A7676E Series Hardware Design

LTE Module

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1 Introduction

This document describes the hardware interface of the module, which can help users quickly understand the interface definition, electrical performance and structure size of the module. Combined with this document and other application documents, users can understand and use A7676E module to design and develop applications quickly. SIMCom provides a set of evaluation boards to facilitate A7676E module testing and use. The evaluation board tools include an EVB board, a USB cable, an antenna, and other peripherals.

1.1 Product Outline

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

Table 1: Module frequency bands

Standard	Bands	MASE	LASE
GSM	EGSM900	✓	✓
	DCS1800	✓	✓
LTE-FDD	LTE-FDD B1	✓	✓
	LTE-FDD B3	✓	✓
	LTE-FDD B8	✓	✓
	LTE-FDD B20	✓	✓
	LTE-FDD B31	✓	✓
	LTE-FDD B72	✓	✓
GNSS		✓	
Category		CAT1	CAT1

With a small physical dimension of 24*24*2.4mm and with the functions integrated, the module can meet almost any space requirement in users' applications, such as smart phone, PDA, industrial handhold, machine-to-machine and vehicle application, etc.
A7676E provides 124 pins, including 80 LCC pins in the outer ring and 44 LGA pins in the inner ring. This document will introduce all the functional pins.

1.2 Hardware Interface Overview

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

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

1.3 Hardware Block Diagram

The block diagram of the A7676E module is shown in the figure below.

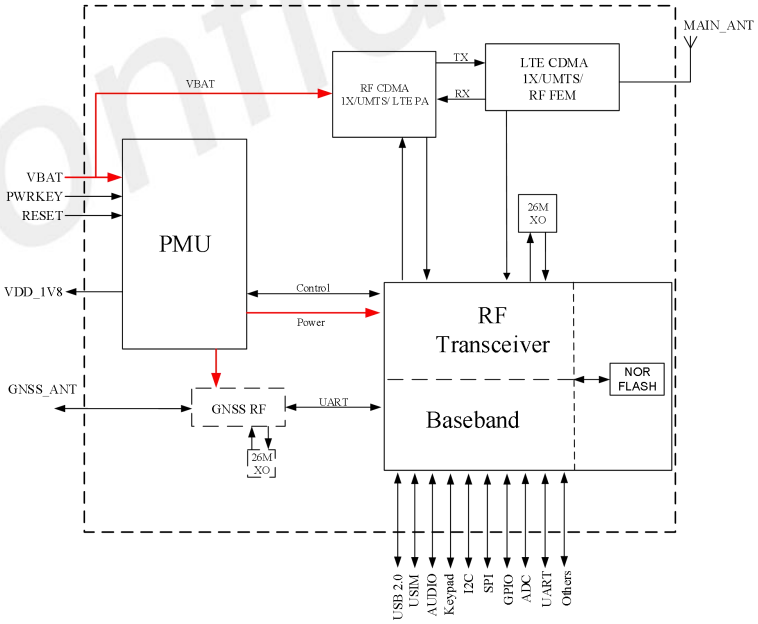

Figure 1: A7676E block diagram

1.4 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	VBAT: 3.4V ~4.2V, Recommended VBAT: 3.8V
Power saving	Current in sleep mode: TBD
Radio frequency bands	Please refer to the table 1
Transmitting power	GSM/GPRS power level: -- EGSM900: 4 (33dBm±2dB) -- DCS1800: 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)
Antenna	GSM/LTE antenna interface GNSS antenna interface(optional)
SMS	MT, MO, CB, Text, PDU mode Short Message (SMS)storage device: USIM Card, CB does not support saving in SIM Card Support CS domain and PS domain SMS
USIM interface	Support identity card: 1.8V/ 3V
USIM application toolkit	Support SAT class 3, GSM 11.14 Release 98 Support USAT
Phonebook management	Support phonebook types: SM/FD/ON/AP/SDN
Audio feature	Support analog audio interface
UART interface	●Full function serial port Baud rate support from 300bps to 3686400bps AT command and data can be sent through serial port Support RTS/CTS Hardware flow control Support serial port multiplexing function conforming to GSM 07.10 protocol ●Debug serial port Support debug usage
USB	USB 2.0 compliant, host mode not supported. This interface can be used for AT command sending, data transmission, software debugging and upgrading.
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size:24*24*2.4mm Weight:2.8±0.1g
Temperature range	Normal operation temperature: -30°C to +80°C

	Extended operation temperature: -40°C to +85°C* Storage temperature -45°C to +90°C

NOTE

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

2 Package Information

2.1 Pin Assignment Overview

The following Figure is a high-level view of the pin assignment of the module for A7676E.

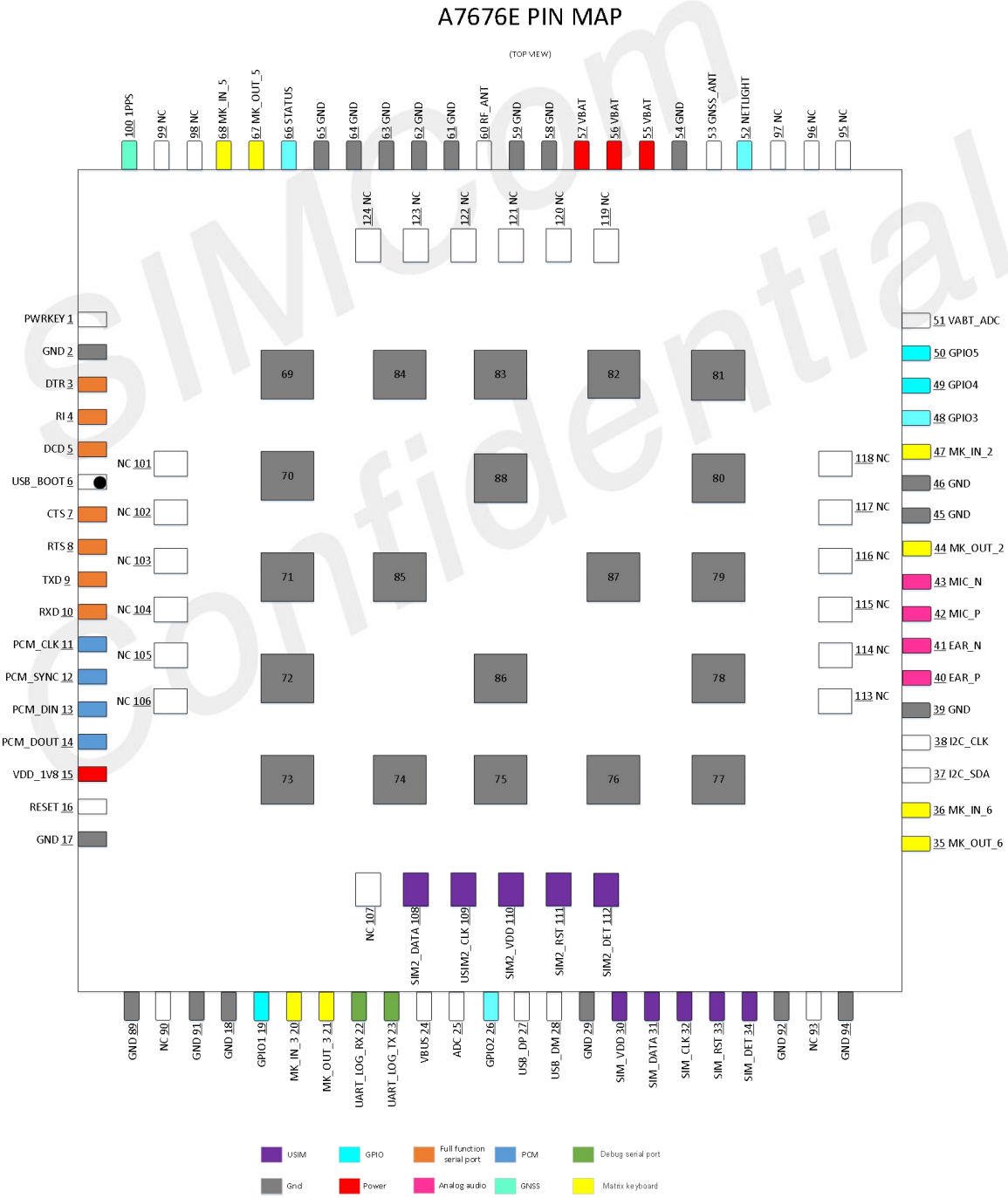

Figure 2: Pin assignment overview for A7676E

Table 3: Pin Description

PIN NO	PIN NAME	PIN NO	PIN NAME
1	PWRKEY	2	GND
3	DTR	4	RI
5	DCD	6	USB_BOOT●
7	CTS	8	RTS
9	TXD	10	RXD
11	PCM_CLK	12	PCM_SYNC
13	PCM_DIN	14	PCM_DOUT
15	VDD _1V8	16	RESET
17	GND	18	GND
19	GPIO1	20	MK_IN_3
21	MK_OUT_3	22	UART_LOG_RX
23	UART_LOG_TX	24	VBUS
25	ADC	26	GPIO2
27	USB_DP	28	USB_DM
29	GND	30	USIM1_VDD
31	USIM1_DATA	32	USIM1_CLK
33	USIM1_RST	34	USIM1_DET
35	MK_OUT_6	36	MK_IN_6
37	I2C_SDA	38	I2C_SCL
39	GND	40	EAR_P
41	EAR_N	42	MIC_P
43	MIC_N	44	MK_OUT_2
45	GND	46	GND
47	MK_IN_2	48	GPIO3
49	GPIO4	50	GPIO5
51	VBAT_ADC	52	NETLIGHT
53	GNSS_ANT♦	54	GND
55	VBAT	56	VBAT
57	VBAT	58	GND
59	GND	60	RF_ANT
61	GND	62	GND
63	GND	64	GND
65	GND	66	STATUS
67	MK_OUT_5	68	MK_IN_5
69	GND	70	GND

71	GND	72	GND
73	GND	74	GND
75	GND	76	GND
77	GND	78	GND
79	GND	80	GND
81	GND	82	GND
83	GND	84	GND
85	GND	86	GND
87	GND	88	GND
89	GND	90	NC
91	GND	92	GND
93	NC	94	GND
95	NC	96	NC
97	NC	98	NC
99	NC	100	1PPS♦
101	NC	102	NC
103	NC	104	NC
105	NC	106	NC
107	NC	108	USIM2_DATA
109	USIM2_CLK	110	USIM2_VDD
111	USIM2_RST	112	USIM2_DET
113	NC	114	NC
115	NC	116	NC
117	NC	118	NC
119	NC	120	NC
121	NC	122	NC
123	NC	124	NC

NOTE

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

' ♦ ' Indicates that these Pins are GPS function pins, which only exist on the module with 'Mase' model, not on the module with 'Lase' model

2.2 Pin Descriptions

Table 4: Pin parameter abbreviation

Pin type	Description

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

Table 5: 1.8V IO parameters definition

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

Table 6: 3.3V IO parameters definition

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

		driving capacity at high level output Vpad=VCC-0.5V			

Table 7: Pin description

Pin name	Pin No.	Pin parameter		Description	Note
		Power domain	Type		
Power supply					
VBAT	55,56, 57	-	PI	Module input voltage ranges from 3.4V to 4.2V, Typical values is 3.8V. and the peak current value can reach 2A.	
VDD_1V8	15	-	PO	1.8V power output, output current up to 50 mA. Cannot provide to high power load, can provide power for level conversion circuit, etc.	
GND	2,17,18, 29,39, 45,46, 54,58, 59,61, 62,63, 64,65, 69,70, 71,72, 73,74, 75,76, 77,78, 79,80, 81,82, 83,84, 85,86, 87,88, 89,91, 92,94	-	-	Ground	
System Control					
PWRKEY	1	-	DI,PU	Power ON/OFF input, active low. VIH: 0.7*VBAT VIL: 0.3*VBAT	PWRKEY has been internally pulled-up to VBAT with 50KΩ resistor, default high.
RESET	16	-	DI,PU	System reset control input, active low. VIH: 0.7*VBAT VIL: 0.3*VBAT	RESET has been pulled-up to VBAT with 50KΩ (typical) resistor, default high.

USIM interface					
USIM1_DATA	31	1.8/3.0V	I/O,PU	USIM bus data, this pin has been pull-up with 4.7KΩ resistor to USIM1_VDD.	
USIM1_RST	33	1.8/3.0V	I/O,PU	USIM bus reset output.	
USIM1_CLK	32	1.8/3.0V	I/O,PU	USIM bus clock output.	
USIM1_VDD	30	1.8/3.0V	PO	USIM card power supply output, supports 1.8v/3.0v output according to the card type, its output current is up to 50mA.	
USIM1_DET	34	1.8V	I/O,PD	USIM insert detect, it can be set to high/low active with the AT command, refer to Document [25]	
USIM2_DATA	108	1.8/3.0V	I/O,PU	USIM bus data, this pin need pull-up with 4.7KΩ resistor to USIM2_VDD externally.	
USIM2_RST	111	1.8/3.0V	I/O,PU	USIM bus reset output.	
USIM2_CLK	109	1.8/3.0V	I/O,PU	USIM bus clock output.	
USIM2_VDD	110	1.8/3.0V	PO	USIM card power supply output, supports 1.8v/3.0v output according to the card type, its output current is up to 50mA.	
USIM2_DET	112	1.8V	DI,PD	USIM insert detect, it can be set to high/low active with the AT command, refer to Document [25]	
USB interface					
VBUS	24	-	AI	Valid USB detection input. Active high, Vmax(valid)=3.0V, Vmax(detection)=5.2V	
USB_DM	28	-	I/O	Negative line of the differential, bi-directional USB signal.	
USB_DP	27	-	I/O	Positive line of the differential, bi-directional USB signal.	
Full function UART interface					
RTS	8	1.8V	DI	RTS input	If unused, keep it open.
CTS	7	1.8V	DO	CTS output	
RXD	10	1.8V	DI	Data input	
TXD	9	1.8V	DOH	Data output	
RI	4	1.8V	DO	Ringing indicator	
DCD	5	1.8V	DO	Carrier detection	
DTR	3	1.8V	DI	DTE Ready	
Debug UART					
UART_LOG_TXD	23	1.8V	DOH	Log output	Default used as debug port.
UART_LOG_RXD	22	1.8V	DI	Log input	

I2C interface					
I2C_SCL	38	1.8V	DO	I2C clock output	If unused, keep it open. Need pull up to VDD_1V8 externally.
I2C_SDA	37	1.8V	I/O	I2C data I/O	
PCM interface					
PCM_CLK	11	1.8V	I/O,PD	PCM clock	If unused, keep it open.
PCM_SYNC	12	1.8V	I/O,PD	PCM frame synchronization clock signal	
PCM_DIN	13	1.8V	DO,PD	PCM receive data signal	
PCM_DOUT	14	1.8V	DI,PD	PCM send data signal	
Analog audio interface					
EAR_P	40	1.8V	AIO	Earphone output positive	If unused, keep it open.
EAR_N	41	1.8V	AIO	Earphone output negative	
MIC_P	42	1.8V	AIO	MIC input positive	
MIC_N	43	1.8V	AIO	MIC input negative	
GPIO					
GPIO1	19	1.8V	IO,PU	General purple I/O	If unused, keep it open.
GPIO2	26	1.8V	IO,PD	General purple I/O	
GPIO3	48	1.8V	IO,PD	General purple I/O	
GPIO4	49	1.8V	IO,PU	General purple I/O	
GPIO5	50	1.8V	IO,PU	General purple I/O	
GNSS Interface					
1PPS	100	1.8V	DO	1PPS signal output	If unused, keep it open.
ANT interface					
RF_ANT	60	-	AIO	Main antenna	
GNSS_ANT	53	-	AIO	GNSS antenna	
Matrix keyboard					
MK_IN2	47	1.8V	DI	Matrix keyboard input	If unused, keep it open.
MK_IN3	20	1.8V	DI		
MK_IN5	68	1.8V	DI		
MK_IN6	36	1.8V	DI		
MK_OUT2	44	1.8V	DO	Matrix keyboard output	If unused, keep it open.
MK_OUT3	21	1.8V	DO		
MK_OUT5	67	1.8V	DO		
MK_OUT6	35	1.8V	DO		
Other pins					
ADC	25	-	AI	General Purpose ADC	If unused, keep it open.
VBAT_ADC	51	-	AI	VBAT ADC	If unused, keep it

					open.
NETLIGHT	52	1.8V	DO	Network registration status indicator (LED). For more detail, please refer the chapter 3.10.	
STATUS	66	1.8V	DO	Module status indicator (LED).	
USB_BOOT	6	1.8V	DI	Firmware download guide control input. when pull-down to GND and press PWRKEY,module will access in USB download mode.	Do place 2 test points for debug. Do not pull down USB_BOOT during normal power up !

NOTE

Please reserve a test point for USB_BOOT, VDD_1V8 and UART_LOG_TX. If there is no USB connector, please also reserve a test point for USB_VBUS, USB_DP, and USB_DM for Firmware upgrade.

2.3 Mechanical Information

The following figure shows the package outline drawing of A7676E.

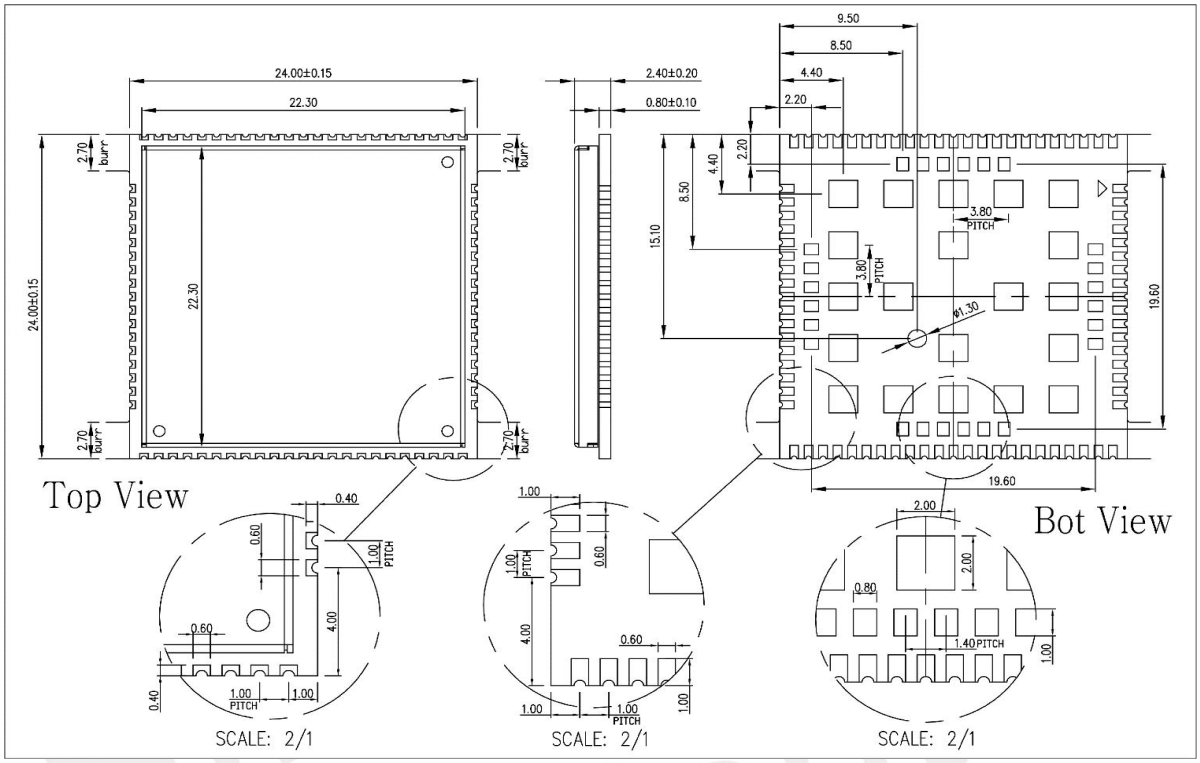

Figure 3: Dimensions (Unit: mm)

NOTE

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

2.4 Footprint Recommendation

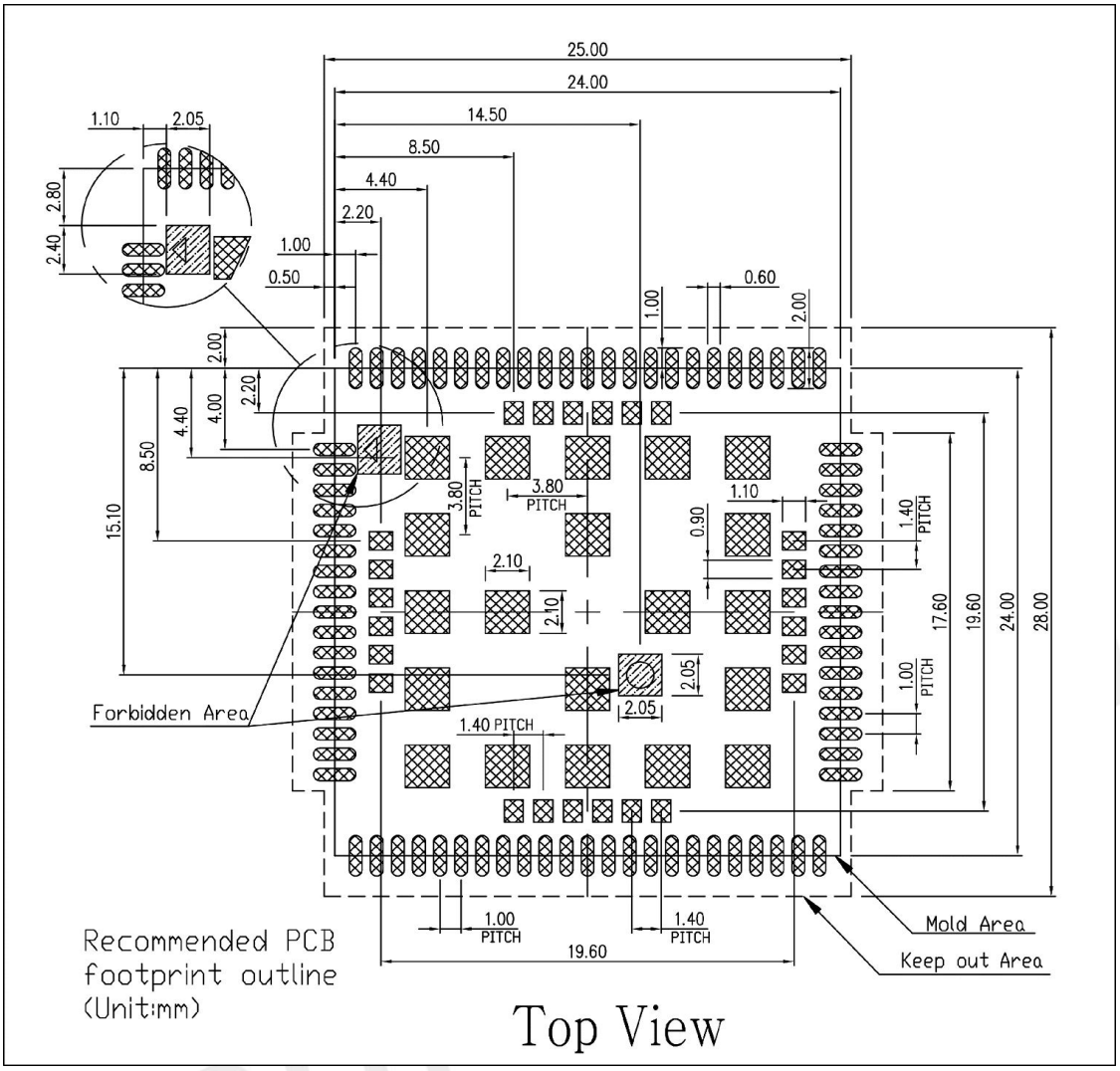

Figure 4: Footprint recommendation (Unit: mm)

2.5 Recommend Stencil Size

Recommend stencil thickness≥0.12mm and <0.15mm.

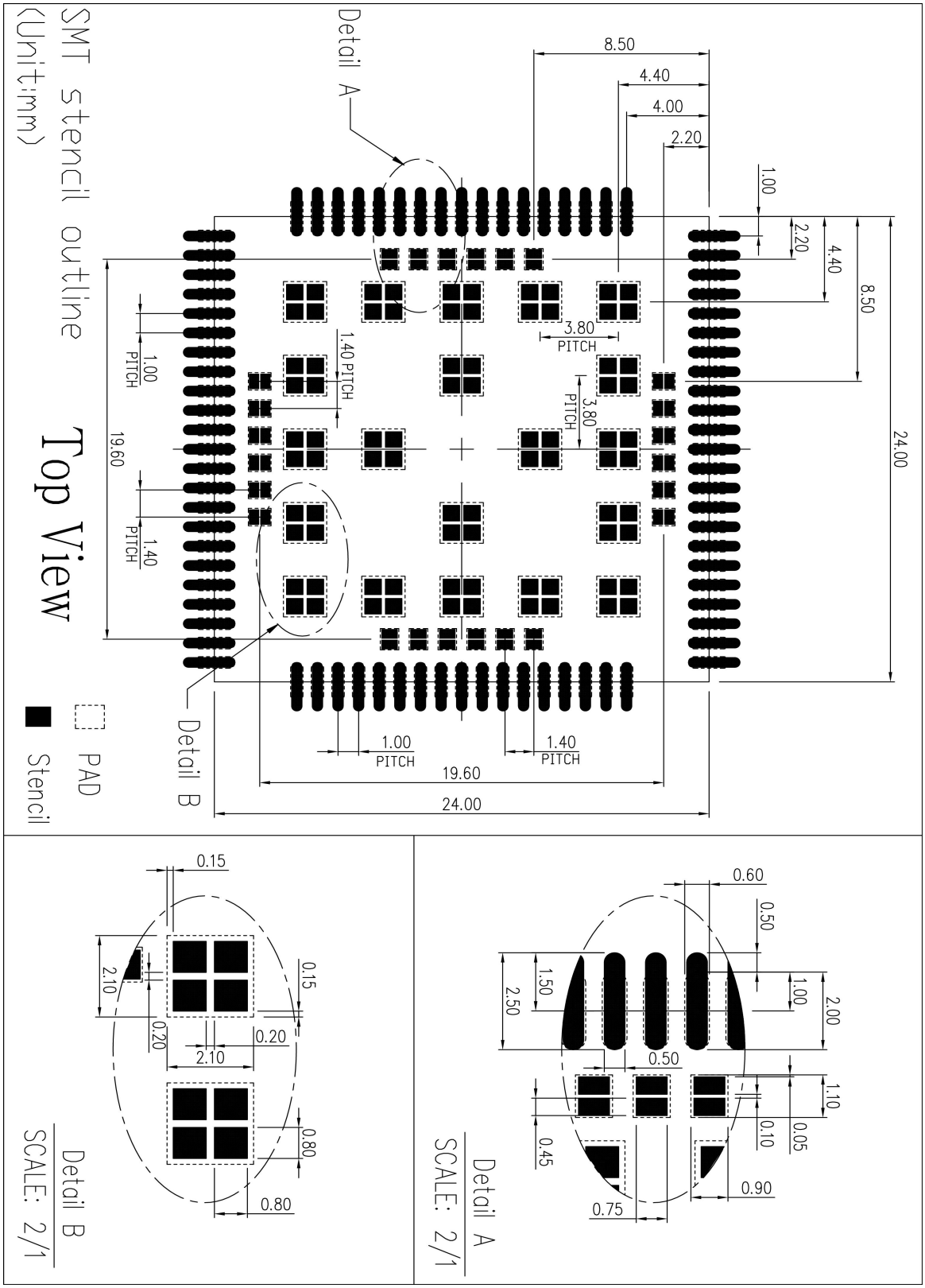

Figure 5: Recommend stencil dimension (Unit: mm)

3 Interface Application

3.1 Power Supply

A7676E offers 3 power supply pins (55, 56, 57) as VBAT power input pin. A7676E use these three pins supply the internal RF and baseband circuit.
When the module is at the maximum power in GSM TX mode, the peak current can reach 2A (peak current), which results in a large voltage drop on Vbat. In order to ensure that the voltage drop is less than 300mV, the power supply capacity of external power supply must be no less than 2A.

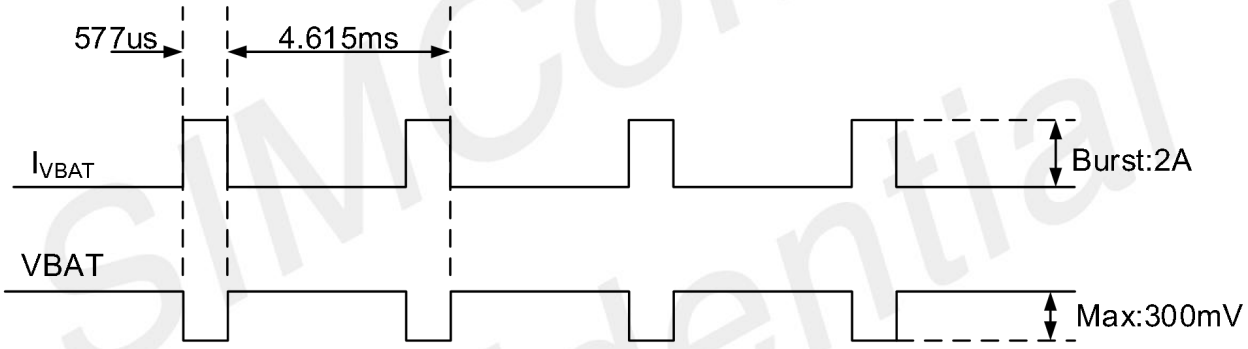

Figure 6: VBAT voltage drop during burst emission (EDGE/GPRS)

NOTE

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

Table 8: VBAT pins electronic characteristic

Parameter	Description	Min	Typ.	Max	Unit
VBAT	Module supply voltage	3.4	3.8	4.2	V
IVBAT (peak)	Module consumption peak current	-	2	-	A
IVBAT (average)	Module average consumption current (normal mode)	Refer to Table 41			
IVBAT (sleep)	Module average consumption current (sleep mode)				

IVBAT (power-off)	Module average consumption current (off leakage current)	-	20	-	uA

3.1.1 Power Supply Design Guide

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

NOTE

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

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

If the Vbat input contains high-frequency interference, it is recommended to add magnetic beads for filtering. The recommended types of magnetic beads are BLM21PG300SN1D and MPZ2012S221A.

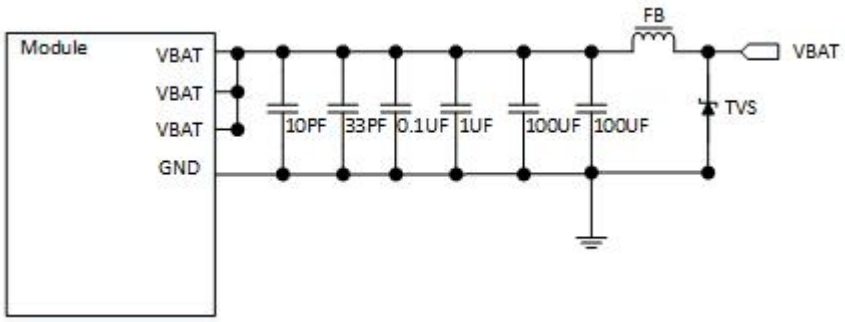

Figure 7: Power supply application circuit

In addition, in order to prevent the damage of A7676E caused by surge and overvoltage, it is recommended to parallel one TVS on the Vbat pin of the module.

Table 9: Recommended TVS diode list

No.	Manufacturer	Part Number	VRWM	Package
1	JCET	ESDBW5V0A1	5V	DFN1006-2L

2	WAYON	WS05DPF-B	5V	DFN1006-2L
3	WILL	ESD5611N	5V	DFN1006-2L
4	WILL	ESD56151W05	5V	SOD-323

NOTE

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

3.1.2 Recommended Power Supply Circuit

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

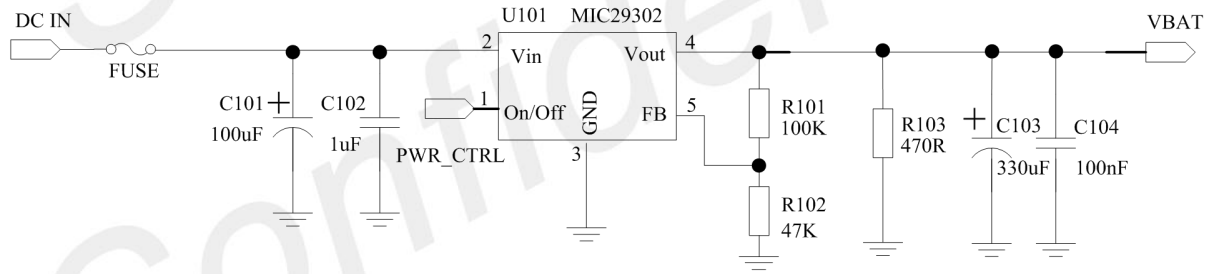

Figure 8: Linear regulator reference circuit

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

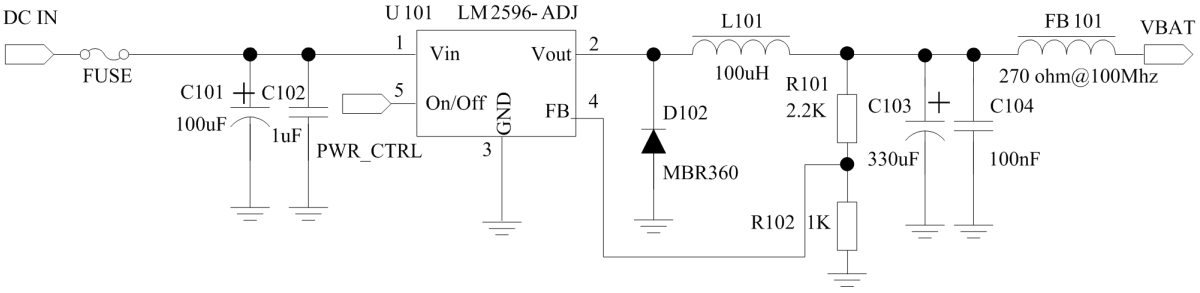

Figure 9: power supply reference circuit

3.1.3 Voltage Monitor

AT command 'AT+CBC' can be used to monitor VBAT voltage.
AT command 'AT+CVALARM' can be used to set high/low voltage alarm, When the actual voltage exceeds the preset range, a warning message will be reported through the AT port.
AT command 'AT+CPMVT' can be used to set high/low voltage power off, When the actual voltage exceeds the preset range, the module will shut down automatically.

NOTE

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

3.2 Power On/ Off and Reset

3.2.1 Power on

Customer can power on the module by pulling down the PWRKEY pin. This pin has been pulled up inside the module to Vbat.
It is recommended that when using the module, adding TVS diode at the module pin can effectively enhance the ESD performance.
The recommended circuit is as follows:

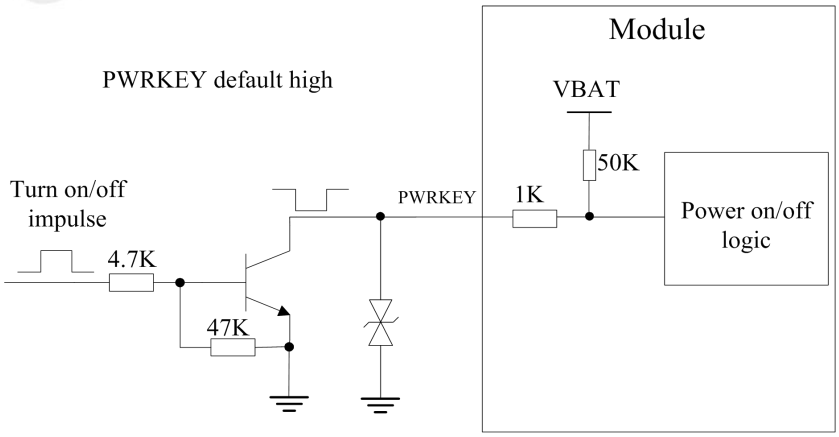

Figure 10: Reference power on/off circuit

NOTE

Do not parallel capacitors which the value is exceed 100nF on PWRKEY or RESET pin. It will cause module power on automatically when VBAT powered.
It is forbidden to pull down both RESET key and PWRKEY to power on the module at the same time.

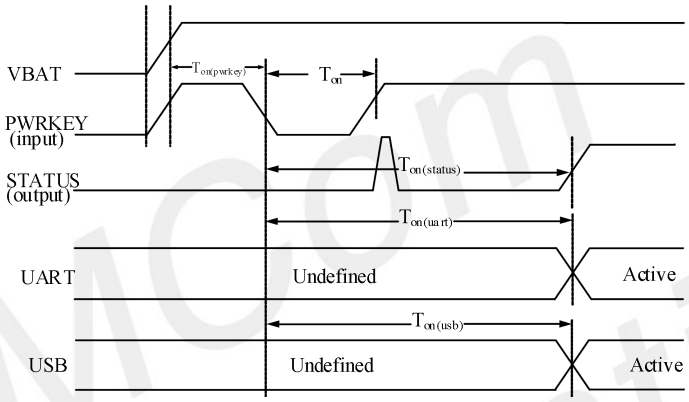

Figure 11: Power on timing sequence

Table 10: Power on timing and electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
Ton	The time of active low-level impulse of PWRKEY pin to power on module	-	50	-	ms
Ton(status)	The time from power-on issue to STATUS pin output high level (indicating power up ready)	-	7	-	s
Ton(uart)	The time from power-on issue to UART port ready	-	7	-	s
Ton(usb)	The time from power-on issue to USB port ready	-	7	-	s
VIH	Input high level voltage on PWRKEY pin	0.7* VABT	-	VBAT	V
VIL	Input low level voltage on PWRKEY pin	0	0	0.3* VBAT	V

NOTE

When the module is powered on without external USB, status will have a short pulse. After the module is powered on, status is high level; If the module is connected to an external USB, the status is always low when the module is powered on. After the module is powered on, the status is high.

3.2.2 Power off

A7676E 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 ℃, A7676E will report warning information through AT port. When the temperature exceeds the range of - 40 ~ + 85 ℃, A7676E will shut down automatically. For a detailed description of 'AT+ CPOF' and 'AT+ CPMVT', please refer to document [1].

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

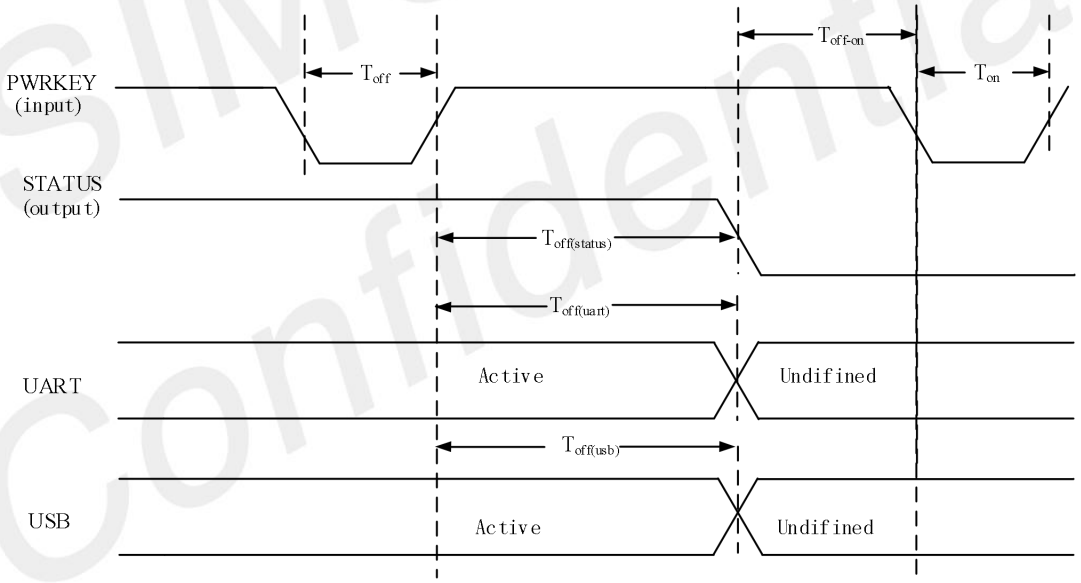

Figure 12: Power off timing sequence

Table 11: Power off sequence parameters

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

	interface)				
Toff-on	Power off - power on buffer time	2	-	-	s

NOTE

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

3.2.3 Reset Function

A7676E 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:

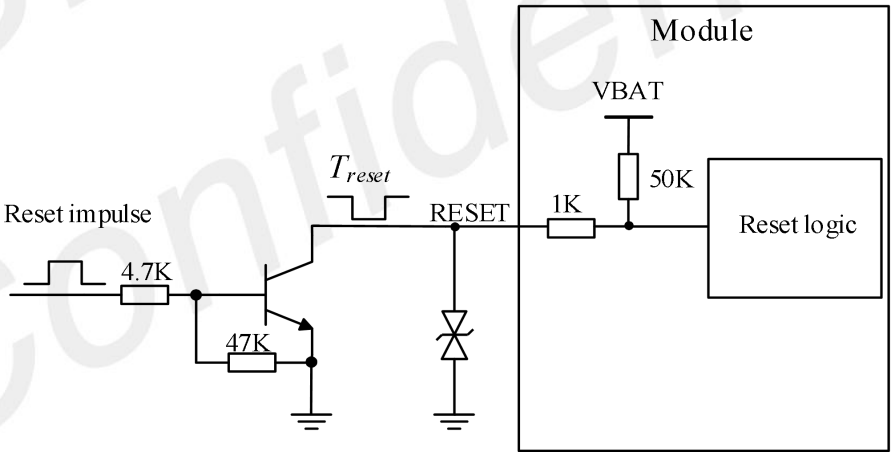

Figure 13: Reference reset circuit

Table 12: RESET pin electronic characteristic

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

				VBAT	

NOTE

It is recommended to use the reset pin only in case of emergency, such as the module is not responding. The reset time is recommended to be 2.5s.

3.3 UART Interface

A7676E provides two serial ports, the main communication serial port is UART, one ordinary serial port, and the UART_LOG dedicate to printing log.

3.3.1 UART Design Guide

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

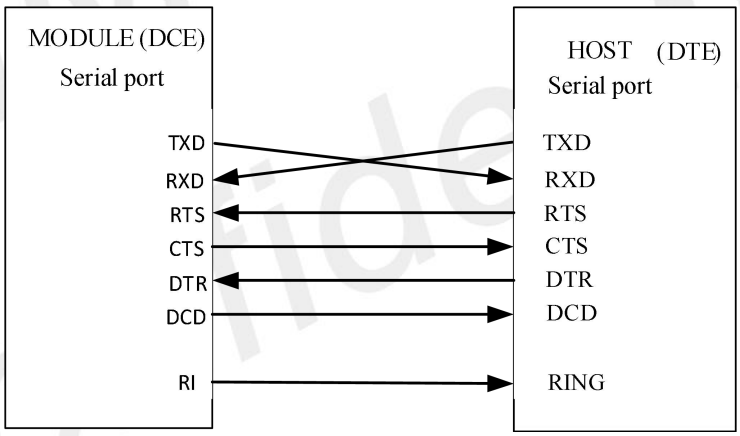

Figure 14: Serial port connection diagram (full-function mode)

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

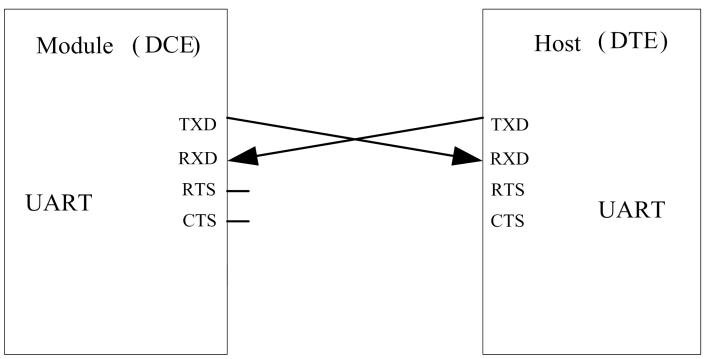

Figure 15: Serial port connection diagram (NULL mode)

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

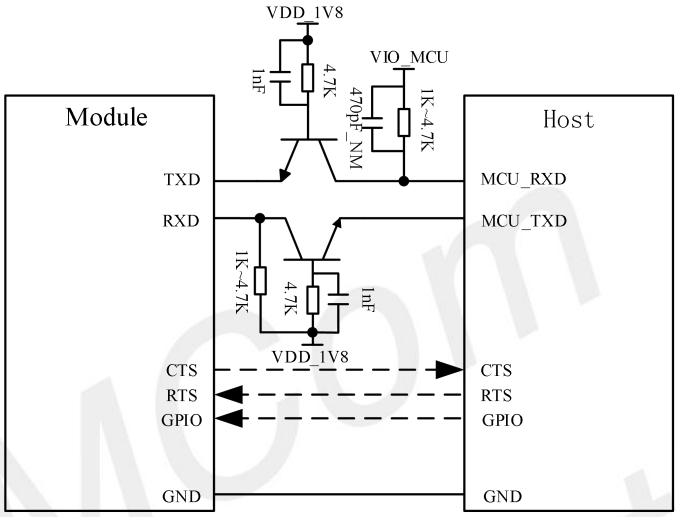

Figure 16: Triode level conversion circuit

NOTE

1. Main UART supports the following baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1842000, 3686400. The default baud rate is 115200bps.
2. The parasitic capacitance of the transistor will affect the edge of the high-speed digital signal. It is not recommended to use this circuit when the signal speed is higher than 115200bps.

3.3.2 RI and DTR Behavior

RI usually keeps high level output. When receiving a short message or URC report, RI outputs a low level for 120ms (short message)/60ms (URC), and then returns to a high-level state; RI will output a low level, when receiving a phone call as the called party. After outputting low level, RI will remain low until the host accepts the call using the "ATA" command or the caller stops calling RI, in the end, it will become high level.

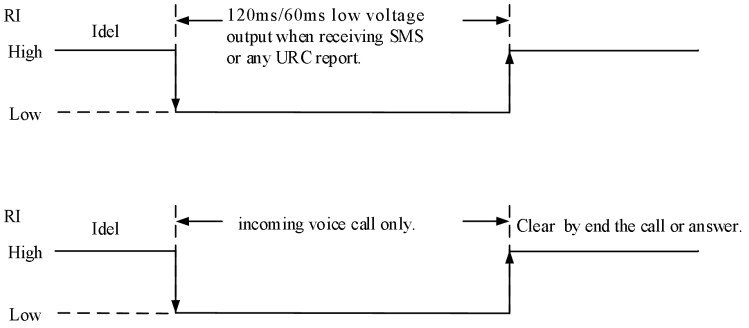

Figure 17: RI behaviour (SMS and URC report)

After setting the AT command “AT+CSCLK=1”, and then pulling up the DTR pin, Module will enter sleep mode when module is in idle mode. In sleep mode, the UART is unavailable. When A7676E enters sleep mode, pulling down DTR can wakeup module.
After setting the AT command “AT+CSCLK=0”, A7676E Series will do nothing when the DTR pin is pulling up.

3.4 USB Interface

The A7676E 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

A7676E can be used as a USB slave device. The recommended connection circuit diagram is as follows:

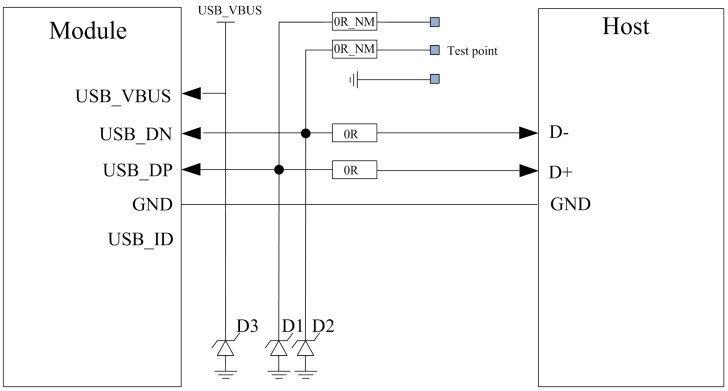

Figure 18: USB circuit diagram

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

NOTE

1. The USB data cable must be strictly routed in 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

A7676E provides one forced download boot interface 'USB_BOOT'.

Table 13: USB_BOOT description

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

If the module upgrade fails to boot, you can force upgrade through the USB_BOOT port.
Before the module is powered on, pull the USB_BOOT pin to GND, then apply VBAT power to the module, and press RESET to enter the download mode. After entering the download mode, you need to release USB_BOOT and remove the pull-up.

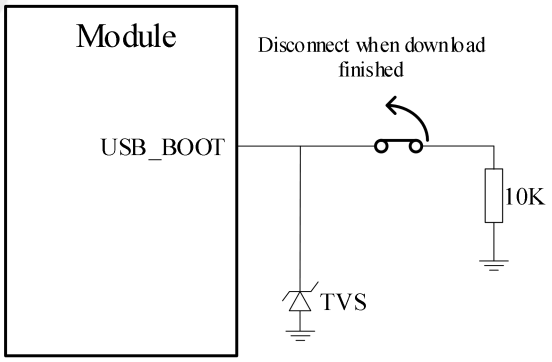

Figure 19: Reference USB_BOOT circuit

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

Figure 20: Force-download port

NOTE

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

3.5 USIM Interface

A7676E supports both 1.8V and 3.0V USIM Cards. The interface power of the USIM card is provided by the voltage regulator inside the module, and the normal voltage value is 3V or 1.8V.

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

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

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

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

3.5.1 SIM Application Guide

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

reference circuit.

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

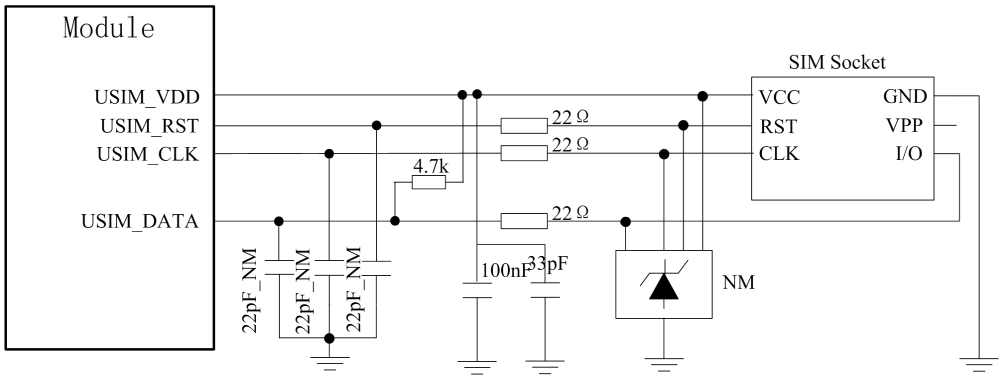

Figure 21: SIM interface reference circuit

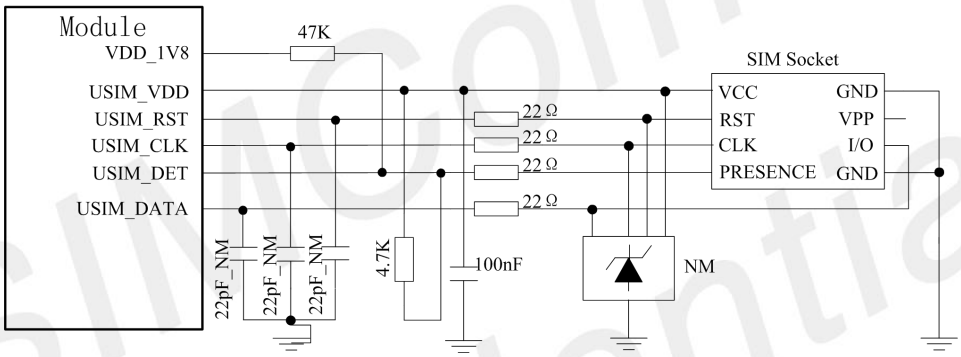

Figure 22: SIM interface reference circuit (8PIN)

NOTE

1. USIM1_DATA has been pulled up with a 4.7KΩ resistor to USIM1_VDD in module. A 100nF capacitor on USIM_VDD is used to reduce interference. For more details of AT commands about USIM, please refer to document [1].

2. USIM2_DATA has no pull resistor, need to add 4.7KΩ resistor pulled up to USIM2_VDD externally.

3.5.2 Recommend USIM Card Holder

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

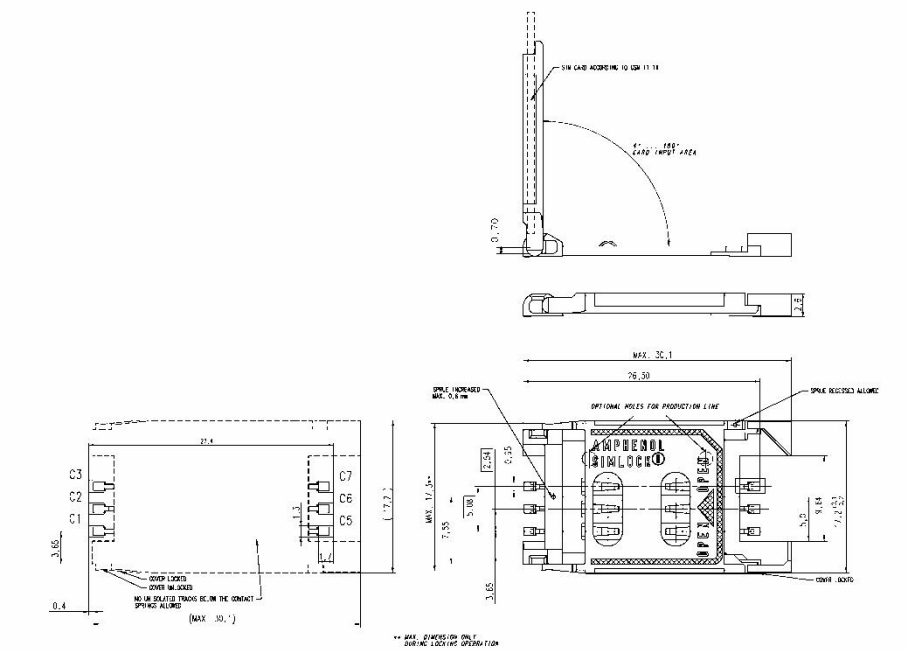

Figure 23: Amphenol C707 10M006 512 USIM card socket

Table 16: Amphenol USIM socket pin description

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

3.6 Analog audio interface

A7676E modules integrate audio codec and audio front end, provide 1 channel of analog audio MIC input interface and 1 channel of analog audio SPK output interface, customers can connect to the external phone handle for voice calls.

ADC: 90dB SNR@20~20kHz

DAC: 95dB SNR@20~20kHz

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

Table 17: MIC input ADC parameter list

Parameter	MIN	Type	MAX	Unit
Clock frequency	-	6.144	-	MHz

Table 18: Analog audio Parameter

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

3.6.1 Analog audio reference design

The analog audio recommendation circuit is as follows:

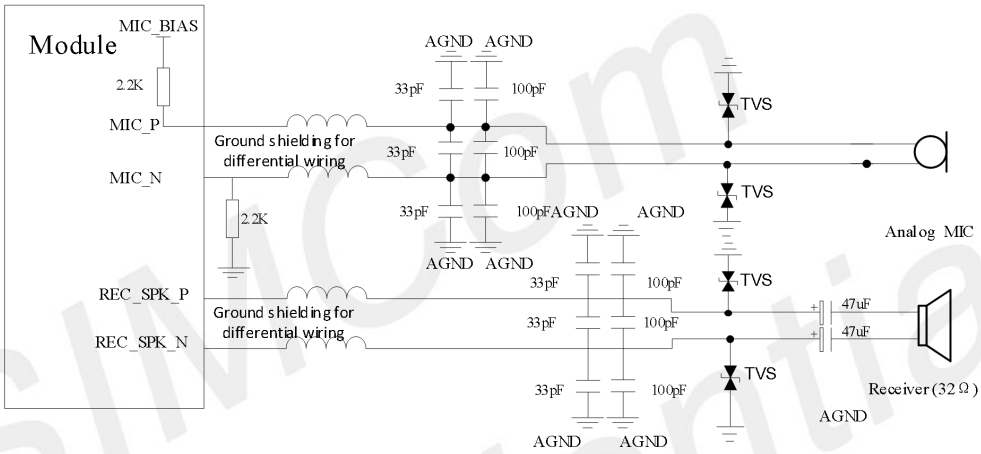

Figure 24: Analog audio interface reference circuit

3.7 Matrix keyboard interface

A7676E provides a 4*4 matrix keyboard interface.

Table 19: matrix keyboard PIN description

PIN Name	PIN NO.	I/O	describe
MK_IN2	47	DI	Matrix keyboard input
MK_IN3	20	DI	
MK_IN5	68	DI	
MK_IN6	36	DI	
MK_OUT2	44	DO	Matrix keyboard output
MK_OUT3	21	DO	
MK_OUT5	67	DO	
MK_OUT6	35	DO	

The matrix keyboard interface recommendation circuit is as follows:

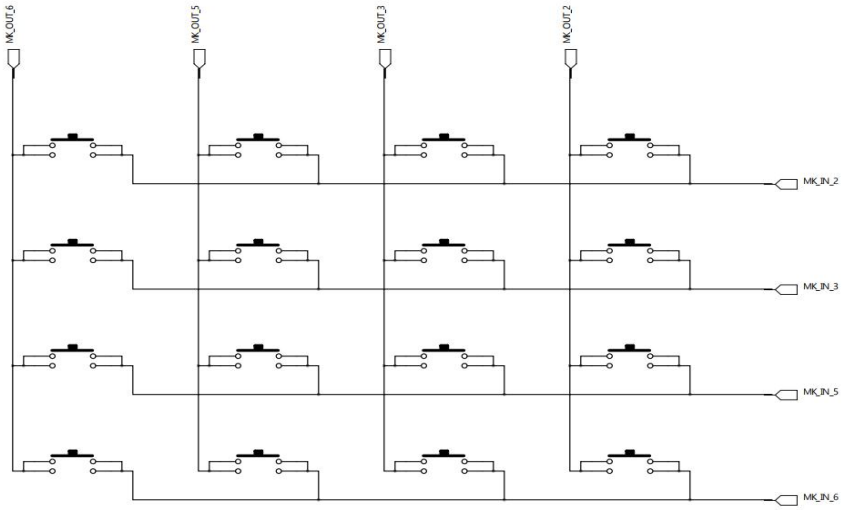

Figure 25: Matrix keyboard interface reference circuit

3.8 GPIO Interface

A7676E module provides multiple GPIOs.

Table 20: Standard GPIO Resources of A7676E

Pin No.	Pin name	AT command operation GPIO number	Pin typ.	Power domain	Default function	Pad Edge wakeup
19	GPIO1	GPIO1	IO	1.8V	PU	Yes
26	GPIO2	GPIO2	IO	1.8V	PD	Yes
48	GPIO3	GPIO3	IO	1.8V	PD	No
49	GPIO4	GPIO4	IO	1.8V	PU	Yes
50	GPIO5	GPIO5	IO	1.8V	PU	Yes

3.9 I2C Bus

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

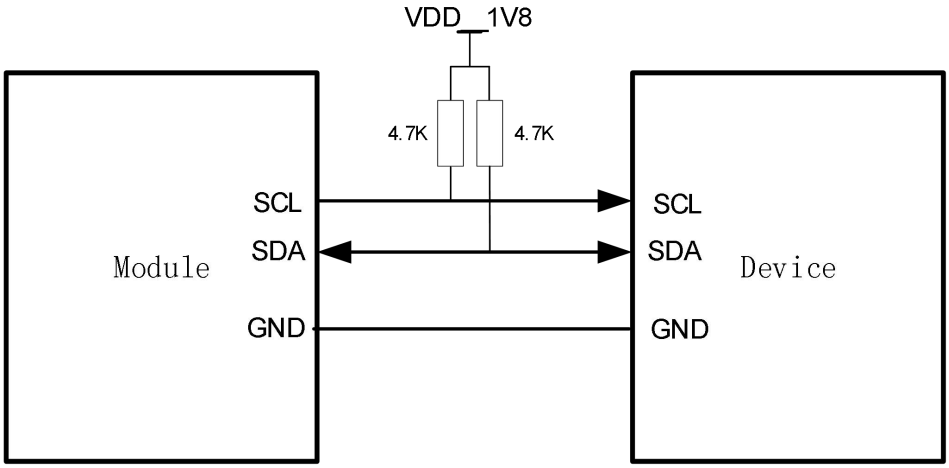

Figure 26: I2C reference circuit

NOTE

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

3.10 Network status

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

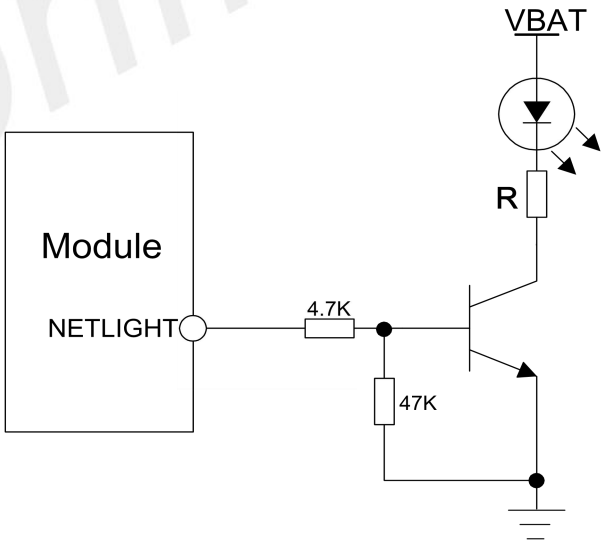

Figure 27: NETLIGHT reference circuit

NOTE

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

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

Table 21: 2G mode NETLIGHT pin status

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

Table 22: LTE mode NETLIGHT pin status

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

3.11 Other interface

3.11.1 ADC

A7676E have 1 general ADC and 1 dedicated VBAT_ADC pins. General ADC converters can digitize voltage values within 0 to 1.8V .VABT_ADC just available for digitizing battery voltage. These electronic specifications are shown in the following table.

Table 23: General ADC electronic characteristics

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

Table 24: VBAT_ADC electronic characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	9	-	Bits
Input Range	0	-	4.2	V

NOTE

"AT+CADC=2" can be used to read the voltage of the ADC pin(0~1.8V).

" AT+CBC " can be used to read the voltage of VBAT(0~4.2V), please design according to the VABT_ADC reference schematic diagram.
for more details, please refer to document [1].

If it is necessary to detect the power ADC, there is no voltage dividing resistance inside the module,The recommended reference design of VBAT_ADC as follow:

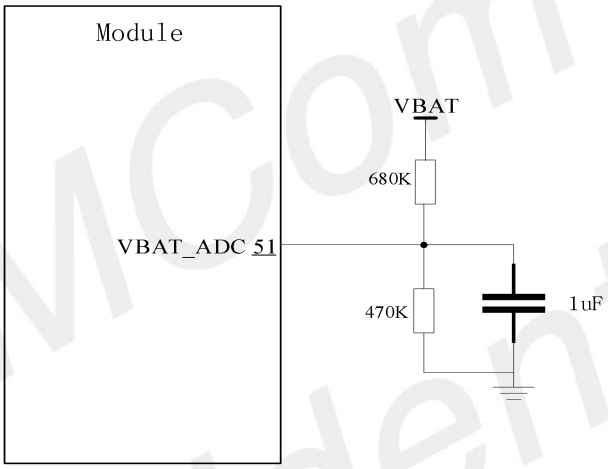

Figure 28: VBAT_ADC reference design

3.11.2 LDO

A7676E has 1 LDO outputs：VDD_1V8

VDD_1V8 is the module's system IO power supply, which can only provide a current capacity of 50mA. It cannot be used as a high current drive source.

Table 25: 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

VDD_1V8 is the system power supply. If the damage will affect the system startup, it is recommended

that customers add TVS protection. The recommended model is ESD56051N.

4 RF Specifications

4.1 GSM/LTE Specifications

Table 26: Conducted transmission power

Frequency	Power	Min.
EGSM900	33dBm ±2dB	5dBm ± 5dB
DCS1800	30dBm ±2dB	0dBm ± 5dB
EGSM900 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
DCS1800 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm
LTE-FDD B20	23dBm +/-2.7dB	<-40dBm
LTE-FDD B31	23dBm +/-2.7dBc	<-40dBm
LTE-FDD B72	23dBm +/-2.7dB	<-40dBm

Table 27: GSM Operating bands

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

Table 28: E-UTRA operating bands

E-UTRA	UL Freq.	DL Freq.	Duplex Mode
1	1920~1980 MHz	2110~2170 MHz	FDD
3	1710~1785 MHz	1805~1880 MHz	FDD
8	880~915 MHz	925~960 MHz	FDD
20	832~862MHz	791~821MHz	FDD
31	452.5~457.5MHz	462.5~467.5MHz	FDD
72	451~456MHz	461~466MHz	FDD

Table 29: Conducted receive sensitivity

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

Table 30: Reference sensitivity (QPSK)

E-UTRA Band	3GPP standard						Actual	Duplex Mode
	1.4 MHz	3MHz	5MHz	10MHz	15 MHz	20 MHz	10 MHz	
1			-100	-97	-95.2	-94	TBD	FDD
3	-101.7	-98.7	-97	-94	-92.2	-91	TBD	FDD
8	-102.2	-99.2	-97	-94			TBD	FDD
20			-97	-94	-91.2	-90	TBD	FDD
31	-100	-96.7	-94.5				TBD	FDD
72	-100	-96.7	-94.5				TBD	FDD

4.2 GSM/LTE Antenna Requirements

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

Table 31: GSM/LTE antenna requirements

Passive	Recommended standard
Operating band	See table 26 and table 27
Direction	omnidirectional
Gain	> -3dBi (Avg)
Input impedance	50 ohm
Efficiency	> 50 %
Maximum input power	50W
VSWR	< 2
Isolation	>20dB
PCB insertion loss(<1GHz)	<0.5dB
PCB insertion loss(1GHz~2.2GHz)	<1dB
PCB insertion loss(2.3GHz~2.7GHz)	<1.5dB

4.3 GNSS Specifications

Table 32: GNSS operating bands

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

Table 33: GNSS performance

GNSS	GPS	BeiDou	GLONASS
Tracking sensitivity	TBD	TBD	TBD
Coldstart sensitivity	TBD	TBD	TBD
Hot start TTFF	<1s		
Cold start TTFF	<40s		
Accuracy	<2m		

4.4 GNSS Antenna Requirements

Table 34: Recommended Antenna Characteristics (GNSS)

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

4.5 Antenna Reference Design

4.5.1 Passive Antenna for GSM/LTE/GNSS

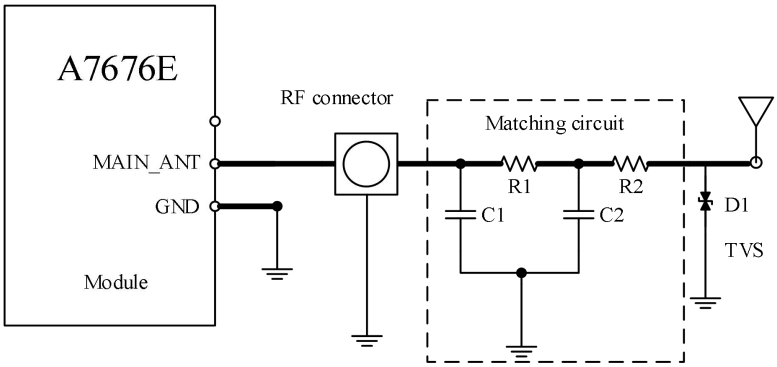

Figure 29: Passive antenna reference

NOTE

GNSS passive antenna design is default solution. If the customer designs GNSS active antenna, please refer to the scheme design in the next section

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

Table 35: TVS part number list

Package	Type	Supplier
0201	CE0201S05G01R	SOCAY
0402	PESD0402-03	PRISEMI

4.5.2 Active Antenna for GNSS

If GNSS uses active antenna, it needs external LDO for power supply, which can be designed according to the following figure, C use 100pF by default.

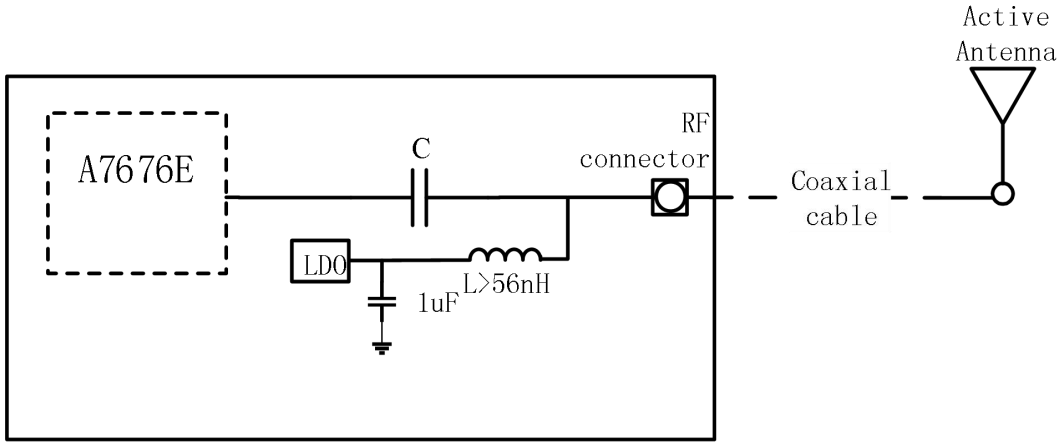

Figure 30: Active antenna reference

4.6 PCB layout

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

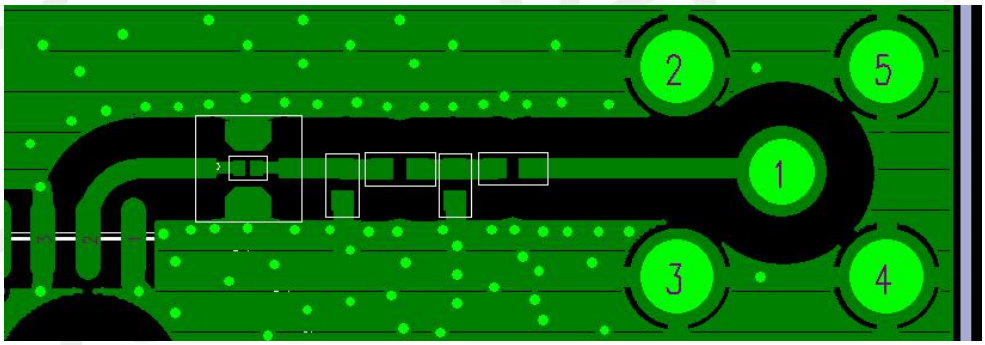

Figure 31: Reference PCB layout

5 Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of A7676E are listed in the following table, exceeding these limits may cause permanent damage to the module.

Table 36: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage on VBAT	-0.5	-	4.8	V
Voltage on USB_VBUS	-0.5	-	5.4	V
Voltage at digital pins (GPIO, I2C, UART,PCM)	-0.3	-	2.0	V
Voltage at IO pins	-0.3	-	2.0	V
(USIM)	-0.3	-	3.9	V
Voltage at PWRKEY, RESET	-0.3	-	4.8	V

5.2 Operating conditions

Table 37: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.4	3.8	4.2	V
Voltage at USB_VBUS	3.0	5.0	5.4	V

Table 38: 1.8V Digital I/O characteristics*

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

	pull-down resistor)				
IIL	Input low leakage current (no pull up resistor)	-10	-	-	uA

NOTE

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

The operating temperature of A7676E is listed in the following table.

Table 39: 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 A7676E product.

Table 40: Operating mode Definition

Mode		Function
Normal operation	GSM/ LTE Sleep	In this case, the current consumption of module will be reduced to the minimal level and the module can still receive paging message and SMS.
	GSM/LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	GSM/ LTE Talk	Connection between two subscribers is in progress. In this case, the power consumption depends on network settings

		such as DTX off/on, FR/EFR/HR, hopping sequences, and antenna.
	GSM/LTE Standby	Module is ready for data transmission, but no data is currently sent or received. In this case, power consumption depends on network settings.
	GPRS/EDGE/LTE Data transmission	There is data transmission in progress. In this case, power consumption is related to network settings (e.g., power control level); uplink/downlink data rates, etc.
Minimum functionality mode		AT command 'AT+CFUN=0' AT+CSCLK=1 can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work and the USIM card will not be accessible, but the serial port and USB port are still accessible. The power consumption in this mode is lower than normal mode.
Flight mode		AT command 'AT+CFUN=4' or pulling down the FLIGHTMODE pin can be used to set the module to flight mode without removing the power supply. In this mode, the RF part of the module will not work, but the serial port and USB port are still accessible. The power consumption in this mode is lower than normal mode.
Power off		Module will go into power off mode by sending the AT command 'AT+CPOF' or pull down the PWRKEY pin, normally. In this mode the power management unit shuts down the power supply, and software is not active. The serial port and USB are is not accessible.

5.3.2 Sleep mode

In sleep mode, the current consumption of module will be reduced to the minimal level, and module can still receive paging message and SMS.
Several hardware and software conditions must be satisfied together in order to let A7676E enter sleep mode:

- USB condition
- Software condition
- UART condition

NOTE

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

5.3.3 Minimum functionality mode and Flight mode

Minimum functionality mode ceases majority function of the module, thus minimizing the power consumption. This mode is set by the AT command which provides a choice of the functionality levels.

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

If A7676E has been set to minimum functionality mode, the RF function and SIM card function will be closed. In this case, the serial port and USB are still accessible, but RF function and SIM card will be unavailable.
If A7676E 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 A7676E is in minimum functionality or flight mode, it can return to full functionality by the AT command “AT+CFUN=1”.

5.4 Current Consumption

The current consumption is listed in the table below.

Table 41: Current consumption on VBAT Pins (VBAT=3.8V)

GSM sleep/idle mode	
Current under CFUN=0, CSCLK=1	2mA
GSM supply current (GNSS off，without USB connection)	Sleep mode@BS_PA_MFRMS=2 Typical: TBD Idle mode@BS_PA_MFRMS=2 Typical: TBD
LTE sleep/idle mode	
LTE supply current (GNSS off，without USB connection)	Sleep mode@DRX=0.32STypical: TBD Idle mode @DRX=0.32STypical: TBD
GSM Talk	
EGSM 900	@power level #5 Typical: TBD
DCS1800	@power level #5 Typical: TBD
GPRS	
EGSM900(2 Rx,4 Tx)	@power level #5 Typical: TBD
DCS1800(2 Rx,4 Tx)	@power level #0Typical: TBD
EGSM900(3Rx, 2 Tx)	@power level #5 Typical: TBD
DCS1800(3Rx, 2 Tx)	@power level #0Typical: TBD
EDGE	
EGSM900(2 Rx,4 Tx)	@power level #8Typical: TBD
DCS1800(2 Rx,4 Tx)	@power level #2Typical: TBD
EGSM900(3Rx, 2 Tx)	@power level #8Typical: TBD
DCS1800(3Rx, 2 Tx)	@power level #2Typical: TBD

LTE Cat1	
LTE-FDD B1	@5MHz 23.0dBm Typical: TBD @10MHz 23.0dBm Typical: TBD
LTE-FDD B3	@5MHz 23.0dBm Typical: TBD @10MHz 23.0dBm Typical: TBD
LTE-FDD B8	@5MHz 23.0dBm Typical: TBD @10MHz 23.0dBm Typical: TBD
LTE-FDD B20	@5MHz 23.0dBm Typical: TBD @10MHz 23.0dBm Typical: TBD
LTE-FDD B31	@5MHz 23.0dBm Typical: TBD
LTE-FDD B72	@5MHz 23.0dBm Typical: TBD

5.5 ESD Notes

A7676E is sensitive to ESD in the process of storage, transporting, and assembling. When A7676E is mounted on the users' mother board, the ESD components should be placed beside the connectors which human body may touch, such as SIM card holder, audio jacks, switches, keys, etc. The following table shows the A7676E ESD measurement performance without any external ESD component.

Table 42: The ESD performance measurement table (Temperature: 25℃, Humidity: 45%.)

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

NOTE

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

6 SMT Production Guide

6.1 Top and Bottom View of A7676E

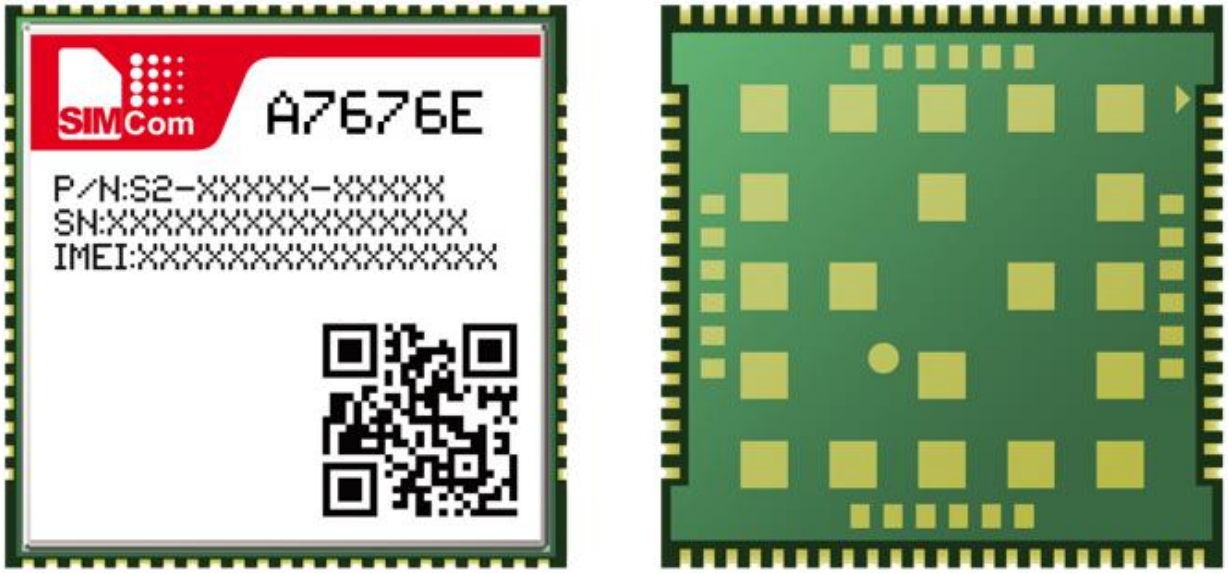

Figure 32: Top and bottom view of A7676E

NOTE

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

6.2 Label Information

Figure 33: Label information for A7676E

Table 43: The description of label information

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

6.3 Typical SMT Reflow Profile

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

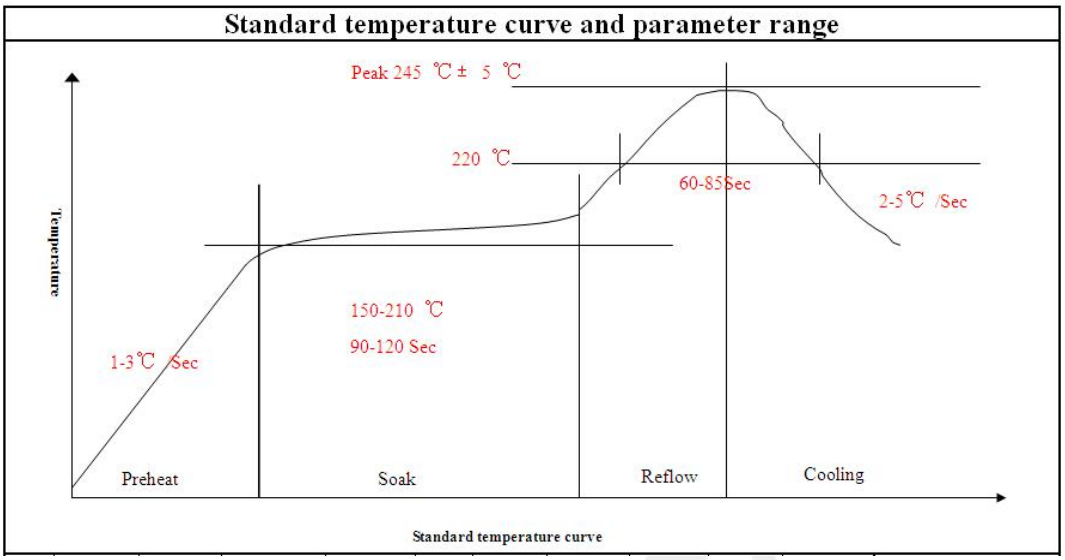

Figure 34: The ramp-soak-spike reflow profile of A7676E

NOTE

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

6.4 Moisture Sensitivity Level (MSL)

A7676E is qualified to Moisture Sensitivity Level (MSL) 3 in accordance with JEDEC J-STD-033.

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

Table 44: Moisture Sensitivity Level and Floor Life

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

NOTE

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

7 Packaging

A7676E module support tray packaging.

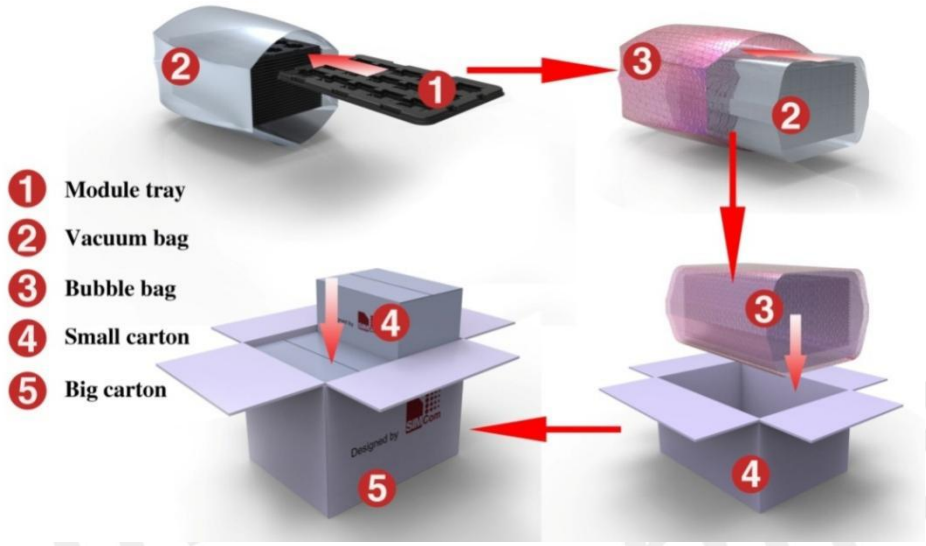

Figure 35: packaging diagram

Module tray drawing：

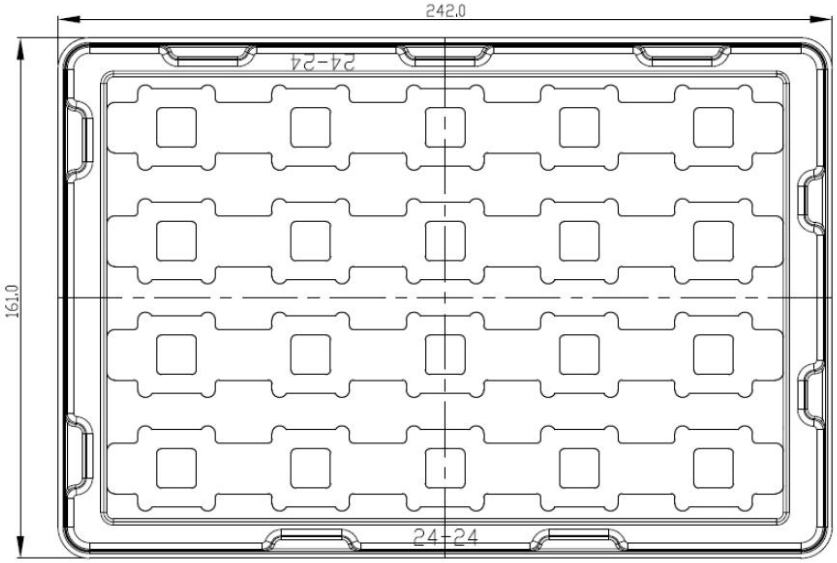

Figure 36: Tray drawing

Table 45: Tray size

Length（±3mm）	Width（±3mm）	Module number

242.0	161.0	20

Small carton drawing：

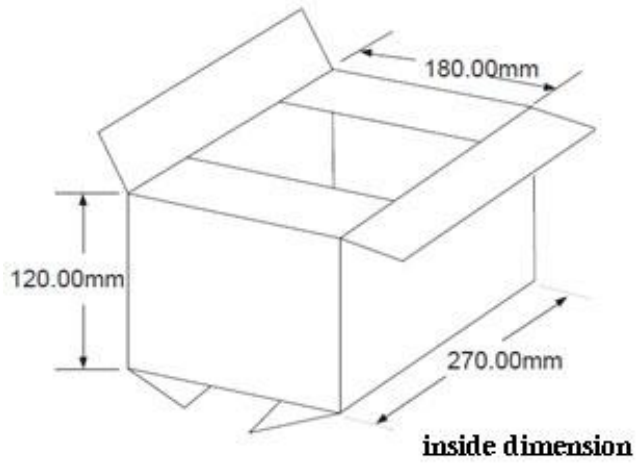

Figure 37: Small carton drawing

Table 46: Small Carton size

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

Big carton drawing：

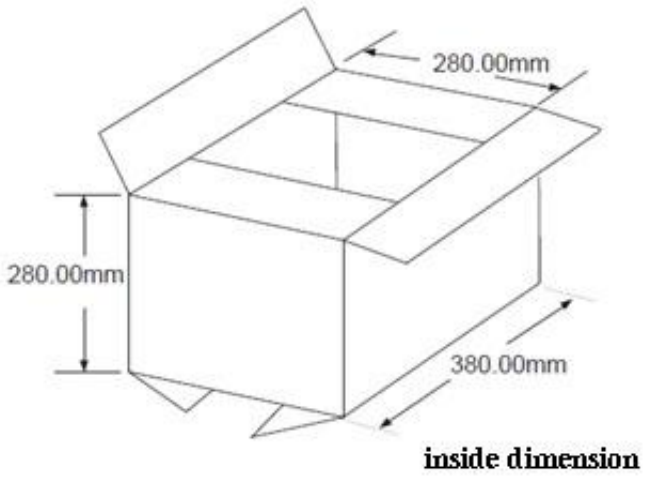

Figure 38: Big carton drawing

Table 47: Big Carton size

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

8 Appendix

8.1 Coding Schemes and Maximum Net Data Rates over Air Interface

Table 48: Coding Schemes and Maximum Net Data Rates over Air Interface

Multislot 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

LTE-FDD device category (Downlink)	Max data rate（peak）	Modulation type
Category 1	10Mbps	QPSK/16QAM/64QAM
LTE-FDD device category (Uplink)	**Max data rate（peak）**	**Modulation type**
Category 1	5Mbps	QPSK/16QAM

8.2 Related Documents

Table 49: Related Documents

NO.	Title	Description
[1]	**A76XX Series_AT Command Manual_V1.03**	**AT Command Manual**
[2]	ITU-T Draft new recommendationV.25ter	Serial asynchronous automatic dialing and control
[3]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[4]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[5]	GSM 07.05	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[6]	GSM 11.14	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[7]	GSM 11.11	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[8]	GSM 03.38	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[9]	GSM 11.10	Digital cellular telecommunications system (Phase 2)；Mobile Station (MS) conformance specification； Part 1: Conformance specification
[10]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[11]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[12]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[13]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[14]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[15]	EN 301 908-02 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000. Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article

		3.2 of the R&TTE Directive
[16]	EN 301 489-24 V1.2.1	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
[17]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[18]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[19]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[20]	2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
[21]	Module secondary-SMT-UGD-V1.xx	Module secondary SMT Guidelines
[22]	A7600Series_UART_Application Note_V1.xx	This document describes how to use UART interface of SIMCom modules.
[23]	Antenna design guidelines for diversity receiver system	Antenna design guidelines for diversity receiver system
[24]	A7600 Series_SleepMode_Application Note_V1.xx	Sleep Mode Application Note
[25]	A7600 Series_UIM HOT SWAP_Application Note_V1.00	This document introduces UIM card detection and UIM hot swap.

8.3 Terms and Abbreviations

Table 50: Terms and Abbreviations

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

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

8.4 Safety Caution

Table 51: 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.