A7600E-H CAT4 Series-PCIE Hardware Design

LTE Module

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Version History

Date	Version	Description of change	Author
2020-09-09	1.00	Original	Gaochao.li Cunbao.feng
2021-02-24	1.01	1.Increase weight information 2.Modify the description of power supply requirements	Xiaojun.guo

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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 A7600E-H CAT4 Series-PCIE module to design and develop applications quickly. SIMcom provides a set of evaluation boards to facilitate A7600E-H CAT4 Series-PCIE 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 global market, the A7600E-H CAT4 Series-PCIE modules support 4 air-interface standards including GSM, WCDMA, LTE-TDD and LTE-FDD. Users can choose the module according to the wireless network configuration. The supported radio frequency bands are described in the following table.

So far, the following models have been included that A7600E-HNVD / A7600E-HNVW.
Please refer to the table below for detailed frequency bands:

Table 1: A7600E-H CAT4 Series-PCIE Series Frequency Bands

Standard	Frequency	A7600E-HNVD	A7600E-HNVW
GSM	EGSM 900MHz	✓	✓
	DCS 1800MHz	✓	✓
WCDMA	BAND 1	✓	✓
	BAND 8	✓	✓
LTE-FDD	LTE-FDD B1	✓	✓
	LTE-FDD B3	✓	✓
	LTE-FDD B5	✓	✓
	LTE-FDD B7	✓	✓
	LTE-FDD B8	✓	✓
	LTE-FDD B20	✓	✓
LTE-TDD	LTE TDD B38	✓	✓
	LTE TDD B40	✓	✓
Diversity antenna		✓	
Category		CAT4	CAT4

NOTE

A7600E-H CAT4 series PCIE does not support audio interface function, A7600E-H CAT4 series PCIEA supports audio interface function.

The A7600 CAT4 series PCIE(A)D module has a built-in DC-DC chip, which can be powered by a lower VCC voltage.

The A7600E-H series has many functional configurations. PCIE boards of different frequency bands can be provided according to customer needs. For specific needs, please contact local sales.

1.2 Hardware Interface Overview

A7600E-H CAT4 Series-PCIE provides various hardware interfaces.

- Power Supply
- USB2.0 Interface
- PERST#
- W_DISABLE#
- LED_WWAN#
- WAKE#
- USIM Interface
- UART Interface (support CTS/RTS flow control)
- I2C Interface
- Analog Audio Interface

1.3 Hardware Block Diagram

The following figure is A7600E-H CAT4 Series-PCIE hardware block diagram.

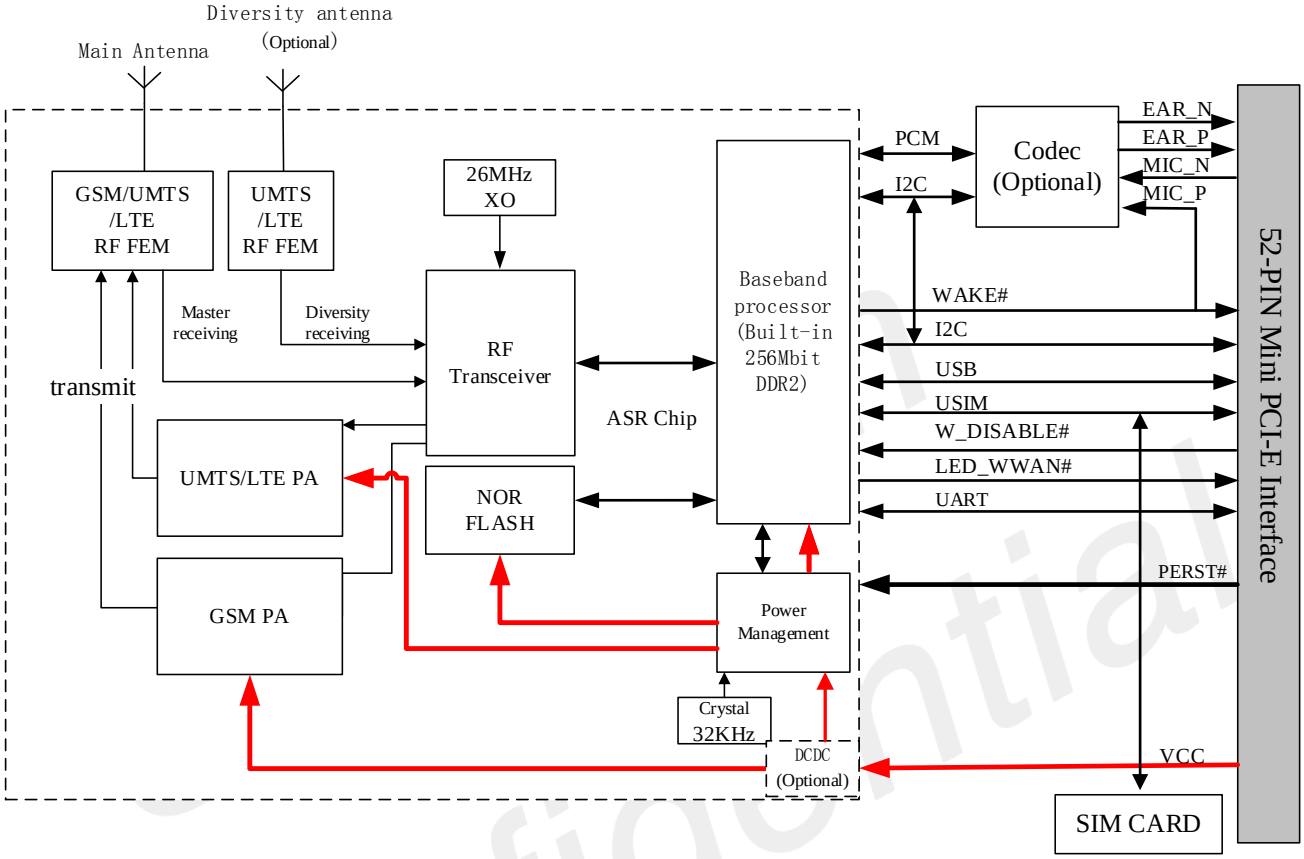

Figure 1: A7600E-H CAT4 Series-PCIE Block Diagram

1.4 Functional Overview

Table 2: A7600E-H CAT4 Series-PCIE Key Features

Feature	Implementation
Power supply	voltage range: 3.4V~4.2V (3.8V typical) for A7600E-H Cat4 series PCIE(A) 3.0V~3.6V (3.3V typical) for A7600E-H Cat4 series PCIE(A)D
Power consumption	Current consumption in sleep mode: <5mA
Frequency bands	Please refer to the table 1
Transmitting power	GSM/GPRS power level： -- GSM850/EGSM900: 4 (33dBm±2dB) --DCS1800/PCS1900: 1 (30dBm±2dB)

	EDGE power level： -- GSM850/EGSM900: E2 (27dBm±3dB) -- DCS1800/PCS1900: E1 (26dBm+3/-4dB) UMTS power level： --WCDMA: 3 (24dBm+1/-2dB)： LTE power level: 3 (23dBm±2.7dB)
Data Transmission Throughput	GPRS Multiple time slot level 12 EDGE Multiple time slot level 12 UMTS R99：384 kbps DL/UL HSPA+：5.76 Mbps(UL), 42 Mbps(DL) FDD-LTE category 4 ： 150 Mbps (DL)，50 Mbps (UL) TDD-LTE category 4 ： 130 Mbps (DL)，35 Mbps (UL)
Antenna	GSM/UMTS/LTE Main antenna interface LTE Diversity antenna interface
SMS	MT,MO, CB, Text , PDU mode Short Message（SMS）storage device: USIM Card, CB does not support saving in SIM Card Support CS domain and PS domain SMS
USIM interface	Support identity card: 1.8V/ 3V
USIM application toolkit	Support SAT class3, GSM 11.14 Release 99 Support USAT
Phonebook management	Support phonebook types : SM/FD/ON/AP/SDN
Audio feature	According to user needs, customized modules supporting analog audio interface (A7600E-H CAT4 series PCIEA, optional)
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
USB	USB 2.0 compliant, host mode not supported. This interface can be used for AT command sending, data transmission.
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size: 50.80*31*5.1mm Weight: 11g（Typical）
Temperature range	Normal operation temperature: -30°C to +80°C Extended operation temperature: -40°C to +85°C* Storage temperature -45°C to +90°C

NOTE

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

2 Package Information

2.1 Pin Out Diagram

The module has 52 pins.

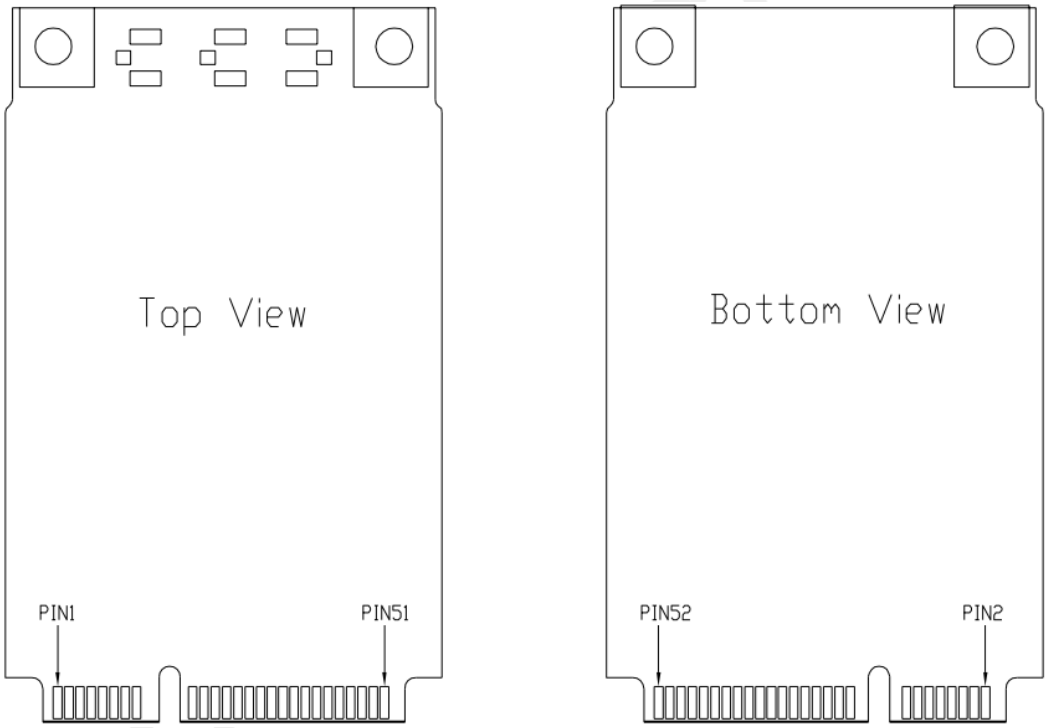

Figure 2：A7600E-H CAT4 Series-PCIE Pin out Diagram

2.2 Pin Description

Table 3: Pin Description

Pin name	Pin number	I/O	Description	Comment
Power supply				
VCC	2,24,39,41,52	I	Power supply for module	Recommended voltage value: A7600E-H

				CAT4 series PCIE(A): 3.8V A7600E-H CAT4 series PCIE(A)D: 3.3V
GND	4,9,15,18,21,26,27,29,34,35,37,40,43,50		Ground	-
Reset				
PERST#	22	I	Reset input (Active low)	If unused, keep open.
USB 2.0				
USB_DP	38	I/O	USB 2.0 high speed port for data transfer, voice call, debug and FW download, etc.	If unused, keep open.
USB_DN	36			
USIM card interface				
USIM_VDD	8	O	Power output for USIM card, its output Voltage depends on USIM card type automatically. Its output current is up to 50mA.	-
USIM_DATA	10	I/O	USIM Card data I/O, which has been pulled up via a 4.7KΩ resistor to USIM_VDD internally. Do not pull it up or down externally.	-
USIM_CLK	12	O	USIM clock.	Make sure the rise time and fall time of USIM_CLK less than 40ns
USIM_RST	14	O	USIM Reset.	-
USIM_DET	16	I	USIM card detect.	For specific information, please refer to the document [23]
UART interface				
UART_CTS	11	I	Clear to Send	If unused, keep open
UART_RTS	13	O	Request to send	
UART_RXD	17	I	Receive Data	
UART_TXD	19	O	Transmit Data	
UART_RI	44	O	Ring Indicator	
UART_DTR	46	I	DTE get ready	
I2C interface				
SCL	30	O	I2C clock output	If unused,

SDA	32	I/O	I2C data input/output	keep open. The internal has been pulled up to 1.8V through a 2.2K resistor.
Others				
WAKE#/MIC_P	1	I/O	A7600E-H CAT4 Series-PCIE: Wake up host, output A7600E-H CAT4 Series-PCIEA: MIC positive, input	If unused, keep open.
MIC_N	3	I	A7600E-H CAT4 Series-PCIE: NC A7600E-H CAT4 Series-PCIEA: MIC negative input	
EAR_P	5	O	A7600E-H CAT4 Series-PCIE: NC A7600E-H CAT4 Series-PCIEA: Receiver positive output	
EAR_N	7	O	A7600E-H CAT4 Series-PCIE: NC A7600E-H CAT4 Series-PCIEA: Receiver negative output	
W_DISABLE#	20	I	Flight mode control interface	If unused, keep open.
LED_WWAN#	42	O	Network Status Indication output	If unused, keep open.
NC	6,23,25,28,31,33,45,47,48,49,51	--	No connection	Keep open

2.3 Package Dimensions

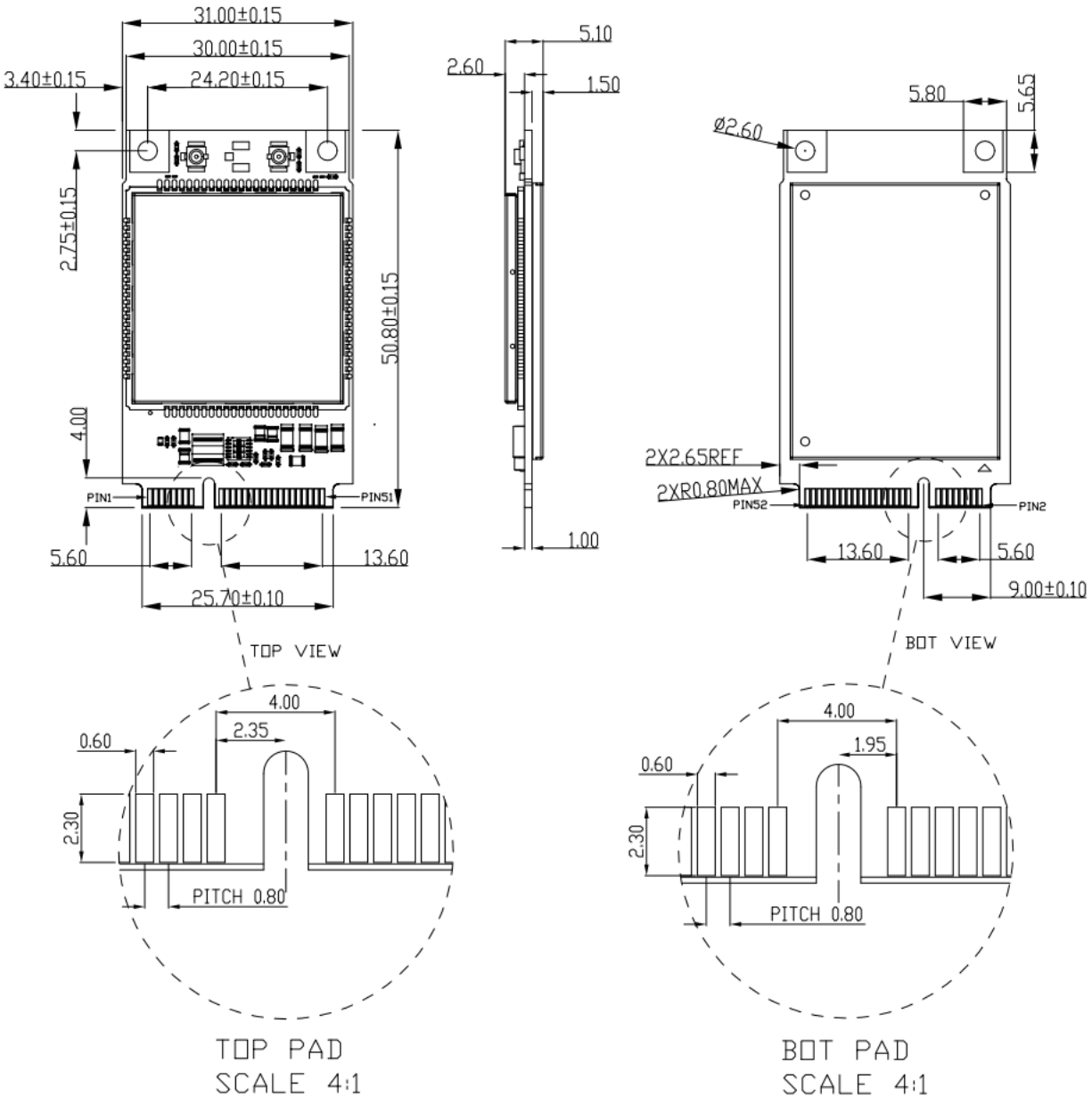

Figure 3: Dimensions of A7600E-H CAT4 Series-PCIE (Unit: mm)

3 Interface Application

3.1 Power Supply

The recommended power supply voltage of A7600E-H CAT4 Series-PCIE is 3.8V. When the module is at the maximum power in GSM TX mode, the peak current can reach 2A.

It is recommended to place two 0.1/1uf capacitors close to VBAT. Two capacitors of 33 / 10PF are added to improve the RF performance and system stability. Add 300-400uf voltage stabilizing capacitor (tantalum capacitor is recommended to enhance the power supply transient response ability in case of sudden current). It is recommended that the width of the VBAT trace between the power supply on the PCB and the module is at least 2mm.

Table 4 : VCC pins electronic characteristic

Symbol	Parameter	Min	Type	Max	Unit
VCC(A7600E-H CAT4 Series-PCIE(A)D)	Power supply voltage	3.0	3.3	3.6	V
VCC(A7600E-H CAT4 Series-PCIE(A))	Power supply voltage	3.4	3.8	4.2	V
I_{VCC}	Supply current capability	-	2	-	A

3.2 Power on/PERST#

3.2.1 Power on

A7600E-H CAT4 Series-PCIE automatically power on when PCIE VCC powered.

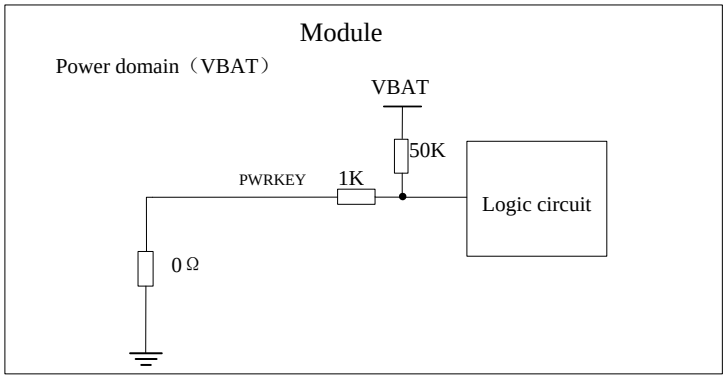

Figure 4：Power on Reference Circuit

3.2.2 PERST#

A7600E-H CAT4 Series-PCIE can be reset by pulling the PERST# pin down to ground.

※ NOTE

It is recommended to use PERST# pin only in emergency situations. For example, the module is not responding.

The PERST# pin has been pulled up with a 50KΩ resistor to VCC internally, so there is no need to pull it up externally. Please refer to the following figure for the recommended reference circuit.

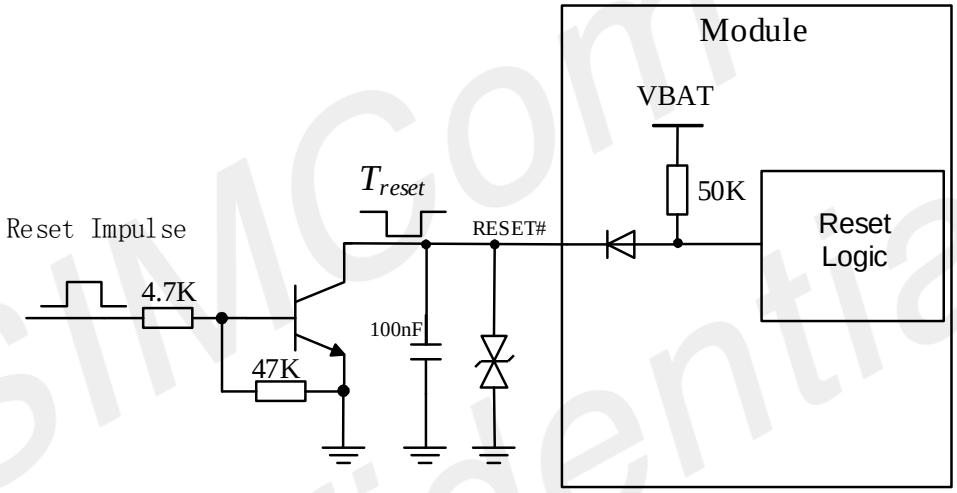

Figure 5: PERST# Reference Circuit

Table 5: PERST# Pin Electronic Characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
TPERST#	The active low level time impulse on PERST# pin to reset module	2	2.5	-	S
VIH	Input high level voltage	2.94	-	VCC	V
VIL	Input low level voltage	0	0	0.5	V

※ NOTE

It is recommended to use the PERST# pin only in emergency situations, such as when the module does not respond. The reset time is recommended to be 2.5s.

3.3 UART Interface

3.3.1 UART reference design

The A7600E-H CAT4 series-PCIE provides a 1.8V serial bus. When the user uses a full-featured serial port, please refer to the following connection method:

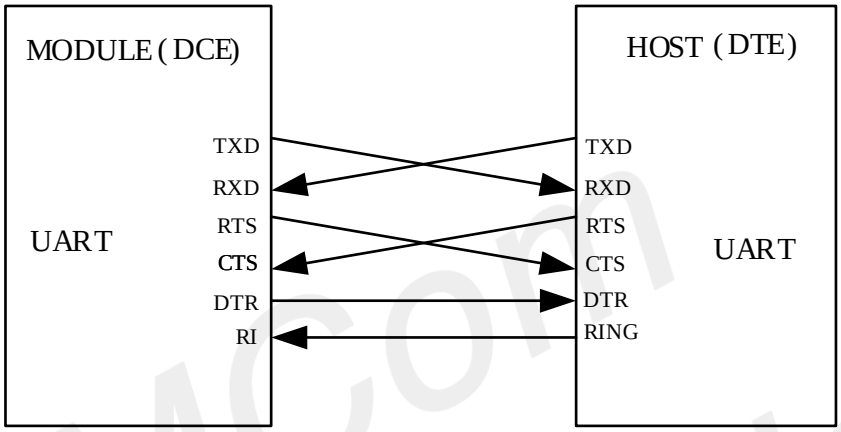

Figure 6: UART Full model

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

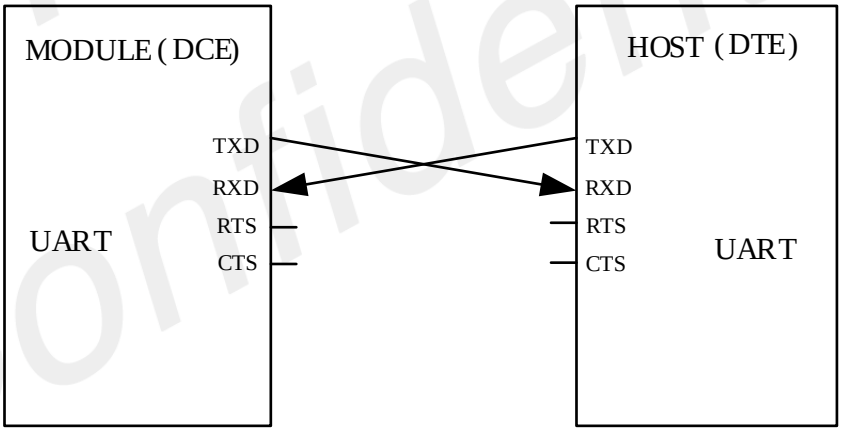

Figure 7: UART Null model

The A7600E-H CAT4 Series-PCIE UART is 1.8V interface. A level shifter should be used if user's application is equipped with a 3.3V UART interface. The level shifter TXB0108RGYR provided by Texas Instruments is recommended. The reference design of the TXB0108RGYR is in the following figures.

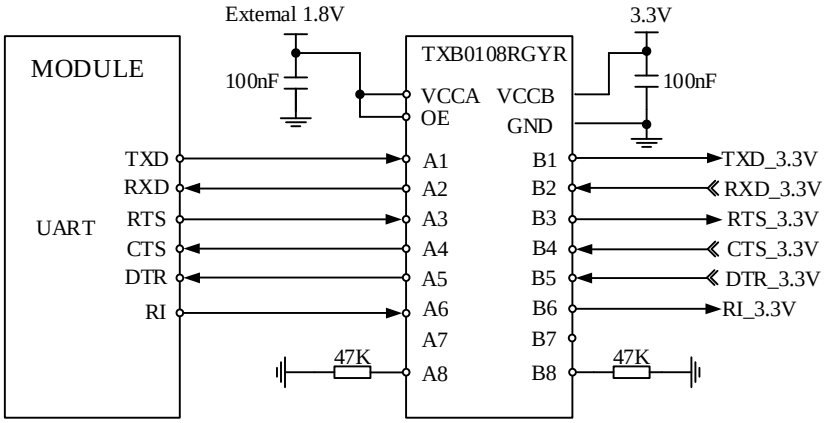

Figure 8: Reference circuit of level shift

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.

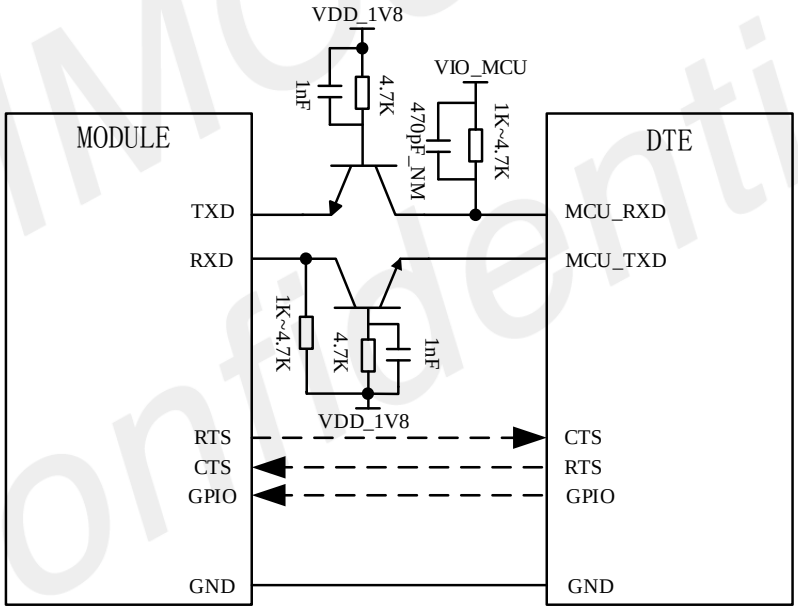

Figure 9: Triode level conversion circuit

NOTE

1. A7600E-H CAT4 Series-PCIE supports the following baud rate: 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1842000, 3686400. Default baud rate is 115200bps.
2. Due to the existence of parasitic capacitance of triode, it will affect the edge of 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 description

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

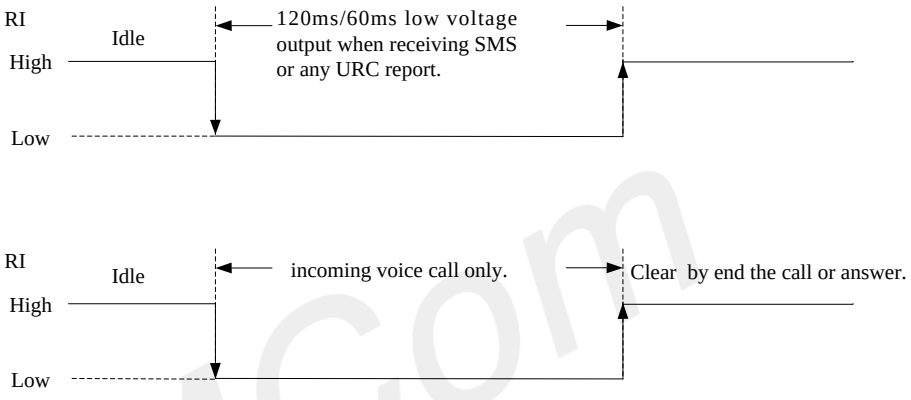

Figure 10：RI behaviour（SMS,URC report and incomming call）

DTR can be used as the sleep wake-up pin of A7600E-H CAT4 series PCIE. When the module enters sleep mode, pulling down DTR can wake up module.

3.4 USB 2.0

A7600E-H CAT4 Series-PCIE contains a USB interface compliant with the USB2.0 specification, but does not support USB charging function and does not support USB HOST mode. It supports high speed (480Mbps) and full speed (12Mbps). The interface can be used for AT command sending, data transmission, software debugging and upgrading. Map out ttyUSB1-ttyUSB2 under Linux or android system (refer to Linux or android debugging document for details).

USB is the main debugging port and software upgrade interface. Please refer to the following figure for the recommended reference circuit.

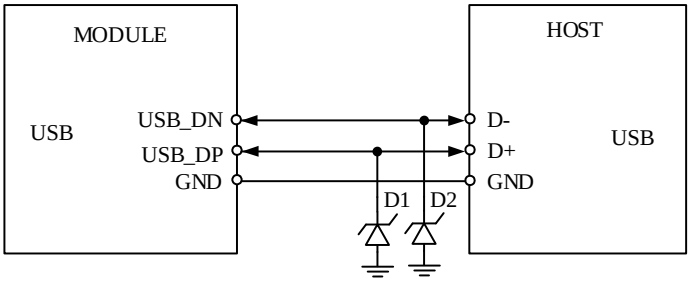

Figure 11: USB Reference Circuit

NOTE

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.

3.5 USIM Interface

A7600E-H CAT4 Series-PCIE 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.

3.5.1 USIM Electronic characteristic

Table 6: 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	0.25*USIM_VDD	V

Table 7: 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
V_{IH}	High-level input voltage	0.7*USIM_VDD	-	USIM_VDD +0.4	V
V_{IL}	Low-level input voltage	-0.4	0	0.25*USIM_VDD	V
V_{OH}	High-level output voltage	USIM_VDD -0.45	-	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.25*USIM_VDD	V

3.5.2 USIM reference design

It is recommended to refer to the following circuit to design the SIM card circuit, 100nF decoupling capacitor, TVS can be reserved.

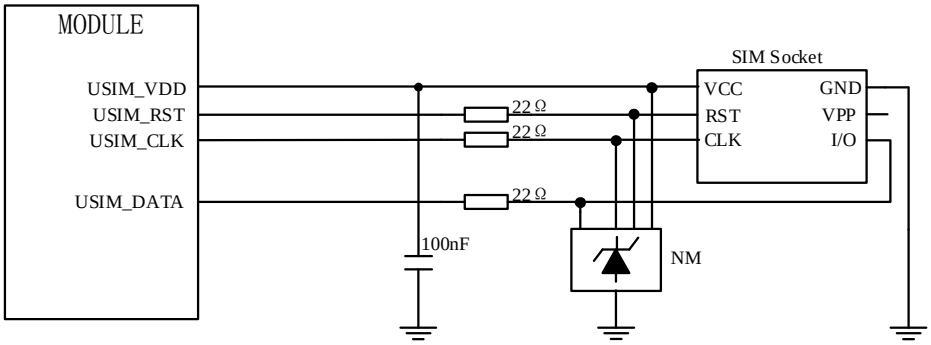

Figure 12: USIM interface reference circuit

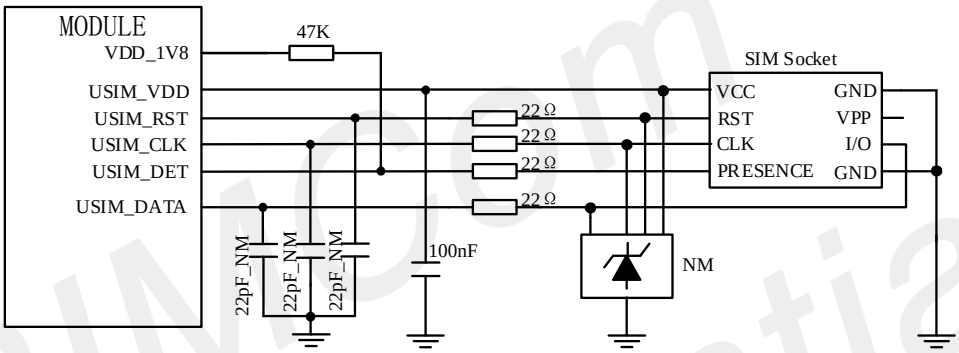

Figure 13: USIM interface reference circuit (8PIN)

NOTE

1. USIM_DATA has been pulled up to USIM_VDD through a 4.7KΩ resistor, the external circuit does not need to be pulled up
2. USIM_CLK is very important signal; customer must make sure the rise time and fall time of USIM_CLK less than 40ns.

3.6 I2C Interface

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

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

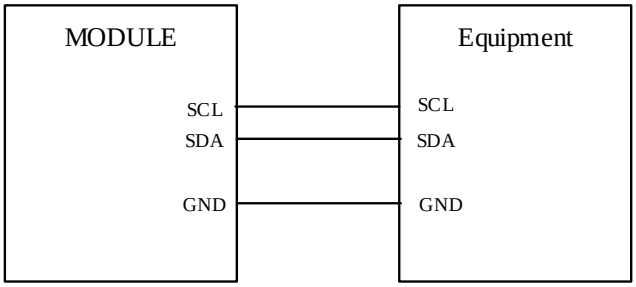

Figure 14: I2C reference circuit

NOTE

SCL and SDA have pull-up resistor inside, external resistor is not needed.

3.7 LED_WWAN#

The LED_WWAN# pin can be used to drive a network status indication LED by default. Reference circuit is recommended in the following figure:

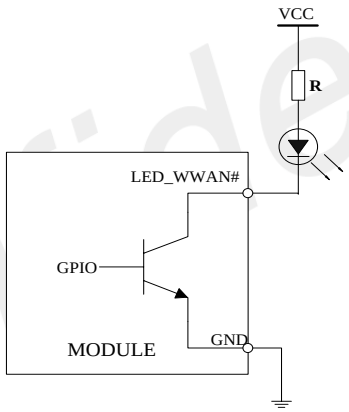

Figure 15: LED_WWAN# Reference Circuit

NOTE

The value of the resistor named “R” depends on the specific parameters of VCC and LED.

LED_WWAN# 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 8: 2G/3G mode LED_WWAN# pin status

LED Status	Module status
Always On	Searching Network
200ms ON, 200ms OFF	Data Transmit
800ms ON, 800ms OFF	Registered network
OFF	Power off / AT+CSCLK=1, and DTR is pulled high.

Table 9: LTE mode LED_WWAN# pin status

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

3.8 W_DISABLE#

The W_DISABLE# pin can be used to control A7600E-H CAT4 Series-PCIE to enter or exit the Flight mode. In Flight mode, the RF circuit is closed to prevent interference with other equipments and minimize current consumption.

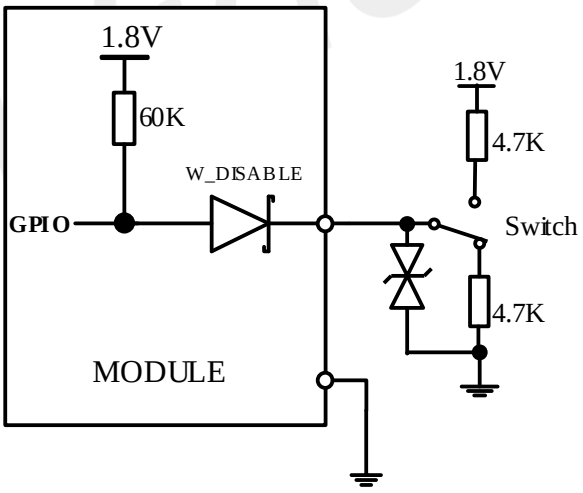

Figure 16: W_DISABLE# Reference Circuit

※ NOTE

The bidirectional TVS is recommended to be placed close to the module to enhance the anti-ESD performance.

Table 10: W_DISABLE# Pin Electrical Characteristic

Symbol	Parameter	Min	Type	Max	Unit
V_{IH}	High-level input voltage	1.26	1.8	2.2	V
V_{IL}	Low-level input voltage	-0.4	0	0.45	V

3.9 WAKE#

WAKE# interface and Mic_ P interface share the same physical interface. As the first pin of A7600E-H CAT4 series-PCIE, the WAKE# pin can be used as an interrupt signal to host.

The WAKE# pin is externally pulled up to the 1V8 power supply. When the module receives a short message or URC report, WAKE# outputs a low level for 120ms (short message)/60ms (URC), and then returns to a high level state; When receiving a telephone call as the called party, WAKE# outputs a low level and keeps it low until the host accepts the call using the "ATA" command, or the caller stops calling the RI.

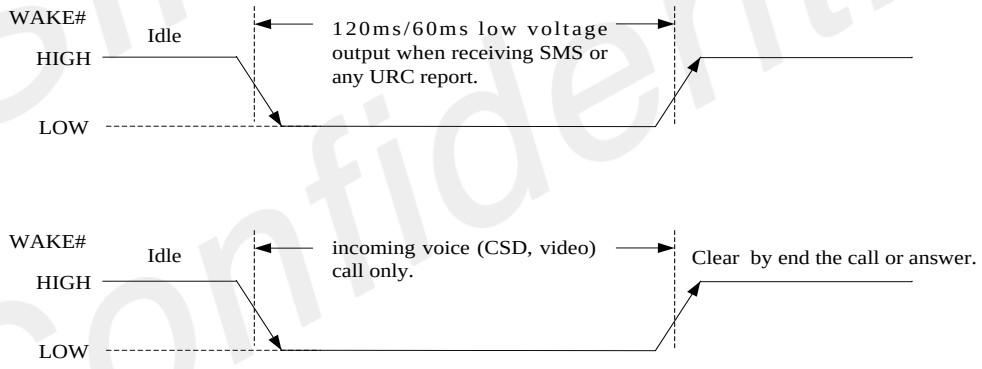

Figure 17: WAKE# behaviour

However, if the module is used as caller, the WAKE# will remain high. Please refer to the following figure.

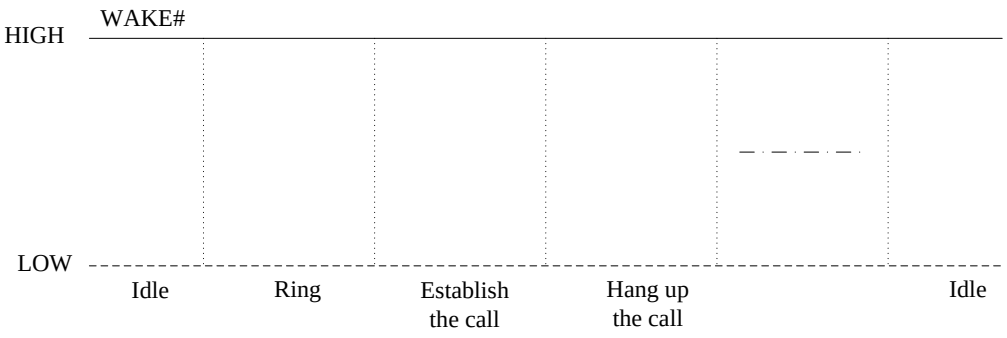

Figure 18: WAKE# behaviour as a caller

WAKE# Reference circuit is recommended in the following figure:

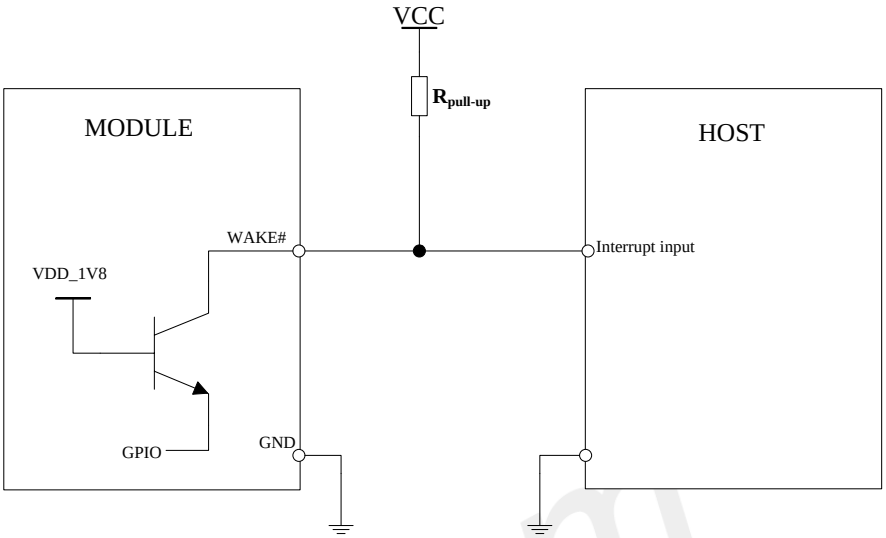

Figure 19: WAKE# Reference Circuit

NOTE

Modules with MIC_P function (under development) do not support WAKE# function.

4 RF Specifications

4.1 GSM/UMTS/LTE Specifications

Table 11: 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
WCDMA B1	24dBm +1/-3dB	<-50dBm
WCDMA B8	24dBm + 1/-3dB	<-50dBm
LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23dBm +/-2.7dB	<-40dBm
LTE-FDD B5	23dBm +/-2.7dB	<-40dBm
LTE-FDD B7	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm
LTE-FDD B20	23dBm +/-2.7dB	<-40dBm
LTE-TDD B38	23dBm +/-2.7dB	<-40dBm
LTE-TDD B40	23dBm +/-2.7dB	<-40dBm

Table 12: 2G/3G frequency band information

Frequency	DL	UL
EGSM900	925～960MHz	880～915 MHz
DCS1800	1805～1880 MHz	1710～1785 MHz
WCDMA B1	2110～2170 MHz	1920～1980 MHz
WCDMA B8	925～960 MHz	880～915 MHz

Table 13: 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
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
38	2570 ~ 2620 MHz	2570 ~ 2620 MHz	TDD
40	2300 ~ 2400 MHz	2300 ~ 2400 MHz	TDD

Table 14: Conducted receive sensitivity

Frequency	Receive sensitivity(Typical)	Receive sensitivity(MAX)
EGSM900	< -108dBm	3GPP
DCS1800	< -108dBm	3GPP
WCDMA B1	< -110dBm	3GPP
WCDMA B8	< -110dBm	3GPP
LTE FDD/TDD	Refer to table 15	3GPP

Table 15: Reference sensitivity (QPSK)

E-UTRA Band	3GPP standard						Measured value	Duplex Mode
	1.4 MHz	3MHz	5MHz	10MHz	15 MHz	20 MHz	10 MHz	
1	-	-	-100	-97	-95.2	-94	-100	FDD
3	-101.7	-98.7	-97	-94	-92.2	-91	-100	FDD
5	-103.2	-100.2	-98	-95	-	-	-101	FDD
7			-98	-95	-93.2	-92	-98	FDD
8	-102.2	-99.2	-97	-94	-	-	-101	FDD
20			-97	-94	-91.2	-90	-98	FDD
38	-	-	-100	-97	-95.2	-94	-100	TDD
40	-	-	-100	-97	-95.2	-94	-101	TDD

※ 特别注意

The measured value is under the condition of 10 MHz, the main antenna and the diversity antenna.

4.2 Antenna Requirements

Recommended antenna characteristics are described in the following table:

Table 16:Recommended Antenna Characteristics

Passive	Recommended standard
operating band	refer to band information table
Direction	omnidirectional
Gain	> -3dBi (Avg)
Input impedance	50 ohm
Efficiency	> 50 %
Maximum input power	50W
VSWR	< 2
Isolation	>20dB
Antenna route insertion loss (<1GHz)	<0.8dB
Antenna route insertion loss (1710MHz-2170MHz)	<1.2dB
Antenna route insertion loss (2300MHz-2650MHz)	<1.5dB

4.3 Antenna Reference Design

For antenna design, layout between the module and the antenna must be 50Ω impedance. It is recommended to add RF connector for calibration and test, and add RF matching circuit for antenna tuning. The recommended circuit is as follows:

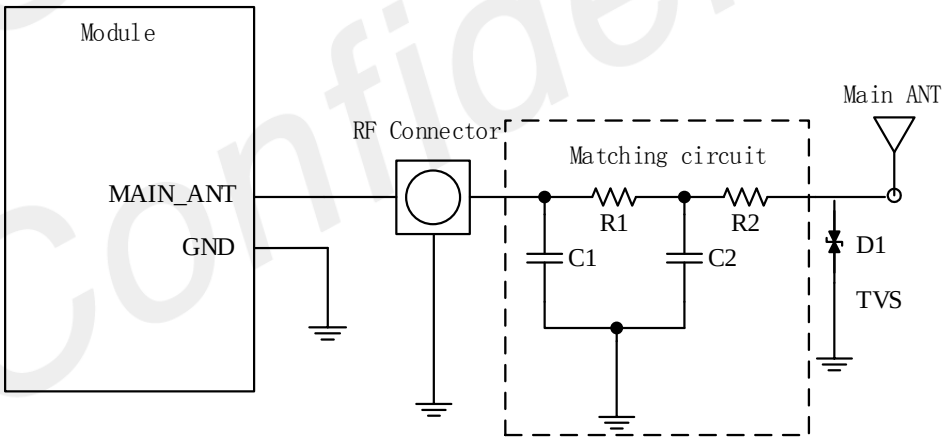

Figure 20: Antenna matching circuit (MAIN_ANT)

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 17: TVS part number list

Package	Part	Vendor
0201	CE0201S05G01R	SOCAY
0402	PESD0402-03	PRISEMI

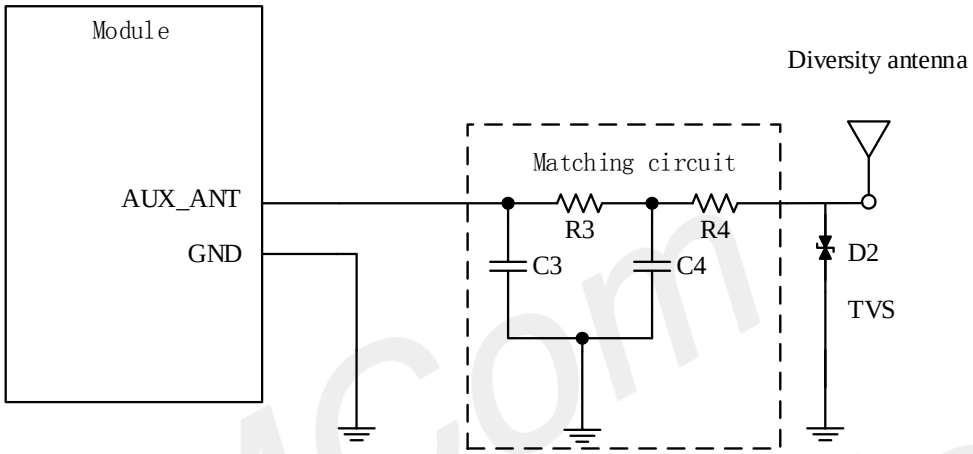

Figure 21: Antenna matching circuit (AUX_ANT)

In above figure, the component R3/R4/C3/C4 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, R3 and R4 paste 0Ω, C3 and C4 do not paste by default. The component D2 is a Bidirectional ESD Protection device, which is suggested to add to protection circuit, The recommended TVS models are shown in Table 28.

※ NOTE

It is recommended to keep the LTE diversity antenna. For more information, please refer to the document [22].

5 Electrical Specifications

5.1 Absolute Maximum Ratings

The absolute maximum ratings are described by the following table. Module may be damaged beyond these ratings.

Table 18: Absolute maximum ratings

Symbol	Parameter	Min	Type	Max	Unit
V_{CC}	VCC input voltage	-0.5	-	4.5	V
V_{IO}	Voltage at digital pins (1.8V digital I/O) *	-0.3	-	2.1	V
USIM	USIM I/O	-0.3	-	2.1	V
		-0.3	-	3.9	V
PERST#	PERST# PIN	-0.3	-	4.5	V

NOTE

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

5.2 Recommended Operating Conditions

Please refer to the follow table for recommended operating conditions.

Table 19: Operating Conditions

Symbol	Parameter	Min	Type	Max	Unit
V_{CC} (A7600E-H CAT4 Series-PCIE(A)D)	V_{CC} Input voltage	3.0	3.3	3.6	V
V_{CC} (A7600E-H CAT4 Series-PCIE(A))	V_{CC} Input voltage	3.4	3.8	4.2	V

Table 20：1.8V digital I/O electrical parameter

Symbol	Parameter	Min	Type	Max	Unit
VIH	input high voltage	1.35	1.8	2.1	V
VIL	input low voltage	-0.3	-	0.45	V
VOH	output high voltage	1.35	-	1.8	V
VOL	input low voltage	0	-	0.4	V
IOH	High-level output current(no pull down resistor)	3	-	9	mA
IOL	Low-level output current(no pull up resistor)	-3	-	-9	mA
IIH	Input high leakage current (no pull down resistor)	-	-	10	uA
IIL	Input low leakage current(no pull up resistor)	-10	-	-	uA

※ Note

The above parameters are applicable to: I2C, UART

Table 21: Operating temperature

Parameter	Min	Type	Max	Unit
Operating temperature	-30	25	80	℃
Extend Operating 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

The table below summarizes the various operating modes of A7600E-H CAT4 Series-PCIE.

Table 22: Operating Mode

Mode		Function
Normal operation	GSM/WCDMA/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/WCDMA/LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	GSM/WCDMA/LTE Talk	Connection between two subscribers is in progress. In this case, the power consumption depends on the network and the configuration of the module.
	GSM/WCDMA/LTE Standby	Module is ready for data transmission, but no data is currently sent or received. In this case, power consumption depends on network settings.
	GPRS/EDGE/LTE Data transmission	There is data transmission in progress. In this case, power consumption is related to network settings (e.g. power control level); uplink/downlink data rates, and the network configuration (e.g. using a multi-slot configuration).
Minimum functionality mode		AT command “AT+CFUN=0” can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work or the USIM card will not be accessible, or both RF part and USIM card will be closed, and 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 W_DISABLE# 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		Customer could cut off the VCC to power off module.

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-H CAT4 Series-PCIE enter into sleep mode:

1. UART condition

2. USB condition
3. Software condition

5.3.3 Function mode

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

- AT+CFUN=0: Minimum functionality
- AT+CFUN=1: Full functionality (Default)
- AT+CFUN=4: Disable RF function of the module (Flight mode)

If A7600E-H CAT4 Series-PCIE 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 andSIM card will be unavailable.

If A7600E-H CAT4 Series-PCIE 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-H CAT4 Series-PCIE is in minimum functionality or flight mode, it can return to full functionality by the AT command “AT+CFUN=1”.

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

5.4 Current Consumption

The current consumption is listed in the table below.

Table 23: Current Consumption (VCC=3.8V)

GSM sleep/idle mode	
GSM/GPRS supply current （without USB connection）	Sleep mode @ BS_PA_MFRMS=2 Typical: 3.5mA Idle mode @ BS_PA_MFRMS=2 Typical: 74mA
UMTS sleep/idle mode	
WCDMA supply current （without USB connection）	Sleep mode @DRX=9 Typical: 2.7mA Idle mode @DRX=9 Typical: 80mA
LTE sleep/idle mode	
LTE supply current （without USB connection）	Sleep mode Typical: 3.8mA Idle mode Typical: 80mA
GSM	

EGSM 900	@power level #5 Typical: 320 mA
DCS1800	@power level #0 Typical: 262 mA
UMTS	
WCDMA B1	@power 24dBm Typical: 540 mA
WCDMA B8	@power 24dBm Typical: 585 mA
GPRS	
EGSM 900 (1RX,4 TX)	@power level #5 Typical: 630 mA
DCS1800 (1RX,4 TX)	@power level #0 Typical: 395 mA
EGSM 900 (3RX, 2TX)	@power level #5 Typical: 370 mA
DCS1800 (3RX, 2TX)	@power level #0 Typical: 275 mA
EDGE	
EGSM900 (1 RX, 4 TX)	@power level #8 Typical: 460 mA
DCS1800 (1 RX, 4 TX)	@power level #2 Typical: 300 mA
EGSM900 (3 RX, 2 TX)	@power level #8 Typical: 336 mA
DCS1800 (3 RX, 2 TX)	@power level #2 Typical: 208 mA
HSDPA	
WCDMA B1	@power 24dBm Typical: 487 mA
WCDMA B8	@power 24dBm Typical: 430 mA
LTE data	
LTE-FDD B1	@5MHz 23dBm Typical: 587 mA @10MHz 23dBm Typical: 595 mA
LTE-FDD B3	@5MHz 23dBm Typical: 597 mA @10MHz 23dBm Typical: 585 mA
LTE-FDD B5	@5MHz 23dBm Typical: 550 mA @10MHz 23dBm Typical: 564 mA
LTE-FDD B7	@5MHz 23dBm Typical: 680 mA @10MHz 23dBm Typical: 690mA
LTE-FDD B8	@5MHz 23dBm Typical: 644 mA @10MHz 23dBm Typical: 646mA
LTE-FDD B20	@5MHz 23dBm Typical: 610 mA @10MHz 23dBm Typical: 610 mA
LTE-TDD B38	@5MHz 23dBm Typical: 396 mA @10MHz 23dBm Typical: 405 mA
LTE-TDD B40	@5MHz 23dBm Typical: 368 mA @10MHz 23dBm Typical: 372 mA

※ Note

In the table above the current consumption value is the typical one of the module tested in the laboratory. In the mass production stage, there may be some difference.

5.5 Electro-Static Discharge

A7600E-H CAT4 Series-PCIE is an ESD sensitive component, so more attention should be paid to the procedure of handling and packaging. The ESD test results are shown in the following table.

Table 24: ESD characteristics (Temperature: 25℃, Humidity: 45 %)

Part	Contact discharge	Air discharge
VCC,GND	+/-5K	+/-10K
Antenna port	+/-5K	+/-10K
USB Interface	+/-2K	+/-4K
UART Interface	+/-2K	+/-4K
Other PADs	+/-1K	+/-2K

6 Packaging

A7600E-H CAT4 Series-PCIE module support tray packaging.

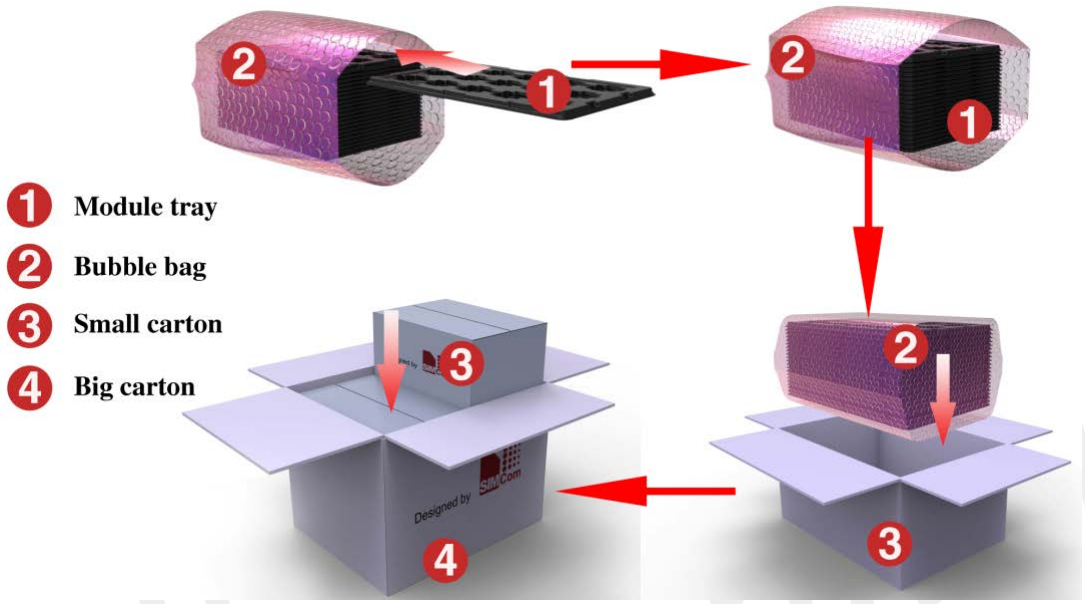

Figure 22: Tray packaging

Module tray drawing:

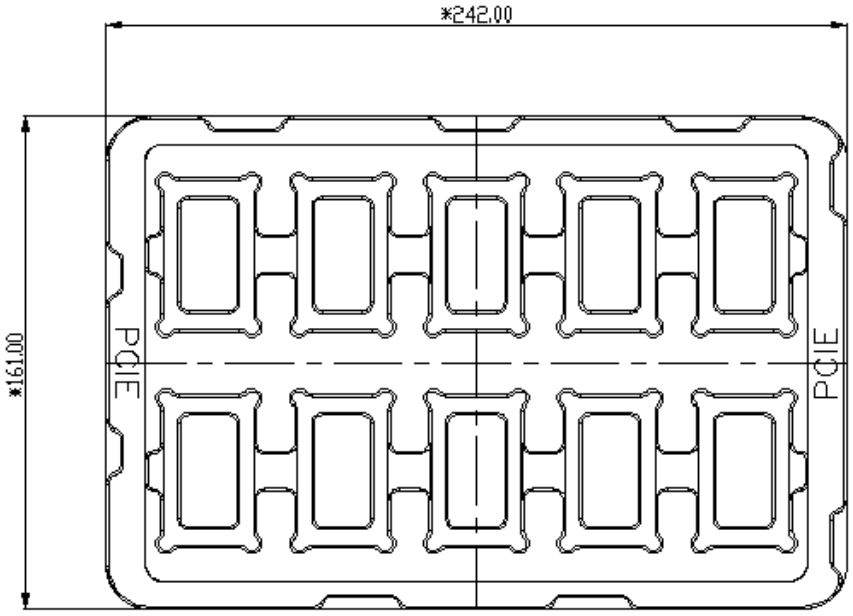

Figure 23: Tray drawing

Table 25: Tray size

Length（±3mm）	Width（±3mm）	Number
242.0	161.0	10

Small carton drawing:

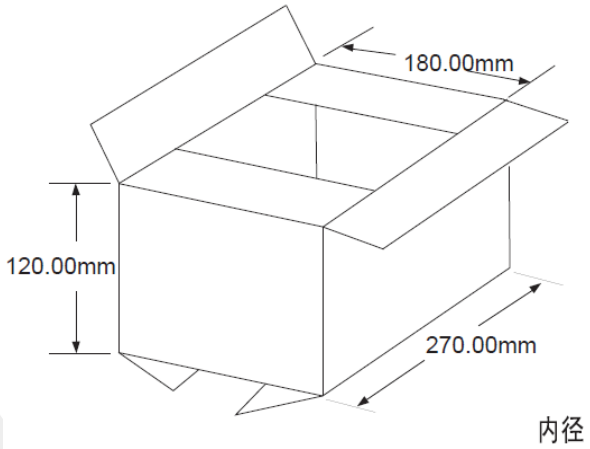

Figure 24: Small carton drawing

Table 26: Small Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Number
270	180	120	10*10=100

Big carton drawing:

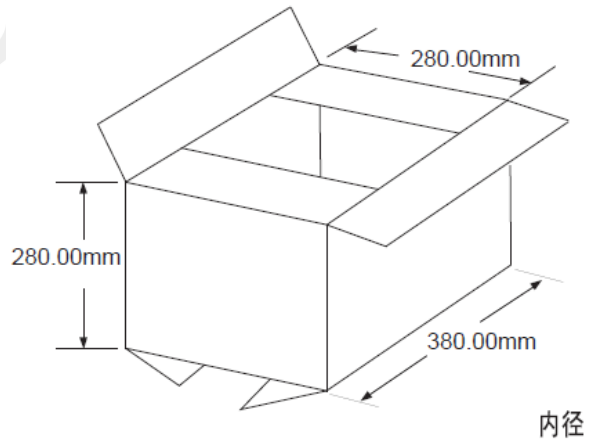

Figure 25: Big carton drawing

Table 27: Big Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Number
380	280	280	100*4=400

7 Appendix

7.1 Coding Schemes and Maximum Net Data Rates

Table 28: Coding Schemes and Maximum Net Data Rates

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
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

7.2 Related Documents

Table 29: Related Documents

SN	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]	Antenna design guidelines for diversity receiver system	Antenna design guidelines for diversity receiver system
[23]	A7600 Series_UIM HOT SWAP_Application Note_V1.00	This document introduces UIM card detection and UIM hot swap.

7.3 Terms and Abbreviations

Table 30: 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
Phone book 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

7.4 Safety Caution

Table 31: 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 to not operate normally for 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. Forget to think much of these instructions may lead to the flight safety or offend against 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, for example no mobile fee or a invalid SIM card. While you are in this condition and need emergent help, please remember using 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.