A7906E-M2
Hardware Design

LTE Module

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SIMCom Wireless Solutions Limited

Building B, SIM Technology Building, No.633 Jinzhong Road, Changning District, Shanghai P.R.China

Tel: +86 21 31575100

Email: simcom@simcom.com

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Version History

Date	Version	Description of change	Author
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1. Introduction

This document describes the electronic specifications, RF specifications, interfaces, mechanical characteristics and testing results of the SIMCom M.2 card. With the help of this document and other software application notes/user guides, users can understand and use A7906E-M2 to design and develop mobile and laptop applications quickly.

1.1 Product Outline

Aimed at the global market, A7906E-M2 supports WCDMA, LTE-TDD and LTE-FDD, support DL 2CA. The supported radio frequency bands are described in the table1.

Table 1: A7906E-M2 frequency bands

Standard	Frequency bands
WCDMA	B1/B5/B8
LTE-FDD	B1/B3/B5/B7/B8/B20/B28/B32
LTE-TDD	B38/B39/B40/B41
2CA	B1+B1/B5/B8/B20 B3+B3/B5/B7/B8/B20/B28 B7+B5/B7/B8/B20/B28 B20+B32 B38+B38 B39+B39 B40+B40 B41+B41

> **NOTE**
>
> B32 is only for secondary component carrier

With a physical dimension of 30.0*42.0*2.3 mm, A7906E-M2 can meet PCI Express M.2 Specification, and can meet almost any space requirement in users' applications.

With M.2 Type 3042-S3-B, A7906E-M2 has almost all common interface integrated, such as USB2.0, PCIe, USIM card, UART, I2C, GPIOs, DRP, LED#, MAIN_ANT and AUX_ANT etc.

With all the interfaces, A7906E-M2 can also be utilized in the industrial handheld, machine-to-machine laptop application and especially the router.

1.2 Hardware Block Diagram

The block diagram of A7906E-M2 is shown as below:
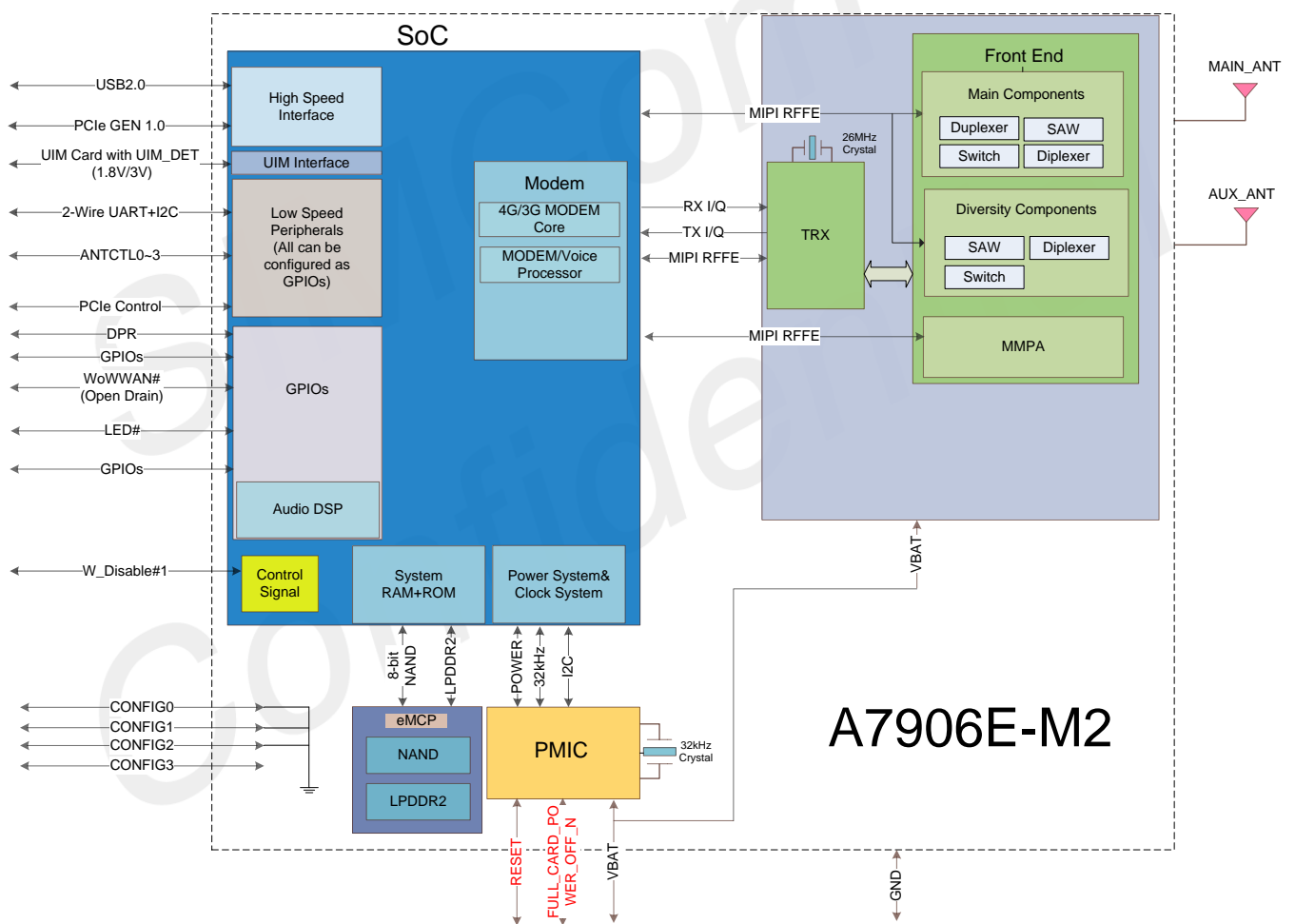
Figure 1: A7906E-M2 block diagram

1.3 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	VBAT:3.135～4.4 Typical supply voltage: 3.7V
Power consumption	Power off current: <100uA Current in sleep mode : TBD (USB suspend)
Radio frequency bands	Please refer to the table 1
Transmitting power	WCDMA power class: 3 (0.25W) LTE power class: 3 (0.25W)
Data Transmission Throughput	UMTS R99 speed: 384 kbps DL/UL HSPA+: 5.76 Mbps(UL), 42 Mbps(DL) LTE-FDD CAT6: Max 300Mbps (DL), 50Mbps (UL) LTE-TDD CAT6: Max 226Mbps (DL), 28Mbps (UL)
Antenna	WCDMA/LTE main antenna. WCDMA/LTE diversity antenna
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
PCIe interface	● Compliant with the PCI Express Base 3.0 Specification, Revision 1.0. ● Dual mode PCIe controller, working as Root Complex or Endpoint ● Support PCI Express Gen1 2.5Gb/s raw bandwidth ● Support link width x1 ● Embedded DMA engine with up to 250MB/s throughout ● AXI Master/Slave interface for inbound/outbound data transfer
UART interface	● Baud rate: 300bps to 921600bps(default:115200bps) ● Can be used as the AT commands or data stream channel ● Multiplex ability according to GSM 07.10 Multiplexer Protocol
I2C interface	● Apply to the "I2C Specification, version 3.0" ● Clock up to 400Kbps
USB	High speed interface, support USB operations at low-speed and full-speed, which refer to USB1.0 and USB1.1.
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size:30*42*2.3mm Weight: 5.8g
Temperature range	Normal operation temperature: -30°C to +70°C 3GPP compliant Non operation temperature: -40°C to +85°C* Storage temperature -40°C to +90°C 72 hours

NOTE

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

2. Package Information

2.1 Top and Bottom View of Module

Figure 2: Top and bottom view of module (bottom side reserved ground plane for thermal)

2.2 Pin Assignment Overview

All functions of the M.2 card will be provided through 75 (including 8 notch pins) pads that will be connected to the customers' platform. The following table is the high-level view of the pin assignment of the card.

		CONFIG_2=GND	75	
74	VBAT	GND	73	
72	VBAT	GND	71	
70	VBAT	CONFIG_1=GND	69	
68	NC	RESET#(I)(1.8V)	67	
66	USIM_DET(I)(1.8V)	ANTCTL3(O)(1.8V)	65	
64	DBG_UART_RXD(I)(1.8V)	ANTCTL2(O)(1.8V)	63	
62	DBG_UART_TXD(O)(1.8V)	ANTCTL1(O)(1.8V)	61	
60	UART_TXD(O)(1.8V)	ANTCTL0(O)(1.8V)	59	
58	UART_RXD(I)(1.8V)	GND	57	
56	NC	REFCLKP	55	
54	PEWake#(DIO)(3.3V)	REFCLKN	53	
52	CLKREQ# (DIO)(3.3V)	GND	51	
50	PERST# (I)(3.3V)	PERp0	49	
48	HOST_WK_MODULE(I)(1.8V)	PERn0	47	
46	GPIO3(IO)(1.8V)	GND	45	
44	GPIO2(IO)(1.8V)	PETp0	43	
42	I2C_SDA(IO/OD)(1.8V)	PETn0	41	
40	I2C_SCL(O/OD)(1.8V)	GND	39	
38	NC	NC	37	
36	USIM_VDD	NC	35	
34	USIM_DATA	GND	33	
32	USIM_CLK	NC	31	
30	USIM_RST	NC	29	
28	GPIO8(IO)(1.8V)	GND	27	
26	GPIO10_3V3(IO)(3.3V)	DPR(I)(1.8V)	25	
24	GPIO7(IO)(1.8V)	WoWWAN#(OD)(1.8V/3.3V)	23	
22	GPIO6(IO)(1.8V)	CONFIG_0=GND	21	
20	GPIO5(IO)(1.8V)	Notch		
	Notch	Notch		
	Notch	Notch		
	Notch	Notch		
	Notch	GND	11	
10	LED#(OD)(3.3V)	USB_D-	9	
8	W_DISABLE#1(I)(3.3V)	USB_D+	7	
6	Full_Card_Power_Off#(I)(1.8/3.3V)	GND	5	
4	VBAT	GND	3	
2	VBAT	CONFIG_3=NC	1	

Figure 3: Pin assignment

2.3 Pin Description

Table 3: IO parameters definition

Pin type	Description
PI	Power input
PO	Power output
AI	Analog input
AIO	Analog input/output
DIO	Bidirectional digital input /output
DI	Digital input
DO	Digital output
DOH	Digital output with high level
DOL	Digital output with low level
PU	Pull up
PD	Pull down
OD	Open Drain
OC	Open collector

Table 4: IO parameters definition

Voltage domain	Parameter		Min	Typ	Max
P3	VDD_P3=1.8V				
	VOH	High level output	1.35V	-	1.8V
	VOL	Low level output	0V	-	0.45V
	VIH	High level input	1.2V	1.8V	2.1V
	VIL	Low level input	-0.3V	-	0.6V
	Rp	Pull up/down resistor	80K ohm	-	240K ohm
P4	VDD_P4=1.8V				
	VOH	High level output	1.44V	-	1.8V
	VOL	Low level output	0V	-	0.4V
	VIH	High level input	1.26V	1.8V	2.1V
	VIL	Low level input	-0.3V	-	0.36V
	Rp	Pull up/down resistor	360K ohm	-	
	VDD_P4=2.85V				
	VOH	High level output	2.28V	-	2.85V
	VOL	Low level output	0V	-	0.4V

	VIH	High level input	2.0V	-	3.15V
	VIL	Low level input	-0.3V	-	0.57V
	Rp	Pull up/down resistor	285K ohm		
P5	VDD_P5=2.85V				
	VOH	High level output	2.28V	-	2.85V
	VOL	Low level output	0V	-	0.4V
	VIH	High level input	2.0V	-	3.15V
	VIL	Low level input	-0.3V	-	0.57V
	Rp	Pull up/down resistor	285K ohm		

Table 5: Pin description

Pin name	Pin No.	Electrical Description	Description	Comment
Power supply				
VBAT	2,4,70,72,74	- PI	M.2 card power supply, voltage range: 3.135~4.4V, typical 3.7V.	User should connect these pins together.
GND	3,5,11,27,33,39,45,51,57,71,73	- PI	Ground	
System Control				
Full_Card_Power_Off#	6	- DI,PD	H: Module powers on. L: Module powers off.	It's internally pulled to Low. It's 3.3V tolerant but can be driven by either 1.8V or 3.3V GPIO.
Reset#	67	- DI,PU	System reset control input, active low.	
W_DISABLE#1	8	P5 DI	WWAN RF Disable, active low	Can be driven by 3.3V GPIO.
Configuration pins				
CONFIG0	21	- GND	Connect to ground	A7906E-M2 module is configured as the WWAN USB2.0 interface type
CONFIG1	69	- GND	Connect to ground	
CONFIG2	75	- GND	Connect to ground	
CONFIG3	1	- NC	Not connected	
USB2.0				
USB_D+	7	- AIO	Positive line of the differential, bi-directional USB signal.	Main communication interface. USB2.0 is up to 480Mbps.
USB_D-	9	- AIO	Negative line of the differential, bi-directional USB signal.	
PCIe interface				

PETn0	41	-	AO	PCIe TX Differential signals Negative	In developing
PETp0	43	-	AO	PCIe TX Differential signals Positive	
PERn0	47	-	AI	PCIe RX Differential signals Negative	
PERp0	49	-	AI	PCIe RX Differential signals Positive	
REFCLKN	53	-	AIO	PCIe Reference Clock signal Negative	
REFCLKP	55	-	AIO	PCIe Reference Clock signal Positive	
PCIE assistant interface					
PERST#	50	P5	DI	Asserted to reset module PCIe interface default. Active low.	In developing
CLKREQ#	52	P5	DIO	PCIe clock request. It is output signal requires an external 100K resistor to 3.3V power source. Active low.	
PEWake#	54	P5	DO	Asserted to wake up system. It is output signal requires an external 100K resistor to 3.3V power source. Active low.	
USIM interface					
USIM_VDD	36	P4	PO	Power output for USIM card, the voltage depends on the USIM card type. Its output current is up to 50mA.	All lines of USIM interface should be protected against ESD.
USIM_DATA	34	P4	DIO	USIM Card data I/O, which has been pulled up via a 10KR resistor to USIM_VDD internally. Do not pull it up or down externally.	
USIM_CLK	32	P4	DO	USIM clock output	
USIM_RST	30	P4	DO	USIM Reset output	
USIM_DET	66	P3	DI	USIM card detecting input signal which has been pulled up via a 10KR resistor to VDD_P3 internally.	
ANTCTL signals					
ANTCTL0	59	P3	DO	Tunable ANT CTRL0	In developing
ANTCTL1	61	P3	DO	Tunable ANT CTRL1	
ANTCTL2	63	P3	DO	Tunable ANT CTRL2	
ANTCTL3	65	P3	DO	Tunable ANT CTRL3	

UART interfaces					
UART_RXD	58	P3	DO	UART receive data	These signals are 1.8V voltage domain. If unused, keep them open.
UART_TXD	60	P3	DIO	UART transmit data	
DBG_UART_TXD	62	P3	DI	Debug log output	
DBG_UART_RXD	64	P3	DO	Debug log intput	
I2C interfaces					
I2C_SCL	40		OD,DO	I2C clock	If unused, keep them open.
I2C_SDA	42		OD,DIO	I2C data	
GPIO interfaces					
GPIO5	20	P3	DIO	General Purpose Input/Output	If unused, keep them open.
GPIO6	22	P3	DIO	General Purpose Input/Output	
GPIO7	24	P3	DIO	General Purpose Input/Output	
GPIO10_3V3	26	P5	DIO	General Purpose Input/Output	
GPIO8	28	P3	DIO	General Purpose Input/Output	
GPIO2	44	P3	DIO	General Purpose Input/Output	
GPIO3	46	P3	DIO	General Purpose Input/Output	
Other pins					P3
LED#	10	P3	OD	It is an open drain, active low signal, used to allow the M.2 card to provide status indicators via LED devices that will be provided by the system.	These signals are open-drain output. If unused, keep them open.
WoWWAN#	23	P3	OD	WWAN to wake up the host. It is open drain and active low.	
DPR	25	P3	DI	Hardware Pin for BodySAR Detection, active low. H: Max transmitting power will not be reduced (default) L: Max transmitting power will be reduced	In developing
HOST_WK_MODULE	48	P3	DI		It is default high status, when the host need wake up module, host could pull down this pin.
Not Connected pins					
NC	29,31,35,37,38,56,68.				Keep unconnected.
Notch					

Notch	12,13,14,15,16, 17,18,19	Notch	

2.4 Package Dimensions
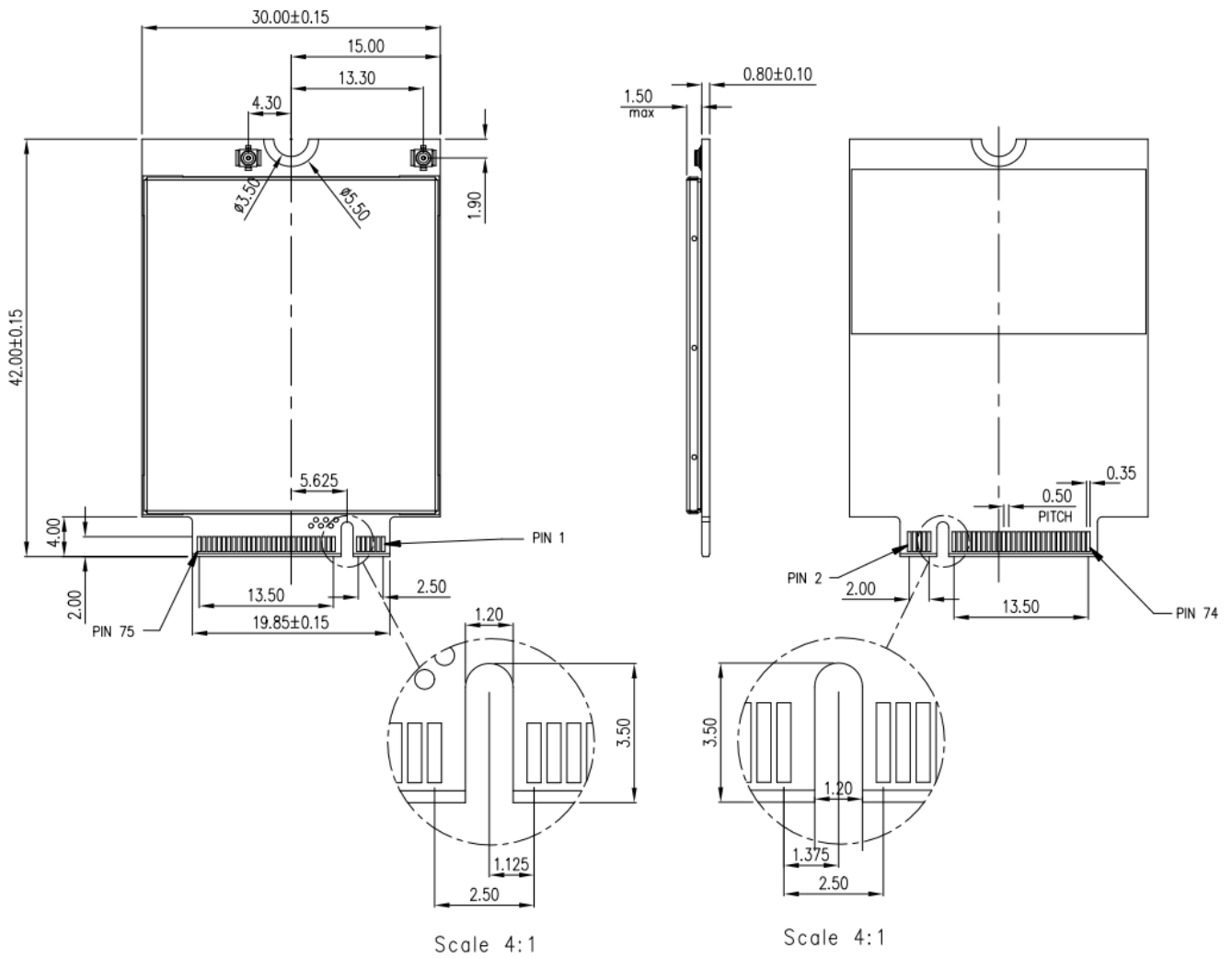
Figure 4: Dimensions of A7906E-M2 (Unit: mm)

2.5 Label information
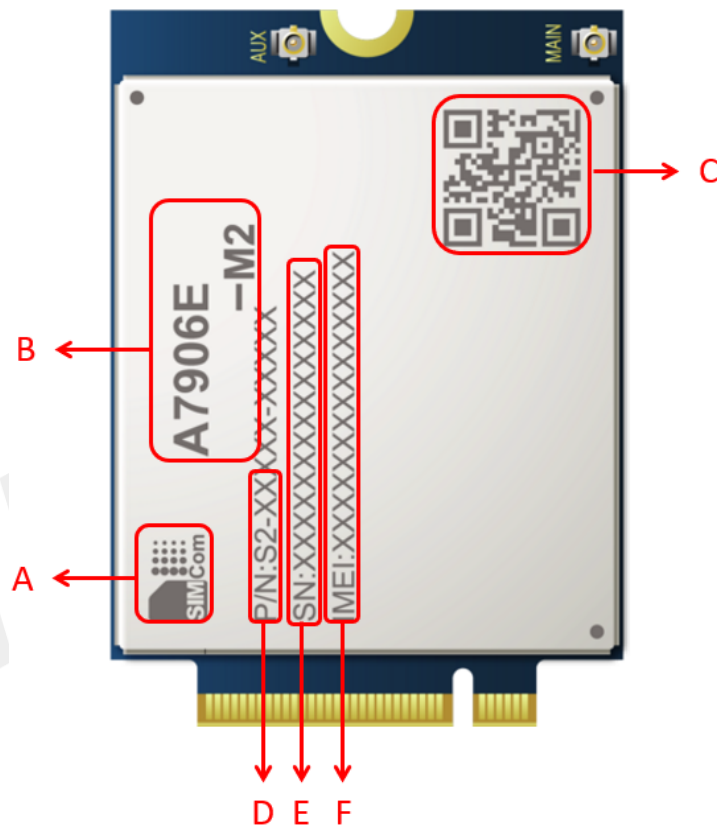
Figure 5: Label information

Table 6: The description of label information

No.	Description
A	SIMCom logo
B	Project name
C	QR code
D	Module part number
E	Serial number
F	International mobile equipment identity

3. Interface Application

3.1 Power Supply

The recommended power supply of A7906E-M2 is 3.7V and the voltage ranges from 3.135 V to 4.4 V. The A7906E-M2 has 5 power pins and 11 ground pins, to ensure the A7906E-M2 card works normally, all the pins must be connected. The connector pin is defined to support 500mA current per pin continuously.

Table 7: VBAT pins electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VBAT	Module power voltage.	3.135	3.7	4.4	V
I$_{VBAT(peak)}$	Module power peak current in normal mode.	-	1.0	-	A
I$_{VBAT(power-off)}$	Module power current in power off mode.	70	-	100	uA

3.1.1 Power Supply Design Guide

Make sure that the voltage on the VBAT pins will never drop below 3.135V, even during a transmit event, when current consumption may rise up to 1.0A. If the voltage drops below 3.135V, the module might be powered off automatically.

NOTE

Be sure the power supply for VBAT pins can support more than1.0A, using a total of more than 100uF capacitors is recommended, in order to avoid the voltage dropping to lower than 3.135V.

Some multi-layer ceramic chip (MLCC) capacitors (0.1/1uF) with low ESR in high frequency band can be used for EMC.

These capacitors should be put as close as possible to VBAT pads. Also, users should keep VBAT trace on circuit board wider than 1.0 mm to minimize PCB trace impedance. The following figure shows the

recommended circuit.

If the VBAT generated by a switch mode power supply, it is suggested to add a bead to suppress the Interference. Recommend part of FB101 is BLM21PG300SN1D or MPZ2012S221A.
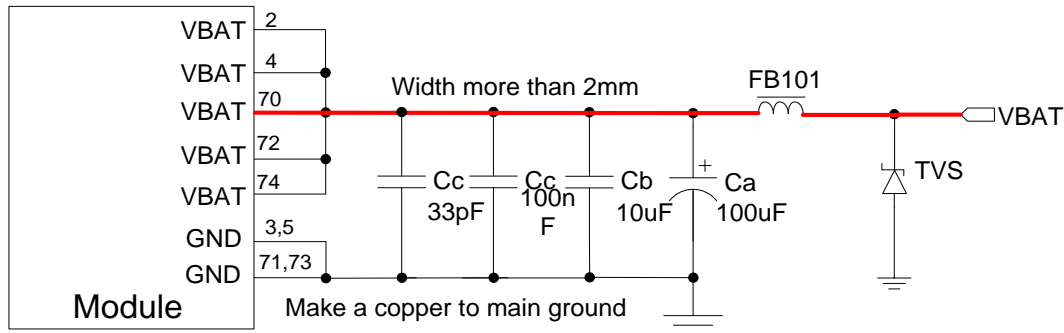
Figure 6: Power supply application circuit

NOTE

The test condition: The voltage of power supply for VBAT is 3.7V, Ca is a 100 µF tantalum capacitor (ESR=0.7Ω).
PIN3,5,71,73 are the main return current path of module, these pins should be coppered by a ground plane to main ground.
All other GND pins also need connect to ground.

In addition, in order to guard for over voltage protection, it is suggested to use a TVS diode to protect the M.2 card. TVS diode should be placed near VBAT pins.

Table 8: Recommended TVS diode list

No.	Manufacturer	Part Number	VRWM	Package
1	JCET	ESDBW5V0A1	5V	DFN1006-2L
2	WAYON	WS05DPF-B	5V	DFN1006-2L
3	WILL	ESD5611N	5V	DFN1006-2L
4	WILL	ESD56151W05	5V	SOD-323

3.1.2 Recommended Power Supply Circuit

It is recommended that a switching mode power supply or a linear regulator power supply is used. It is important to make sure that all the components used in the power supply circuit can resist the current which could be more than 1A.

The following figure shows the linear regulator reference circuit with 5V input and 3.7V output.
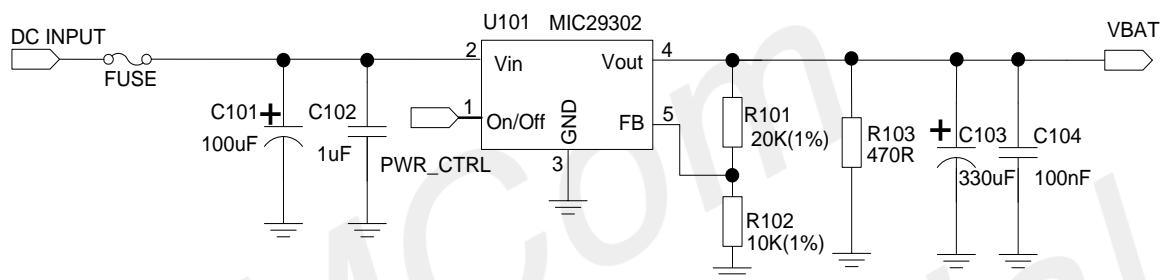
Figure 7: Linear regulator reference circuit

If there is a high dropout between input and VBAT, or the efficiency is extremely important, then a switching mode power supply will be preferable. The following figure shows the switching mode power supply reference circuit with 12V input and 3.7V output.
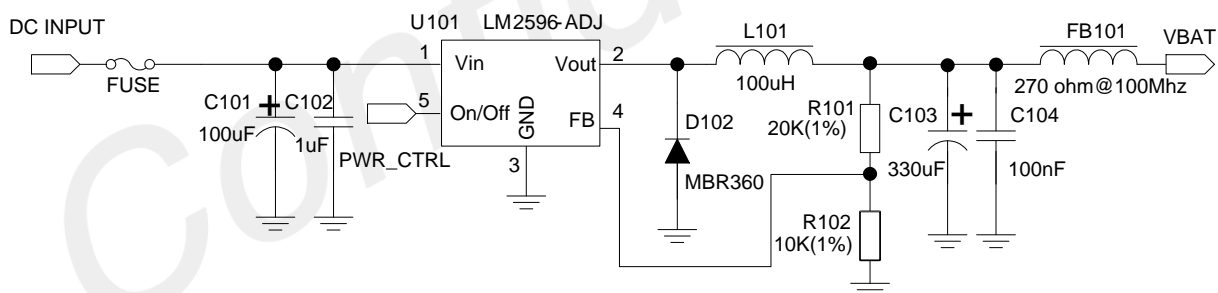
Figure 8: Switching mode power supply reference circuit

> **NOTE**
>
> The Switching Mode power supply solution for VBAT must be chosen carefully against Electro Magnetic Interference and ripple current from depraving RF performance.
> PWR_CTRL must connect to host in case that the module system crash.

3.1.3 Voltage Monitor

To monitor the VBAT voltage, the AT command "AT+CBC" can be used.

For monitoring the VBAT voltage outside or within a special range, the AT command "AT+CVALARM" can be used to enable the Over-voltage warning function.

If users need to power off module when the VBAT voltage is out of a range, the AT command "AT+CPMVT" can be used to enable over-voltage power-off function.

> **NOTE**
>
> Over-voltage warning function and over-voltage power-off function are disabled by default. For more information about these AT commands, please refer to Document [1].
> The module will power on automatically after the under-voltage power off procedure if the Full_Card_Power_Off# signal keeps at high level.

3.2 Full_Card_Power_Off#

Module can be powered on by pulling the Full_Card_Power_Off# pin up to high level through GPIO, which is 3.3V tolerant.

Full_Card_Power_Off# signal is an active low input signal and will turn the module on when asserted high (≥1.7 V) and will force the module to shut down when asserted low (≤0.2 V). This pin is 3.3V tolerant and can be driven by either 1.8V or 3.3V GPIO and has been pulled down internal.
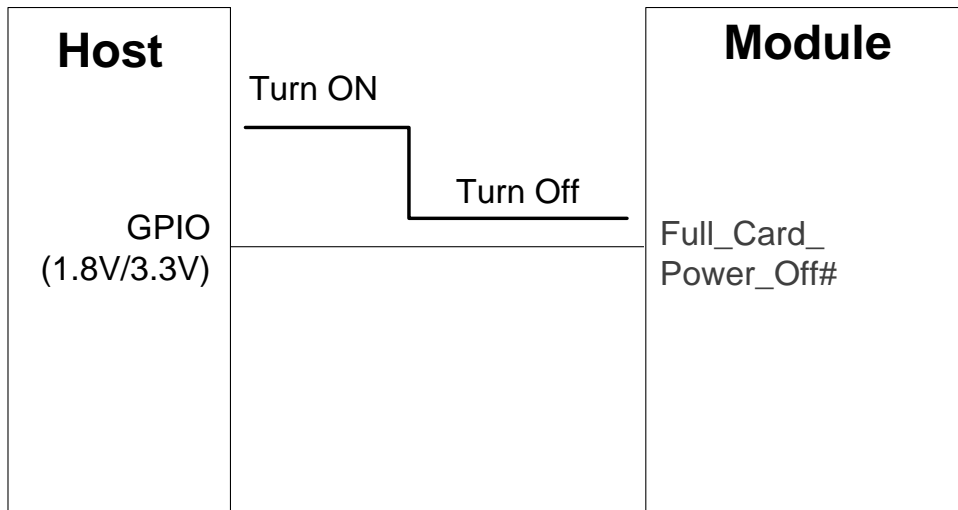
Figure 9: Reference power on/off circuit

> **NOTE**
>
> Module could be automatically power on by connecting Full_Card_Power_Off# pin to VBAT via 0R resistor directly.

3.2.1 Power on

The power-on scenarios are illustrated in the following figure.
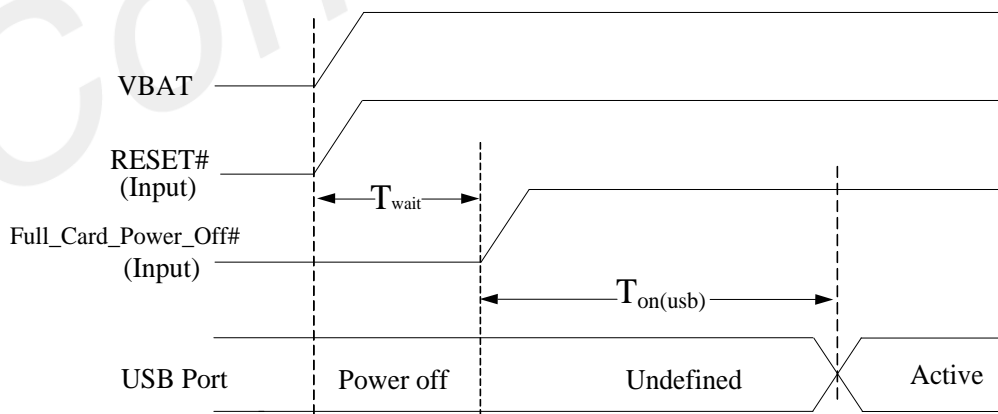
Figure 10: Power on timing sequence

Table 9: Power on timing and electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
T$_{wait}$	The time which is used to wait the VBAT to be stable.	100	-	-	ms
T$_{on(usb)}$	The time from power-on issue to USB port ready	-	TBD	-	s
V$_{IH}$	Input high level voltage on Full_Card_Power_Off# pin	1.0	1.7	4.4	V
V$_{IL}$	Input low level voltage on Full_Card_Power_Off# pin	-0.3	0	0.2	V

3.2.2 Power off

The following conditions could make the module power off.

● Condition 1: Power off module by holding the Full_Card_Power_Off# pin to a low level.

● Condition 2: Power off module by removing the VBAT.

● Condition 3: Power off module by AT command "AT+CPOF".

● Condition 4: Over-voltage or under-voltage automatic power off.

● Condition 5: Over-temperature or under-temperature automatic power off.

NOTE

The over-temperature and over-voltage function is disabled by default.

If the temperature is outside the range of -30~+70℃, some warnings will be reported via AT port. If the temperature is outside the range of -40~+85℃, module will be powered off automatically. (if the function is enabled)

The module will power on automatically after the condition 3 ~ 4 power off procedure if the Full_Card_Power_Off# signal keeps at high level.

These procedures under condition 1~3 will make the M.2 card disconnect from the network and allow the software to enter a safe state, and save data before the card be powered off completely.

The power off scenario by pulling down the Full_Card_Power_Off# pin is illustrated in the following figure.
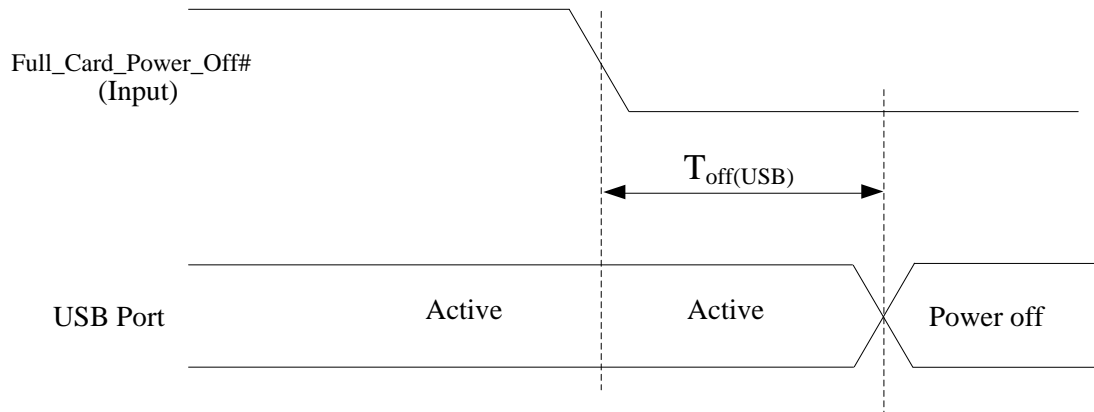
Figure 11: Power off timing sequence

Table 10: Power off timing and electronic characteristic

Symbol	Parameter	Time value			Unit
		Min.	Typ.	Max.	
T$_{off(usb)}$	The time from power-off issue to USB port off	-	18	-	s

3.3 Reset Function

Module can be reset by pulling the RESET# pin down to ground.

> **NOTE**
>
> This function is only used as an emergency reset, when both AT command "AT+CPOF" and the Full_Card_Power_Off# pin have lost efficacy.

The RESET# need a pull up with a resistor to 1.8V or 3.3V, it is strongly recommended to put a100pF capacitor and an ESD protection diode close to the RESET# pin. Please refer to the following figure for the recommended reference circuit.
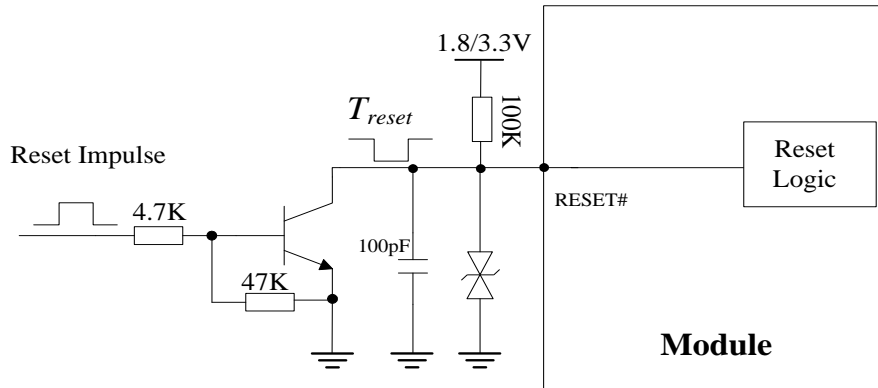
Figure 12: Reference reset circuit

Table 11: RESET pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset}	The active low level impulse time on RESET_N pin to reset module	100	150	500	ms
V_{IH}	Input high level voltage	1.17	1.8	2.1	V
V_{IL}	Input low level voltage	-0.3	0	0.8	V

3.4 UART interface

Module provides a 2-wire UART (universal asynchronous serial transmission) interface as DCE (Data Communication Equipment). AT commands and data transmission can be performed through UART interface.

The following figures show the reference design.
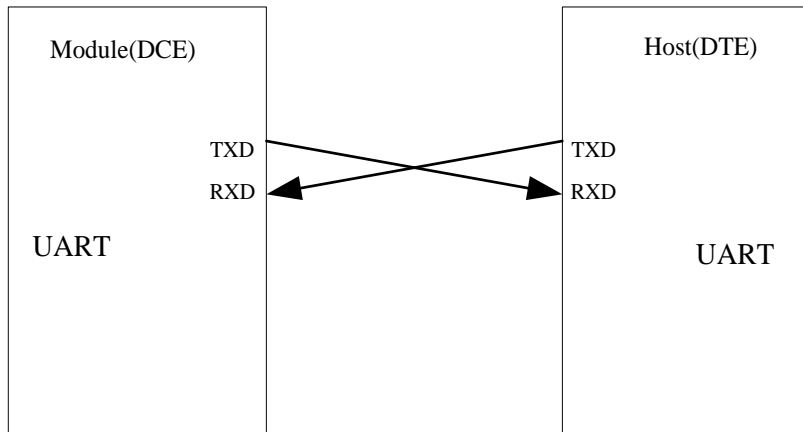
Figure 13: UART modem

The module UART is 1.8V voltage interface. If user's UART application circuit is 3.3V voltage interface, the level shifter circuits should be used for voltage matching. The TXB0102RGYR provided by Texas Instruments is recommended. The following figure shows the voltage matching reference design.
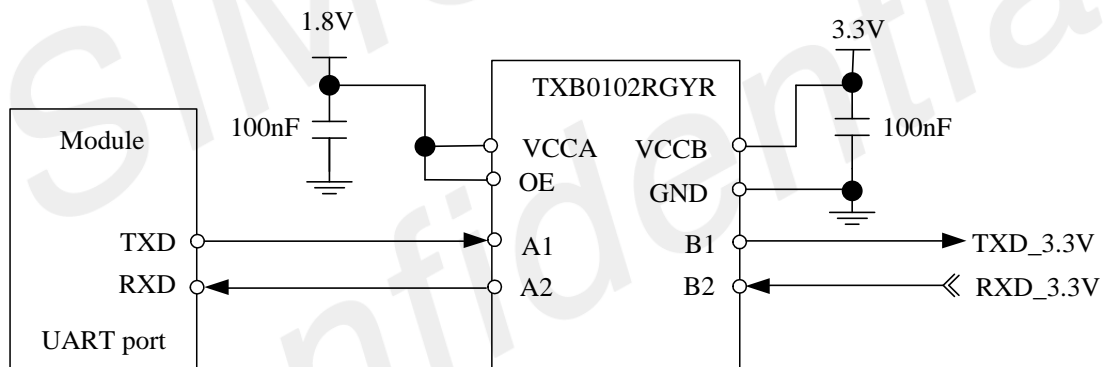
Figure 14: Reference circuit of level shift

Customers can use another level shifter circuits as follow.
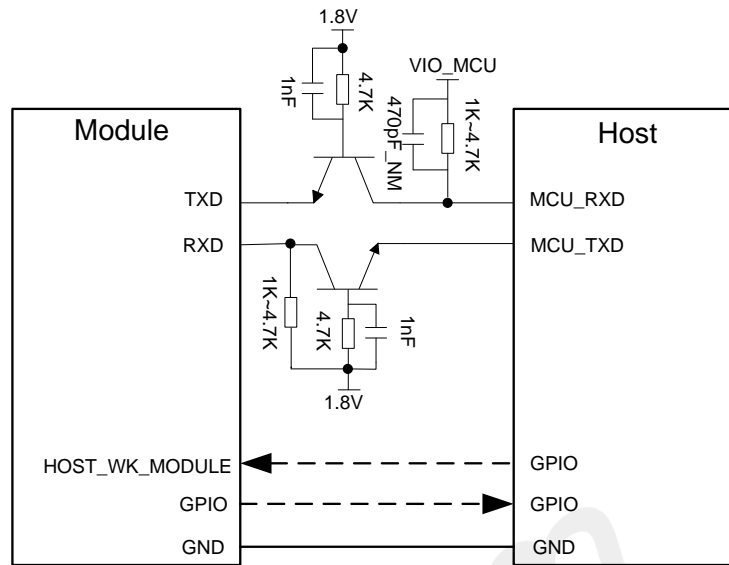
Figure 15: Level matching circuit with triode

NOTE

User need to use high speed transistors such as MMBT3904, or use NMOS such as 2SK3541T2L.
Module supports the following baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600. The default band rate is 115200bps.
Dotted line signal should refer to the TXD and RXD circuit.
HOST_WK_MODULE function please refer chapter 3.17.

3.5 I2C Interface

Module provides an I2C interface compatible with I2C specification, version 3.0, with clock rate up to 400 kbps. Its operation voltage is 1.8V.

The following figure shows the I2C bus reference design.
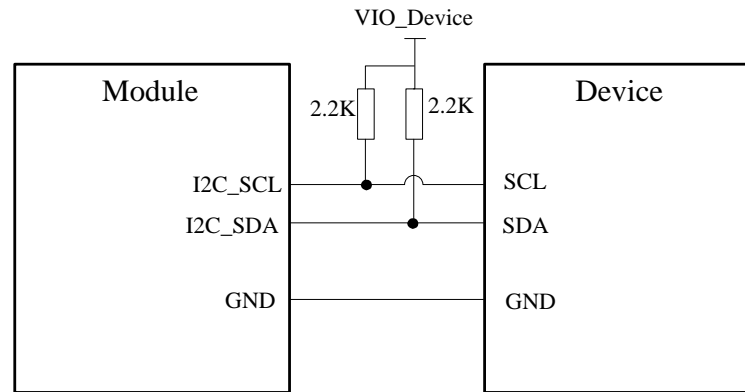
Figure 16: I2C reference circuit

NOTE

I2C_SDA and I2C_SCL have no pull-up resistors in module. So, 2 external pull up resistors are necessary in application circuit.

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

3.6 WoWWAN#

The WoWWAN# pin is an open drain signal which can be used as an interrupt signal to the host. Normally it will keep high logic level until certain conditions such as receiving SMS, voice call (CSD, video) or URC reporting, then WoWWAN# will change to low logic level to inform the host (client PC), the pulse time is 1 second.
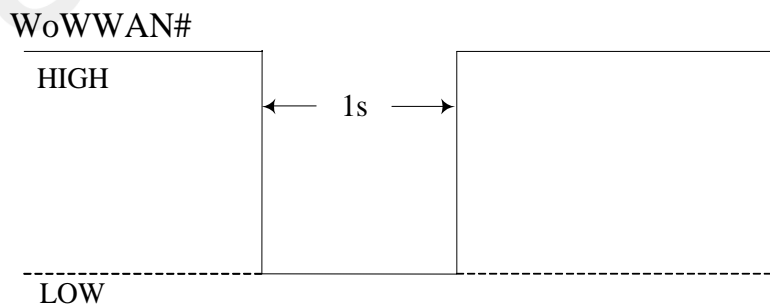
Figure 17: WoWWAN# behavior（SMS and URC report etc.）

WoWWAN# Reference circuit is recommended in the following figure.
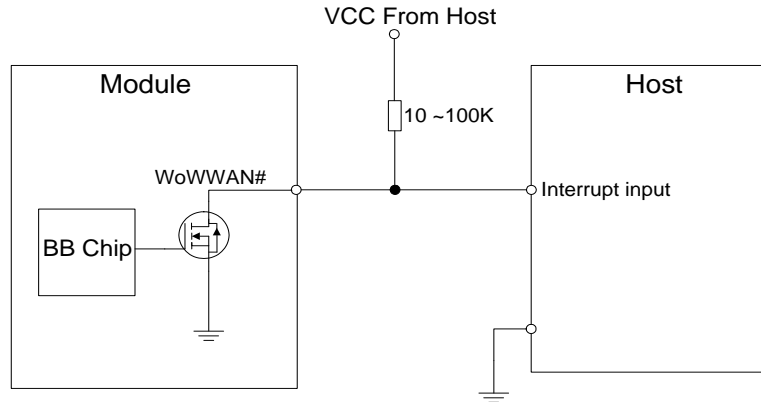
Figure 18: WoWWAN# reference circuit

3.7 USB2.0 Interface

The module implements a USB interface compliant with the USB2.0 specification. The module supports three USB speeds: low-speed (1.5Mbps), full-speed (12Mbps) and high-speed (480Mbps). But the OTG function and USB charging function are not supported.

> **NOTE**
>
> The USB_D- and USB_D+ nets must be traced by 90Ohm+/-10% differential impedance.

Module is used as a USB device by default. 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, receiving SMS, etc. The reference schematic is as following:
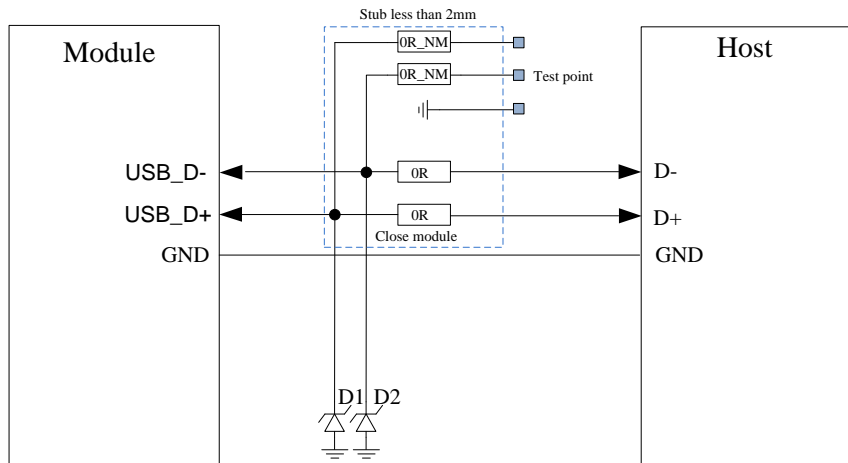
Figure 19: USB reference circuit

Because of the high bit rate on USB bus, more attention should be paid to the influence of the junction capacitance of the ESD component on USB data lines.

Typically, for the USB2.0 signals (USB_D- and USB_D+), the capacitance should not be more than 3pF. It is recommended to use an ESD protection component such as ESD9M5.0ST5G provided by On Semiconductor (www.onsemi.com).

3.8 PCIe Interface

A7906E-M2 supports PCIe Gen1 one lane interfaces, which data rate up to 2.5Gbps raw bandwidth, x1 link width, and can be used as Root Complex or Endpoint mode. CLKREQ# and PEWAKE# needs pull up to 3.3V by 100K resesitor in customers' design.

The following figure is the PCIe reference circuit.
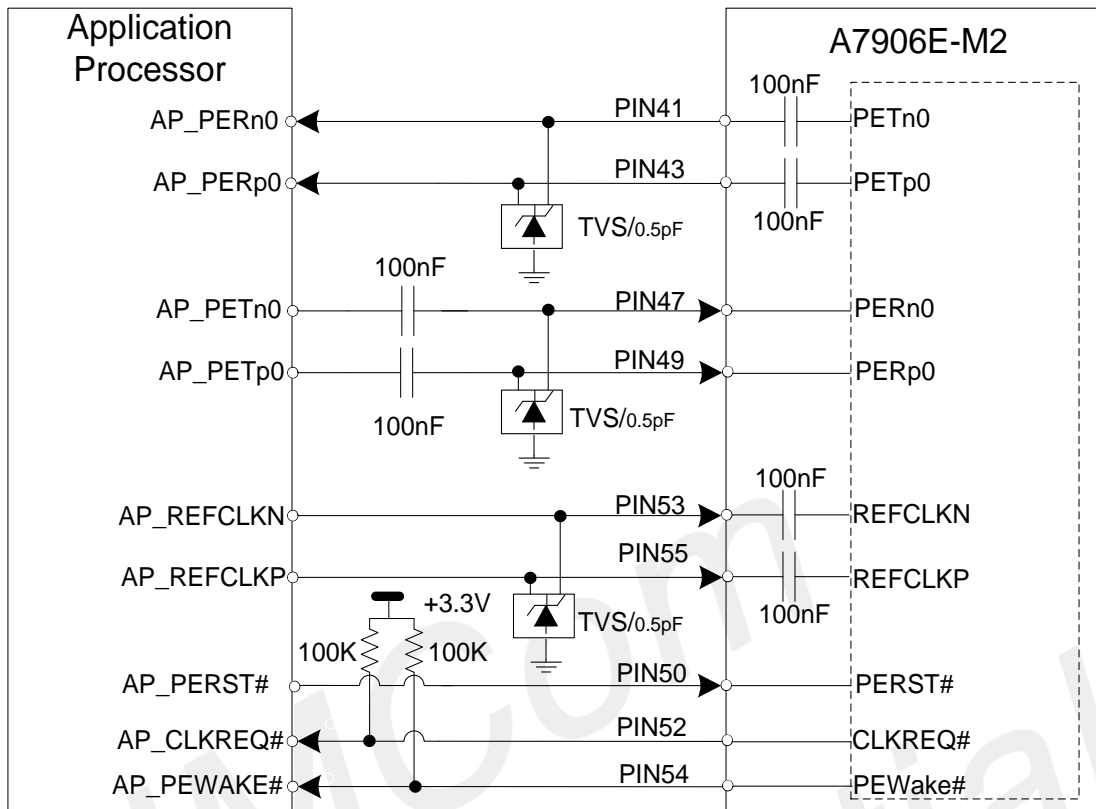
Figure 20: PCIe interface reference circuit (EP Mode)

NOTE

PCIe function is under development.

The AC capacitors of AP_PETn0 and AP_PETp0 should be closed to AP.

The voltage domain of PCIe assistant signals is 3.3V.

Table 12: Definition of PCIe interface

Pin Name	Pin No.	Electrical Description	Functional Description	Comment
PETn0	41	AIO	PCI Express Lane 0, Transmit Pair, Negative Signal 2.5GHz serial interface	
PETp0	43	AIO	PCI Express Lane 0, Transmit Pair, Positive Signal 2.5GHz serial interface	
PERn0	47	AIO	PCI Express Lane 0, Receive Pair, Negative Signal 2.5GHz Serial interface	
PERp0	49	AIO	PCI Express Lane 0, Receive Pair, Positive Signal 2.5GHz Serial interface	
REFCLKN	53	AIO	100MHz PCI Express platform reference Clock Negative signal of differential pair	
REFCLKP	55	AIO	100MHz PCI Express platform Reference Clock. Positive signal of differential pair	
PERST#	50	DI	PERSTR# is a functional reset to the Add-In module active low	3.3V voltage domain, CLKREQ# and PEWAKE# required pull up external, Default as EP mode. If unused, please keep open
CLKREQ#	52	DIO	PCIe reference clock request signal active low	
PEWAKE#	54	DIO	PCIe wake up signal active low	

Table 13: PCIe interface recommended TVS diode list

No.	Manufacturer	Part Number	Package
1	WILL	ESD5302N-3/TR	DFN1006-3L

PCIe interface layout guidelines:
- Require differential trace impedance is 90±10% Ω.
- The intra-lane length mismatch of the differential signal lanes is less than 700um (5ps).
- Gap from other signals keeps 4xline width.
- Gap between Rx-to-Tx keeps 4xline width.
- Should be routed away from sensitive signals.
- The TVS diode should be placed close to the PCIe pins of M.2 connector.

3.9 USIM Interface

Module supports both 1.8V and 3.0V USIM Cards.

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	1.75	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 15: USIM electronic characteristic 3.0V mode (USIM_VDD=2.85V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	2.75	2.85	3.05	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

3.9.1 USIM Application Guide

It is recommended to use an ESD protection component such as ESDA6V1-5W6 produced by ST (www.st.com) or SMF12C produced by ON SEMI (www.onsemi.com). Note that the USIM peripheral circuit should be close to the USIM card socket. The following figure shows the 6-pin SIM card holder reference circuit.
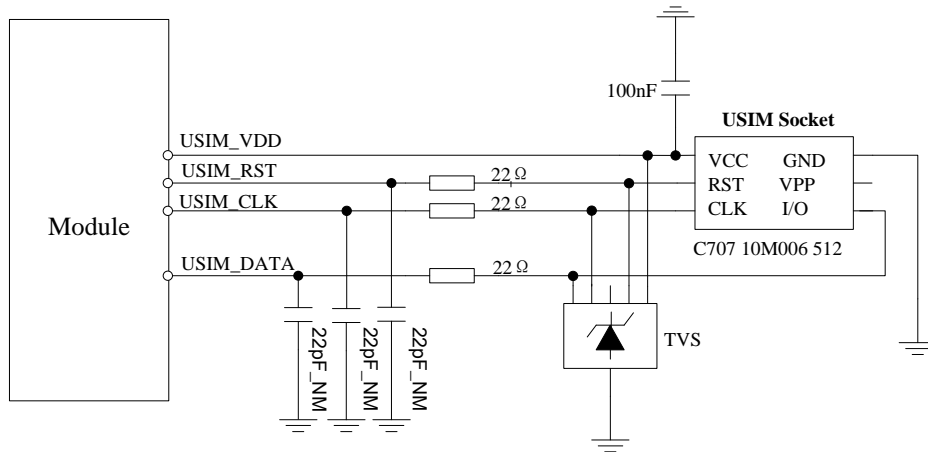
Figure 21: USIM interface reference circuit

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

The following figure shows the 8-pin SIM card holder reference circuit.
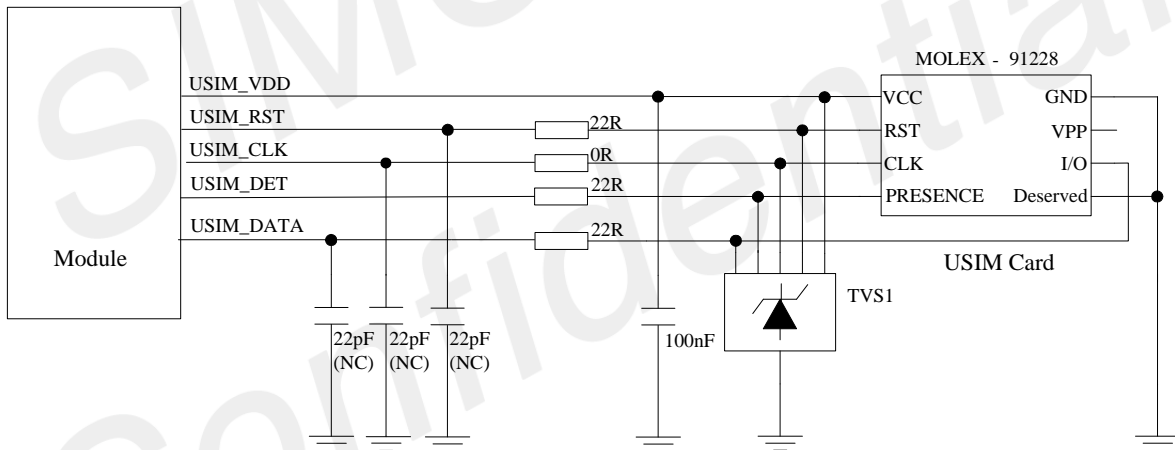
Figure 22: USIM interface reference circuit with USIM_DET

If the USIM card detection function is not used, user can keep the SIM Detect pin open.

3.9.2 USIM layout guide

SIM card circuit is susceptible, the interference may cause the SIM card failures or some other situations, so it is strongly recommended to follow these guidelines while designing:

- Make sure that the SIM card holder should be far away from the antenna while in PCB layout.
- SIM traces should keep away from RF lines, VBAT and high-speed signal lines.
- The traces should be as short as possible.
- Keep SIM holder's GND connect to main ground directly.
- Shielding the SIM card signal by ground.
- Recommended to place a 0.1~1uF capacitor on USIM_VDD line and keep close to the holder.
- The rise/fall time of USIM_CLK should not be more than 40ns.
- Add some TVS and the parasitic capacitance should not exceed 60pF.

3.10 GPIO

Module provides 7 GPIOs for customer use.

Table 16: GPIO resources

Pin No	PIN Name	GPIO in command	No AT	INT	Power Domain	Default status	Default Function	Multiplex Function
20	GPIO5	5		√	P3	B-PD	GPIO	
22	GPIO6	6		√	P3	B-PD	GPIO	
24	GPIO7	7		√	P3	B-PD	GPIO	
26	GPIO10_3V3	10			P5	B-PD	GPIO	
28	GPIO8	8		√	P3	B-PD	GPIO	
44	GPIO2	2		√	P3	B-PD	GPIO	
46	GPIO3	3		√	P3	B-PD	GPIO	

3.11 DPR

DPR (Dynamic Power Reduction) signal is used by A7906E-M2 to assist in meeting regulatory SAR (Specific Absorption Rate) requirements for RF exposure. The signal is provided by a host system proximity sensor to module to provide an input trigger causing a reduction in the radio transmit output power.

User can use AT command to active this function, if do not need this function, this pin can be keep floating.

Table 17: DPR interface

Pin no	Pin Name	Pin status	Function
25	DPR	Low	Max transmitting power will be reduced by set through AT command
		High	Max transmitting power will not be reduced (default)
		Floating	Max transmitting power will not be reduced

The proximity sensor should be controlled by host, following figure shows the connection relationship between module and sensor.
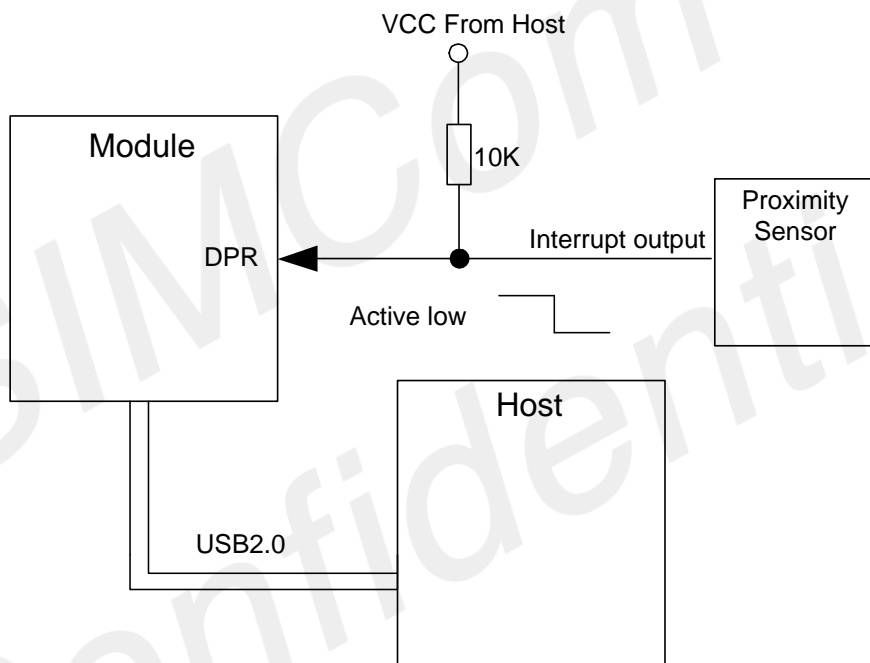
Figure 23: Connection of DPR pin

> **NOTE**
>
> The DRP function is under developing.

3.12 CONFIG Pins

These signals provide the means to indicate the specific configuration of the module. A7906E-M2 is configured as WWAN-USB2.0 (A7906E-M2 do not support USB3.0).

Table 18: CONFIG Pins

Pin no	Pin Name	Description
21	CONFIG_0	Connected to GND internally.
69	CONFIG_1	Connected to GND internally.
75	CONFIG_2	Connected to GND internally.
1	CONFIG_3	No Connect internally.

In the M.2 specification, the 4 pins are defined as below:

Table 19: Config interface

Config_0 (Pin 21)	Config_1 (Pin 69)	Config_2 (Pin 75)	Config_3 (Pin 1)	Module type and Main host interface	Port Configuration
GND	GND	GND	GND	SSD – SATA	N/A
GND	NC	GND	GND	SSD – PCIe	N/A
GND	GND	NC	GND	WWAN – PCIe	0
GND	NC	NC	GND	WWAN – PCIe	1
GND	GND	GND	NC	WWAN – USB 3.0	0
GND	NC	GND	NC	WWAN – USB 3.0	1
GND	GND	NC	NC	WWAN – USB 3.0	2
GND	NC	NC	NC	WWAN – USB 3.0	3
NC	GND	GND	GND	WWAN – SSIC	0
NC	NC	GND	GND	WWAN – SSIC	1
NC	GND	NC	GND	WWAN – SSIC	2
NC	NC	NC	GND	WWAN – SSIC	3
NC	GND	GND	NC	WWAN – PCIe	2
NC	NC	GND	NC	WWAN – PCIe	3
NC	GND	NC	NC	RFU	N/A
NC	NC	NC	NC	No module Present	N/A

3.13 LED1#

LED1# is open drain output and is used to allow A7906E-M2 to provide network status via LED which will be provided by the host.
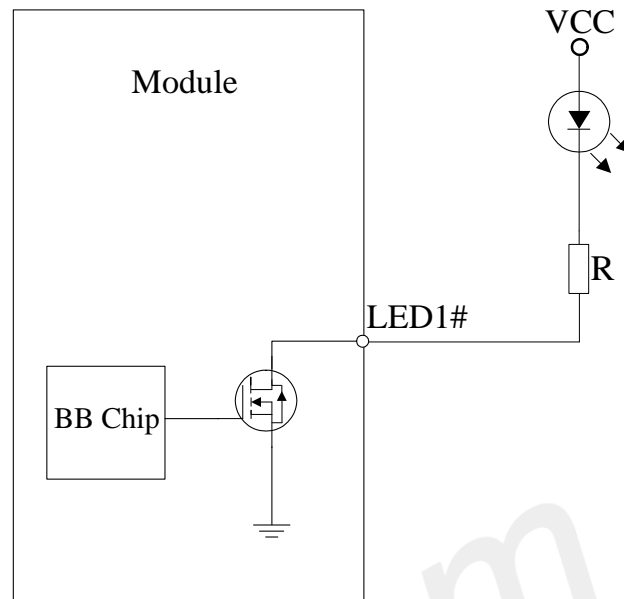
Figure 24: LED1# reference circuit

> **NOTE**
>
> The value of the resistor named "R" depends on the LED characteristic.

The timing sequence is as followed:

Table 20: LED1# pin status

LED1# pin status	Module status
Always On	Searching Network; Call Connect (include VOLTE, SRLTE)
200ms ON, 200ms OFF	Data Transmit; 4G registered;
800ms ON, 800ms OFF	3G registered network
OFF	Power off; Sleep

3.14 W_DISABLE1#

The W_DISABLE1# pin controls A7906E-M2 to enter or exit the flight mode, when the W_DISABLE1# signal is asserted to low level, all RF functions would be disabled. When the W_DISABLE1# signal is not asserted, the RF function will be active if it was not disabled by other means such as software.

Its reference circuit is shown in the following figure.
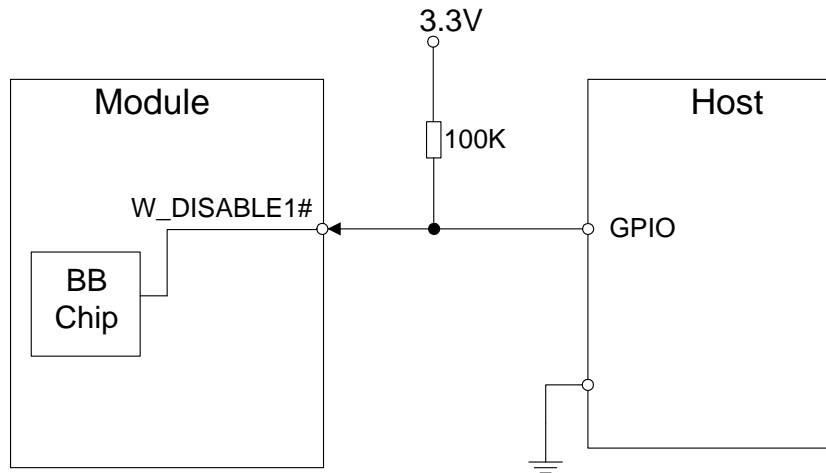
Figure 25: Flight mode switch reference circuit

W_DISABLE1# pin status as below:

Table 21: W_DISABLE1# pin status

W_DISABLE1# pin status	Module operation
Input Low Level	Flight Mode: RF is closed
Input High Level	AT+CFUN=4: RF is closed AT+CFUN=1: RF is working (default)

3.15 ANTCTRL interface

ANTCTL[0:3] are used for tunable antenna control and should be routed to anappropriate antenna control circuitry.

The following table are the definitions for antenn control interfaces.

Table 22: Definition of antenna control interface

Pin Name	Pin No.	Electrical Description	Description	Comments
ANTCTL0	59	DO	Antenna tuner control0	1.8V voltage domain. If unused, please keep open
ANTCTL1	61	DO	Antenna tuner control1	

ANTCTL 2	58	DO	Antenna tuner control2	
ANTCTL3	56	DO	Antenna tuner control3	

NOTE

This function is under development, for details please contact SIMCom support teams.

3.16 HOST_WK_MODULE interface

The HOST_WK_MODULE is a input signal for host wake up module from sleep mode, it is default high status and active low.

The module supports sleep mode by USB suspend/resume protocol, but if customer only use UART interface instead of USB interface, than customer need HOST_WK_MODULE pin to wake up module from sleep mode.

Customer could pull down this pin to wake up module.

Table 23: Definition of HOST_WK_MODULE

Pin Name	Pin No.	Electrical Description	Functional Description	Comment
HOST_WK_MODUL E	48	DI,PU	Pull down this signal to wake up module from sleep mode.	If customer use USB interface, this signal could be kept open.

NOTE

The connection of HOST_WK_MODULE please refer to chapter 3.4.

4. Antenna Interfaces

A7906E-M2 provides a main antenna interface and a diversity antenna interface. The antenna ports have an RF impedance of 50Ω.

4.1 WCDMA/LTE Operating Frequency

The following table shows WCDMA/LTE Operating frequencies

Table 24: A7906E-M2 WCDMA/LTE Operating frequencies

Band	Uplink (UL)	Downlink (DL)	Duplex Mode
WCDMA B1	1920 ~1980 MHz	2110 ~2170 MHz	FDD
WCDMA B5	824~849 MHz	869~894MHz	FDD
WCDMA B8	880 ~915 MHz	925 ~960 MHz	FDD
LTE B1	1920 ~1980 MHz	2110 ~2170 MHz	FDD
LTE B3	1710 ~1785 MHz	1805 ~1880 MHz	FDD
LTE B5	824~849 MHz	869~894MHz	FDD
LTE B7	2500~2570MHz	2620~2690MHz	FDD
LTE B8	880 ~915 MHz	925 ~960 MHz	FDD
LTE B20	832~862MHz	791~ 821MHz	FDD
LTE B28	703~748MHz	758~803MHz	FDD
LTE B32	N/A	1452~1492MHz	FDD
LTE B38	2570 ~2620 MHz	2570 ~2620 MHz	TDD
LTE B39	1880 ~1920 MHz	1880 ~1920 MHz	TDD
LTE B40	2300 ~2400 MHz	2300 ~2400 MHz	TDD
LTE B41	2555 ~2655 MHz	2555 ~2655 MHz	TDD

NOTE

LTE-FDD B32 supports Rx only and is only for secondary component carrier.

4.2 Antenna Installation

4.2.1 Antenna Requirements

The following table shows the requirements on main antenna, Diversity antenna and GNSS antenna.

Recommended Antenna Characteristics

Table 25: WCDMA/LTE antenna

Item	Requirements
Direction	Omni directional
Gain	> -3dBi (Avg)
Input impedance	50 Ω
Efficiency	> 30 %
VSWR	< 2
Cable insertion Loss <1GHz	<1dB
Cable insertion Loss 1GHz~2.2GHz	<1.5dB
Cable insertion Loss 2.3GHz~2.7GHz	<2dB

NOTE

It is recommended to use a passive GNSS antenna when LTE B13 or B14 is supported, as the use of active antenna may generate harmonics which will affect the GNSS performance.

4.3.2 Recommended RF Connector for Antenna Installation

When choosing antennas, user should pay attentions to the connector on antenna which should match with the connector on the module.

The standard 2x2 mm size RF receptacle connectors have been used on A7906E-M2. The dimension of the connector on A7906E-M2 is 2.0*2.0*0.6mm, which is from Murata, and the Part Number is MM4829-2702B/ RA4/ RB0.

Shows the RF connector dimension in the following figure:

Scale: Free
Tolerances Unless
Otherwise Specified: +/-0.2
Unit: mm
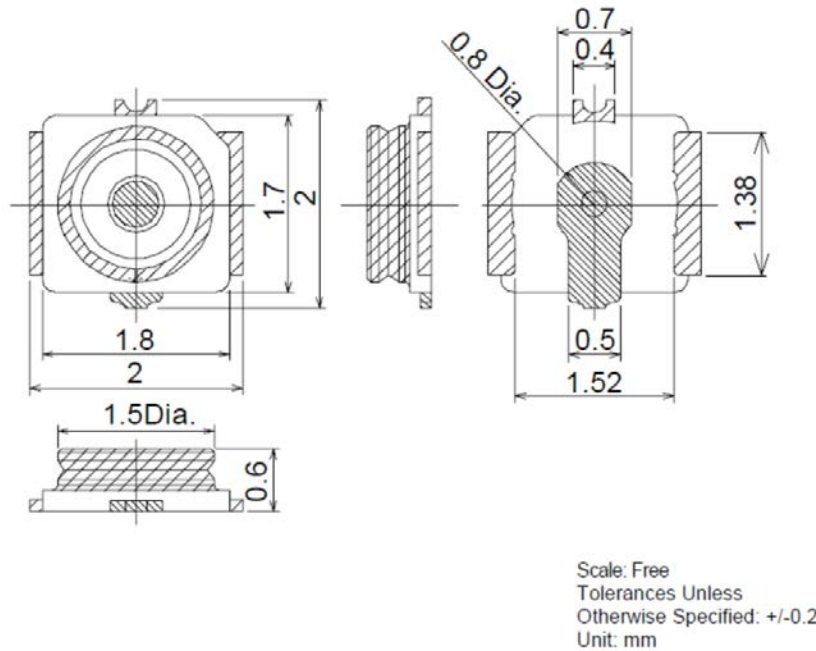
Figure 26: RF connector

The major specifications of the RF connector as below:

Table 26: the major specifications of the RF connector

Item	Specification
Nominal Frequency Range	DC to 6 GHz
Nominal Impedance	50Ω
Temperature Rating	-40℃ to + 85℃
Initial Contact Resistance (without conductor resistance)	Center contact 20.0mΩmax. Outer contact 20.0mΩmax.
Voltage Standing Wave Ratio (V.S.W.R.)	Meet the requirements of 1.3max.(DC ~3GHz) 1.45max.(3GHz~6GHz)

There are two kinds of coaxial cables mating the RF connector in the A7906E-M2, SIMCom recommend use Murata and SUZHOU KELI, and the Part Number is MXFR32HP1000 of the Murata and KLC-2058 of the KELI.

5. Electrical Specifications

5.1 Absolute maximum ratings

Absolute maximum rating for digital and analog pins of module are listed in the following table:

Table 27: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT pins	-0.3	-	4.7	V
Voltage at digital pins (GPIO,I2C,UART, I2S)	-0.3	-	2.1	V
Voltage at digital pins (USIM)	-0.3	-	3.05	V
Voltage at FULCARD_POWER_OFF#	-0.3	-	4.7	
Voltage at RESET#	-0.3	-	2.1	

5.2 Operating conditions

Table 28: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.135	3.7	4.4	V

Table 29: 1.8V Digital I/O characteristics*

Parameter	Description	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	V
V_{OL}	Low-level output voltage	0	-	0.45	V

I_{OH}	High-level output current(no pull down resistor)	-	2	-	mA
I_{OL}	Low-level output current(no pull up resistor)	-	-2	-	mA
I_{IH}	Input high leakage current (no pull down resistor)	-	-	1	uA
I_{IL}	Input low leakage current(no pull up resistor)	-1	-	-	uA

NOTE

These parameters are for digital interface pins, such as UART, I2C, ANTCTL and GPIOs (DPR, SIM DETECT).

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

Table 30: Operating temperature

Parameter	Min.	Typ.	Max.	Unit
Normal operation temperature(3GPP compliant)	-30	25	70	℃
Extended operation temperature*	-40	25	85	℃
Storage temperature	-40	25	90	℃

NOTE

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

5.3 Operating Mode

5.3.1 Operating Mode Definition

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

Table 31: Operating mode Definition

Mode		Function
Normal operation	UMTS/LTE Sleep	AT command "AT+CSCLK=1" can be used to set the module to a sleep mode. In this case, the current consumption of module will be reduced to a very low level and the module can still receive paging message and SMS.
	UMTS/LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	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.
	UMTS/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.
	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" can be used to set the module to a minimum functionality mode without removing the power supply. In this mode, the RF part of the module will not work and the USIM card will not be accessible, but the serial port and USB port are still accessible. The power consumption in this mode is lower than normal mode.
Flight mode		AT command "AT+CFUN=4" or pulling down the W_disable1# pin can be used to set the module to flight mode without removing the power supply. In this mode, the RF part of the module will not work, but the serial port and USB port are still accessible. The power consumption in this mode is lower than normal mode.
Power off		Module will go into power off mode by pull down the Full_Card_Power_Off# pin, normally. In this mode the power management unit shuts down the power supply, and software is not active. The serial port and USB are is not accessible.

5.3.2 Sleep mode

In sleep mode, the current consumption of module will be reduced to a very low level, and module can still receive paging message and SMS.

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

1. UART condition

2. USB condition

3. Software condition

NOTE

Before designing, pay attention to how to realize sleeping/waking function.

5.3.3 Minimum functionality mode and Flight mode

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

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

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

If module 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 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 on VBAT Pins (VBAT=3.7V)

UMTS sleep/idle mode	
WCDMA supply current (GNSS off，without USB connection)	Sleep mode @DRX=9　Typical: 2.2mA
	Idle mode @DRX=9　Typical: 22mA
LTE sleep/idle mode	
LTE FDD supply current (GNSS off，without USB connection)	Sleep mode Typical: 2.4mA
	Idle mode Typical: 22mA
LTE TDD supply current (GNSS off，without USB connection)	Sleep mode Typical: 2.4mA
	Idle mode Typical: 22mA
HSDPA data	
WCDMA B1	@Power 22dBm Typical: 590mA
WCDMA B5	@Power 22.7dBm Typical: 530mA
WCDMA B8	@Power 22.5dBm Typical: 560mA
LTE data	
LTE-FDD B1	@5MHz　　22.1dBm　　Typical: TBD @10MHz　23.0dBm　　Typical: TBD @20MHz　23.0dBm　　Typical: TBD
LTE-FDD B3	@1.4MHz　22.0dBm　　Typical: 581mA @5MHz　　22.5dBm　　Typical: TBD @10MHz　22.5dBm　　Typical: TBD @20MHz　23.0dBm　　Typical: 648mA
LTE-FDD B5	@1.4MHz　22.2dBm　　Typical: 540mA @5MHz　　23.3dBm　　Typical: TBD @10MHz　22.3dBm　　Typical: 551mA
LTE-FDD B7	@5MHz　　22.0dBm　　Typical: 730mA @10MHz　23.1dBm　　Typical: TBD @20MHz　23.0dBm　　Typical: 860mA
LTE-FDD B8	@1.4MHz　21.8dBm　　Typical: 640mA @5MHz　　23.1dBm　　Typical: TBD @10MHz　22.1dBm　　Typical: 613mA
LTE-FDD B20	@5MHz　　22.1dBm　　Typical: 561mA @10MHz　21.8dBm　　Typical: TBD @20MHz　22.3dBm　　Typical: 592mA
LTE-FDD B28	@3MHz　　22.4dBm　　Typical: 614mA @5MHz　　21.8dBm　　Typical: TBD @10MHz　21.8dBm　　Typical: TBD @20MHz　22.4dBm　　Typical: 647mA
LTE-TDD B38	@5MHz　　21.9dBm　　Typical : 351mA @10MHz　23.3dBm　　Typical : TBD @20MHz　22.0dBm　　Typical : 355mA

LTE-TDD B40	@5MHz 21.7dBm Typical : 385mA @10MHz 23.0dBm Typical : TBD @20MHz 22.1dBm Typical : 405mA
LTE-TDD B41	@5MHz 21.6dBm Typical : 374mA @10MHz 23.1dBm Typical : TBD @20MHz 22.2dBm Typical : 421mA
2CA data	
LTE FDD B1+B1	@Power 22.8dBm Typical: 770mA
LTE FDD B1+B5	@Power 22.8dBm Typical: 770mA
LTE FDD B1+B8	@Power 22.8dBm Typical: 770mA
LTE FDD B1+B20	@Power 22.9dBm Typical: 780mA
LTE FDD B3+B3	@Power 22.8dBm Typical: 810mA
LTE FDD B3+B5	@Power 22.7dBm Typical: 790mA
LTE FDD B3+B7	@Power 22.8dBm Typical: 770mA
LTE FDD B3+B8	@Power 22.4dBm Typical: 750mA
LTE FDD B3+B20	@Power 22.5dBm Typical: 750mA
LTE FDD B3+B28	@Power 22.6dBm Typical: 760mA
LTE FDD B7+B5	@Power 22.7dBm Typical: 790mA
LTE FDD B7+B7	@Power 22.5dBm Typical: 960mA
LTE FDD B7+B8	@Power 22.2dBm Typical: 780mA
LTE FDD B7+B20	@Power 22.5dBm Typical: 900mA
LTE FDD B7+B28	@Power 22.0dBm Typical: 910mA

5.5 RF Output Power

The following table shows the RF output power of A7906E-M2 module.

Table 33: Conducted Output Power

Frequency	Max	Min
WCDMA Bands	24dBm + 1/-3dB	< -50dBm
LTE-FDD Bands	23dBm + 2/-2dB	< -40dBm
LTE-TDD Bands	23dBm + 2/-2dB	< -40dBm

5.6 Conducted Receive Sensitivity

The following tables show conducted RF receiving sensitivity of A7906E-M2 module.

Table 34: A7906E-M2 Conducted RF Receiving Sensitivity

Frequency	Primary (Typ.)	Diversity (Typ.)	SIMO1(Typ.)	SIMO2(Worst Case)
WCDMA B1	-110.0dBm	-111.0dBm	-111.8dBm	-106.7dBm
WCDMA B5	-111.5dBm	-112.0dBm	-113.2dBm	-104.7dBm
WCDMA B8	-109.0dBm	-111.0dBm	-111.6dBm	-103.7dBm
LTE-FDD B1(10M)	-99.0dBm	-98.8dBm	-101.5dBm	-96.3dBm
LTE-FDD B3(10M)	-99.2dBm	-97.9dBm	-101.5dBm	-93.3dBm
LTE-FDD B5(10M)	-99.1dBm	-101.0dBm	-103.1dBm	-94.3dBm
LTE-FDD B7(10M)	-96.4dBm	-97.0dBm	-99.8dBm	-94.3dBm
LTE-FDD B8(10M)	-98.0dBm	-100.0dBm	-102.2dBm	-93.3dBm
LTE-FDD B20(10M)	-99.0dBm	-100.8dBm	-102.7dBm	-93.3dBm
LTE-FDD B28(10M)	-98.7dBm	-100.7dBm	-102.9dBm	-94.8dBm
LTE-FDD B38(10M)	-99.4dBm	-97.0dBm	-101.6dBm	-96.3dBm
LTE-FDD B39(10M)	-99.0dBm	-98.7dBm	-101.3dBm	-96.3dBm
LTE-FDD B40(10M)	-97.1dBm	-97.9dBm	-98.6dBm	-96.3dBm
LTE-FDD B41(10M)	-98.7dBm	-97.0dBm	-101.7dBm	-94.3dBm

NOTE

The data in above table are gotten at static condition.
SIMO is a smart antenna technology that uses a single antenna at the transmitter side and multiple (two for A7906E-M2) antennas at the receiver side, which can improve Rx performance.
Per 3GPP specification.

5.7 ESD

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

Table 35: The ESD performance measurement table (Temperature: 25℃, Humidity: 45%)

Part	Contact discharge	Air discharge
VBAT,GND	+/-5K	+/-10K
Antenna port	+/-5K	+/-10K
Full_Card_Power_Off#	+/-2K	+/-4K
USB	+/-1K	+/-2K
RESET_N	+/-1K	+/-2K
USIM Card	+/-1K	+/-2K
Other PADs	+/-1K	+/-2K

6. Connect A7906E-M2 to board

The module should be equipped well by the connector and screw as the following figure illustration. The module Stand-off and mounting screw also serve as part of the module Electrical Ground path. The Stand-off should be connected directly to the ground plane on the platform. So that when the module is mounted and the mounting screw is screwed on to hold the module in place, this will make the electrical ground connection from the module to the platform ground plane.
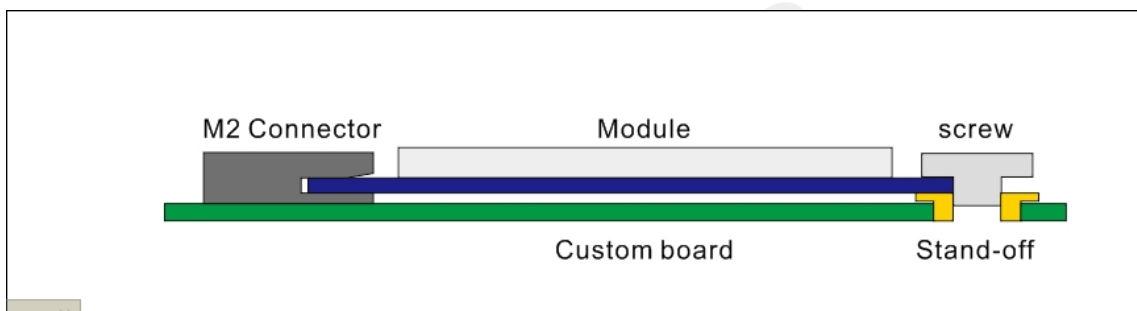

Figure 27: Equipment diagram

7. Thermal Design

Customer should pay attentions to the thermal design of A7906E-M2, for the mass data application scenario, the module would work in max power status and last long time, the temperature of module would increase quickly, especially in high temperature environment.

Module reserved a ground plane on the bottom side for the heat dissipating, customer could conduct the heat to the large board by the silica gel, and the surface area on large board should be more than 460 mm^2. For better thermal performance, customer could use a heat sink device to conduct the heat to the air.
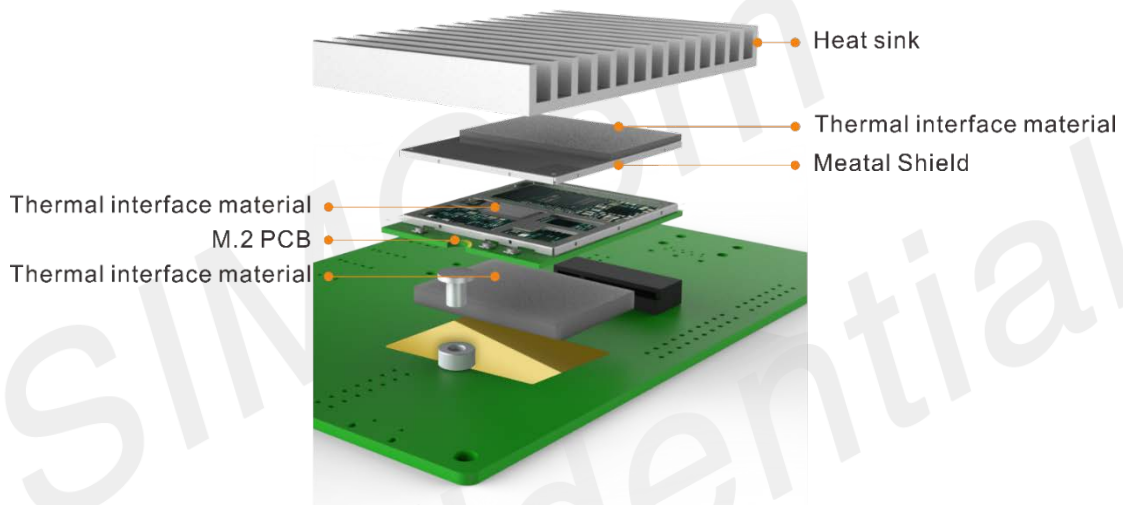

Figure 28: Thermal design diagram

Table 36: The silica gel selection guide

Item	Test method	Recommend value	Unit
Specific Gravity	ASTMD792	3.2±0.1	g/cc
Continuous use Temp	EN344	-40~+220	℃
Volume Resistivity	ASTMD257	$1.0*10^{11}$	Ω-CM
Voltage Endurance	ASTMD149	4	KV/mm
Flame Rating	UL-94	V-0	
Conductivity	ASTMD5470	8	w/m-k

8. Packaging

Module support tray packaging.

1 Module tray
2 Bubble bag
3 Small carton
4 Big carton
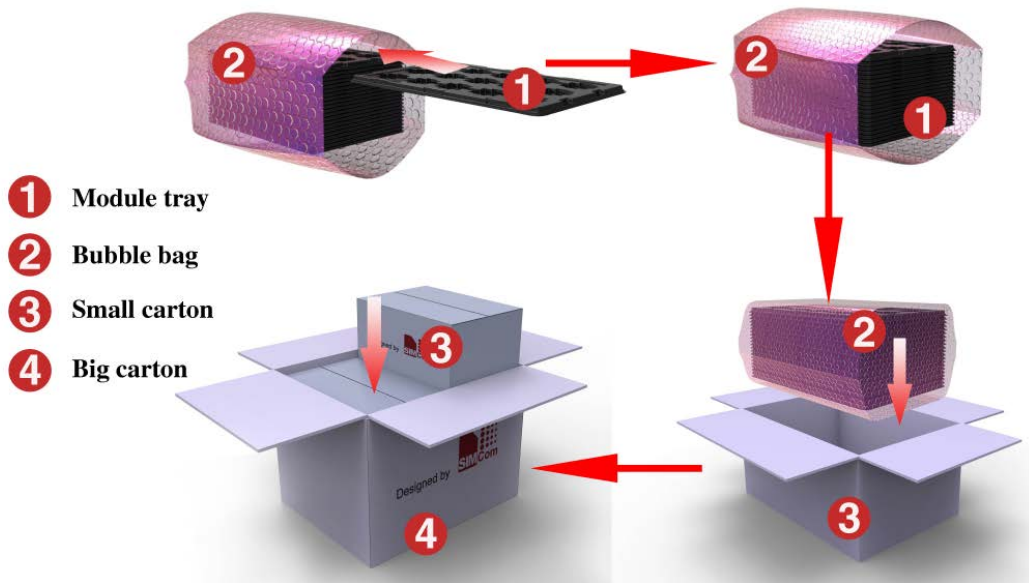
Figure 29: packaging diagram

Module tray drawing：
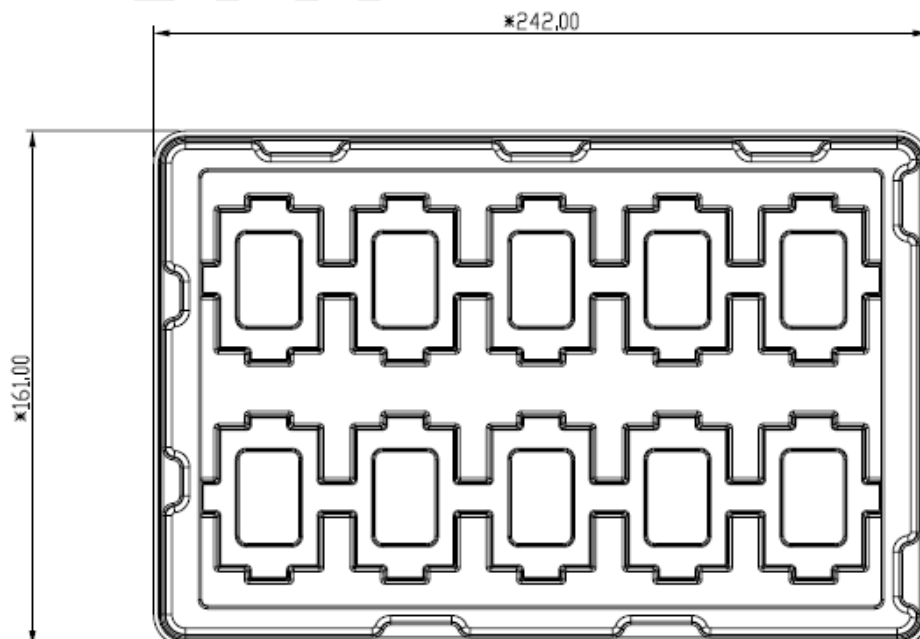
Figure 30: Tray drawing

Table 37: Tray size

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

Small carton drawing：
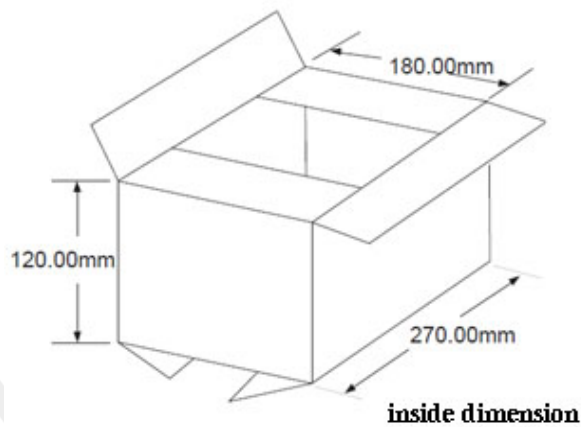
Figure 31: Small carton drawing

Table 38: Small Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Number
270	180	120	10*20=200

Big carton drawing：
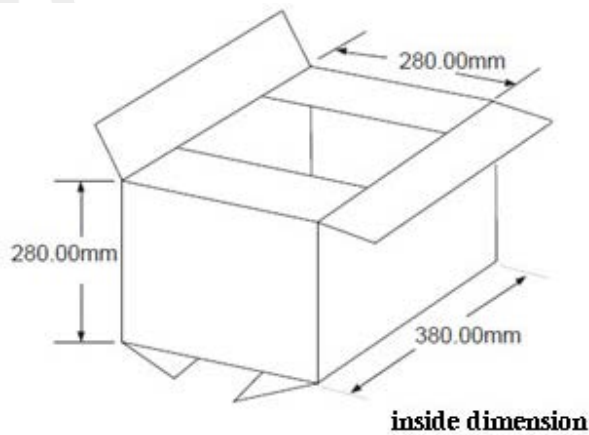
Figure 32: Big carton drawing

Table 39: Big Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Number
380	280	280	200*4=800

9. Appendix

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

Table 40: Coding Schemes and Maximum Net Data Rates over Air Interface

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
Category 5	300Mbps	QPSK/16QAM/64QAM
Category 6	300Mbps	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
Category 5	75Mbps	QPSK/16QAM/64QAM
Category 6	50Mbps	QPSK/16QAM

B. Related Documents

Table 41: Related Documents

NO.	Title	Description
[1]	**A7906E-M2 Series_AT Command Manual_V1.xx**	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+);

[8]		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]	SIM7X00 Series_UART_Application Note_V1.xx	This document describes how to use UART interface of SIMCom modules.
[22]	SIM7X00 Series_GPS_Application Note_V1.xx	GPS Application Note
[23]	Antenna design guidelines for diversity receiver system	Antenna design guidelines for diversity receiver system

C. Terms and Abbreviations

Table 42: 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
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global Standard for Mobile Communications
HR	Half Rate
HSPA	High Speed Packet Access
HSIC	High-speed Inter-chip
I2C	Inter-Integrated Circuit
IMEI	International Mobile Equipment Identity
LTE	Long Term Evolution

MDIO	Management Data Input/Output
MMD	MDIO manageable device
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
NMEA	National Marine Electronics Association
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCS	Personal Communication System, also referred to as GSM 1900
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
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
SGMII	Serial gigabit media independent interface
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

D. Safety Caution

Table 43: Safety Caution

Marks	Requirements
	When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive and not operate normally due to RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forgetting to think much of these instructions may impact the flight safety, or offend local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.
	GSM cellular terminals or mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, especially with a mobile fee or an invalid SIM card. While you are in this condition and need emergent help, please remember to use emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call. Also, some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.