A7602E-H&A7608SA-H Mini-PCIe module Hardware Design

LTE Module

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Version History

Date	Version	Description of change	Author
2022-03-02	1.00	Original	Zhang mimi Yao kebing
2022-05-05	1.01	Added description of analog audio section	Zhang mimi

Contents

Table Index

Figure Index

1 Introduction

This document describes the electronic specifications, RF specifications, interfaces, mechanical characteristics and testing results of the SIMCom module. With the help of this document and other related software application notes/user guides, users can understand and use the modules to design and develop applications quickly.

1.1 Product Outline

Aimed at the global market, the module support 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

Table 1: Module Frequency Bands

Standard	Frequency bands	Module	
		A7602E-H-PCIE	A7608SA-H-PCIE
GSM	850MHz		✓
	900MHz	✓	✓
	1800MHz	✓	✓
	1900MHz		✓
WCDMA	B1	✓	✓
	B2		✓
	B5		✓
	B8	✓	✓
LTE-FDD	B1	✓	✓
	B2		✓
	B3	✓	✓
	B4		✓
	B5	✓	✓
	B7	✓	✓
	B8	✓	✓
	B20	✓	✓
	B28		✓
	B66		✓
LTE-TDD	B34		

	B38	✓	✓
	B39		
	B40	✓	✓
	B41	✓	✓
Category	/	CAT4	CAT4
GNSS	/	Optional	Optional
Aux ANT	/	Optional	Optional

1.2 Hardware Interface Overview

The module provides various hardware interfaces via Mini PCIExpress card connector.

- Power Supply
- PERST#
- W_DISABLE#
- LED_WWAN#
- USB Interface
- USIM Interface
- UART Interface
- I^2C Interface
- PCM Interface
- Analog Audio Interface

1.3 Hardware Block Diagram

The following figure is module's hardware block diagram.

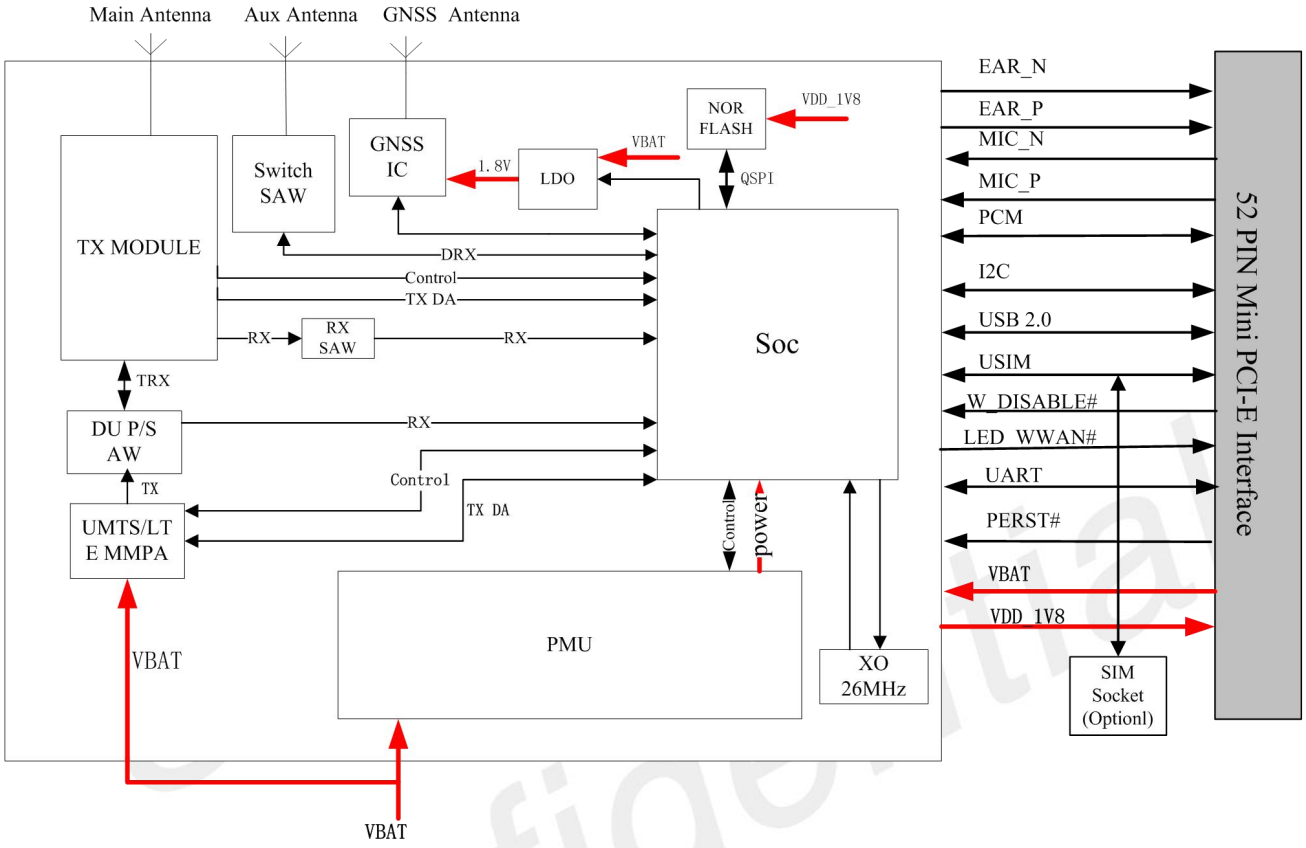


Figure 1: Block Diagram

1.4 Functional Overview

Table 2: Key Features

Feature	Implementation
Power supply	Single supply voltage 3.1V~3.6V (3.3V typical)
Radio frequency bands	Please refer to the Table 1
Transmitting power	GSM/GPRS power class: --GSM850: 4 (2W) --EGSM900: 4 (2W) --DCS1800: 1 (1W) --PCS1900: 1 (1W)

	EDGE power class: --GSM850: E2 (0.5W) --EGSM900: E2 (0.5W) --DCS1800: E1 (0.4W) --PCS1900: E1 (0.4W) UMTS power class: --WCDMA :3 (0.25W) LTE power class: 3 (0.25W)
Data Transmission Throughput	GPRS multi-slot class 12 EDGE multi-slot class 12 UMTS R99 speed: 384 kbps DL/UL HSPA+: 5.76 Mbps(UL), 42 Mbps(DL) HSDPA/HSUPA: 2.2 Mbps(UL), 2.8 Mbps(DL) LTE-FDD CAT4 ： 150 Mbps (DL),50 Mbps (UL) LTE-TDD CAT4 ： 130 Mbps (DL),35 Mbps (UL)
Antenna	GSM/UMTS/LTE main antenna. UMTS/LTE auxiliary antenna GNSS antenna
GNSS	GNSS engine (GPS, BD and GLONASS*) Protocol: NMEA
SMS	MT, MO, CB, Text and PDU mode SMS storage: USIM card or ME(default) Transmission of SMS alternatively over CS or PS
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: DC,MC,RC,SM,ME,FD,ON,LD,EN
Audio feature	Support one analog signal output with 32Ω load resistance,50mW output power, and one analog input.
UART interface	**MAIN UART:** A full modem serial port by default Baud rate: 9600 bps to 3.6Mbps(default:115200 bps) Can be used as the AT commands or data stream channel Support RTS/CTS hardware handshake Multiplex ability according to GSM 07.10 Multiplexer Protocol
USB	USB 2.0 high speed interface
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size: 50.80*31*3.6mm Weight: less than 15g
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

1. Module is able to make and receive voice calls, data calls, SMS and make GPRS/WCDMA/HSPA+/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. GLONASS*：Indicthe function of this module is under development

2 Package Information

2.1 Pin Out Diagram

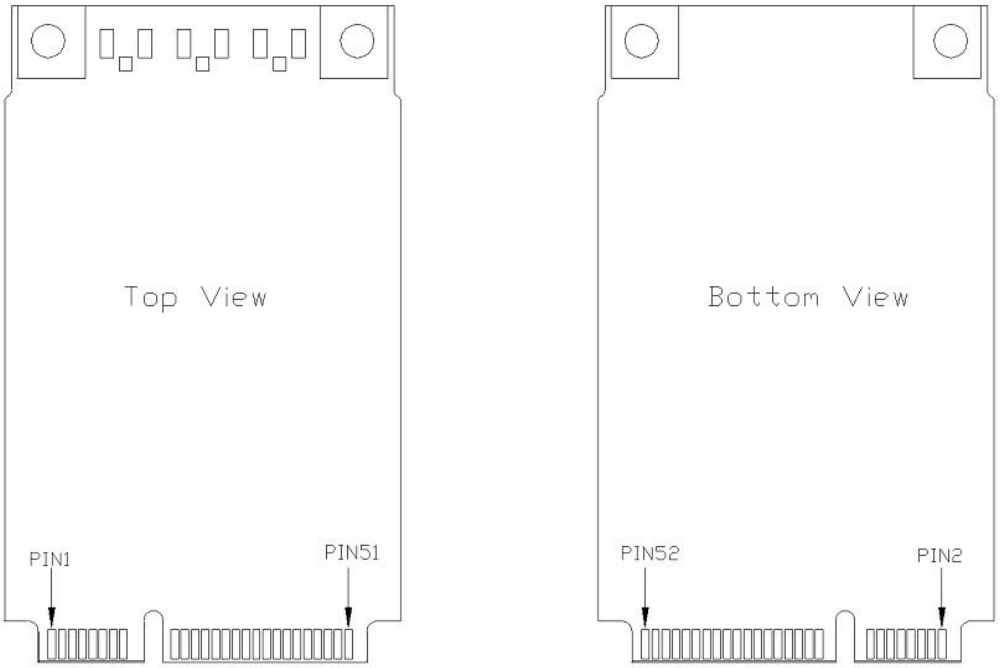


Figure 2: Pin out Diagram

2.2 Schematic diagram of module cooling design

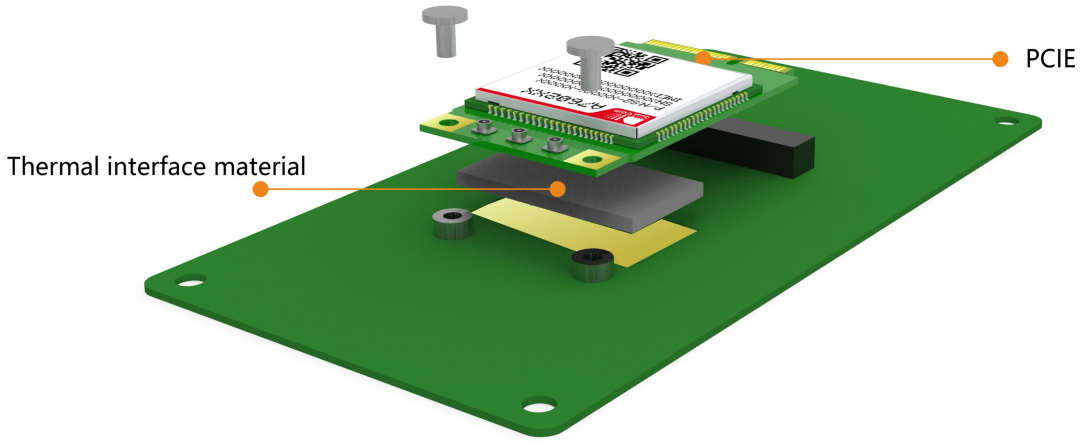


Figure 3: Schematic diagram of thermal design

2.3 PCI Express Mini Card Connector Pin Description

Table 3: Electric Feature

Power domain	Symbol	Description	Min	Typ	Max
P3	1.8 V				
	VOH	Output high	1.6 V	-	1.8 V
	VOL	Output low	0 V	-	0.2 V
	VIH	Input high	1.26 V	1.8 V	2.0 V
	VIL	Input low	-0.3 V	0 V	0.54 V
	Rpu	Pull-up resiter	55 KΩ	79 KΩ	121 KΩ
	Rpd	Pull-down resiter	51 KΩ	87 KΩ	169 KΩ
P5,P8	1.8 V				
	VOH	Output high	1.6 V	-	1.8 V
	VOL	Output low	0 V	-	0.2 V
	VIH	Input high	1.26 V	1.8 V	2.0 V
	VIL	Input low	-0.3 V	-	0.54 V
	Rpu	Pull-up resiter	55 KΩ	79 KΩ	121 KΩ
	Rpd	Pull-down resiter	51 KΩ	87 KΩ	169 KΩ
	3.0 V				
	VOH	Output high	2.4 V	-	-

Table 4: PCI Express Mini Card Connector Pin Description

Pin name	Pin No	Power Domain	Defalt Stats	Description	Comment
Power supply					
VCC	2,24,39,41,52	-	PI	Power supply for module	3.3V typical
GND	15,18,21,26,27, 29,34,35,37,40, 43,50	-	-	Ground	-
AGND	4,9	-	-	Analog ground	
Reset					
PERST#	22	-	DI,PU	Reset input (Active low)	If unused, keep open.
USB 2.0					
USB_DP	38	-	AIO	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	-	PO	Power output for USIM card, its output Voltage depends on USIM card type automatically. Its output current is up to 50mA.	-
USIM_DATA	10	P5	DIO,PU	USIM Card data I/O, which has been pulled up via a 100KR resistor to USIM_VDD internally. Do not pull it up or down externally.	-
USIM_CLK	12	P5	DO,PU	USIM clock.	Make sure the rise time and fall time of USIM_CLK less than 40ns
USIM_RST	14	P5	DO,PU	USIM Reset.	-
USIM_DET	16	P3	DI,PU	USIM card detect.	-
PCM interface					
PCM_CLK	45	P3	DO,PD	PCM data bit clock.	If these pins are unused, keep open.
PCM_OUT	47	P3	DO,PD	PCM data output	
PCM_IN	49	P3	DI,PD	PCM data input	
PCM_SYNC	51	P3	DO,PU	PCM data frame sync signal.	
UART interface					

UART_CTS	11	P3	DI,PU	Clear to Send	If unused, keep open
UART_RTS	13	P3	DO,PU	Request to send	
UART_RXD	17	P3	DI,PU	Receive Data	
UART_TXD	19	P3	DO,PU	Transmit Data	
UART_RI	44	P3	DO,PU	Ring Indicator	
UART_DTR	46	P3	DI,PU	DTE get ready	
I²C interface					
SCL	30	P3	OD,PU	I²C clock output	Pulled up inside the module; If unused, keep open 1.8V interface
SDA	32	P3	OD,PU	I²C data input/output	
Analog Audio					
MICP	1	-	AI	MIC positive input	If unused, keep open.
MICN	3	-	AI	MIC negative input	
EARP	5	-	AO	Receiver positive output	
EARN	7	-	AO	Receiver negative output	
Others					
W_DISABLE#	20	-	DI,PD	Flightmode Control	If unused, keep open.
LED_WWAN#	42	P3	DO,PD	Network Status Indication output	If unused, keep open.
NC	6,23,25,28,31,33,48	-	-	No connection	Keep open

2.4 Package Dimensions

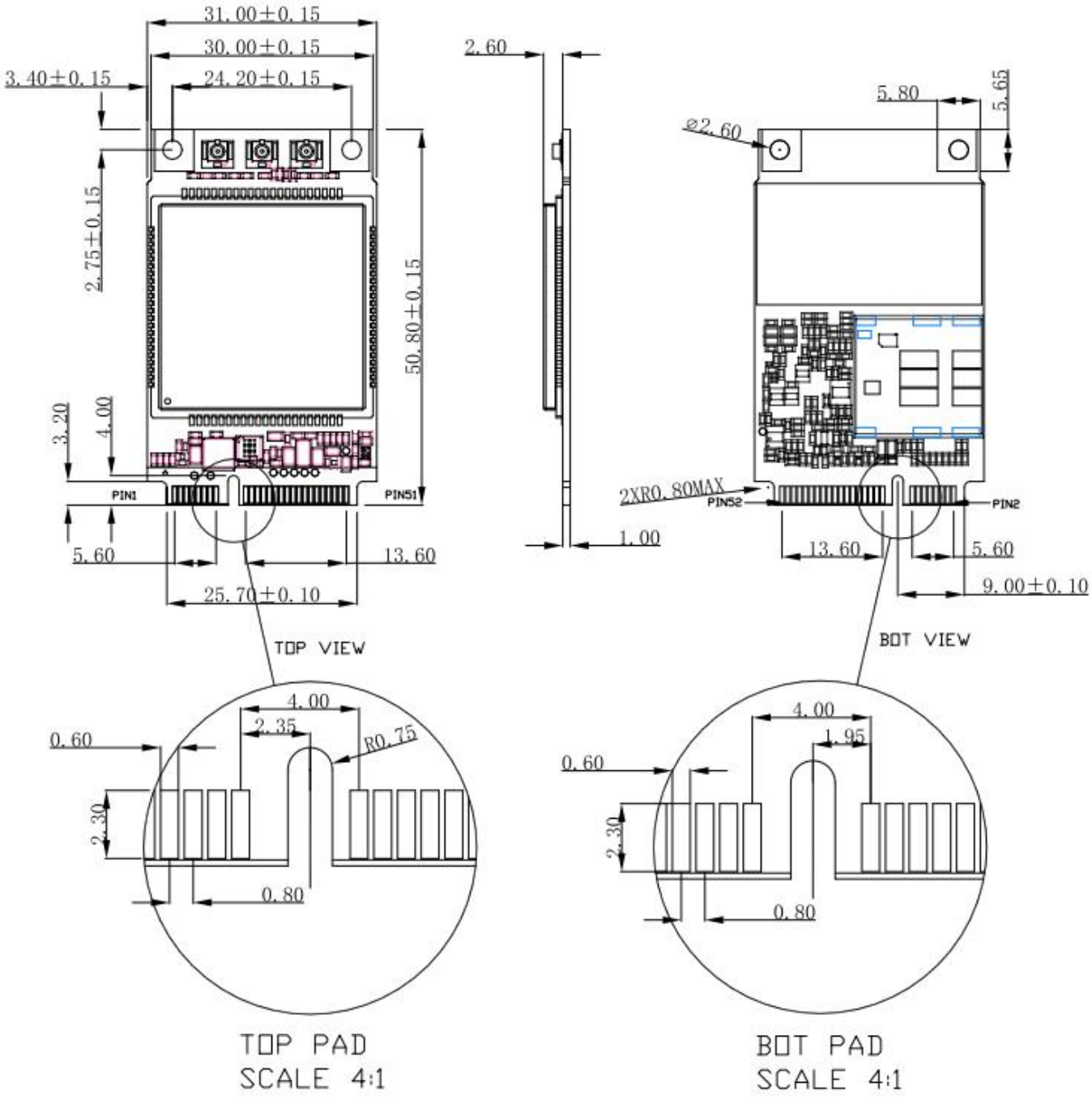


Figure 4: Dimensions of module (Unit: mm)

3 Interface Application

3.1 Power Supply

The recommended power supply voltage of module is 3.3V.

The module would be auto power on when the 3.3V appears, and customer should remove the 3.3V to power off the module. So, when customer design the power circuit, make sure the main power is controlled by host.

Table 5: Recommended 3.3V Power Supply Characteristics

Symbol	Parameter	Min	Type	Max	Unit
V_o	Power supply voltage	3.1	3.3	3.6	V
I_o	Supply current capability	-	2500	-	mA

3.2 PERST#

The module can be reset by pulling the PERST# pin down to ground. The PERST# pin has been pulled up with a resistor to VCC internally, so there is no need to pull it up externally. It is strongly recommended to put a 100nF capacitor and an ESD protection diode close to the PERST# pin. Please refer to the following figure for the recommended reference circuit.

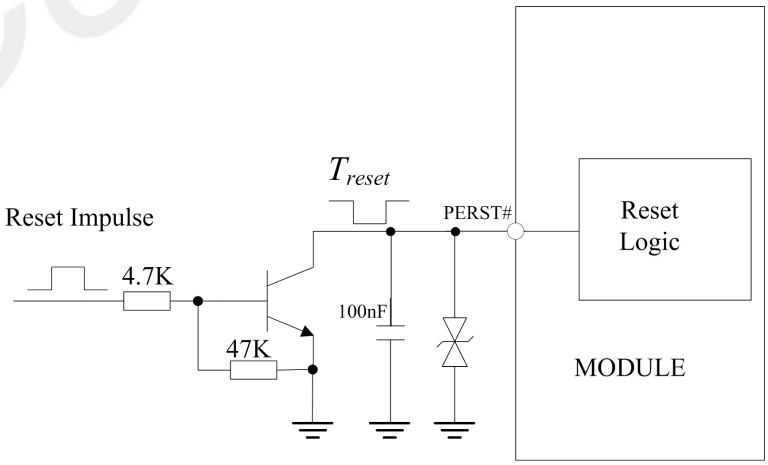


Figure 5: PERST# Reference Circuit

Table 6: PERST# Pin Electronic Characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset}	The active low level time impulse on PERST# pin to reset module	500	1000	2000	mS
V_{IH}	Input high level voltage	0.7*VCC	VCC	VCC+0.3	V
V_{IL}	Input low level voltage	-0.3	0	0.5	V

3.3 W_DISABLE#

The W_DISABLE# pin can be used to control the module to enter or exit the Flight mode. In Flight mode, the RF circuit is closed to prevent interference with other equipment and minimize current consumption.

Table 7: W_DISABLE# Pin Status

W_DISABLE# status	Module operation
Input Low Level	Flight Mode: RF is closed.
Input High Level	The module mode depends on AT+CFUN command: AT+CFUN=1: RF is working. AT+CFUN=4: RF is closed.

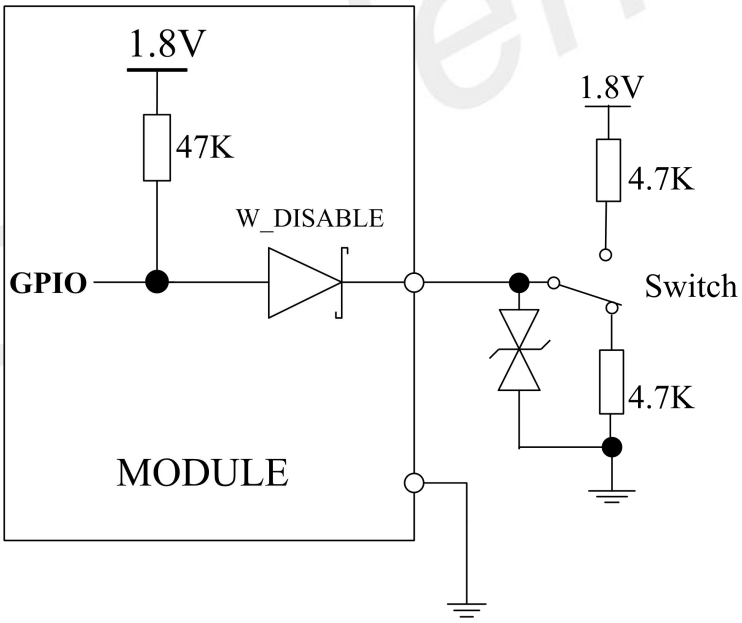


Figure 6: W_DISABLE# Reference Circuit

Table 8: W_DISABLE# Pin Electrical Characteristic

Symbol	Parameter	Min	Type	Max	Unit
V_{IH}	High-level input voltage	1.17	1.8	4.4	V
V_{IL}	Low-level input voltage	-0.3	0	0.3	V

3.4 LED_WWAN#

The LED_WWAN# pin can be used to drive a network status indication LED by default. Its status is listed in the following table.

Table 9: Network Status Indication LED Status

LED Status	Module Status
Always On	Searching Network; Call Connect(include VOLTE,SRLTE)
200ms ON, 200ms OFF	Data Transmit; 4G registered;
800ms ON, 800ms OFF	2G/3G registered network
OFF	Power off; Sleep

NOTE

NETLIGHT output low level as “OFF”, and high level as “ON”.

Reference circuit is recommended in the following figure:

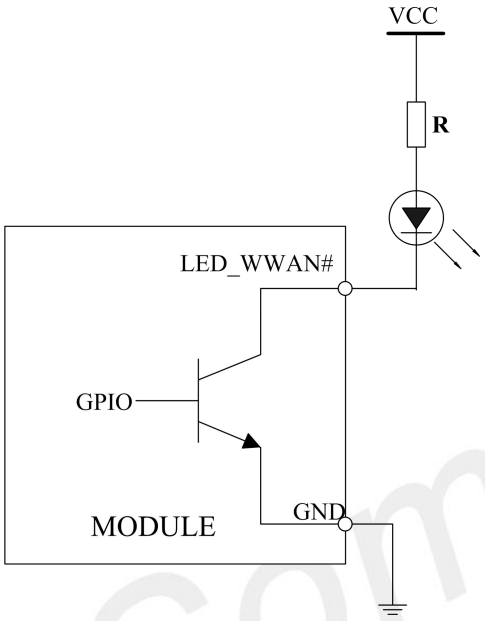


Figure 7: LED_WWAN# Reference Circuit

NOTE

The current input the LED_WWAN# should less than 50mA.The value of R should be selected by the LED character, usually the value is 1K ohm or larger.

3.5 USB Interface

The module is compliant with USB 2.0 specification. It supports full-speed and high- speed when acting as a peripheral device, but the USB charging function is not supported.

The module can be used as a USB device. Module supports the USB suspend and resume mechanism which can reduce power consumption. If there is no data transmission on the USB bus, Module will enter suspend mode automatically, and will be resumed by some events such as voice call or receiving SMS, etc.

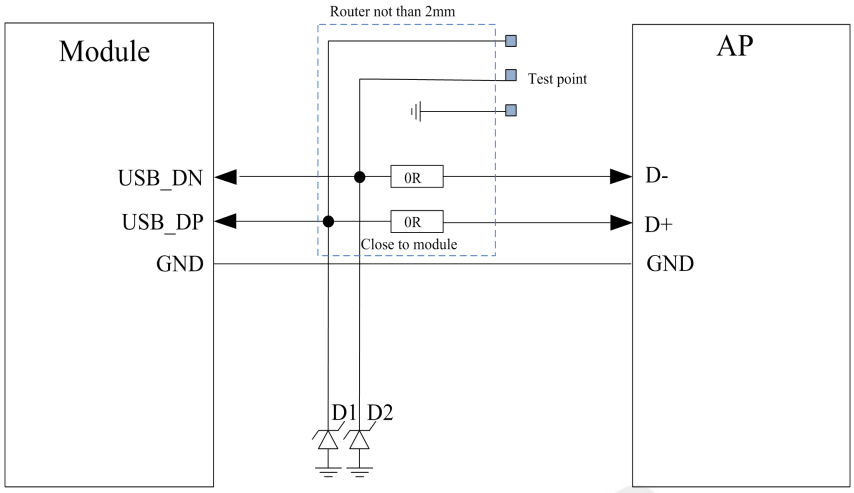


Figure 8: USB Reference Circuit

Because of the high bit rate on USB bus, please pay more attention to the influence of the junction capacitance of the ESD component on USB data lines. Typically, the capacitance should be less than 1pF. It is recommended to use an ESD protection component such as ESD5302N-3 or WE05MUC.

NOTE

1. The USB_DN and USB_DP nets must be traced by 90Ohm+/-10% differential impedance.
2. The module has two kinds of interface (UART and USB) to connect to host CPU. For example, on windows XP operating system, USB interface is mapped to 4virtual ports: “SimTech HS-USB Audio 9001”, “SimTech HS-USB AT port 9001”, “SimTech HS-USB Diagnostics 9001”, “SimTech HS-USB NMEA 9001”.
3. It is suggested to reserved test point.

3.6 USIM Interface

USIM interface complies with the GSM Phase 1 specification and the new GSM Phase 2+ specification for FAST 64 kbps USIM card. Both 1.8V and 3.0V USIM card are supported. USIM interface is powered from an internal regulator in the module.

If the customer uses the SIM card on the module, another SIM card is not supported, choose one of the two

Table 10: USIM Electronic characteristic in 1.8V mode (USIM_VDD =1.8V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	1.75	1.8	1.95	V
V_{IH}	High-level input voltage	0.65*USIM_VDD	-	USIM_VDD +0.3	V
V_{IL}	Low-level input voltage	-0.3	0	0.35*USIM_VDD	V
V_{OH}	High-level output voltage	USIM_VDD -0.45	-	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0	0.45	V

Table 11: USIM Electronic characteristic 3.0V mode (USIM_VDD =3.0V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	2.75	3.0	3.3	V
V_{IH}	High-level input voltage	0.65*USIM_VDD	-	USIM_VDD +0.3	V
V_{IL}	Low-level input voltage	-0.3	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	0.45	V

It is recommended to use an ESD protection component such as ST (www.st.com) ESDA6V-5W6. Note that the USIM peripheral circuit should be close to the USIM card socket. For more details of AT commands about USIM, please refer to document [1].

The USIM_DET pin is used for detection of the USIM card hot plug. User can select the 8-pin USIM card holder to implement USIM card detection function.

USIM_DET has been pulled up to 1.8V inside module;

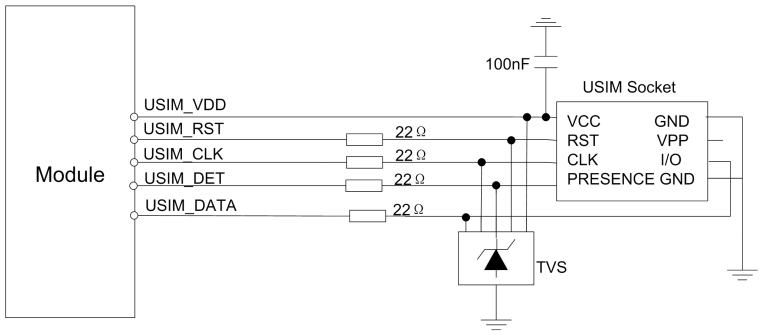


Figure 9: USIM interface reference circuit with detection function

If the USIM card detection function is not used, user can keep the USIM_DET pin open. The reference circuit of 6-pin USIM card holder is illustrated in the following figure.

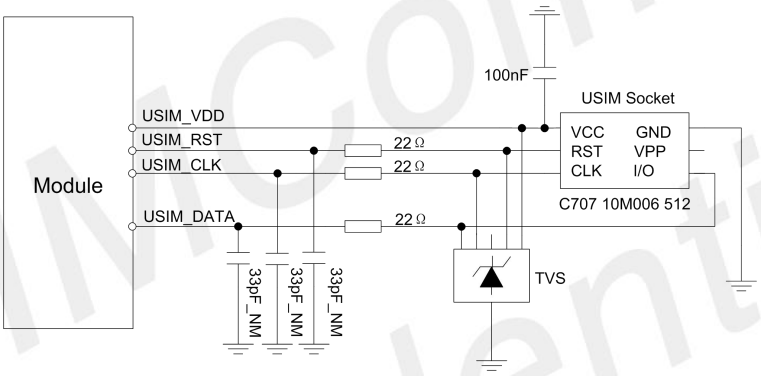


Figure 10: USIM interface reference circuit

NOTE

1. USIM_DATA has been pulled up with a 10KΩ resistor to USIM_VDD in module. A 100nF capacitor on USIM_VDD is used to reduce interference.
2. For more details of AT commands about USIM, please refer to document [1]. USIM_CLK is very important signal, the rise time and fall time of USIM_CLK should be less than 40ns, otherwise the USIM card might not be initialized correctly.
3. The recommend TVS is ESD9B5.0ST5G and AZ5315-02F.

3.7 UART Interface

The module provides one MAIN UART interface.

- **MAIN UART:** Module provides a 7-wire UART (universal asynchronous serial transmission) interface as DCE (Data Communication Equipment). AT commands and data transmission can be performed through UART interface.
  Default baud rate: 115200bps

3.7.1 MAIN UART Design Guide

The application circuit is in the following figures.

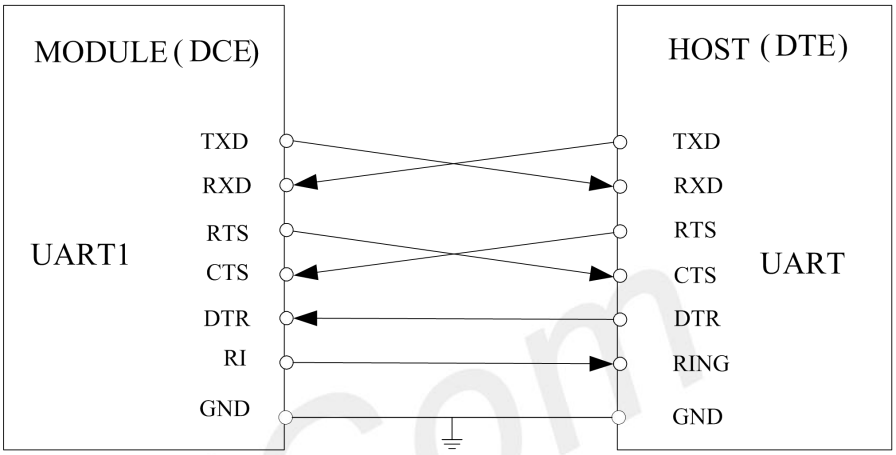


Figure 11: UART Full modem

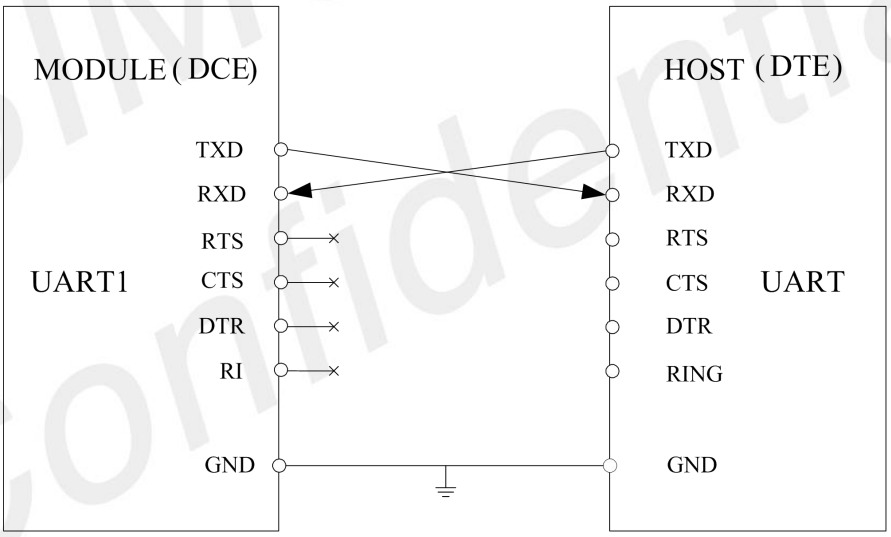


Figure 12: UART Null modem

Table 12: UART Electrical Characteristic

Symbol	Parameter	Min	Typ	Max	Unit
V_{IH}	High-level input voltage	1.17	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	0	0.63	V
V_{OH}	High-level output voltage	1.35	1.8	1.8	V
V_{OL}	Low-level output voltage	0	0	0.45	V

The module's 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.

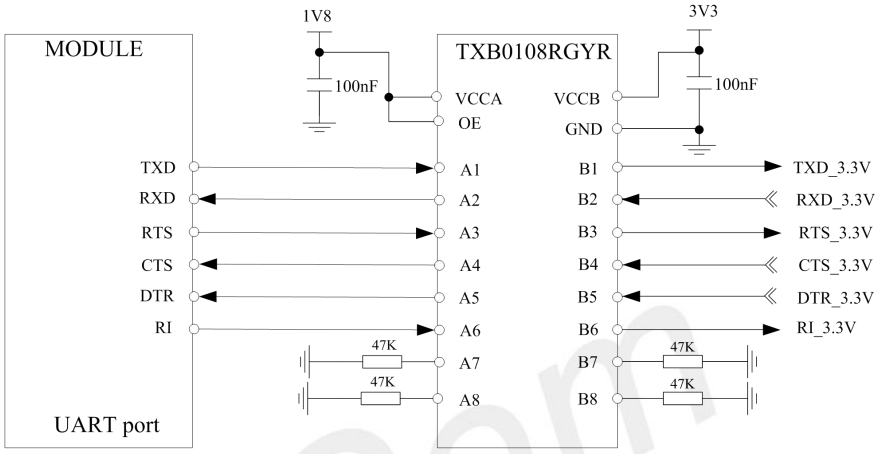


Figure 13: Reference circuit of level shift

customers can use another level shifter circuits as follow

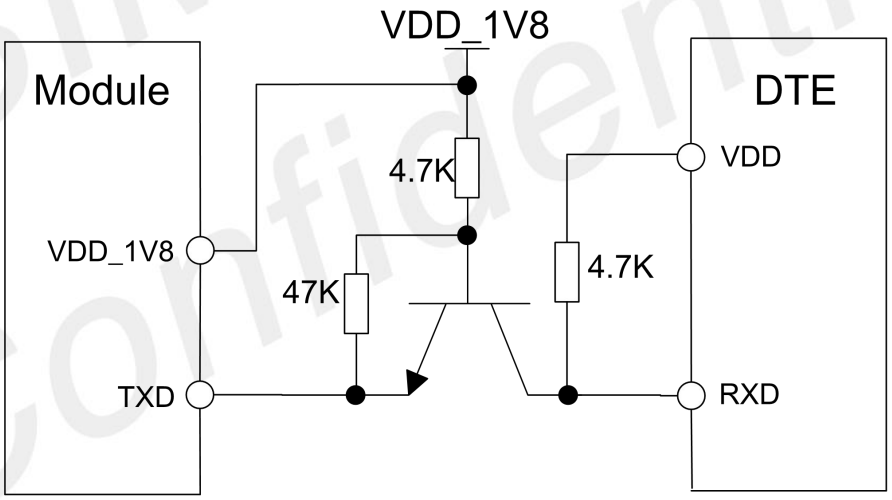


Figure 14: TX level matching circuit

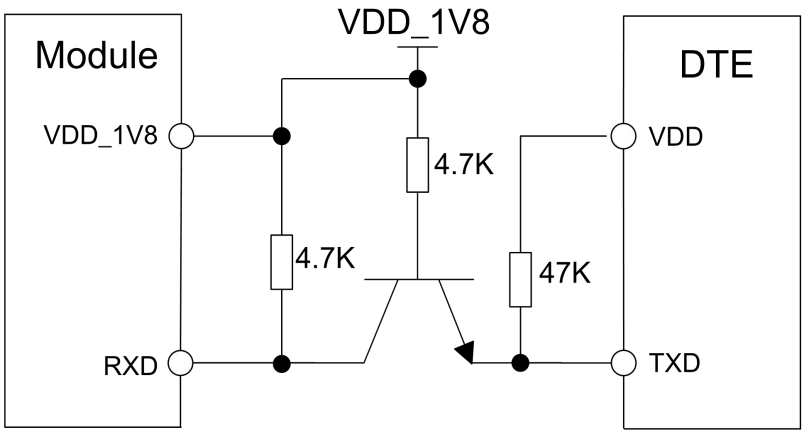


Figure 15: RX level matching circuit

To comply with RS-232-C protocol, the RS-232-C level shifter chip should be used to connect the module to the RS-232-C interface. In this connection, the TTL level and RS-232-C level are converted mutually. SIMCom recommends that user uses the SP3238ECA chip with a full modem. For more information please refers to the RS-232-C chip datasheet.

NOTE

1. User need to use high speed transistors such as MMBT3904.
2. MAIN UART supports the following baud rates: 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 1843200, 3686400 bps. The default band rate is 115200 bps.

3.7.2 RI and DTR Behavior

The RI pin can be used to interrupt output signal to inform the host controller such as application CPU.

Normally RI will keep high level until certain conditions such as receiving SMS, or a URC report coming, and then it will change to low level.

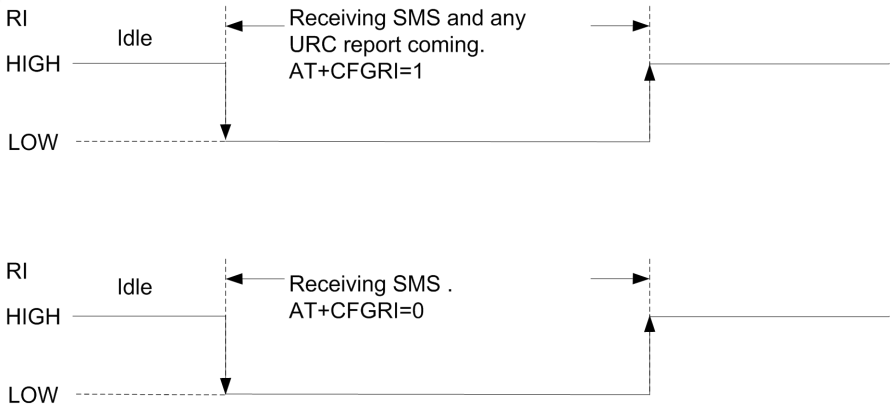


Figure 16: RI Behaviour（SMS and URC report）

Normally RI will be kept at a high level until a voice call, then it will output periodic rectangular wave with 5900 ms low level and 100ms high level. It will output this kind of periodic rectangular wave until the call is answered or hung up.

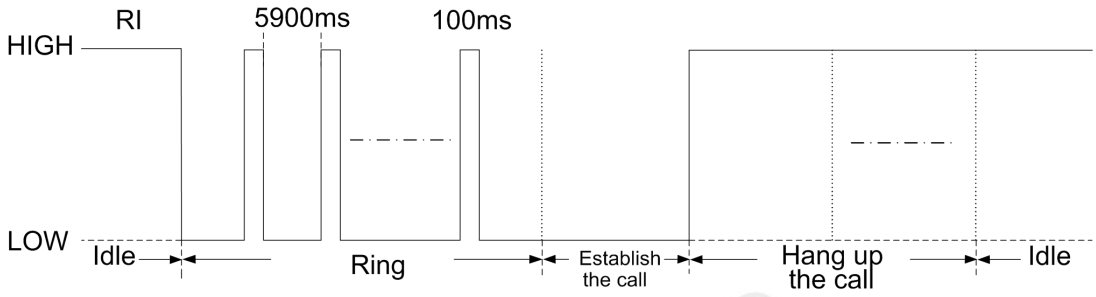


Figure 17: RI Behaviour（Voice Call）

NOTE

For more details of AT commands about UART, please refer to document [1] .

3.7.3 DTR function

After sending the sleep command, pull up DTR, close the serial port, and unload the corresponding bus device on the PC side at the same time, and the module enters sleep ; After the module sleeps, it can be awakened by pulling down DTR.

3.8 I2C Interface

The module provides I²C interface compatible with I²C specification, with clock rate up to 400 kbps. Its operation voltage is 1.8V.

The following figure shows the I²C bus reference design.

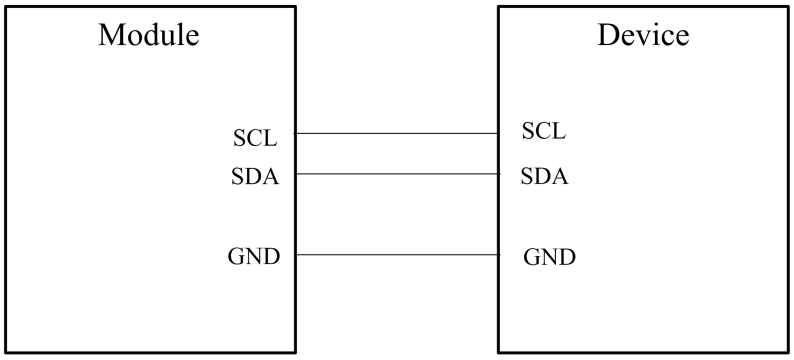


Figure 18: I2C Reference Circuit

NOTE

SDA and SCL are pulled up to 1.8V via 2.2K resistors in module. So external pull up resistors are not needed in application circuit. For more details about I²C AT commands please refer to document [1].

Table 13: I2C Electrical Characteristic

Symbol	Parameter	Min	Typ	Max	Unit
V_{IH}	High-level input voltage	1.17	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	0	0.63	V
V_{OH}	High-level output voltage	1.35	1.8	1.8	V
V_{OL}	Low-level output voltage	0	0	0.45	V

3.9 PCM

PCM interface can be used in short sync master mode only, and only supports 16 bits linear format

Table 14: PCM Specification

Characteristics	Specification
Line Interface Format	Linear (Fixed)
Data length	16bits (Fixed)
PCM Clock/Sync Source	Master Mode (Fixed)
PCM Clock Rate	2048kHz（2G/3G）,4096Khz (4G
PCM Sync Format	Short sync (Fixed)
Data Ordering	MSB

NOTE

PCM interface can be control by AT command. For more details, please refer to document [1]

Table 15: PCM DC Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_{IH}	High-level input voltage	1.17	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	0	0.63	V
V_{OH}	High-level output voltage	1.35	1.8	1.8	V
V_{OL}	Low-level output voltage	0	0	0.45	V

NOTE

The remaining functions are to be developed.

3.10 Analog Audio Interface

MICP/N is used as microphone input; EARP/N is used as audio output.

Table 16: MIC input characteristics

Parameter	Min	Typ	Max	Unit
Mic biasing voltage		1.80		V
Working Current			3	mA
External Microphone Load Resistance	1.2	2.2		KΩ

Table 17: Audio output characteristics

Parameter	Min	Typ	Max	Unit
Load resistance	27	32	-	Ω
Output power	-	50	-	mW

GSM signals can interfere with audio through coupling and conduction. Users can filter out coupling interference by adding 33pF and 10pF capacitors to the audio path. The 33pF capacitor mainly filters out the interference in the GSM900 frequency band, and the 10pF capacitor mainly filters out the interference in the DCS1800 frequency band. The coupling interference of TDD has a lot to do with the user's PCB design. In some cases, the TDD in the 900 frequency band is more serious, and in some cases, the TDD interference in the 1800 frequency band is serious. Therefore, users can select the required filter capacitors according to the actual test results, and sometimes even do not need to paste filter capacitors.

The GSM antenna is the main source of coupling interference for TDD, so users should pay attention to keeping the audio trace away from the RF antenna and VBAT during PCB layout and routing. It is best to place a set of audio filter capacitors close to the module end, and another set close to the interface end. The audio output should be routed according to the differential signal rules.

The conducted interference is mainly caused by the voltage drop of VBAT. If the Audio PA is directly powered by VBAT, it is easier to hear the "squeak" sound at the output end of the SPK. Therefore, it is best to connect the input end of the Audio PA in parallel in the schematic design. Some bulk capacitors and ferrite beads in series.

TDD and GND are also closely related. If the GND is not handled properly, many high-frequency interference signals will interfere with the MIC and Speaker through bypass capacitors and other devices. Therefore, it is very important for the user to ensure the good performance of the GND during the PCB design stage.

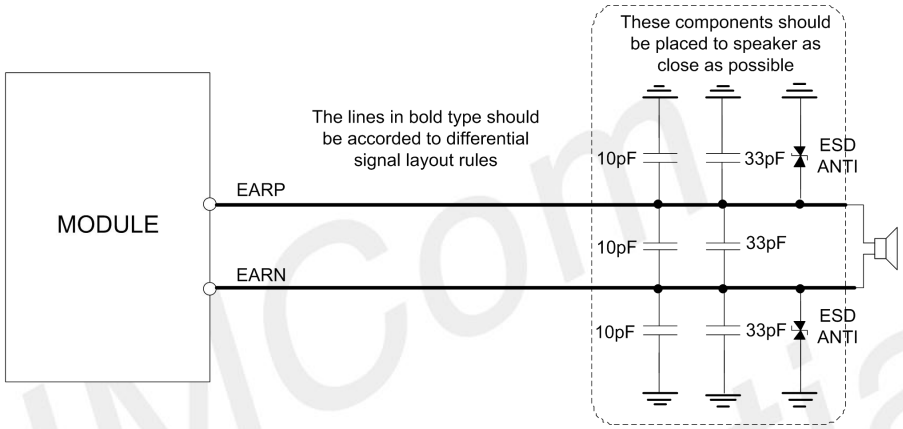


Figure 19: Receiver interface configuration

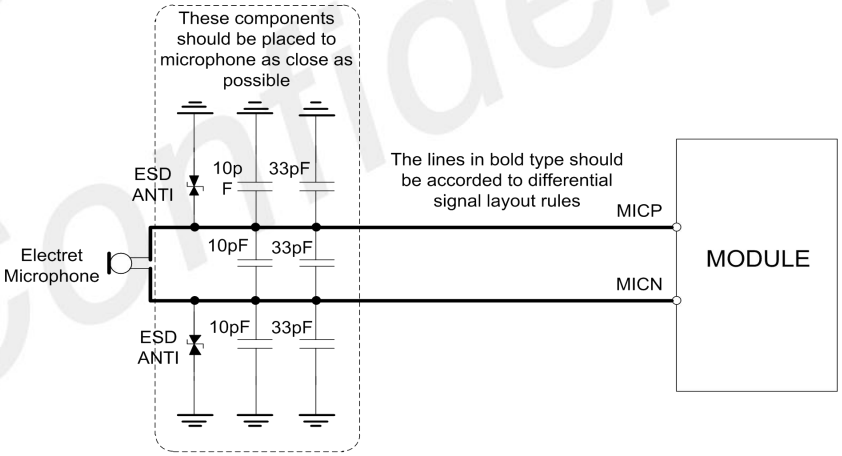


Figure 20: Microphone interface configuration

NOTE

1. Module has integrated MIC bias circuit. There is no need to pull the MICP and MICN up to the external power, just connect it to microphone. MICP and MICN must be differential lines.
2. The recommend TVS is ESD9X5V-2 or ESD9B5.0ST5G.

3.11 GNSS Control Interface

The GNSS function is optional.

3.11.1 GNSS control

If you only want to enable/disable GNSS control, please execute AT+CGNSSPWR=1 or AT+CGNSSPWR=0.

When using AP_Flash fast hot start mode, you need to execute AT+CGNSSPWR=0,1 to store the positioning data in the module after the GNSS is set to the upper position for the first time. When AT+CGNSSPWR=1,1 is executed next time, the positioning data will be loaded into GNSS again. In ASR1601, this command can only control the GNSS module by pulling up/down the power pin.

Table 18: VGNSS AT control command

AT+CGNSSPWR GNSS power control	
Test Command **AT+CGNSSPWR=?**	Response **+CGNSSPWR: (0,1)** **OK**
Read Command **AT+CGNSSPWR?**	Response **+CGNSSPWR: 0/1** **OK**
Write Command **AT+CGNSSPWR=<on/off>**	Response 1)If successfully: **OK** 2)If failed: **ERROR**

Defined Values

<on/off>	0 Close GPS 1 Active GPS

3.12 Test point

3.12.1 DEBUG_UART

The module has reserved test points. Used for log output. Default baud rate: 115200 bps.

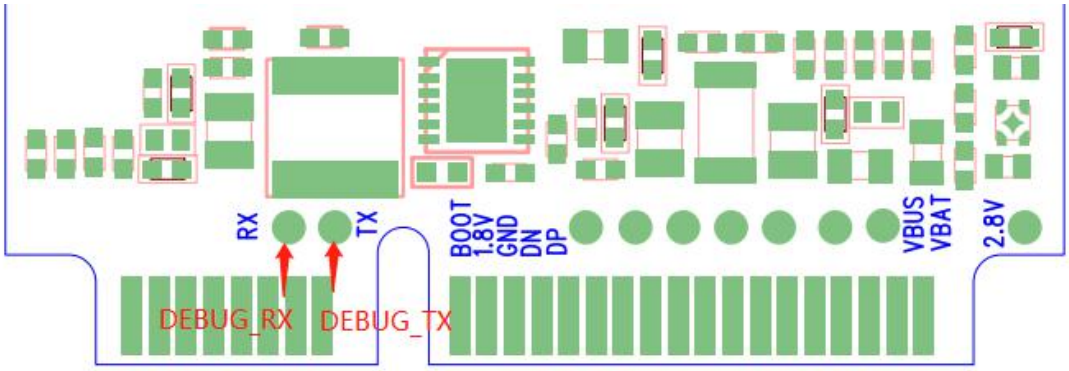


Figure 21: DEBUG_UART

3.12.2 USB_BOOT

Before the module is powered on, USB_BOOT is pulled down to GND, and then powered on, the system will enter the download mode.

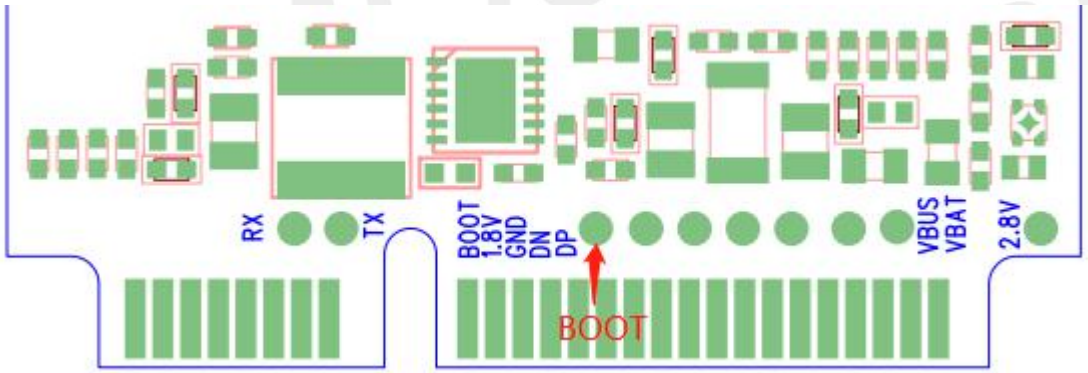


Figure 22: USB_BOOT

Table 19: Audio output characteristics

Test point name	I/O	Power domain	Default status	Index
USB_BOOT	DI	1.8 V	B-PU	

If the module download failed, then customer can make module enter download mode via this Pin.
Before the module power on, pull the USB_BOOT to ground，then push the PWRKEY to power on module, when the module enter download mode, the pull down should be removed.

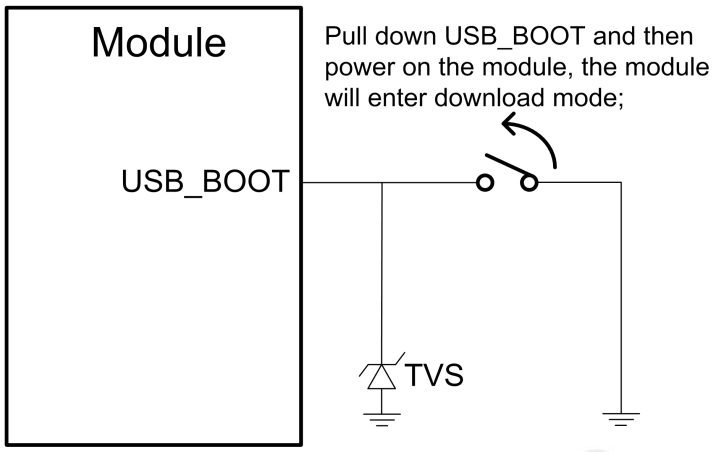


Figure 23: USB_BOOT Circuit

4 RF Specifications

4.1 GSM/WCDMA/LTE

Table 20: Conducted transmission power

Frequency	Power	Min.
GSM850	33dBm ±2dB	5dBm ± 5dB
EGSM900	33dBm ±2dB	5dBm ± 5dB
DCS1800	30dBm ±2dB	0dBm ± 5dB
PCS1900	30dBm ±2dB	0dBm ± 5dB
GSM850 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
EGSM900 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
DCS1800 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
PCS1900 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
WCDMA B1	24dBm +1/-3dB	<-50dBm
WCDMA B2	24dBm +1/-3dB	<-50dBm
WCDMA B5	24dBm +1/-3dB	<-50dBm
WCDMA B8	24dBm + 1/-3dB	<-50dBm

LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD B2	23dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23dBm +/-2.7dB	<-40dBm
LTE-FDD B4	23dBm +/-2.7dB	<-40dBm
LTE-FDD B5	23dBm +/-2.7dB	<-40dBm
LTE-FDD B7	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm
LTE-FDD B20	23dBm +/-2.7dB	<-40dBm
LTE-FDD B28	23dBm +/-2.7dB	<-40dBm
LTE-FDD B66	23dBm +/-2.7dB	<-40dBm
LTE-TDD B34	23dBm +/-2.7dB	<-40dBm
LTE-TDD B38	23dBm +/-2.7dB	<-40dBm
LTE-TDD B39	23dBm +/-2.7dB	<-40dBm
LTE-TDD B40	23dBm +/-2.7dB	<-40dBm
LTE-TDD B41	23dBm +/-2.7dB	<-40dBm

Table 21: Operating frequencies

Frequency	Receiving	Transmission
GSM850	869～894MHz	824～849 MHz
EGSM900	925～960MHz	880～915 MHz
DCS1800	1805～1880 MHz	1710～1785 MHz
PCS1900	1930~1990 MHz	1850~1910 MHz
WCDMA B1	2110～2170 MHz	1920～1980 MHz
WCDMA B2	1930~1990 MHz	1850~1910 MHz
WCDMA B5	869～894 MHz	824～849 MHz
WCDMA B8	925～960 MHz	880～915 MHz
GPS	1574.4 ～1576.44 MHz	-
GLONASS	1598 ～1606 MHz	-
BD	1559 ～1563 MHz	

NOTE

The LTE Operating frequencies are shown in the following Table 20.

Table 22: E-UTRA operating bands

E-UTRA Operating Band	Uplink (UL) operating band	Downlink (DL) operating band	Duplex Mode

1	1920 ~1980 MHz	2110 ~2170 MHz	FDD
2	1850~1910 MHz	1930~1990 MHz	FDD
3	1710 ~1785 MHz	1805 ~1880 MHz	FDD
4	1710~1755MHz	2110~2155MHz	FDD
5	824～849 MHz	869～894MHz	FDD
7	2500~2570MHz	2620~2690MHz	FDD
8	880 ~915 MHz	925 ~960 MHz	FDD
20	832~862MHz	791~ 821MHz	FDD
28	703~748MHz	758~803MHz	FDD
66	1710~1780MHz	2110~2200MHz	FDD
34	2010~2025MHz	2010~2025MHz	TDD
38	2570 ~2620 MHz	2570 ~2620 MHz	TDD
39	1880~1920MHz	1880~1920MHz	TDD
40	2300 ~2400 MHz	2300 ~2400 MHz	TDD
41	2496~2690 MHz	2496~2690 MHz	TDD

Table 23: Conducted receive sensitivity

Frequency	Receive sensitivity(Typical)	Receive sensitivity(MAX)
GSM850	< -109dBm	3GPP
EGSM900	< -109dBm	3GPP
DCS1800	< -109dBm	3GPP
PCS1900	< -109dBm	3GPP
WCDMA B1	< -110dBm	3GPP
WCDMA B2	< -110dBm	3GPP
WCDMA B5	< -110dBm	3GPP
WCDMA B8	< -110dBm	3GPP
LTE FDD/TDD	See table 22.	3GPP

Table 24: Reference sensitivity (QPSK)

E-UTRA band	3GPP standard							Test Value
	1.4 MHz	3 MHz	5 MHz	10 MHz	5 MHz	15 MHz	20 MHz	
FDD B1	-	-	-100	-97	-95.2	-94	FDD	-985
FDD B2	-102.7	-99.7	-98	-95	-93.2	-92	FDD	-98.5
FDD B3	-101.7	-98.7	-97	-94	-92.2	-91	FDD	-99
FDD B4	-104.7	-101.7	-100	-97	-95.2	-94	FDD	-98
FDD B5	-103.2	-100.2	-98	-95			FDD	-99.5
FDD B7			-98	-95	-93.2	-92	FDD	-96.5
FDD B8	-102.2	-99.2	-97	-94			FDD	-98.5

FDD B20			-97	-94	-91.2	-90	FDD	-96.5
FDD B28		-100.2	-98.5	-95.5	-93.7	-91	FDD	99.5
FDD B66	-104.7	-101.7	-100	-97	-95.2	-94	FDD	-98.5
FDD B34			-100	-97	-95.2		TDD	-99
FDD B38	-	-	-100	-97	-95.2	-94	TDD	-97.5
FDD B39			-100	-97	-95.2		TDD	-99.5
FDD B40	-	-	-100	-97	-95.2	-94	TDD	-98
FDD B41	-	-	-99	-96	-94.2	-93	TDD	-99

NOTE

Test value @ 10MHz

4.2 RF Antenna Connector

The module have 3 antenna connectors, one of which is the GSM/UMTS/LTE main antenna connector, the others are UMTS/LTE auxiliary antenna connector and GPS/GLONASS antenna connector. Recommended antenna characteristics of the module are described by 2 following tables.

Table 25: Recommended Passive Antenna Characteristics

Passive	Recommended standard
Direction	omnidirectional
Gain	> -3dBi (Avg)
Input impedance	50 ohm
Efficiency	> 50 %
VSWR	< 2

Table 26: Recommended Active Antenna Characteristics

	Performance	
Band	TRP	TIS
GSM850	≧ 29dBm	≦ -104dBm
EGSM900	≧ 29dBm	≦ -104dBm
DCS1800	≧ 26dBm	≦ -104dBm
PCS1900	≧ 26dBm	≦ -104dBm
WCDMA B1	≧ 19dBm	≦ -104dBm
WCDMA B2	≧ 19dBm	≦ -104dBm
WCDMA B5	≧ 19dBm	≦ -104dBm
WCDMA B8	≧ 19dBm	≦ -104dBm
LTE B1	≧ 18dBm	≦ -92dBm(10MHz)
LTE B2	≧ 18dBm	≦ -92dBm(10MHz)
LTE B3	≧ 18dBm	≦ -89dBm(10MHz)
LTE B4	≧ 18dBm	≦ -89dBm(10MHz)
LTE B5	≧ 18dBm	≦ -89dBm(10MHz)
LTE B7	≧ 18dBm	≦ -89dBm(10MHz)
LTE B8	≧ 18dBm	≦ -89dBm(10MHz)
LTE B20	≧ 18dBm	≦ -89dBm(10MHz)
LTE B28	≧ 18dBm	≦ -89dBm(10MHz)
LTE B66	≧ 18dBm	≦ -89dBm(10MHz)
LTE B34	≧ 18dBm	≦ -92dBm(10MHz)
LTE B38	≧ 18dBm	≦ -92dBm(10MHz)

LTE B39	≧ 18dBm	≦ -92dBm(10MHz)
LTE B40	≧ 18dBm	≦ -92dBm(10MHz)
LTE B41	≧ 18dBm	≦ -91dBm(10MHz)

NOTE

The above LTE only test 10MHZ bandwidth

The RF connector in the module side is an ultra small surface mount coaxial connector (Part Number: U.FL-R-SMT, vended by HRS). It has high performance with wide frequency range, surface mountable and reflows solderable. Following are parameters (Figure 19). Certainly user can visit http://www.hirose-connectors.com/ for more information.

To get good RF performance in user's design, SIMCom suggests user to use the matching RF adapter cable which is also supplied by HRS (Part Number: U.FL-LP（V）-040), the following figure (Figure 20) is the dimensions of U.FL series RF adapter cable. User can contact SIMCom for more information.

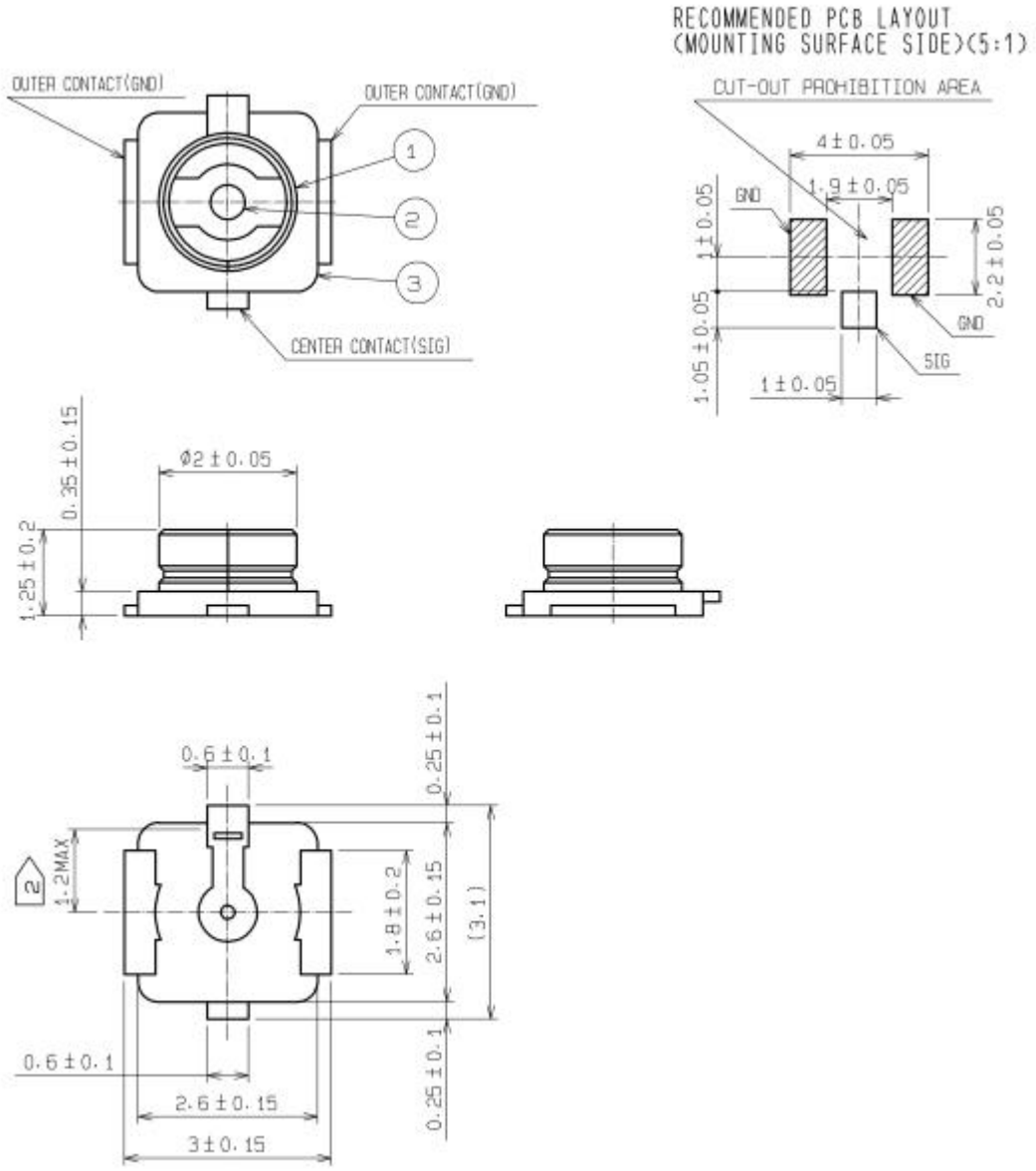
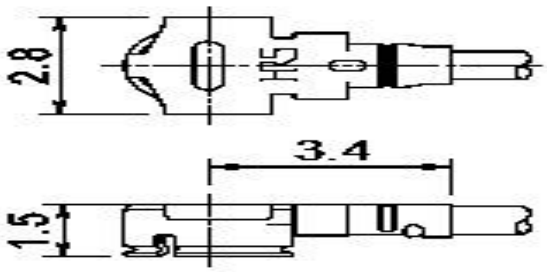


Figure 24: U.FL-R-SMT (Unit: mm)



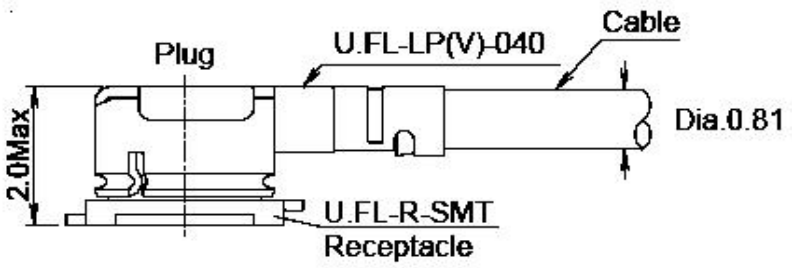


Figure 25: U.FL series RF adapter cable (Unit: mm)

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

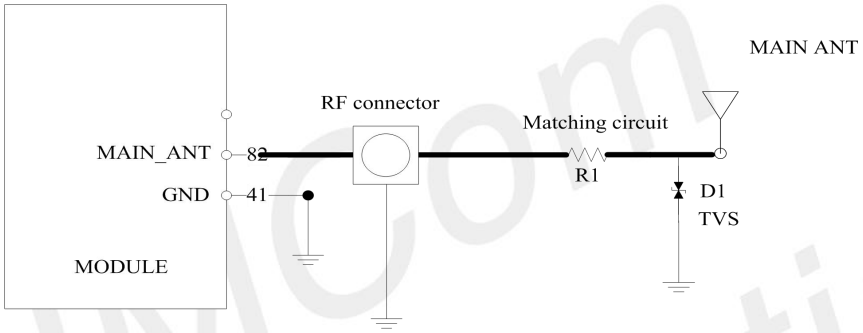


Figure 26: Antenna matching circuit (MAIN_ANT)

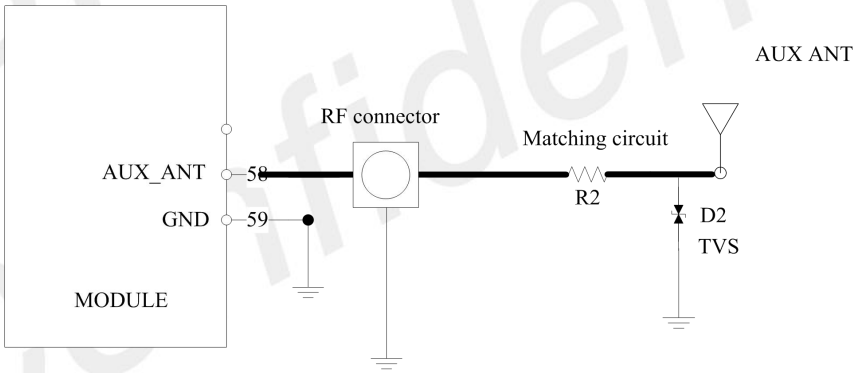


Figure 27: Antenna matching circuit (AUX_ANT)

In above figure, the component R1/R2 is reserved for antenna matching, the value of components can only be got after the antenna tuning, usually, The RF test connector in the figure is used for the conducted RF performance test, and should be placed as close as to the module's antenna pin. The traces impedance between components must be controlled in 50Ω. The component D1/D2 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 27: TVS part number list

Package	Type	Supplier
0402	PESD0402-03	PRISEMI
0402	PESD0402-12	PRISEMI

NOTE

SIMCom suggests the LTE auxiliary antenna to be kept on, since there are many high bands in the designing of LTE-TDD, such as band38, band40 and band41.

4.3 GNSS

Module merges GNSS (GPS/GLONASS/BD/QZSS GALILEO) satellite and network information to provide a high-availability solution that offers industry-leading accuracy and performance. This solution performs well, even in very challenging environmental conditions where conventional GNSS receivers fail, and provides a platform to enable wireless operators to address both location-based services and emergency mandates.

4.3.1 GNSS Technical specification

- Tracking sensitivity: -159 dBm（GPS）/-158 dBm（GLONASS）/-159 dBm（BD）/-159 dBm（GALILEO）
- Cold-start sensitivity: -148 dBm
- Accuracy (Open Sky): 2.5 m (CEP50)
- TTFF (Open Sky): Hot start <1 s, Cold start<35 s
- Receiver Type: 16-channel, C/A Code
- GPS L1 Frequency: 1575.42±1.023 MHz
- GLONASS: 1597.5~1605.8 MHz
- BD: 1559.05~1563.14 MHz
- GALILEO: 1575.42±1.023 MHz
- Update rate: Default 1 Hz
- GNSS data format: NMEA-0183
- GNSS Current consumption: 100mA (GSM/UMTS/LTE Sleep ,in total on VBAT pins)
- GNSS antenna: Passive/Active antenna

4.3.2 GNSS Application Guide

Users can adopt an active antenna or a passive antenna to module. If using a passive antenna, an external LNA is a must to get better performance.

The following figure is the reference circuits.

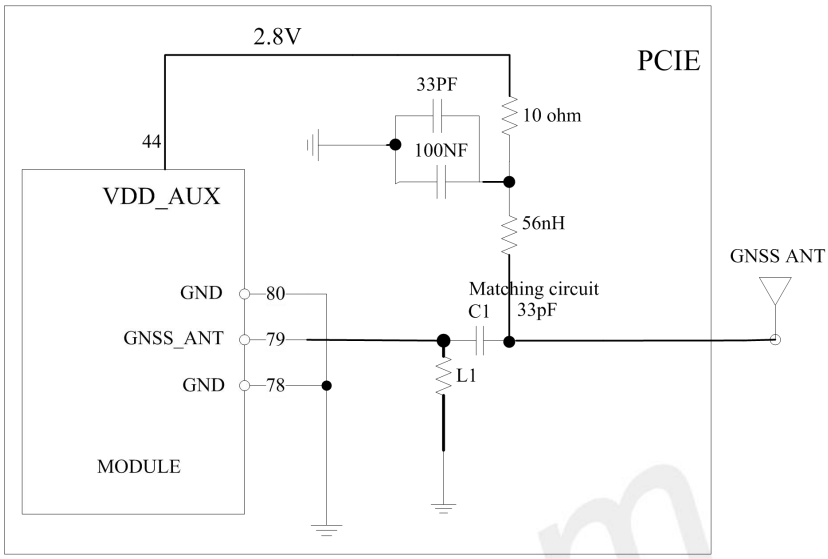


Figure 28: Active Antenna Circuit

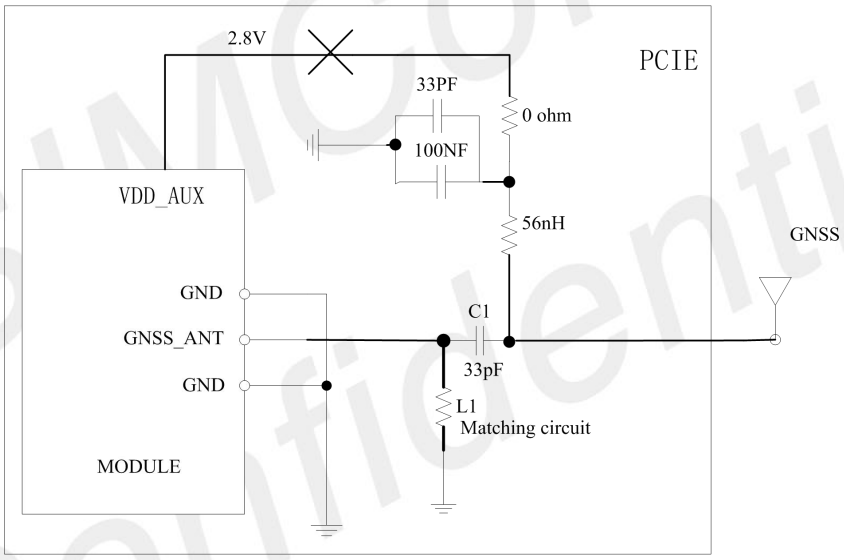


Figure 29: Passive antenna circuit

In above two figures, the component C1 is used for DC isolation, and L1 is used for antenna matching, the value of it can be obtained after the antenna tuning usually, so the default value is NC. In active antenna circuit, users also can use an external LDO/DCDC to provide VDD voltage which value should be taken according to active antenna characteristic, and VDD can be shut down to avoid consuming additional current when not being used.

Users can adopt an active antenna as GNSS signal receiver. The following is the reference circuit.
This command is used to control the power supply of the built-in LNA of the active antenna.

Table 28: VDD_AUX AT control command

AT+CVAUXS Set state of the pin named VDD_AUX	
Test Command **AT+CVAUXS=?**	Response 1) **+CVAUXS: (**list of supported **<state>s)** **OK**
Read Command **AT+CVAUXS?**	Response **+CVAUXS: <state>** **OK**
Write Command **AT+CVAUXS=<state>**	Response 1) **OK** 2) **ERROR**
Defined Values	
<state>	0 output of the pin disabled. 1 output of the pin enabled.

NOTE

1.If the antenna is active type, the power should be given by main board because there is no power supply on the GPS antenna pad. If the antenna is passive, it is suggested that the external LNA should be used.
2.If customer need save the power when the GNSS function is disabled, then customer should design a switch circuit to cut off the active antenna power to get a lower power consumption.

4.3.3 GNSS Operate Mode

The module supports A-GPS, A-GPS includes mobile-assisted and mobile-based mode.

In mobile-assisted mode, when a request for position location is issued, available network information is provided to the location server (e.g. Cell-ID) and assistance is requested from the location server. The location server sends the assistance information to the handset. The handset/mobile unit measures the GNSS observables and provides the GNSS measurements along with available network data (that is appropriate for the given air interface technology) to the location server. The location server then calculates the position location and returns results to the requesting entity.

In mobile-based mode, the assistant data provided by the location server encompasses not only the information required to assist the handset in measuring the satellite signals, but also the information required to calculate the handset's position. Therefore, rather than provide the GNSS measurements and available network data back to the location server, the mobile calculates the location on the handset and passes the result to the requesting entity.

In standalone (autonomous) mode, the handset demodulates the data directly from the GNSS satellites. This mode has some reduced cold-start sensitivity, and a longer time to first fix as compared to the assisted modes. However, it requires no server interaction and works out of network coverage.

This combination of GNSS measurements and available network information provides:

- High-sensitivity solution that works in all terrains: Indoor, outdoor, urban, and rural
- High availability that is enabled by using both satellite and network information

Therefore, while network solutions typically perform poorly in rural areas and areas of poor cell geometry/density, and while unassisted, GNSS-only solutions typically perform poorly indoors. The module's GNSS solution provides optimal time to fix, accuracy, sensitivity, availability, and reduced network utilization in both of these environments, depending on the given condition.

GNSS can be used by NMEA port. User can select NMEA as output through USB. NMEA sentences are automatic and no command is provided. NMEA sentences include GSV, GGA, RMC, GSA, and VTG. Before using GNSS, user should configure module in proper operating mode by AT command. Please refer to related document for details. Module can also get position location information through AT directly.

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 29: Absolute maximum ratings

Symbol	Parameter	Min	Type	Max	Unit
V_{CC}	VCC input voltage	-0.3	3.3	4.6	V
V_{IO}	Voltage at digital pins (1.8V digital I/O) *	-0.3	-	2.1	V

NOTE

These parameters are for digital interface pins, such as I^2C, UART, GPIO.

5.2 Recommended Operating Conditions

Please refer to the follow table for recommended operating conditions.

Table 30: Operating Conditions

Symbol	Parameter	Min	Type	Max	Unit
V_{CC}	3.3V Input voltage	3.1	3.3	4.6	V
V_{IO}	Voltage at digital pins (1.8V digital I/O)	0	1.8	1.95	V
T_{OPER}	Operating temperature	-40	+25	+85	℃
T_{STG}	Storage temperature	-45	+25	+90	℃

5.3 Operating Mode

5.3.1 Operating Mode

The table below summarizes the various operating modes of the module.

Table 31: Operating Mode

Mode		Function
Normal operation	GSM/UMTS/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, call, SMS and TCP/UDP.
	GSM /UMTS/LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	GSM /UMTS/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.
	GPRS/EDGE/UMTS/LTE/WIFI 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/UMTS/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.
Power off		Customer could cut off the VCC to power off module.

5.3.2 Power saving mode

The module has two power saving modes: minimum functionality mode and sleep mode. In which module will achieve lower power consumption for power saving.

5.3.3 Sleep mode

In sleep mode, the current consumption of module will be reduced to the minimal level, and module can still receive paging message, SMS, TCP and UDP.
The module has two sleep modes, the corresponding floor current in each mode is different, and the two

modes can be switched by AT command

- AT*CPCBTYPE=0,0: floor current 2.5mA@3.3V(Default) (CFUN=0)；
- AT*CPCBTYPE=0,1: floor current 1.5mA@3.3V(CFUN=0).

There are three steps to let the module enter into the sleep mode:

- Execute AT command **AT+CVAUXS=0** to power off the antenna;
- Execute AT command **AT+CGNSSPWR=0, AT+CGNSSTST=0** to turn off the GPS power supply;
- Execute AT command **AT+CSCLK=1** to enable the sleep mode;

The following is a detailed explanation of the two sleep modes

5.3.3.1 USB suspend mode

When the host supports the USB suspend function, this mode can be used for hibernation.In this mode, the USB power supply will always supply power. At this time, the module can be hibernated by controlling the host to hibernate. When the host exits the sleep mode, the module also exits the sleep mode, and the sleep current in this mode is about 2.5mA. The following is a flow chart of module sleep and wake-up in this mode

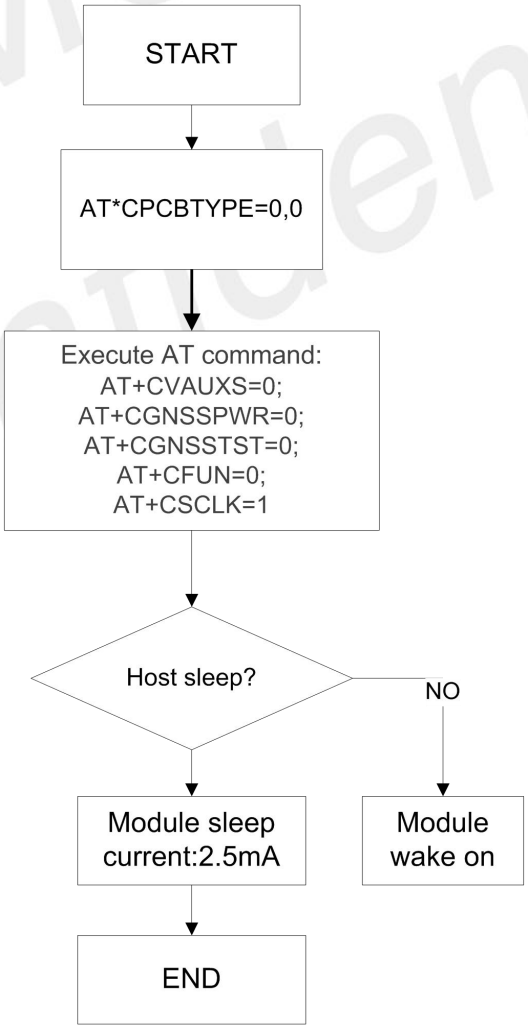


Figure 30:Module sleep(USB suspend mode)

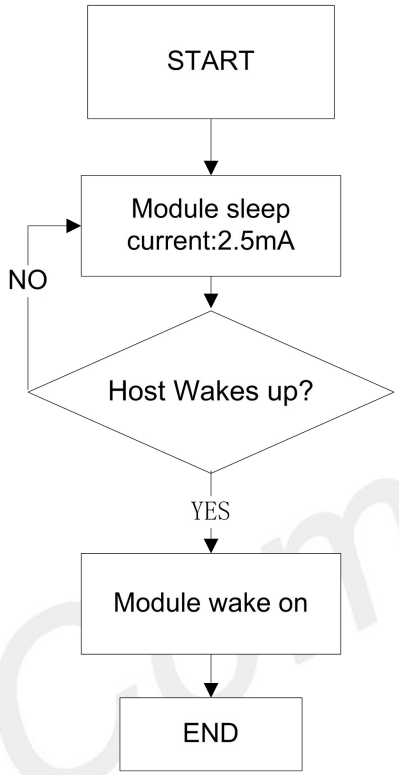


Figure 31: Module wakes up(USB suspend mode)

5.3.3.2 USB voltage controllable mode

In this mode, when the module is working normally, the USB power supply keeps supplying power. When the module sleeps, the USB power supply is disconnected. At this time, the module can be hibernated by controlling the host to sleep. However, when the module wakes up, it needs to pull down DTR externally, and the module will wake up after the running host exits dormancy. The sleep current in this mode is about 1.5mA.

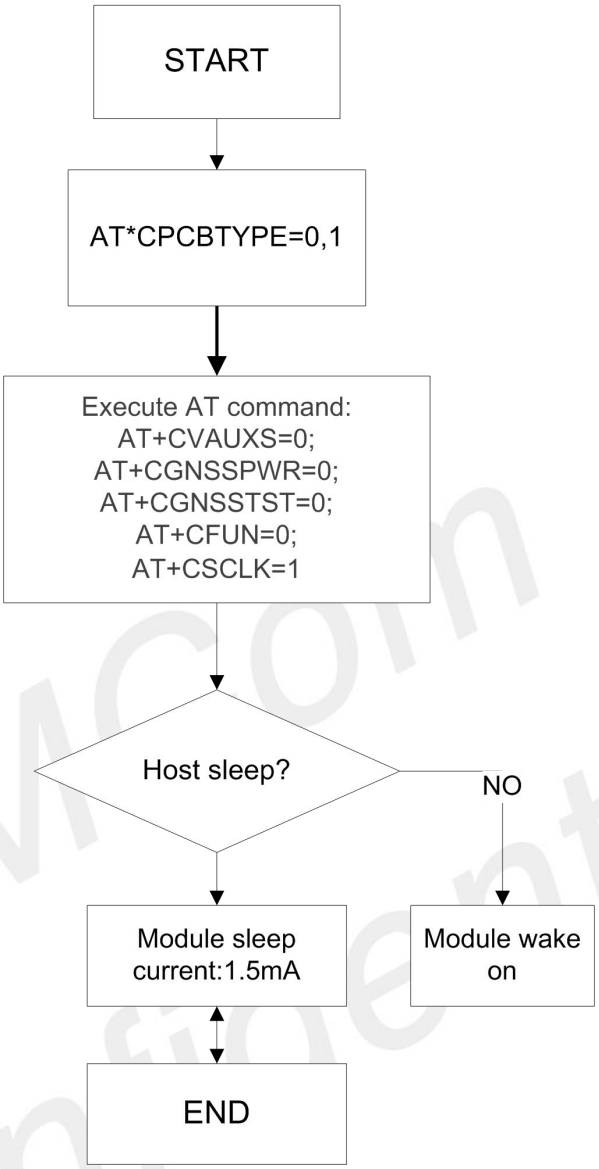


Figure 32: Module sleep(USB voltage controllable mode)

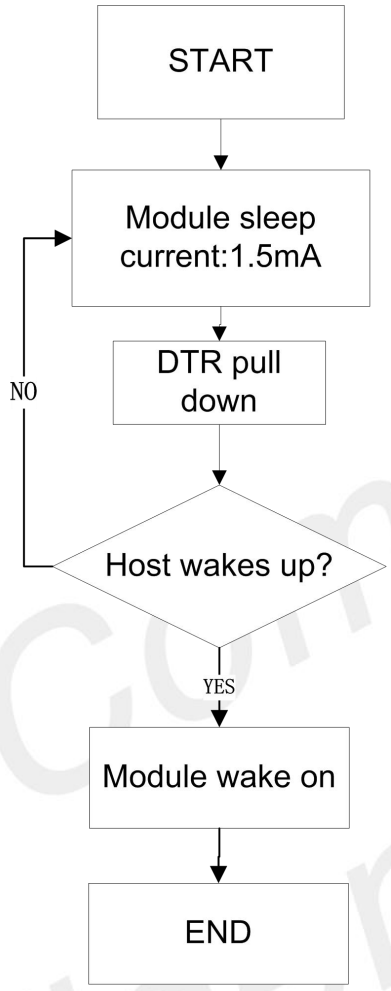


Figure 33: Module wakes up(USB voltage controllable mode)

The corresponding sleep currents in the two different modes are different. Customers can choose the appropriate sleep mode according to actual needs.

Others hardware and software conditions must be satisfied together in order to let module enter into sleep mode:

1. UART condition
2. Software condition

NOTE

Before designing, pay attention to how to realize sleeping/waking function and refer to Document [22] for more details.

5.3.4 Minimum functionality mode

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

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

The module has been set to minimum functionality mode, module will firstly enter sleep mode, then the RF function and USIM card function will be closed. In this case, the serial port is still accessible, but RF function or USIM card will be unavailable. When module 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 32: Current Consumption (VCC=3.3V)

GNSS	
GNSS supply current (AT+CFUN=0, with USB connection)	@ -140dBm，Tracking Typical:60mA
GSM sleep/idle mode	
GSM/GPRS supply current (GNSS off)	Sleep mode@ BS_PA_MFRMS=2 Typical: 2.8mA （ USB suspend mode ） Sleep mode@ BS_PA_MFRMS=2 Typical: 2mA （ USB voltage controllable mode ） Idle mode@ BS_PA_MFRMS=2 Typical: 30mA
UMTS sleep/idle mode	
WCDMA supply current (GNSS off)	Sleep mode @DRX=1.28s Typical: 4.0mA（USB suspend mode ） Sleep mode @DRX=1.28s Typical: 3.0mA （USB voltage controllable mode ） Idle mode @DRX=1.28s Typical: 30mA
LTE sleep/idle mode	
LTE-FDD supply current (GNSS off)	Sleep mode @DRX=1.28s Typical: 3.5mA（USB suspend mode ） Sleep mode @DRX=1.28s Typical: 2.8mA （USB voltage controllable mode ） Idle mode @DRX=1.28s Typical: 30mA
LTE-TDD supply current	Sleep mode @DRX=1.28s Typical: 3.5mA（USB suspend mode ）

(GNSS off)	Sleep mode @DRX=1.28s Typical: 2.8mA（USB voltage controllable mode ） Idle mode @DRX=1.28s Typical: 30mA
GSM Talk	
EGSM900	@power level #5 Typical: 300mA
DCS1800	@power level #0 Typical: 245mA
UMTS Talk	
WCDMA B1	@Power 21dBm Typical: 480mA
WCDMA B8	@Power 21dBm Typical: 550mA
GPRS	
GSM900(1 Rx,4 Tx)	@power level #5 Typical: 600mA
GSM900(3 Rx,2 Tx)	@power level #5 Typical: 470mA
DCS1800(3 Rx,2 Tx)	@power level #0 Typical: 350mA
DCS1800(1 Rx,4 Tx)	@power level #0 Typical: 460mA
EGPRS	
GSM900(1 Rx,4 Tx)	@power level #8 Typical: 450mA
GSM900(3Rx,2 Tx)	@power level #8 Typical: 320mA
DCS1800(3Rx,2 Tx)	@power level #2 Typical: 320mA
DCS1800(1 Rx,4 Tx)	@power level #2 Typical: 460mA
HSDPA Data	
WCDMA B1	@Power 21dBm Typical: 490mA
WCDMA B8	@Power 21dBm Typical: 550mA
LTE Data	
LTE-FDD B1	@5MHz 22.3 dBm Typical: 577 mA @10MHz 22.4 dBm Typical: 590 mA @20MHz 22.4 dBm Typical: 630 mA
LTE-FDD B3	@5MHz 22.2 dBm Typical: 479 mA @10MHz 22.1 dBm Typical: 498 mA @20MHz 22.1 dBm Typical: 530 mA
LTE-FDD B5	@5MHz 22.2 dBm Typical: 610 mA @10MHz 22.1 dBm Typical: 600 mA @20MHz 22.1 dBm Typical: 630 mA
LTE-FDD B8	@5MHz 22.8 dBm Typical: 644 mA @10MHz 22.8 dBm Typical: 646 mA
LTE-TDD B34	@5MHz 21.5 dBm Typical: 407 mA @10MHz 21.7 dBm Typical: 416 mA @20MHz 21.6 dBm Typical: 435 mA
LTE-TDD B38	@5MHz 21.8 dBm Typical: 370 mA @10MHz 21.8 dBm Typical: 380 mA @20MHz 21.8 dBm Typical: 403 mA
LTE-TDD B39	@5MHz 21.5 dBm Typical: 407 mA @10MHz 21.6 dBm Typical: 420 mA @20MHz 21.7 dBm Typical: 444 mA
LTE-TDD B40	@5MHz 21.5 dBm Typical: 407 mA @10MHz 21.7 dBm Typical: 416 mA @20MHz 21.7 dBm Typical: 444 mA
LTE-TDD B41	@5MHz 21.6 dBm Typical: 390 mA @10MHz 21.7 dBm Typical: 396 mA

	@20MHz	21.7 dBm	Typical: 420 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

The module 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 33: ESD characteristics (Temperature: 25℃, Humidity: 45 %)

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

6 Packaging

The module support tray packaging.

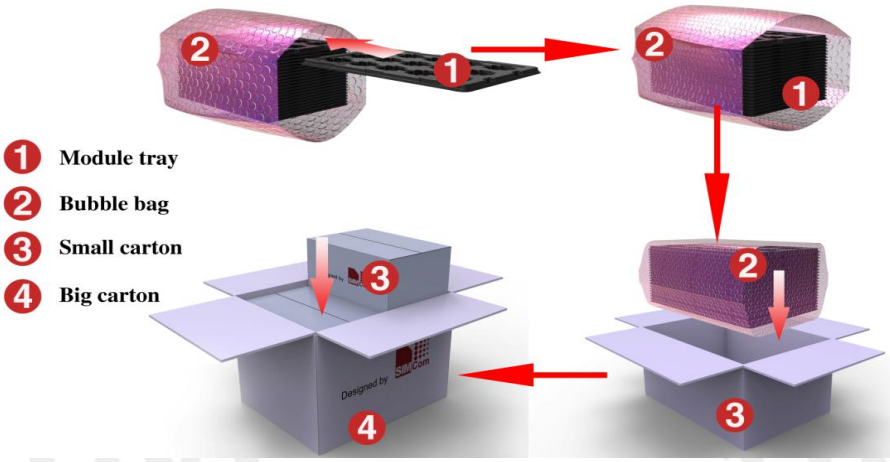


Figure 34: Tray packaging

Module tray drawing:

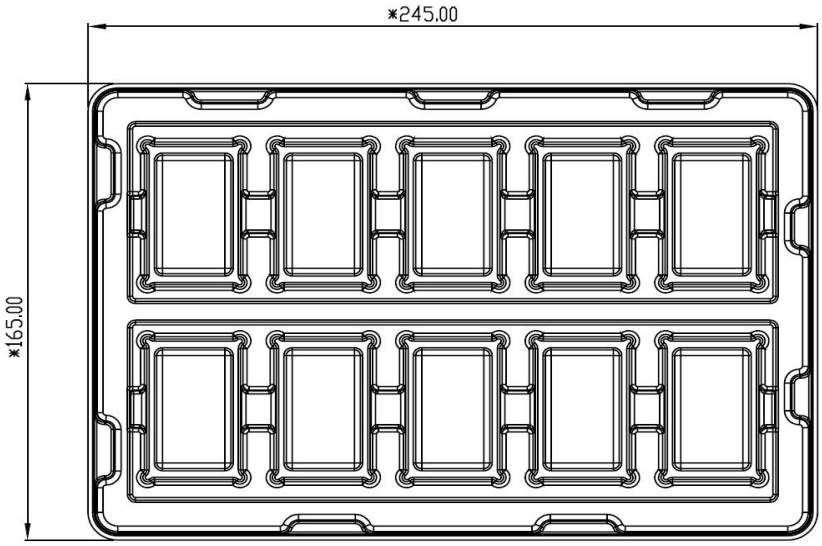


Figure 35: Tray drawing

Table 34: Tray size

Length（±3mm）	Width（±3mm）	Number
245.0	165.0	10

Small carton drawing:

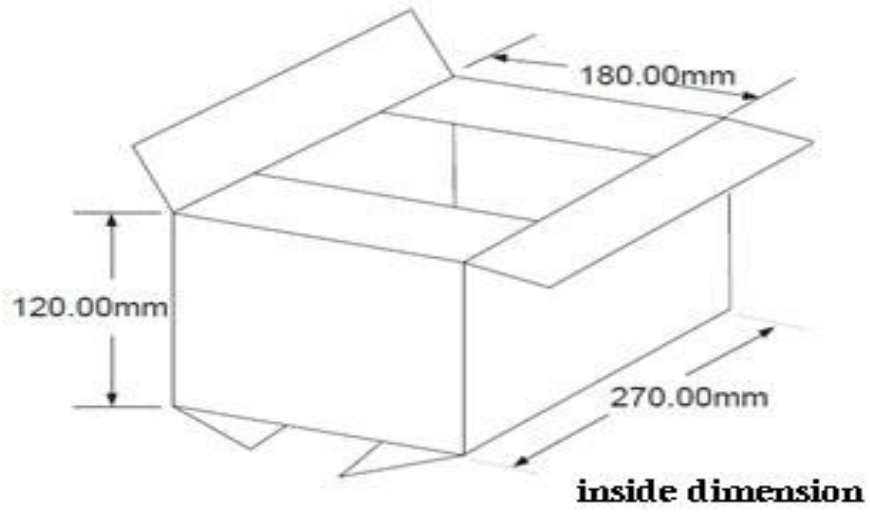


Figure 36: Small carton drawing

Table 35: Small Carton size

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

Big carton drawing:

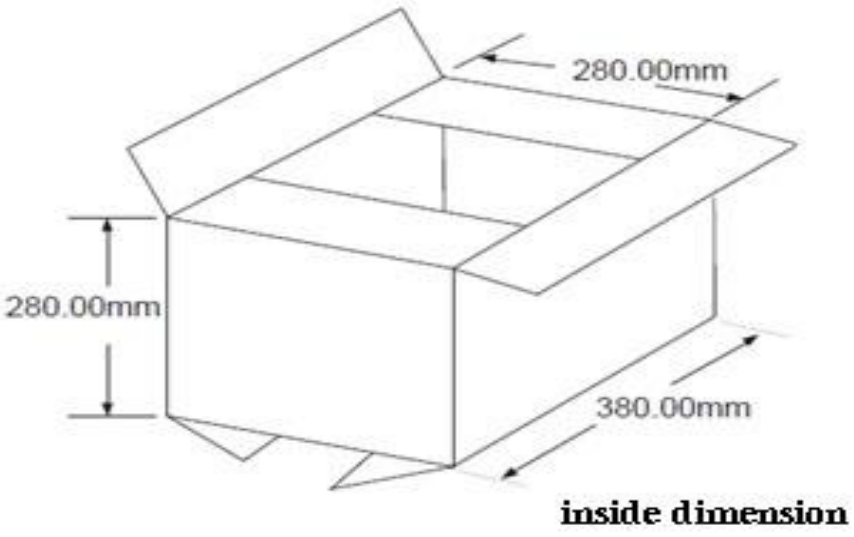


Figure 37: Big carton drawing

Table 36: 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 over Air Interface

Table 37: 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
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	1.2M bps	16QAM,QPSK
Category 2	1.2M bps	16QAM,QPSK
Category 3	1.8M bps	16QAM,QPSK
Category 4	1.8 Mbps	16QAM,QPSK
Category 5	3.6 Mbps	16QAM,QPSK
Category 6	3.6 Mbps	16QAM,QPSK
Category 7	7.2 Mbps	16QAM,QPSK
Category 8	7.2 Mbps	16QAM,QPSK
Category 9	10.2 Mbps	16QAM,QPSK
Category 10	14.4 Mbps	16QAM,QPSK
Category 11	0.9 Mbps	QPSK
Category 12	1.8 Mbps	QPSK
Category 13	17.6 Mbps	64QAM
Category 14	21.1 Mbps	64QAM
Category 15	23.4 Mbps	16QAM
Category 16	28 Mbps	16QAM
Category 17	23.4 Mbps	64QAM
Category 18	28 Mbps	64QAM
Category 19	35.5 Mbps	64QAM
Category 20	42 Mbps	64QAM
Category 21	23.4 Mbps	16QAM
Category 22	28 Mbps	16QAM
Category 23	35.5 Mbps	64QAM
Category 24	42.2 Mbps	64QAM
HSUPA device category	**Max data rate (peak)**	**Modulation type**
Category 1	0.96 Mbps	QPSK
Category 2	1.92 Mbps	QPSK
Category 3	1.92 Mbps	QPSK
Category 4	3.84 Mbps	QPSK
Category 5	3.84 Mbps	QPSK
Category 6	5.76 Mbps	QPSK
LTE-FDD device category (Downlink)	**Max data rate (peak)**	**Modulation type**
Category 1	10 Mbps	QPSK/16QAM/64QAM
Category 2	50 Mbps	QPSK/16QAM/64QAM
Category 3	100 Mbps	QPSK/16QAM/64QA

		M
Category 4	150 Mbps	QPSK/16QAM/64QAM

LTE-FDD device category (Uplink)	Max data rate (peak)	Modulation type
Category 1	5 Mbps	QPSK/16QAM
Category 2	25 Mbps	QPSK/16QAM
Category 3	50 Mbps	QPSK/16QAM
Category 4	50 Mbps	QPSK/16QAM

7.2 Related Documents

Table 38: Related Documents

SN	Title	Description
[1]	A7600 Series AT Command Manual_V1.xx	AT command Manual
[2]	ITU-T Draft new recommendation V.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
[23]	ANTENNA DESIGN GUIDELINES FOR DIVERSITY RECEIVER SYSTEM	ANTENNA DESIGN GUIDELINES FOR DIVERSITY RECEIVER SYSTEM

7.3 Terms and Abbreviations

Table 39: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
ARP	Antenna Reference Point
BER	Bit Error Rate
BTS	Base Transceiver Station
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate

EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
EVDO	Evolution Data Only
FCC	Federal Communications Commission (U.S.)
FD	SIM fix dialing phonebook
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
HSPA	High Speed Packet Access
I^2C	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
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
SPI	serial peripheral interface
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
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
ZIF	Zero intermediate frequency
WCDMA	Wideband Code Division Multiple Access
VCTCXO	Voltage control temperature-compensated crystal oscillator
USIM	Universal subscriber identity module
UMTS	Universal mobile telecommunications system
UART	Universal asynchronous receiver transmitter

7.4 Safety Caution

Table 40: 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.