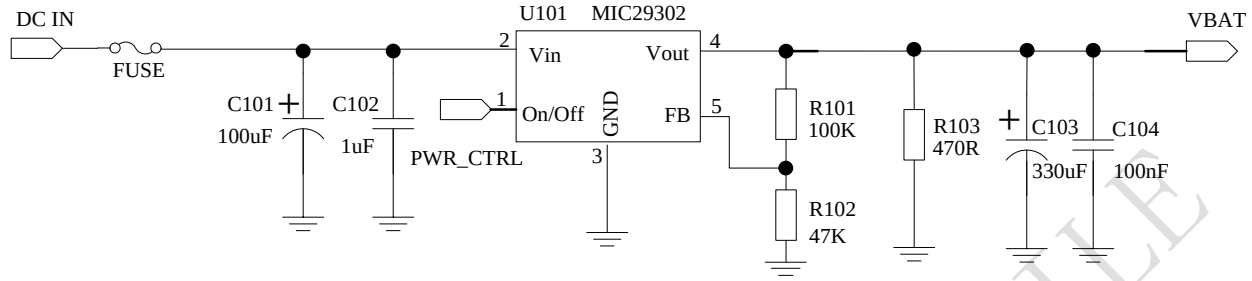

Figure 8: Recommended circuit for linear power supply

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

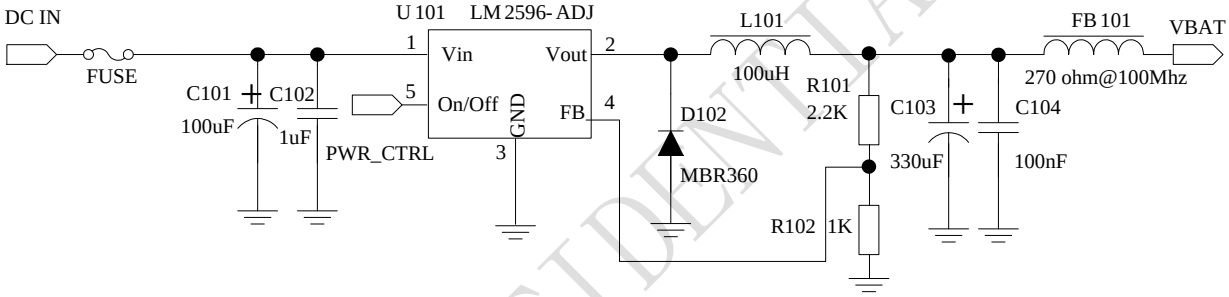

Figure 9: Recommended circuits for switching power supply

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:

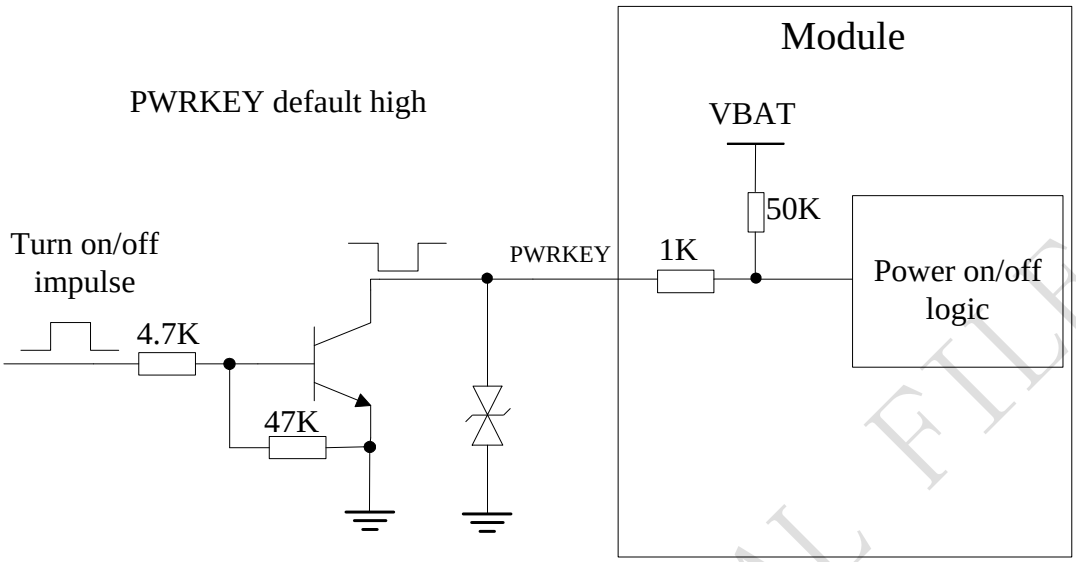

Figure 10: Power on/off reference circuit

Note: When PWRKEY pin is connected to the ground through 0 ohm resistor, the module will start automatically.

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.

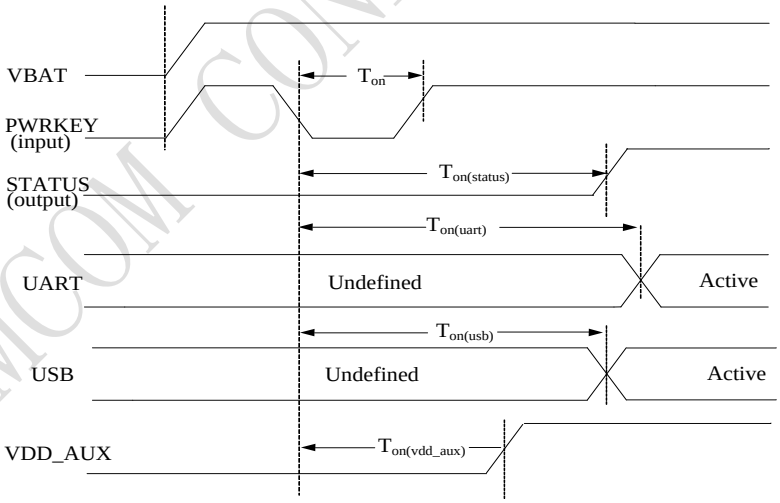

Figure 11: PWRKEY power on sequence

Table 10: Power on sequence parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{on}	Power on low level pulse width	-	50	-	ms
$T_{on(status)}$	Power on time (according to status pin)	-	10.9	-	s
$T_{on(uart)}$	Power on time (according to UART interface)	-	11	-	s
$T_{on(vdd\_aux)}$	Power on time (according to VDD_AUX pin)	-	10	-	s
$T_{on(usb)}$	Power on time (according to USB interface)	-	8.7	-	s
V_{IH}	PWRKEY input high voltage level	2.94V	-	VBAT	
V_{IL}	PWRKEY input low voltage level	0	0	0.5V	

3.2.2. Module Power Off

A7600E 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 ℃, A7600E will report warning information through AT port. When the temperature exceeds the range of - 40 ~ + 85 ℃, A7600E 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:

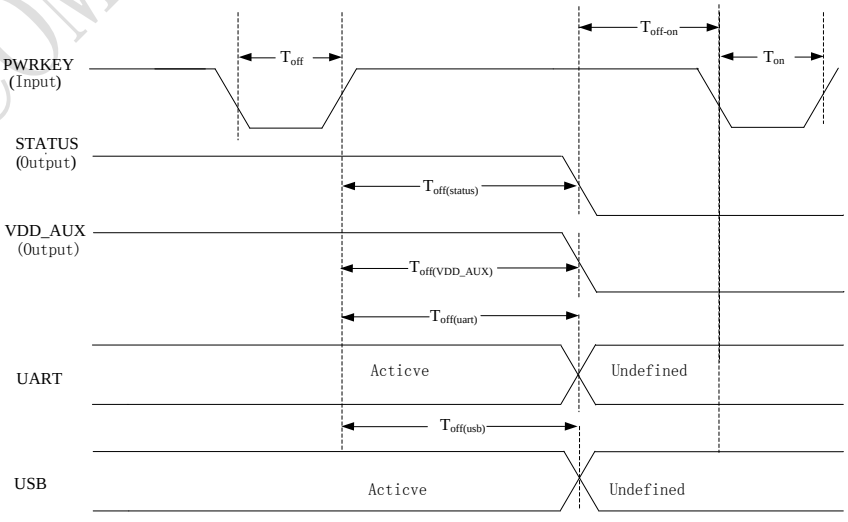

Figure 12: PWRKEY power off sequence

Table 11: Power off sequence parameters

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{off}	Power off low level pulse width	2.5	-	-	s
$T_{off(status)}$	Power off time(according to status interface)	-	1.9	-	s
$T_{off(uart)}$	Power off time(according to UART interface)	-	1.9	-	s
$T_{off(usb)}$	Power off time(according to USB interface)	-	1.9	-	s
$T_{off(VDD\_AUX)}$	Power off time(according to VDD_AUX pin)	-	1.9	-	s
T_{off-on}	Power off - power on buffer time	2	-	-	s

Note: the status pin can be used to judge whether the module is powered on or not. When the module is powered on and initialization is completed, the status outputs a high level, otherwise the low level will be maintained all the time. All measurement are started at the release of PWRKEY.

3.2.3. Module Reset

A7600E can restart the module by pulling down the reset pin of the module. Reset pin also has the function of power on (active low, but this key has no shutdown function), but 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:

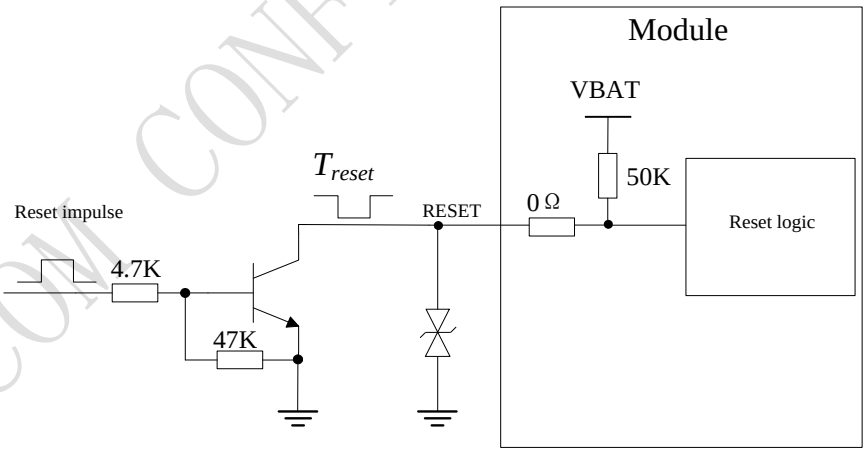

Figure 13: Reference reset circuit

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 provides two serial ports, the main communication serial port is UART, and the CP_UART dedicate to printing log.

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

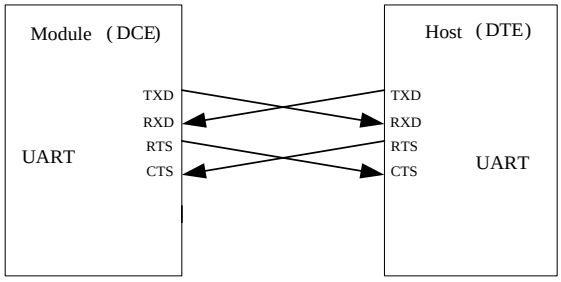

Figure 14: Serial port connection diagram (full function mode)

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

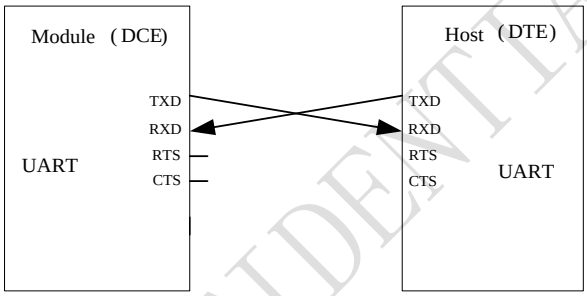

Figure 15: Serial port connection diagram (NULL mode)

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.

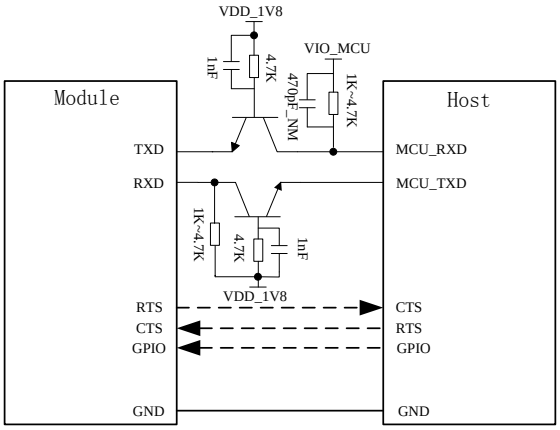

Figure 16: Triode level conversion circuit

Note: A7600E supports the following baud rates: 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600. The default baud rate is 115200bps.

3.4. USB Interface

The A7600E 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

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

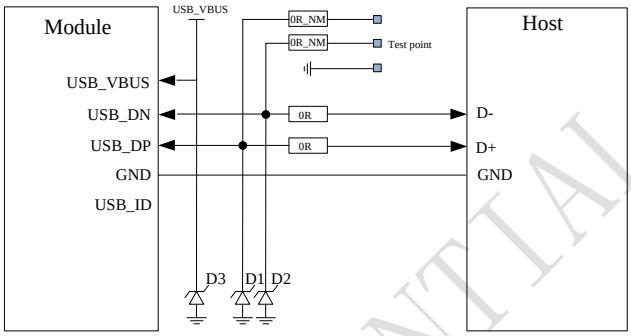

Figure 17: USB circuit diagram

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

A7600E 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.

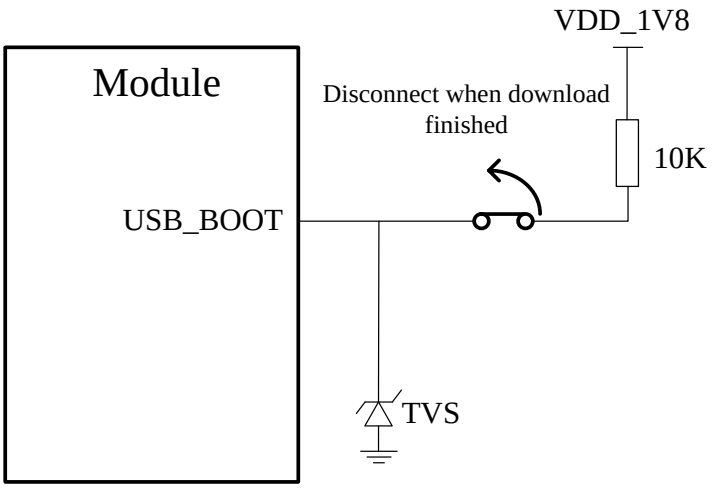

Figure 18: Reference USB_BOOT circuit

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

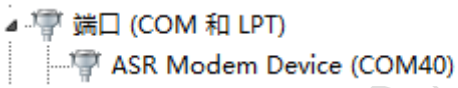

Figure 19: Force-download port

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

3.5. USIM Interface

A7600E supports both 1.8V and 3.0V USIM Cards. The interface power of the USIM card is provided by the voltage regulator inside the module, and the normal voltage value is 3V or 1.8V.

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	1.62	1.8	1.98	V
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	LDO power output voltage	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 -0.4	-	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.

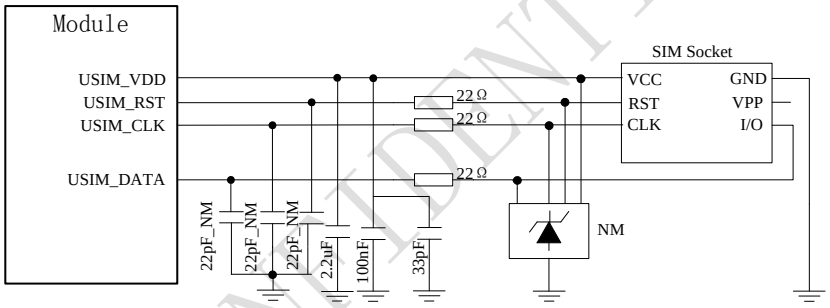

Figure 20: USIM interface reference circuit

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].USIM_CLK is very important signal, the rise time and fall time of USIM_CLK should be less than 40ns, otherwise the USIM card might not be initialized correctly.

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.

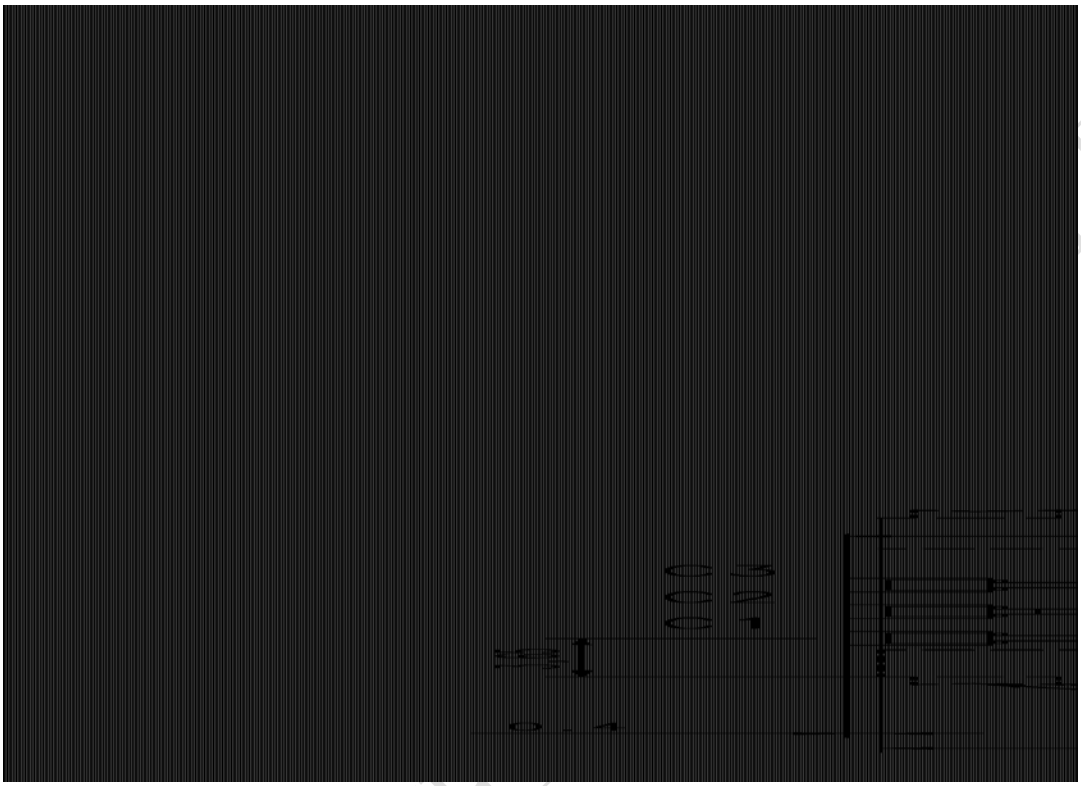

Figure 21: Amphenol C707 10M006 512 USIM card socket

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.

3.6. PCM Interface

A7600E provides a PCM interface for external codec, which can be used in master mode with short sync and 16 bits linear format.

Table 17: PCM parameter list

Characteristics	Specification
Line Interface Format	Linear
Data length	16bits
PCM Clock/Sync Source	Master Mode(Fixed)
PCM Sync Format	8KHz/16KHz/48KHz
PCM Sync Format	Short sync(Fixed)
Data Ordering	MSB

Note: Reference SW document for detail.

3.6.1. PCM Sequence

The related PCM timing is shown in the following figure:

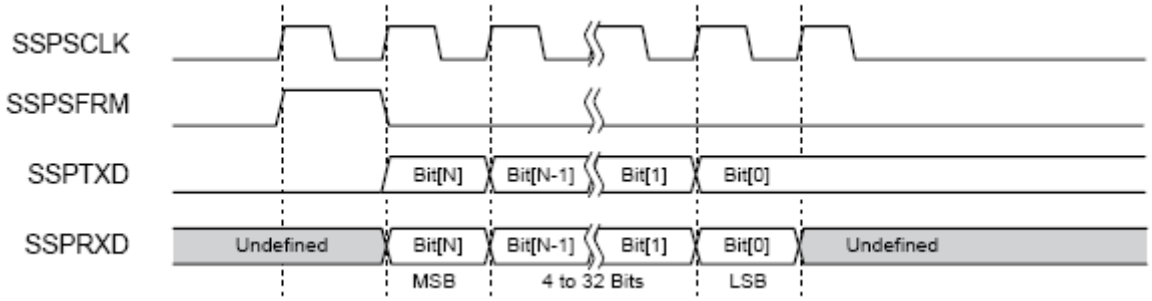

Figure 22: PCM sequence

3.6.2. PCM Reference Design

PCM recommended circuit is shown as follows:

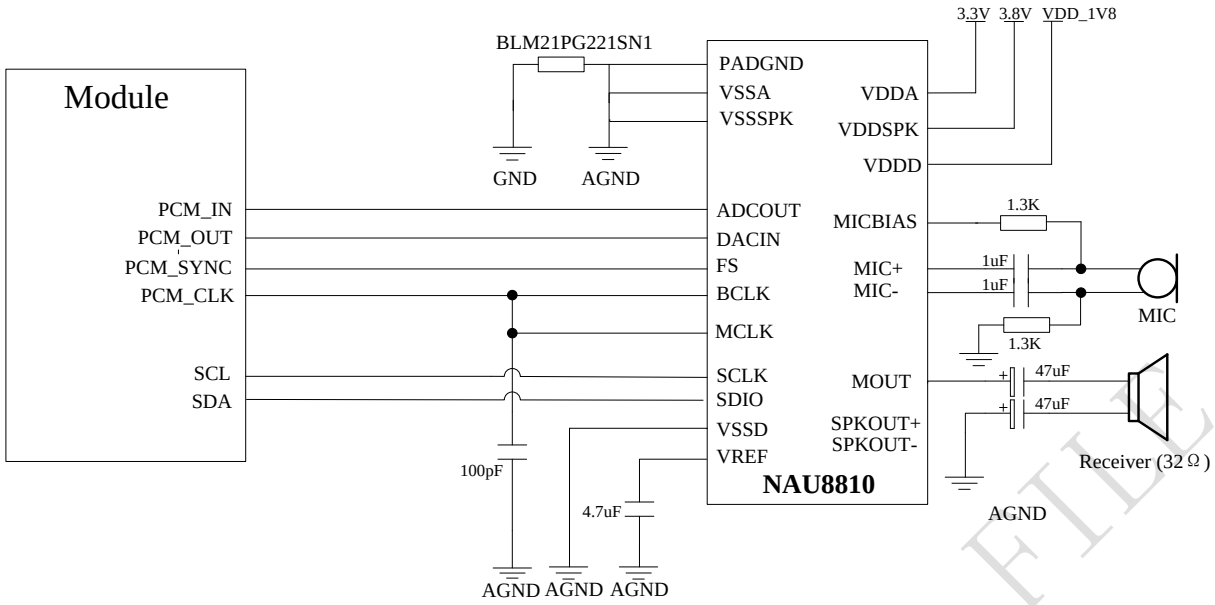

Figure 23: PCM reference circuit

3.7. GPIO Interface

A7600E module provides 13 GPIOs.

Table 18: Standard GPIO Resources

PIN No.	Pin name	AT command operation GPIO number	Pin typ.	Power domain	Default function	Pad Edge wakeup
16	GPIO_16	GPIO16	IO,PU	1.8V	GPIO	Yes
33	GPIO_03	GPIO3	IO,PU	1.8V	GPIO	Yes
34	GPIO_06	GPIO6	IO,PD	1.8V	GPIO	Yes
52	GPIO_41	GPIO41	IO,PU	1.8V	GPIO	No
45	GPIO_63	GPIO63	IO,PD	1.8V	GPIO	Yes
50	GPIO_43	GPIO43	IO,PU	1.8V	GPIO	No
83	GPIO_12	GPIO12	IO,PD	1.8V	GPIO	Yes
86	GPIO_02	GPIO2	IO,PU	1.8V	GPIO	Yes
87	GPIO_77	GPIO77	IO,PU	1.8V	GPIO	Yes
107	GPIO_18	GPIO18	IO,PD	1.8V	GPIO	Yes
112	GPIO_01	GPIO1	IO,PD	1.8V	GPIO	Yes
117	GPIO_22	GPIO22	IO,PD	1.8V	GPIO	Yes
119	GPIO_14	GPIO14	IO,PD	1.8V	GPIO	Yes

3.8. SD Card Interface

A7600E provides a 4-bit SD/MMC interface with clock rate up to 200 MHz. It supports up to 64GB SD

cards.

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

Table 19: 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

3.8.1. Reference Design For External SD Card

ESD/EMI components should be arranged beside SD card socket. Refer to the following application circuit.

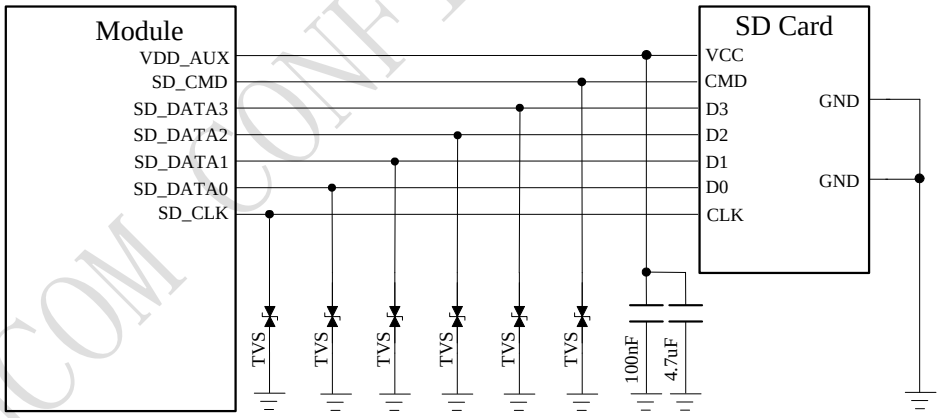

Figure 24: SD reference circuit

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
- CLK to DATA/CMD length matching < 1 mm
- 15–24 Ω termination resistor on clock lines near module
- Total routing length < 50 mm recommended
- Routing distance from module clock pin to termination resistor < 5 mm
- Spacing to all other signals = 2x line width

- Bus capacitance < 15 pF

3.9. I2C Bus

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

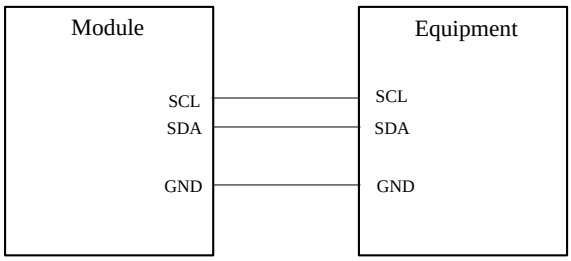

Figure 25: I2C reference circuit

***Note: SCL and SDA have pull-up resistor inside, external resistor is not needed。**

3.10. SPI Interface

A7600E provides a SPI interface as a master only. Its operation voltage is 1.8V, and its clock rate is up to 52 MHz.

3.11. SDIO Interface (in developing）

A7600E provides one SDIO3.0 protocol interface for WLAN expansion.
A7600E support WIFI by default and can provide WIFI solutions.

Table 20: WIFI 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 21: WIFI Synchronization and control interface

Pin No.	Pin name	I/O	Power domain	Description	Remark

33	GPIO_03	DO	1.8V	WIFI VDD enable （WL_PWR_EN）	If there is no WIFI function requirement, it can be used as GPIO.
84	WLAN_PDN	DO	1.8V	WLAN Full Power Down mode	
114	WLAN_26M_CLK	AO	1.8V	WLAN reserved 26M CLK	
115	WLAN_CLK_EN	DI	1.8V	WLAN reserved clock enable	

3.12. Network Status

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

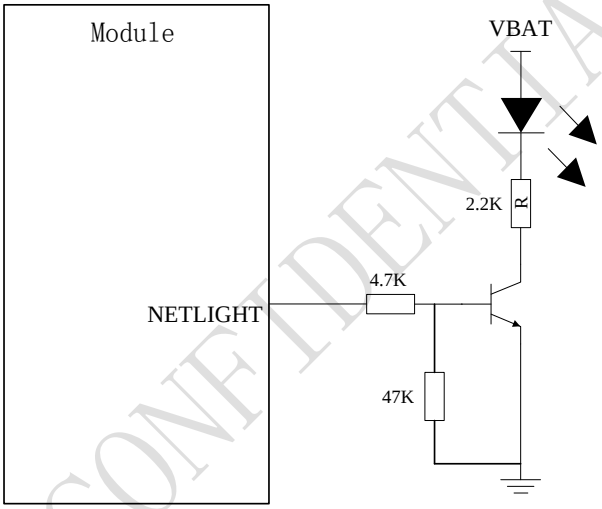

Figure 26: NETLIGHT reference circuit

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 22: 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 23: 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

3.13. Flight Mode Control

The FLIGHTMODE pin can be used to control A7600E to enter or exit the Flight mode. In Flight mode, the RF circuit is closed to prevent interference with other equipment and minimize current consumption. Bidirectional ESD protection component is suggested to add on FLIGHTMODE pin, its reference circuit is shown in the following figure.

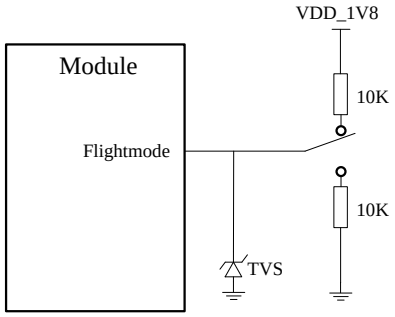

Figure 27: Flight mode switch reference circuit

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 24: FLIGHTMODE pin control

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

3.14. Other Interface

3.14.1. ADC

A7600E has 2 dedicated ADC pins named ADC1 and ADC2. They are available for digitizing analog signals such as battery voltage and so on. These electronic specifications are shown in the following table.

Table 25: 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 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.

Table 26: 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 27: VDD_AUX Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Unit
V_{VDD_AUX}	Output voltage	-	3	-	V
I_O	Output current	-	-	350	mA

4. RF Parameter

4.1. GSM/LTE

Table 28: Conducted emission power

Frequency	power	Minimum power
EGSM900	33dBm ±2dB	5dBm ± 5dB
DCS1800	30dBm ±2dB	0dBm ± 5dB
EGSM900 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
DCS1800 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD 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-FDD B28	23dBm +/-2.7dB	<-40dBm
LTE-TDD B38	23dBm +/-2.7dB	<-40dBm
LTE-TDD B40	23dBm +/-2.7dB	<-40dBm
LTE-TDD B41	23dBm +/-2.7dB	<-40dBm

Table 29: Band information 2G

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

Table 30: Band information E-UTRA

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
28	703 ~748 MHz	758 ~803 MHz	FDD
38	2570 ~2620 MHz	2570 ~2620 MHz	TDD
40	2300 ~2400 MHz	2300 ~2400 MHz	TDD
41	2496 ~2690 MHz	2496 ~2690 MHz	TDD

Table 31: Reception sensitivity conduction

Frequency	Sensitivity（TYP）	Sensitivity（MAX）
EGSM900	< -109dBm	3GPP
DCS1800	< -109dBm	3GPP
LTE FDD/TDD	refer to table 31	3GPP

Table 32: Reference sensitivity (QPSK)

E-UTRA BAND	3GPP standard						实测值	双工模式
	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	-97	-93.2	-97	FDD
8	-102.2	-99.2	-97	-94	-	-	-98	FDD
20			-97	-94	-91.2	-90	-97	FDD
28		-100.2	-98.5	-95.5	-93.7	-91	-98	FDD
38	-	-	-100	-97	-95.2	-94	-98	TDD
40	-	-	-100	-97	-95.2	-94	-98	TDD
41			-98	-95	-93.2	-92	-98	TDD

Note: the measured value is the main antenna at 10MHz.

4.2. GSM/LTE Antenna Reference Design

For antenna design, layout between the module and the antenna must be 50 Ω impedance, and its insertion loss must meet the following requirements:

Table 33: Recommended layout insertion loss

Frequency	insertion loss
700MHz-960MHz	<0.5dB
1710MHz-2170MHz	<0.9dB
2300MHz-2650MHz	<1.2dB

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:

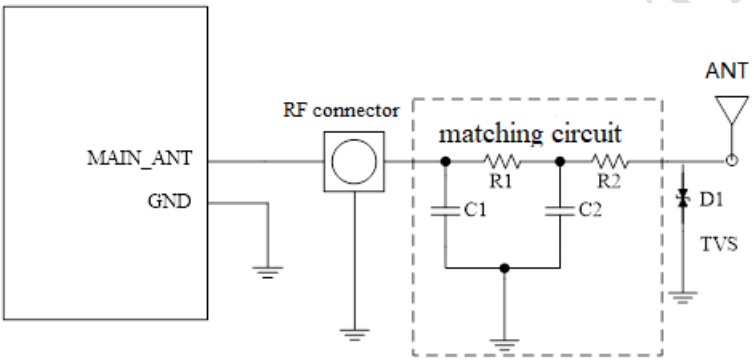

Figure 28: MAIN antenna connection circuit

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. 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 34: TVS recommended part list

Package	Part	Vendor
0201	LXES03AAA1-154	Murata
0402	LXES15AAA1-153	Murata

5. Electrical Specifications

5.1. Absolute Maximum Ratings

Absolute maximum rating for digital and analog pins of A7600E are listed in the following table.

Table 35: 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 (SDIO,GPIO,I2C,SPI,UART and PCM)	-0.3	-	2.1	V
Voltage at digital pins (USIM,SDC)	-0.3	-	2.1	V
	-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 VBUS	TBD	5.0	5.4	V

Table 37: 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 down resistor)	1	-	5	mA
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, UART, PCM, SPI, SDIO and USB_BOOT.

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 A7600E 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.
Minimum functionality 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 enter into sleep mode:

- UART condition
- USB condition
- Software 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 a majority function of 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 A7600E 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 will be unavailable.

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

5.4. Current Consumption

Table 40: 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: 2.5mA Idle mode@ BS_PA_MFRMS=2 Typical:29mA
LTE sleep/idle mode	
LTE supply current (without USB connection)	Sleep mode Typical: 3.5mA Idle mode Typical: 28.5mA
GSM Talk	
SEGSM 900	@power level #5 Typical:: 320 mA
DCS1800	@power level #0 Typical: 262 mA
GPRS data	
EGSM 900 (1 Rx,4 Tx)	@power level #5 Typical:630 mA

DCS1800 (1 Rx,4 Tx)	@power level #0 Typical:395 mA
EGSM 900 (3 Rx, 2 Tx)	@power level #5 Typical:370 mA
DCS1800 (3 Rx, 2 Tx)	@power level #0 Typical: 275 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: 336 mA
DCS1800 (3 Rx, 2 Tx)	@power level #2 Typical: 208 mA
LTE data	
LTE-FDD B1	@10M Typical: 498 mA
LTE-FDD B3	@10M Typical: 562 mA
LTE-FDD B5	@10M Typical: 432 mA
LTE-FDD B7	@10M Typical: 557mA
LTE-FDD B8	@10M Typical: 447mA
LTE-FDD B20	@10M Typical: 456mA
LTE-FDD B28	@10M Typical: 465mA
LTE-TDD B38	@5M 23.2dBm Typical: 396 mA @10M 23.3dBm Typical: 405 mA @20M 23.3dBm Typical: 429 mA
LTE-TDD B40	@5M 22.9dBm Typical: 368 mA @10M 23.0dBm Typical: 372 mA @20M 22.9dBm Typical: 392mA
LTE-TDD B41	@5M 22.9dBm Typical: 368 mA @10M 23.0dBm Typical: 372 mA @20M 22.9dBm Typical: 392mA

5.5. ESD Notes

A7600E is sensitive to ESD in the process of storage, transporting, and assembling. When A7600E is mounted on the users' mother board, the ESD components should be placed beside the connectors which human body mayn't touch, such as USIM card holder, audio jacks, switches, keys, etc. The following table shows the A7600E 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	+/-4K	+/-8K
UART	+/-4K	+/-6K
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

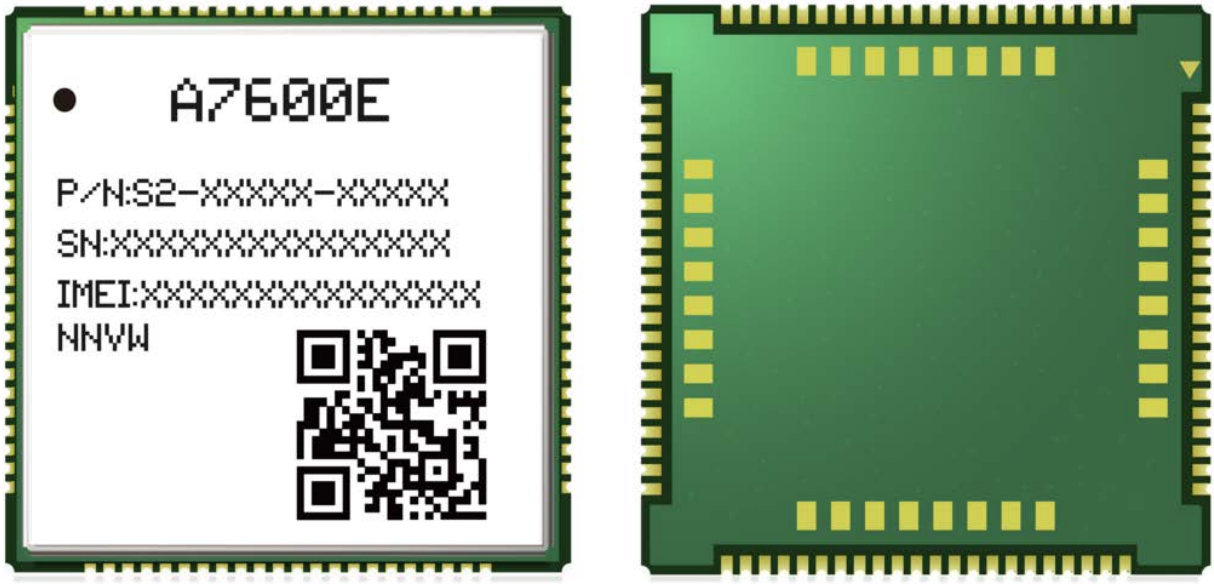

Figure 29: Top and bottom view of A7600E

6.2. Label Information

Figure 30: Label information

Table 42: The description of label information

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

6.3. Typical SMT Reflow Profile

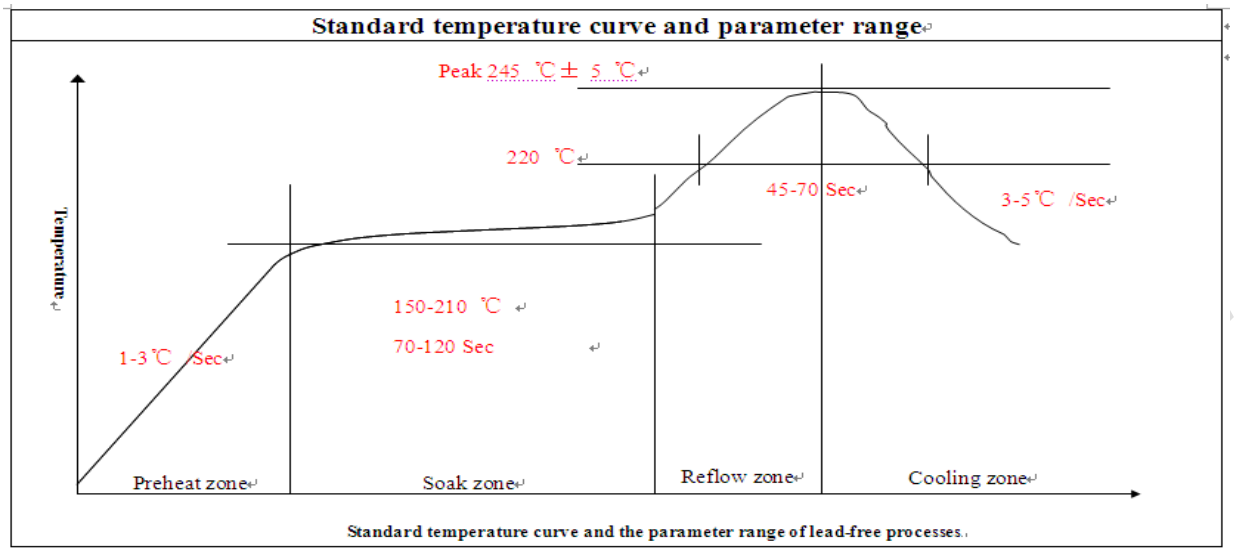

Figure 31: The ramp-soak-spike reflow profile of A7600E

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

6.4. Moisture Sensitivity Level (MSL)

A7600E is qualified to Moisture Sensitivity Level (MSL) 3 in accordance with JEDEC J-STD-033. If the prescribed time limit is exceeded, users should bake modules for 192 hours in drying equipment (<5% RH) at 40+5/-0°C, or 72 hours at 85+5/-5°C. Note that plastic tray is not heat-resistant, and only can be baked at 45° C.

Table 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
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 support tray packaging.

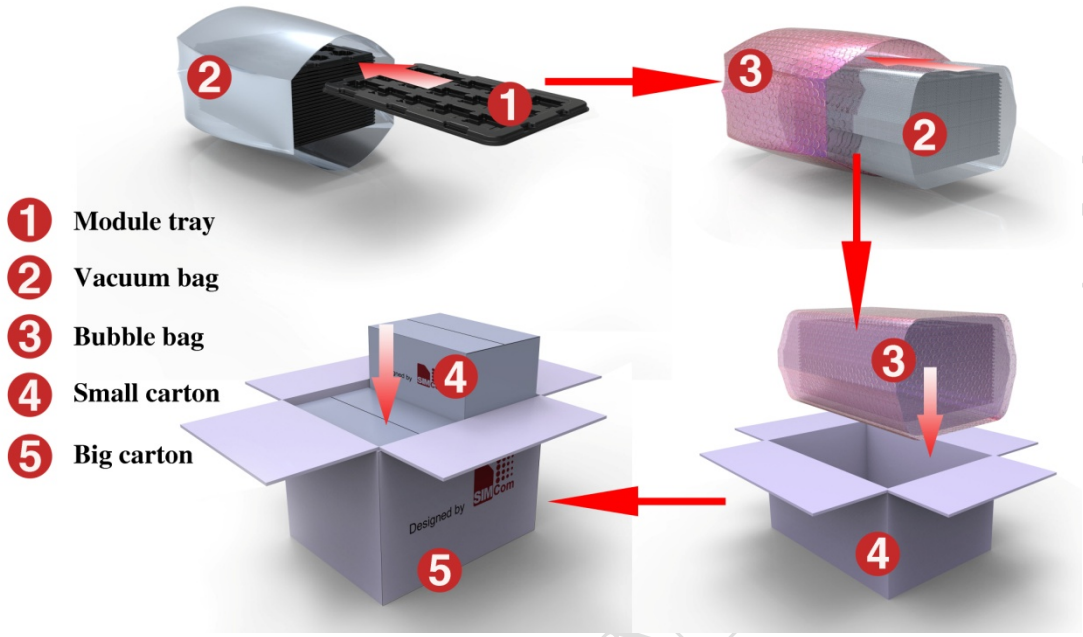

Figure 32: packaging diagram

Module tray drawing:

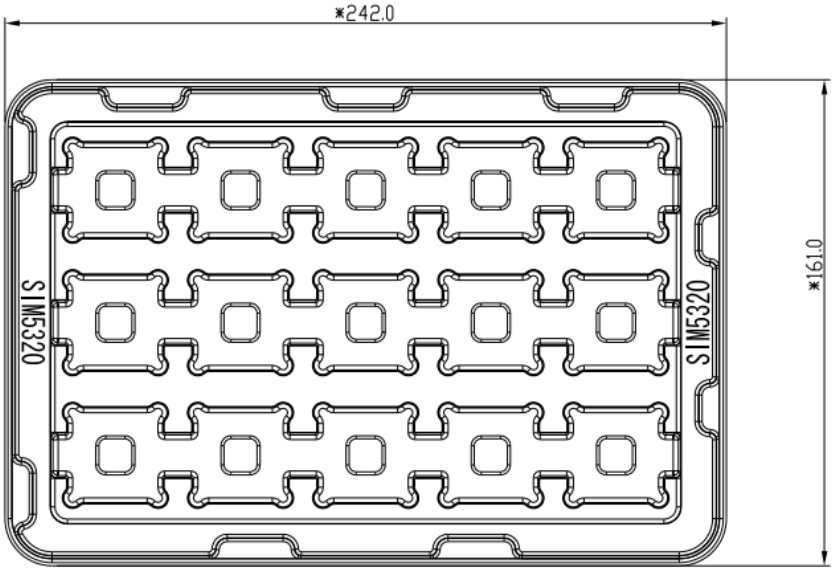

Figure 33: Tray drawing

Table 44: Tray size

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

Small carton drawing:

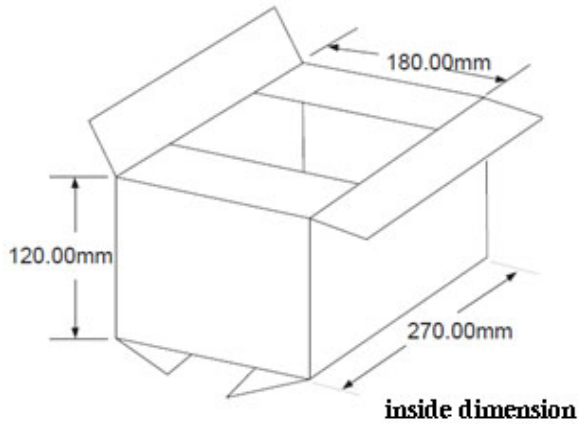

Figure 34: Small carton drawing

Table 45: Small Carton size

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

Big carton drawing:

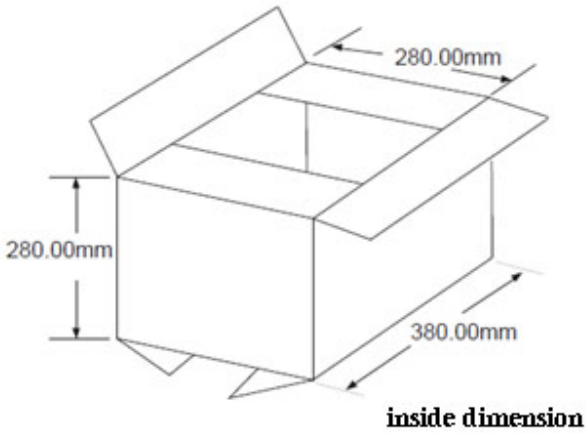

Figure 35: Big carton drawing

Table 46: Big Carton size

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

Appendix

I.Coding Schemes and Maximum Net Data Rates over Air Interface

Table 47: 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

II. 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 Sleep Mode Application Note_V1.xx	Sleep Mode Application Note

III. Terms and Abbreviations

Table 49: 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

IV. 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.

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