SIM7912-M2
Hardware Design

LTE Module

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Contents

Version History **3**

Contents **4**

Table Index **6**

Figure Index **7**

1 Introduction **8**

1.1 Product Outline 8

1.2 Hardware Block Diagram 10

1.3 Functional Overview 11

2 Package Information **13**

2.1 Pin Assignment Overview 13

2.2 Pin Description 15

2.3 Mechanical Information 21

2.4 Package Dimensions 22

3 Interface Application **23**

3.1 Power Supply 23

3.1.1 Power Supply Design Guide 23

3.1.2 Recommended Power Supply Circuit 24

3.1.3 Voltage Monitor 25

3.2 FUL_CARD_POWER_OFF# 26

3.2.1 Power on 26

3.2.2 Power off 27

3.3 Reset Function 28

3.4 UART interface 28

3.5 I2C Interface 29

3.6 SPI Interface 30

3.7 WoWWAN# 31

3.8 USB3.0 Interface 31

3.9 USB2.0 Interface 32

3.10 UIM Interface 33

3.10.1 USIM Application Guide 33

3.11 I2S Interface 34

3.11.1 I2S timing 35

3.11.2 I2S reference circuit 36

3.12 DPR* 36

3.13 CONFIG Pins 37

3.14 LED1# 38

3.15 W_DISABLE1# 38

3.16 W_DISABLE2# 40

4 Antenna Interfaces 41
4.1 Operating Frequency 41
4.2 GNSS Antenna Interface 42
4.3 Antenna Installation 42
4.3.1 Antenna Requirements 42
4.3.2 Recommended RF Connector for Antenna Installation 43

5 Electrical Specifications 45
5.1 Absolute maximum ratings 45
5.2 Operating conditions 45
5.3 Operating Mode 46
5.3.1 Operating Mode Definition 46
5.3.2 Sleep mode 47
5.3.3 Minimum functionality mode and Flight mode 48
5.4 Current Consumption 48
5.5 RF Output Power 50
5.6 Conducted Receive Sensitivity 50
5.7 ESD 52

6 Top and Bottom View of Module 53

7 Package 54

8 Appendix 57
8.1 Coding Schemes and Maximum Net Data Rates over Air Interface 57
8.2 Related Documents 59
8.3 Terms and Abbreviations 61
8.4 Safety Caution 63

Table Index

Table 1: SIM7912G-M2 frequency bands 8
Table 2: General features 11
Table 3: Pin map 13
Table 4: IO parameters definition 15
Table 5: IO parameters definition 15
Table 6: Pin description 16
Table 7: VBAT pins electronic characteristic 23
Table 8: Recommended TVS diode list 24
Table 9: Power on timing and electronic characteristic 26
Table 10: Power off timing and electronic characteristic 27
Table 11: RESET pin electronic characteristic 28
Table 12: SPI interface configure 30
Table 13: UIM electronic characteristic in 1.8V mode (UIM-PWR=1.8V) 33
Table 14: UIM electronic characteristic 3.0V mode (UIM-PWR=2.85V) 33
Table 15: I2S format 34
Table 16: I2S timing parameters 35
Table 17: DPR interface 36
Table 18: CONFIG Pins 37
Table 19: Config interface 37
Table 20: LED1# pin status 38
Table 21: FLIGHTMODE pin status 39
Table 22: SIM7912G-M2 Operating frequencies 41
Table 23: GNSS frequencies 42
Table 24:WCDMA/LTE antenna 42
Table 25:GNSS antenna 43
Table 26: the major specifications of the RF connector 44
Table 27:Absolute maximum ratings 45
Table 28: Recommended operating ratings 45
Table 29: 1.8V Digital I/O characteristics* 45
Table 30:Operating temperature 46
Table 31: Operating mode Definition 46
Table 32:Current consumption on VBAT Pins (VBAT=3.7V) 48
Table 33: Conducted Output Power 50
Table 34:SIM7912G-M2 Conducted RF Receiving Sensitivity 50
Table 35: The ESD performance measurement table (Temperature: 25℃, Humidity: 45%) 52
Table 36: Tray size 55
Table 37: Small Carton size 55
Table 38:Big Carton size 56
Table 39: Coding Schemes and Maximum Net Data Rates over Air Interface 57
Table 40: Related Documents 59
Table 41:Terms and Abbreviations 61
Table 42:Safety Caution 63

Figure Index

Figure 1: Standard Module block diagram....10
Figure 2: pin out diagram....21
Figure 3: Dimensions of SIM7912G-M2 (Unit: mm)....22
Figure 4: Power supply application circuit....24
Figure 5: Linear regulator reference circuit....25
Figure 6: Switching mode power supply reference circuit....25
Figure 7: Reference power on/off circuit....26
Figure 8: Power on timing sequence....26
Figure 9: Power off timing sequence....27
Figure 10: Reference reset circuit....28
Figure 11: UART modem....29
Figure 12: Reference circuit of level shift....29
Figure 13: I2C reference circuit....30
Figure 14: WOWWAN# behaviour（SMS and URC report）....31
Figure 15: WOWWAN# reference circuit....31
Figure 16: USB reference circuit....32
Figure 17: USIM interface reference circuit....33
Figure 18: UIM interface reference circuit with UIM_DET....34
Figure 19: I2S timing....35
Figure 20: Audio codec reference circuit....36
Figure 21: LED1# reference circuit....38
Figure 22: Flight mode switch reference circuit....39
Figure 23: GNSS function switch reference circuit....40
Figure 24: Antenna connector....44
Figure 25: Top and bottom view of Module....53
Figure 26: packaging diagram....54
Figure 27: Tray drawing....55
Figure 28: Small carton drawing....55
Figure 29: Big carton drawing....56

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 SIM7912G-M2 to design and develop mobile and laptop applications quickly.

1.1 Product Outline

Aimed at the global market, SIM7912G-M2 supports WCDMA, LTE-TDD and LTE-FDD, support DL 2CA and 3CA. The supported radio frequency bands are described in the table1.

Table 1: SIM7912G-M2 frequency bands

Standard	Frequency bands
WCDMA	B1/B2/B3/B4/B5/B8/B9/B19
LTE(TDD)	B38/B39/B40/B41
LTE(FDD)	B1/B2/B3/B4/B5/B7/B8/B12/B13/B17/B18/B19/B20/B25/B26/B28/B29/B30/B32/B66
2CA	B1+B3/5/18/19/20/26; B2+B2/4/5/12/13/17/29/30/66; B3+B3/5/7/8/19/20/28; B4+B4/5/12/13/17/29/30; B5+B7/30/66; B7+B7/20/28; B12+B30; B13+B66; B20+B32; B29+B30; B38+B38; B39+B39; B39+B41; B40+B40; B41+B41; B66+B12/29/30/66; (Note: B29; B32 is only for secondary component carrier)
3CA	DL inter-band 3CA:

	B1+B3+B5/8/19/20/28; B1+B7+B20; B2+B4+B5; B2+B4+B13; B2+B5+B30; B2+B12+B30; B2+B29+B30 ; B3+B7+B20; B3+B7+B28 ; B3+B7+B8; B4+B5+B30; B4+B12+B30; B4+B29+B30 ; B5+B66+B2; B13+B66+B2; B66+B12+B30; B66+B29+B30; B66+B5+B30; DL 2 intra-band plus inter-band 3CA: B2+B2+B5; B2+B2+B13 ; B3+B3+B7; B3+B7+B7; B3+B3+B20 ; B3+B3+B28; B3+B3+B1; B4+B4+B5; B4+B4+B13; B7+B7+B28; B5+B66+B66; B13+B66+B66; B66+B66+B2; B39+B39+B41; B39+B41+B41; DL 3 intra-band 3CA: B40+B40+B40; B41+B41+B41; B66+B66+B66
GNSS	GPS/Galileo/QZSS/ GLONASS/ BeiDou/Compass

With a physical dimension of 30.0*42.0*2.3 mm, SIM7912G-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, SIM7912G-M2 had almost all common interface integrated, such as USB2.0,USB3.0, PCIE, UIM card, digital audio(I2S or PCM), UART, I2C, GPIOs, MAIN ANT, DIV ANT and GNSS ANT, etc.

With all the interfaces, SIM7912G-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 SIM7912G-M2 is shown as below:

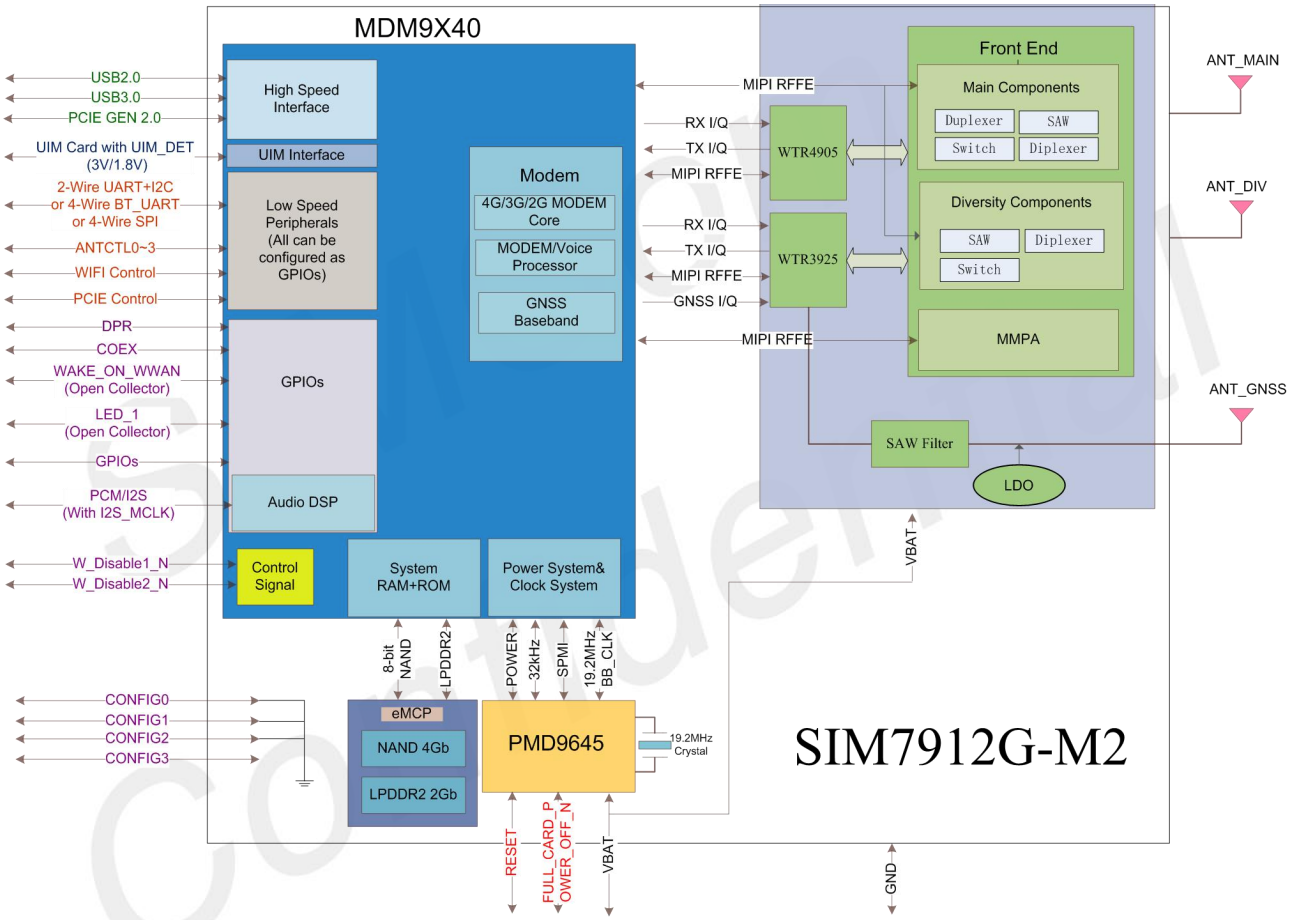

Figure 1: Standard Module block diagram

1.3 Functional Overview

Table 2: General features

Feature	Implementation
Power supply	VBAT:3.135～4.4 Typical supply voltage: 3.7V
Power consumption	Current in sleep mode : <5mA
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) FDD-LTE :Max 600Mbps (DL Category11), 75Mbps (UL Category 5) TDD-LTE :Max 452Mbps (DL Category11), 42Mbps (UL Category 5)
Antenna	WCDMA/LTE main antenna. WCDMA/LTE diversity antenna GNSS antenna
GNSS	GNSS engine (GPS/Galileo/QZSS/ GLONASS/ BeiDou/Compass) 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
Digital Audio feature	One I2S interface with dedicated main-clock for primary digital audio, the I2S also can be configured as PCM ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● MCLK frequency: 12.288MHz (default) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● WCDMA AMR-NB ● VoLTE AMR-WB ● Echo Cancellation ● Noise Suppression
PCIE interface	● One port PCIE interface, support PCIe Gen 2 (PCIe Gen 1 compatible) ● High communication data rate which is up to 5 Gbps per lane.
UART interface	UART: ● 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 ● Could be configured as GPIOs.
I2C interface	I2C: ● Apply to the “I2C Specification, version 3.0” ● Clock up to 400Kbps
SPI interface	SPI: ● High speed SPI interface, master mode only ● Maximum working frequency: 50MHz ● Single chip select (SPI_CS) signal
USB	One USB 3.0 SuperSpeed and high-speed (for backward compatibility) USB3.0: super speed, with data rate which is up to 5 Gbps. USB2.0: 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 or FOTA
Physical characteristics	Size:30*42*2.3mm Weight:6.3g
Temperature range	Normal operation temperature: -30°C to +70°C 3GPP compliant Extended 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 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 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.

Table 3: Pin map

		CONFIG_2	75
74	VBAT	GND	73
72	VBAT	GND	71
70	VBAT	CONFIG_1	69
68	WLAN_PWR_EN(1.8V)	RESET#(1.8V)	67
66	SIM Detect (1.8V)	ANTCTL3(1.8V)	65
64	COEX_RX(1.8V)	ANTCTL2(1.8V)	63
62	COEX_TX(1.8V)	ANTCTL1(1.8V)	61
60	UART_TX/SPI_MOSI(1.8V)	ANTCTL0(1.8V)	59
58	UART_RX/SPI_MISO(1.8V)	GND	57
56	I2S_MCLK/ SI_RST_N(1.8V)	REFCLKP	55
54	PEWAKE#(1.8V)	REFCLKN	53
52	CLKREQ# (1.8V)	GND	51
50	PERST#(1.8V)	PERp0	49
48	GPIO4/WL_SLP_CLK (1.8V)		

		PERn0	47
46	GPIO3/GP_CLK/ SI_INT_N(1.8V)	GND	45
44	GPIO2/WLAN_EN (1.8V)	PETp0	43
42	I2C_SDA/UART_CTS/SPI_CS(1.8V)	PETn0	41
40	I2C_SCL/UART_RTS/SPI_CLK(1.8V)	GND	39
38	BT_EN(1.8V)	USB3.0-Rx+	37
36	UIM-PWR	USB3.0-Rx -	35
34	UIM-DATA	GND	33
32	UIM-CLK	USB3.0-Tx+	31
30	UIM-RESET	USB3.0-Tx -	29
28	I2S_CLK (1.8V)	GND	27
26	W_DISABLE2#(3.3/1.8V)	GPIO_12 - DPR/DPR (1.8V)	25
24	I2S_DOUT(1.8V)	GPIO_11 - WoWWAN#/ WoWWAN# (1.8V)	23
22	I2S_DIN(1.8V)	CONFIG_0	21
20	I2S_WA (1.8V)	Notch	
	Notch	Notch	
	Notch	Notch	
	Notch	Notch	
	Notch	GND	11
10	LED1# (3.3V OD)	USB D-	9
8	W_DISABLE1# (3.3/1.8V)	USB D+	7
6	FUL_CARD_POWER_OFF#(3.3/1.8V)		

4	VBAT	GND	5
		GND	3
2	VBAT		
		CONFIG_3	1

2.2 Pin Description

Table 4: 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 5: 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		

Table 6: 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			Ground	
System Control					
FUL_CARD_POWER_OFF#	6		DI,PD	H: WWAN powers on. L: WWAN 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	P3	DI,PU	System reset control input, active low.	RESET_N has been pulled up to 1.8V via resistor internally.
W_DISABLE1#	8	P3	DI	WWAN RF Disable, active low	It's 3.3V tolerant but can be driven by either 1.8V or 3.3V GPIO.
W_DISABLE2#	26	P3	DI	GNSS disable, active low.	It's 3.3V tolerant but can be driven by either 1.8V or 3.3V GPIO.
Configuration pins					
CONFIG0	21		GND	Connect to ground	SIM7912G-M2 module is configured as the WWAN USB3.0 interface type
CONFIG1	69		GND	Connect to ground	
CONFIG2	75		GND	Connect to ground	
CONFIG3	1		NC	Not connected	
USB2.0/USB3.0					
USB_DP	7		AIO	Positive line of the differential, bi-directional	Main communication

				USB signal.	interface.
USB_DN	9		AIO	Negative line of the differential, bi-directional USB signal.	USB3.0 is up to 5 Gbps; USB2.0 is up to 480Mbps.
USB3.0-TXM	29		AO	USB3.0 transmit data minus	
USB3.0-TXP	31		AO	USB3.0 transmit data plus	
USB3.0-RXM	35		AI	USB3.0 receive data minus	
USB3.0-RXP	37		AI	USB3.0 receive data plus	
PCIE interface					
PETn0	41		AO	PCIe TX Differential signals Negative	Support PCIe GEN 2.0, up to 5Gbps data rate. If unused, please keep them open.
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	P3	DI	Asserted to reset module PCIe interface default. Active low.	If unused, please keep them open.
CLKREQ#	52	P3	DIO	PCIe clock request. Open drain output requires external 100K resistor to 1.8V power source. Active low.	

PEWAKE#	54	P3	DO	Asserted to wake up system. Open drain output requires external 100K resistor to 1.8V power source. Active low.	
USIM interface					
UIM-PWR	36	P4	PO	Power output for UIM card, the voltage depends on the UIM card type. Its output current is up to 50mA.	All lines of UIM interface should be protected against ESD.
UIM-DATA	34	P4	DIO	UIM Card data I/O, which has been pulled up via a 10KR resistor to UIM_PWR internally. Do not pull it up or down externally.	
UIM-CLK	32	P4	DO	UIM clock output	
UIM-RESET	30	P4	DO	UIM Reset output	
SIM1_DETECT	66	P3	DI	UIM 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	These signals are used for Antenna Control and should be routed to the appropriate Antenna Control Circuitry on the platform. These signals are 1.8V voltage domain. If unused, please keep them open.
ANTCTL1	61	P3	DO	Tunable ANT CTRL1	
ANTCTL2	63	P3	DO	Tunable ANT CTRL2	
ANTCTL3	65	P3	DO	Tunable ANT CTRL3	
WLAN control interface					

COEX_RX	64	P3	DI	Wireless coexistence between WWAN and WiFi/BT modules, based on BT-SIG coexistence protocol.	DO NOT PULL UP COEX_TX (PIN 62) DURING NORMAL POWER UP! These signals are 1.8V voltage domain. If unused, keep them open.
COEX_TX	62	P3	DO	Wireless coexistence between WWAN and WiFi/BT modules, based on BT-SIG coexistence protocol.	
WLAN_EN	44	P3	DO	WLAN function enable	
BT_EN	38	P3	DO	Bluetooth function enable	
WL_SLP_CLK	48	P3	DO	WLAN sleep clock output	
WL_PWR_EN	68	P3	DO	WLAN power enable	
Audio interface					
AUDIO_0: PCM_SYNC/ I2S_WA	20	P3	DO	PCM synchronous signal ; I2S word select	These signals are 1.8V voltage domain. If unused, keep them open.
AUDIO_1: PCM_IN/ I2S_DIN	22	P3	DI	PCM data input; I2S data input	
AUDIO_2: PCM_OUT/ I2S_DOUT	24	P3	DO	PCM data output; I2S data output	
AUDIO_3: PCM_CLK I2S_CLK	28	P3	DO	PCM clock output I2S clock output	
I2S_MCLK/ SI_RST_N	56	P3	DO	I2S system main clock/ SLIC reset output	
Multiplex interface					
I2C_SCL/ SPI_CLK/ UART_RTS	40	P3	DO	I2C bus clock signal(default) SPI bus clock signal; UART request to send	These signals are 1.8V voltage domain. External pull-up resisters (2.2K recommended) are needed when the I2C interface is used.
I2C_SDA/ SPI_CS/	42	P3	DIO	I2C bus data signal(default); SPI chip	

UART_CTS				select; UART clear to send	If unused, keep them open.
UART_RX/ SPI_MISO	58	P3	DI	UART receive data(default) Master input slaver output	
UART_TX/ SPI_MOSI	60	P3	DO	UART transmit data(default) Master output slaver input	
Other pins					
LED#1	10	P3	OC	It is an open collector, 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-collector output. If unused, keep them open.
WAKE_ON_WWAN	23	P3	OC	WWAN to wake up the host. It is open collector 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	These signals are 1.8V voltage domain. If unused, keep them open.
GP_CLK/ SI_INT_N	46	P3	DO/DI	General purpose clock output/ SLIC interrupt input	
Notch					
Notch	12			Notch	
Notch	13			Notch	
Notch	14			Notch	
Notch	15			Notch	
Notch	16			Notch	
Notch	17			Notch	
Notch	18			Notch	

Notch	19		Notch

2.3 Mechanical Information

The following figure shows the package outline drawing of the M.2 card.

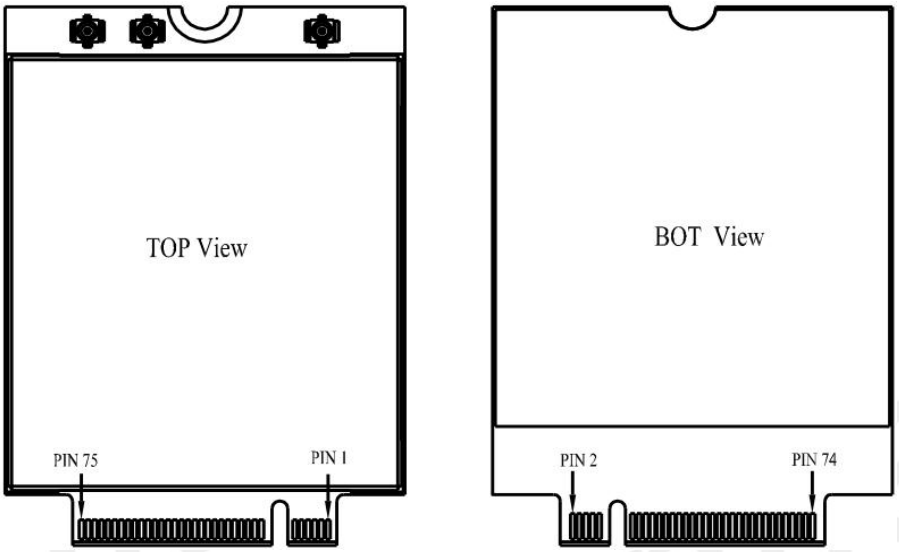

Figure 2: pin out diagram

2.4 Package Dimensions

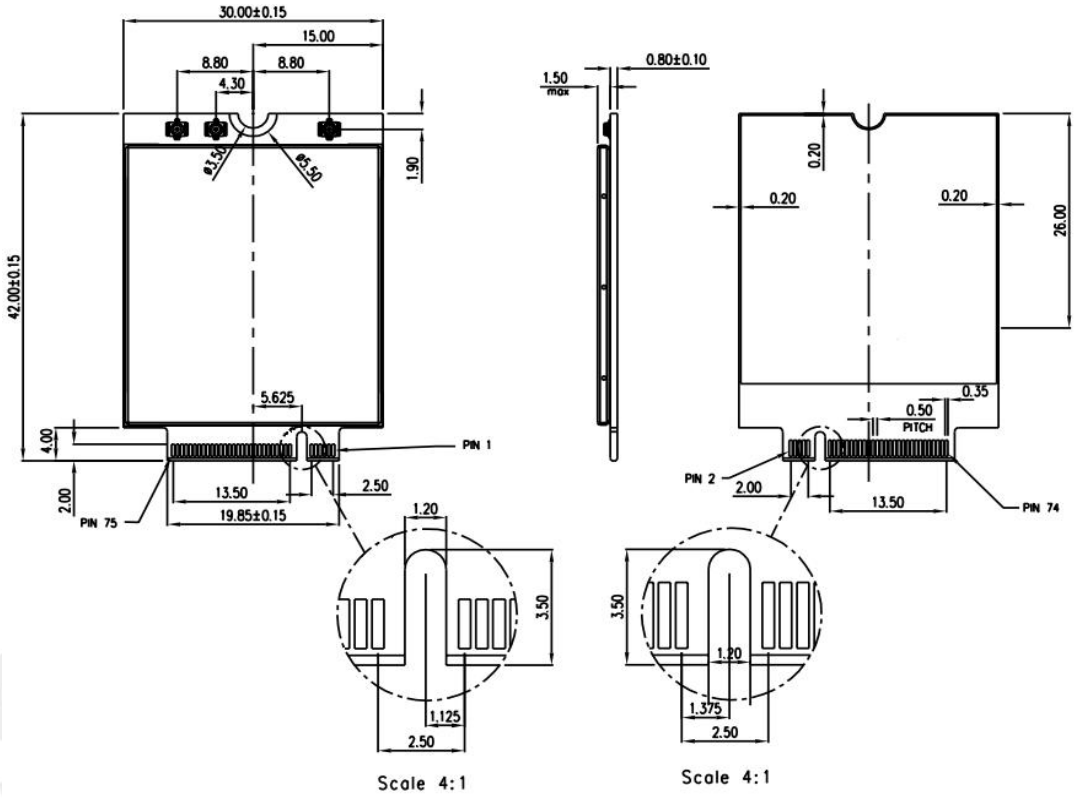

Figure 3: Dimensions of SIM7912G-M2 (Unit: mm)

3 Interface Application

3.1 Power Supply

The recommended power supply of SIM7912G-M2 is 3.7V and the voltage ranges from 3.135 V to 4.4 V. The SIM7912G-M2 has 5 power pins and 11 Ground pins, to ensure the SIM7912G-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	A
$I_{VBAT(power-off)}$	Module power current in power off mode.	-	7	-	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 will 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 drop 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.

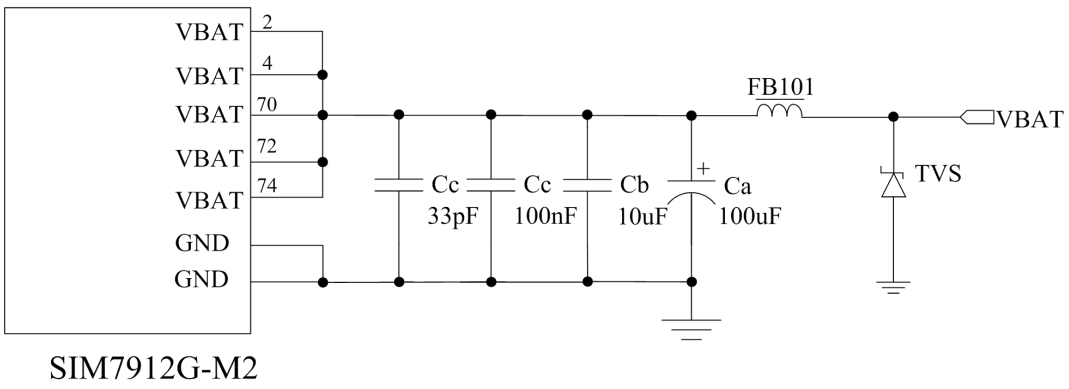

Figure 4: Power supply application circuit

NOTE

The test condition: The voltage of power supply for VBAT is 3.7V, Ca is 100 μF tantalum capacitor (ESR=0.7Ω).

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

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.

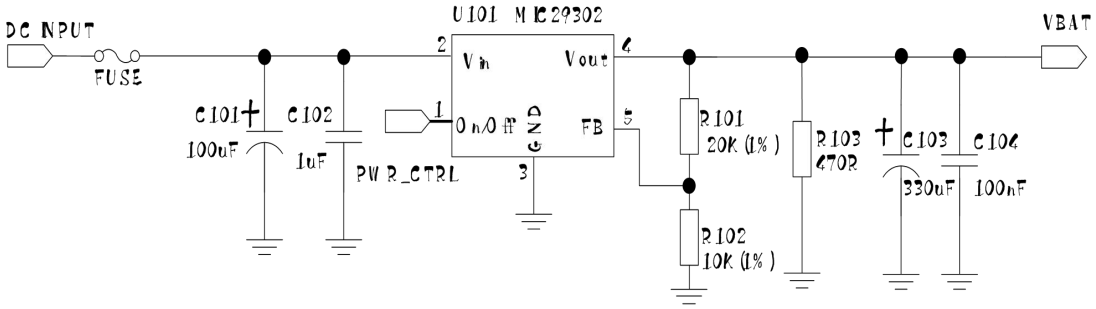

Figure 5: Linear regulator reference circuit

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.

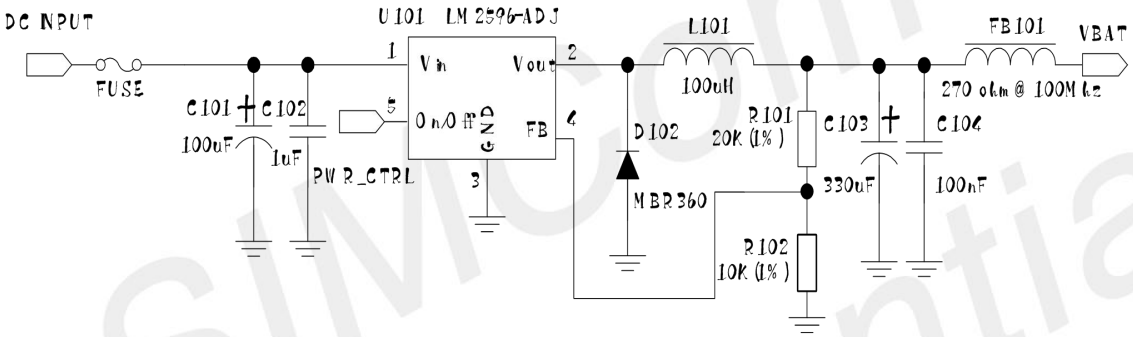

Figure 6: Switching mode power supply reference circuit

NOTE

The Switching Mode power supply solution for VBAT must be chosen carefully against Electro Magnetic Interference and ripple current from depraving RF performance.

3.1.3 Voltage Monitor

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

NOTE

For more details about voltage monitor commands, please refer to Document [1].

3.2 FUL_CARD_POWER_OFF#

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

FUL_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.

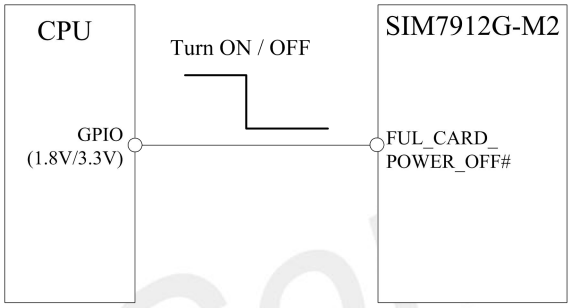

Figure 7: Reference power on/off circuit

NOTE

Note: Module could be automatically power on by connecting FUL_CARD_POWER_OFF# pin to 3V3 via 0R resistor directly.

3.2.1 Power on

The power-on scenarios are illustrated in the following figure.

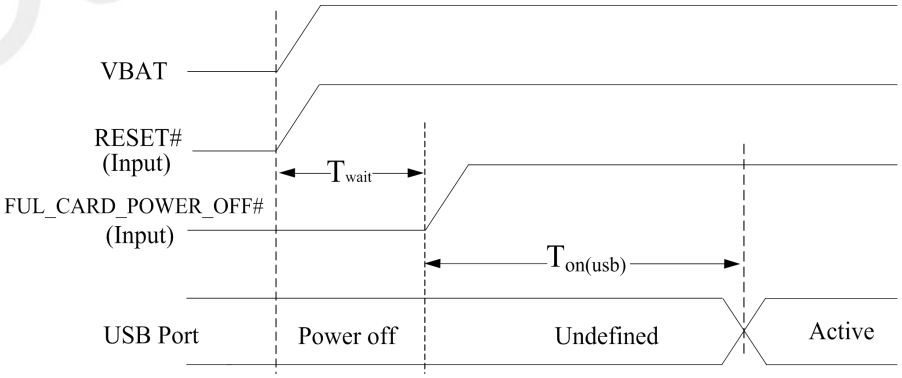

Figure 8: Power on timing sequence

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	-	12	-	s
V_{IH}	Input high level voltage on FUL_CARD_POWER_OFF# pin	1.0	1.7	4.4	V
V_{IL}	Input low level voltage on FUL_CARD_POWER_OFF# pin	-0.3	0	0.2	V

3.2.2 Power off

The following methods can be used to power off the card.

- Method 1: Power off the card by holding the FUL_CARD_POWER_OFF# pin to a low level.
- Method 2: Power off Module by AT command “AT+CPOF”.
- Method 3: over-voltage or under-voltage automatic power off.
- Method 4: over-temperature or under-temperature automatic power off.

NOTE

If the temperature is outside the range of -30~+70℃, some warning will be reported via AT port. If the temperature is outside the range of -40~+85℃, Module will be powered off automatically.

For details about “AT+CPOF”, please refer to Document [1].

These procedures 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 FUL_CARD_POWER_OFF# pin is illustrated in the following figure.

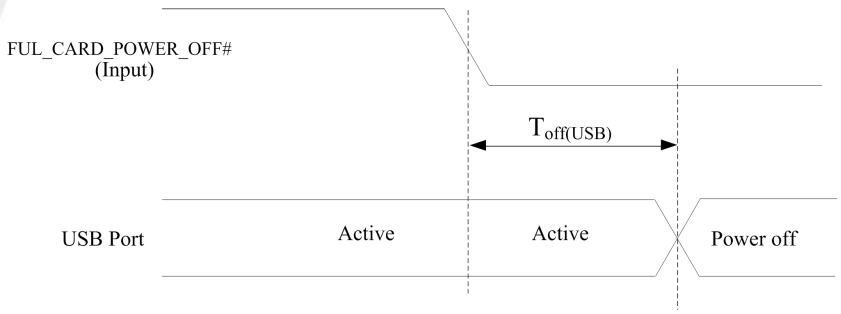

Figure 9: Power off timing sequence

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 FUL_CARD_POWER_OFF# pin have lost efficacy.

The RESET# pin has been pulled up with a resistor to 1.8V internally, so it does not need to be pulled up externally. 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.

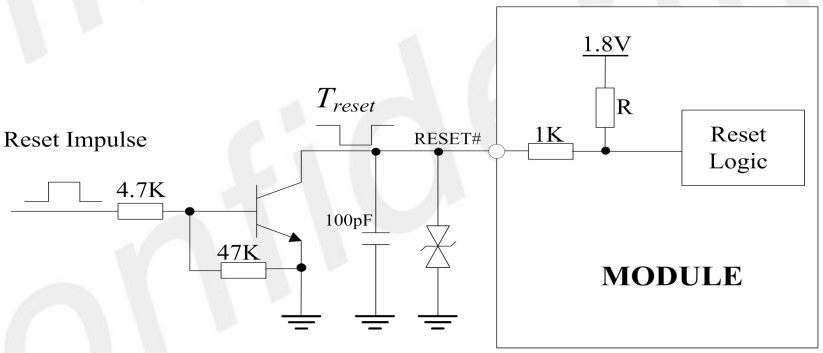

Figure 10: Reference reset circuit

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.

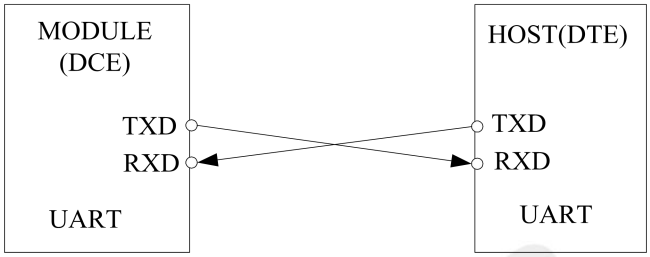

Figure 11: UART modem

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.

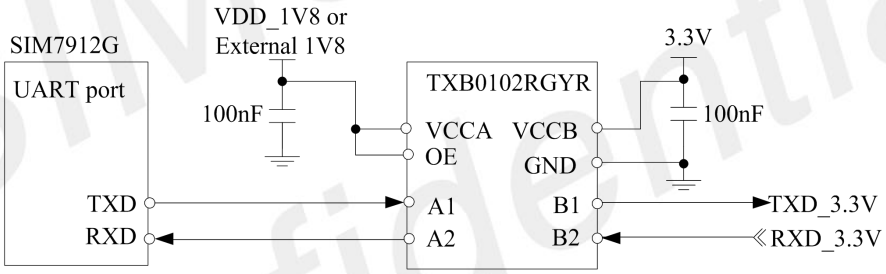

Figure 12: Reference circuit of level shift

NOTE

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.

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.

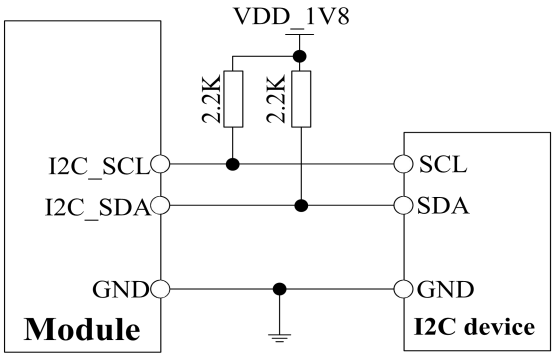

Figure 13: I2C reference circuit

NOTE

SDA and 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 SPI Interface

SIM7912 provides a multiplex SPI interface as a master only. It provides a duplex, synchronous, serial communication link with peripheral devices. Its operation voltage is 1.8V, with clock rates up to 50 MHz The SPI interface could also be configured as UART, I2C or GPIOs, which could refer to the Table below.

Table 12: SPI interface configure

PIN	Mode 0(Default)	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5
	UART +I2C	SPI mode	BT_UART mode	UART +GPIO	I2C+GPIO	GPIOs
60	UART_TX	SPI_MOSI	BT_TXD	UART_TX	GPIO	GPIO
58	UART_RX	SPI_MISO	BT_RXD	UART_RX	GPIO	GPIO
42	I2C_SDA	SPI_CS	BT_CTS	GPIO	I2C_SDA	GPIO
40	I2C_SCL	SPI_CLK	BT_RTS	GPIO	I2C_SCL	GPIO

NOTE

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

3.7 WoWWAN#

The WoWWAN# pin is an open collector 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.

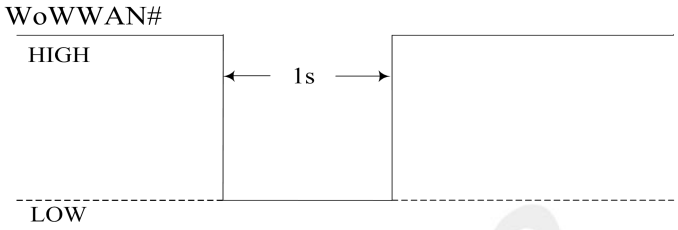

Figure 14: WOWWAN# behaviour（SMS and URC report）

WAKE_ON_WWAN Reference circuit is recommended in the following figure.

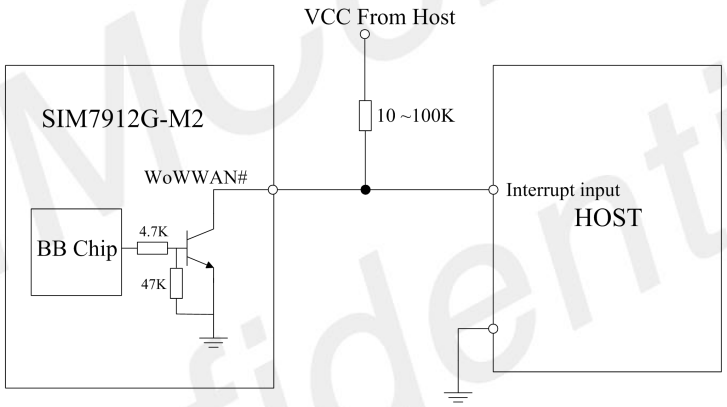

Figure 15: WOWWAN# reference circuit

3.8 USB3.0 Interface

The module support one integrated USB interface which complies with the USB 3.0 specifications and supports super speed up to 5Gbps. The USB interface is used for AT command communication, data transmission, GNSS NMEA output, software debugging and voice over USB.

NOTE

The USB3.0-Tx+ and USB3.0-Tx- should be routed together and the nets must be traced by 90Ohm+/-10% differential impedance. The same treatment should be needed for the routing of USB3.0-RX+ and USB3.0-RX-.

3.9 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_DN and USB_DP 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:

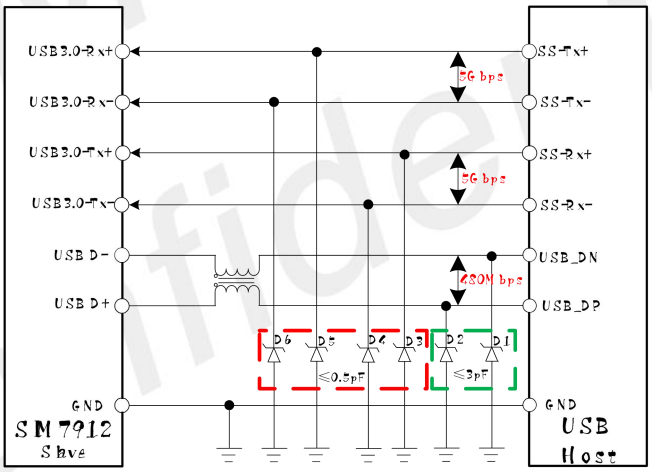

Figure 16: USB reference circuit

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).
However, for the USB3.0 signals (USB3.0-Tx and USB3.0-Rx), the capacitance should not be more than 0.5pF. It is recommended to use an ESD protection component such as ESD9L5.0ST5G provided by On Semiconductor (www.onsemi.com).

3.10 UIM Interface

Module supports both 1.8V and 3.0V UIM Cards.

Table 13: UIM electronic characteristic in 1.8V mode (UIM-PWR=1.8V)

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

Table 14: UIM electronic characteristic 3.0V mode (UIM-PWR=2.85V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
UIM-PWR	LDO power output voltage	2.75	2.85	3.05	V
V_{IH}	High-level input voltage	0.65*UIM-PWR	-	UIM-PWR +0.3	V
V_{IL}	Low-level input voltage	-0.3	0	0.25*UIM-PWR	V
V_{OH}	High-level output voltage	UIM-PWR -0.45	-	UIM-PWR	V
V_{OL}	Low-level output voltage	0	0	0.45	V

3.10.1 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.

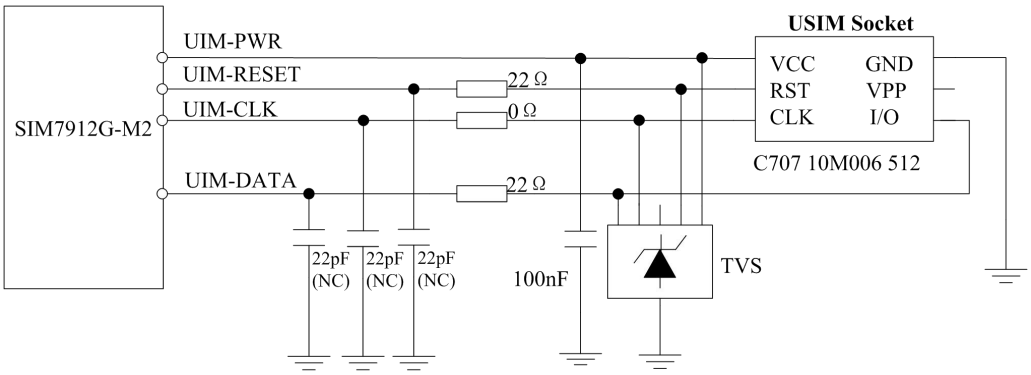

Figure 17: USIM interface reference circuit

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

The following figure shows the 8-pin SIM card holder reference circuit.

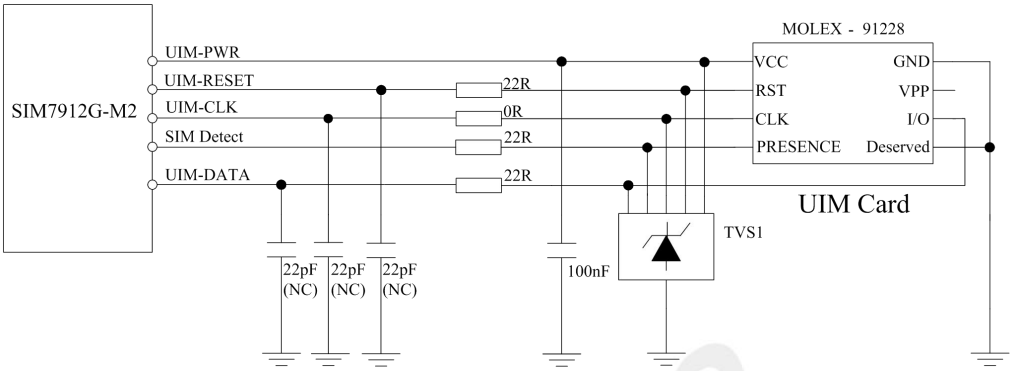

Figure 18: UIM interface reference circuit with UIM_DET

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

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 UIM-PWR line and keep close to the holder.
- The rise/fall time of UIM-CLK should not be more than 40ns.
- Add some TVS and the parasitic capacitance should not exceed 60pF.

3.11 I2S Interface

Module provides an I2S interface for external codec, which comply with the requirements in the Phillips I2S Bus Specifications

Table 15: I2S format

Characteristics	Specification
Line Interface Format	Linear(Fixed)
Data length	16bits(Fixed)
I2S Clock/Sync Source	Master Mode(Fixed)
I2S Clock Rate	1.536 MHz (Default)
I2S MCLK rate	12.288MHz (Default)

Data Ordering	MSB

NOTE

For more details about I2S AT commands, please refer to document [1].

3.11.1 I2S timing

Module supports 48 KHz I2S sampling rate and 32 bit coding signal (16 bit word length), the timing diagram is showed as following:

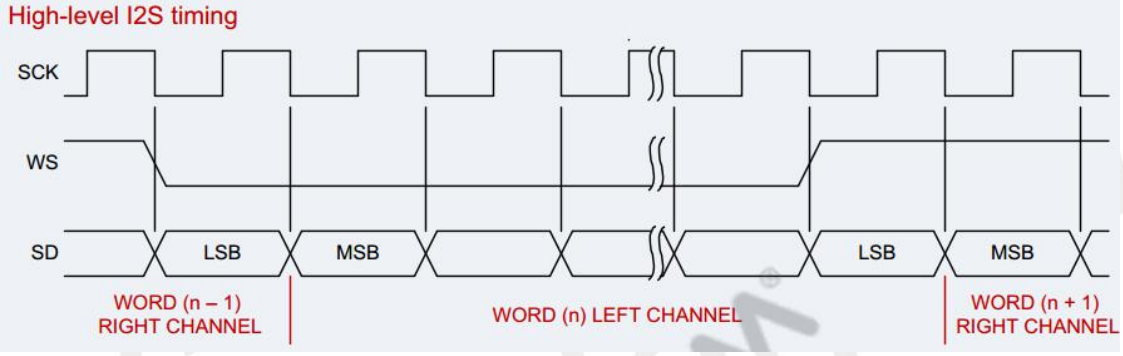

Figure 19: I2S timing

Table 16: I2S timing parameters

Signal	Parameter	Description	Min.	Typ.	Max.	Unit
I2S_MCLK	Frequency	Frequency	–	12.288	12.288	MHz
	T	Clock period	81.380	81.380	–	ns
	t(HC)	Clock high	0.45T	–	0.55T	ns
	t(LC)	Clock low	0.45T	–	0.55T	ns
I2S_CLK	Frequency	Frequency	8	48	48	KHz
	T	Clock period	20.83	20.83	125	us
	t(HC)	Clock high	0.45T	–	0.55T	ns
	t(LC)	Clock low	0.45T	–	0.55T	ns
I2S_WS	t(sr)	DIN/DOUT and WS input setup time	16.276	–	–	ns
	t(hr)	DIN/DOUT and WS input hold time	0	–	–	ns
	t(dtr)	DIN/DOUT and WS output delay	–	–	65.10	ns
	t(htr)	DIN/DOUT and WS output	0	–	–	ns

	hold time				

3.11.2 I2S reference circuit

The following figure shows the external codec reference design.

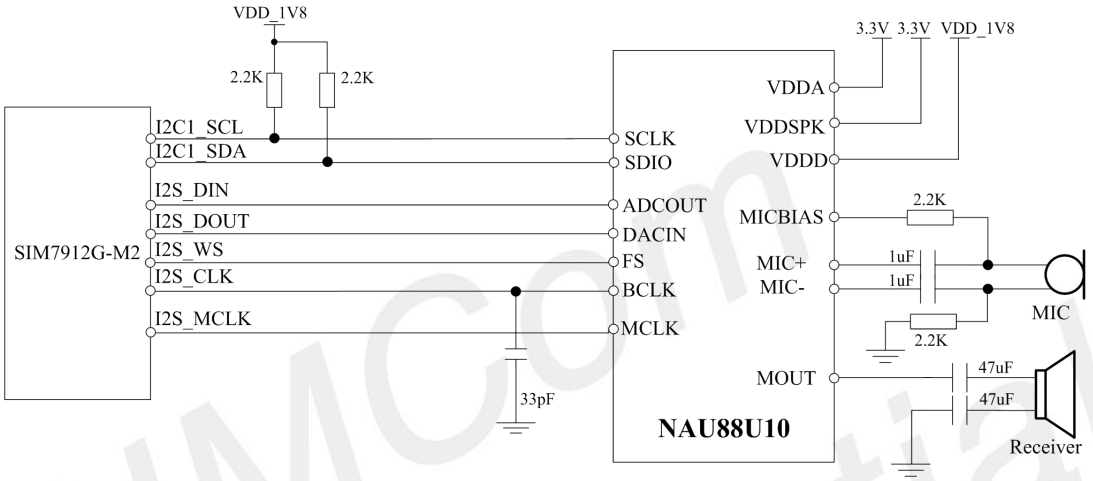

Figure 20: Audio codec reference circuit

3.12 DPR*

DPR (Dynamic Power Reduction) signal is used by SIM7912G-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 the wireless device 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
		High	Max transmitting power will not be reduced (default)
		Floating	Max transmitting power will not be reduced

NOTE

* means the DRP function is under developing.

3.13 CONFIG Pins

These signals provide the means to indicate the specific configuration of the module. SIM7912G-M2 is configured as WWAN-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

3.14 LED1#

LED1# is open collector output and is used to allow SIM7912G-M2 to provide network status via LED which will be provided by the host.

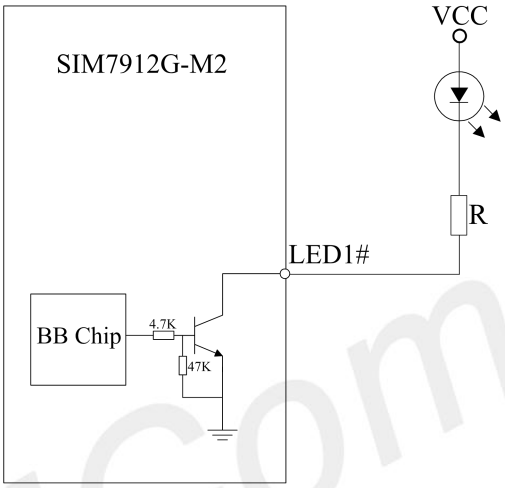

Figure 21: LED1# reference circuit

NOTE

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

The timing sequence is as followed:

Table 20: LED1# pin status

NETLIGHT 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

3.15W_DISABLE1#

The W_DISABLE1# pin controls SIM7912G-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.

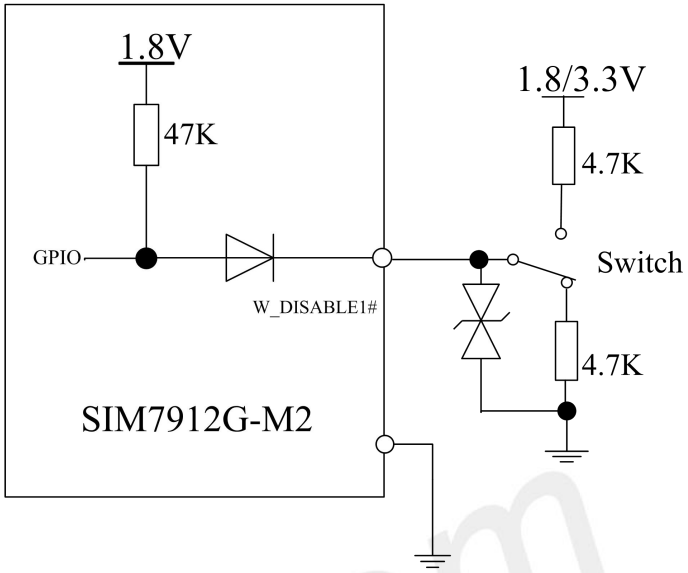

Figure 22: Flight mode switch reference circuit

Flight Mode pin status as below:

Table 21: FLIGHTMODE pin status

FLIGHTMODE 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

3.16 W_DISABLE2#

The W_DISABLE2# pin controls SIM7912G-M2 to enable or disable the GNSS function, when the W_DISABLE2# signal is asserted to low level, the GNSS function would be disabled.
Its reference circuit is shown in the following figure.

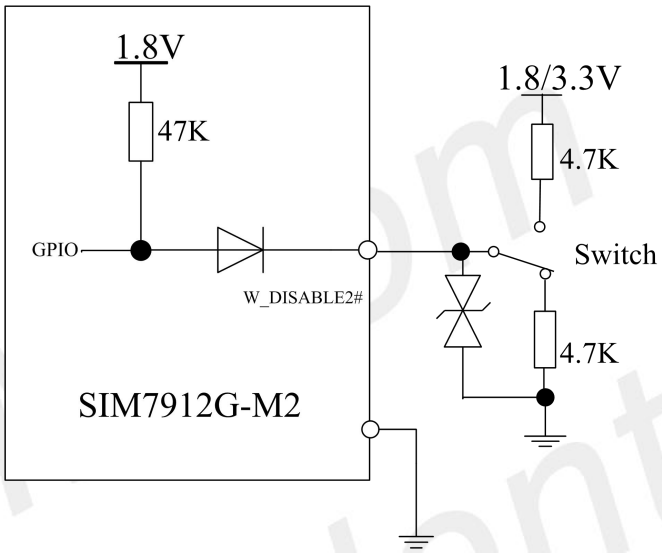

Figure 23: GNSS function switch reference circuit

4 Antenna Interfaces

SIM7912G-M2 provides a main antenna interface, a diversity antenna interface and a GNSS antenna interface. The antenna ports have an RF impedance of 50Ω.

4.1 Operating Frequency

Table 22: SIM7912G-M2 Operating frequencies

WCDMA Band	Uplink (UL)	Downlink (DL)	Duplex Mode
WCDMA B1	1920 ~1980 MHz	2110 ~2170 MHz	FDD
WCDMA B2	1850 ~1910 MHz	1930 ~1990 MHz	FDD
WCDMA B3	1710 ~1785 MHz	1805 ~1880 MHz	FDD
WCDMA B4	1710 ~1755 MHz	2110 ~2155 MHz	FDD
WCDMA B5	824～849 MHz	869～894MHz	FDD
WCDMA B8	880 ~915 MHz	925 ~960 MHz	FDD
WCDMA B9	1750 ~1785 MHz	1845 ~1880 MHz	FDD
WCDMA B19	830 ~845 MHz	875 ~890 MHz	FDD
LTE B1	1920 ~1980 MHz	2110 ~2170 MHz	FDD
LTE B2	1850 ~1910 MHz	1930 ~1990 MHz	FDD
LTE B3	1710 ~1785 MHz	1805 ~1880 MHz	FDD
LTE B4	1710 ~1755 MHz	2110 ~2155 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 B12	699 ~716 MHz	729 ~746 MHz	FDD
LTE B13	777 ~787 MHz	746 ~756 MHz	FDD
LTE B17	704 ~716 MHz	734 ~746 MHz	FDD
LTE B18	815 ~830 MHz	860 ~875 MHz	FDD
LTE B19	830 ~845 MHz	875 ~890 MHz	FDD
LTE B20	832~862MHz	791~ 821MHz	FDD
LTE B25	1850 ~1915 MHz	1930 ~1995 MHz	FDD
LTE B26	814 ~849 MHz	859 ~894 MHz	FDD
LTE B28	703~748MHz	758~803MHz	FDD
LTE B29	N/A	717 ~728 MHz	FDD
LTE B30	2305 ~2315 MHz	2350 ~2360 MHz	FDD

LTE B32	N/A	1452~1492MHz	FDD
LTE B66	1710 ~1780 MHz	2110 ~2200 MHz	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 B29/B32 supports Rx only and is only for secondary component carrier.

4.2 GNSS Antenna Interface

The following table shows frequency specification of GNSS antenna interface.

Table 23: GNSS frequencies

Type	Frequecy
GPS/Galileo/QZSS	1575.42±1.023MHz
GLONASS	1597.5~1605.8MHz
BeiDou/Compass	1561.098±2.046MHz

4.3 Antenna Installation

4.3.1 Antenna Requirements

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

Table 24:WCDMA/LTE antenna

Passive	Recommended standard
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

Table 25:GNSS antenna

Passive	Recommended standard
Frequency Range	1559~1609MHZ
Direction	RHCP or liner, RHCP is the first choice
VSWR	< 2
Passive antenna gain	> 0 dBi
Active antenna NF	< 1.5
Active antenna gain	> 0 dBi
Active antenna Embedded LNA gain	< 17 dB

NOTE

It is recommended to use a passive GNSS antenna when LTE B13 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 SIM7912G-M2. The dimension of the connector on SIM7912G-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:

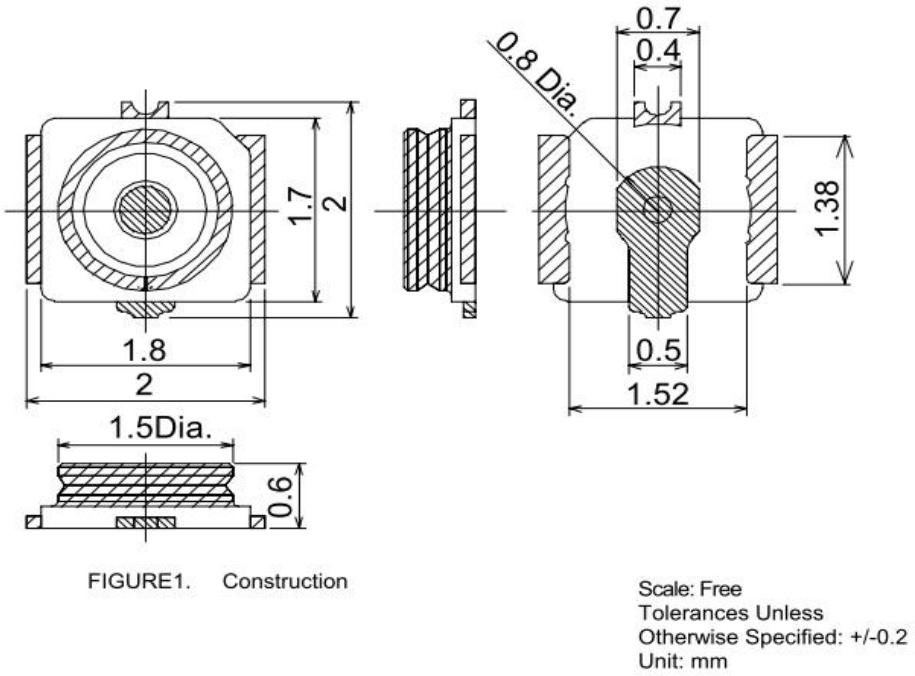

Figure 24: Antenna connector

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 SIM7912G, 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 (UIM)	-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, I2S, RESET#, ANTCTL, COEX 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 sending the AT command “AT+CPOF” or pull down the FUL_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 UIM card function will be closed. In this case, the serial port and USB are still accessible, but RF function and UIM 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)

GNSS	
GNSS supply current (AT+CFUN=0, with USB connection)	@ -140dBm，Tracking Typical:52mA
UMTS sleep mode	
WCDMA supply current (GNSS off，without USB connection)	Sleep mode @DRX=2.56S Typical: 2.45mA
LTE sleep mode	
LTE FDD supply current (GNSS off，without USB connection)	Sleep mode Typical: 3.0mA
LTE TDD supply current (GNSS off，without USB connection)	Sleep mode Typical: 3.0mA
UMTS Talk	
WCDMA B1	@Power 23dBm Typical: 700mA
WCDMA B2	@Power 23dBm Typical: 700mA
WCDMA B3	@Power 23dBm Typical: 700mA
WCDMA B4	@Power 23dBm Typical: 750mA
WCDMA B5	@Power 23dBm Typical: 650mA

WCDMA B8	@Power 23dBm Typical: 700mA
WCDMA B9	@Power 23dBm Typical: 700mA
WCDMA B19	@Power 23dBm Typical: 650mA
HSDPA data	
WCDMA B1	@Power 23dBm Typical: 700mA
WCDMA B2	@Power 23dBm Typical: 700mA
WCDMA B3	@Power 23dBm Typical: 700mA
WCDMA B4	@Power 23dBm Typical: 750mA
WCDMA B5	@Power 23dBm Typical: 650mA
WCDMA B8	@Power 23dBm Typical: 700mA
WCDMA B9	@Power 23dBm Typical: 700mA
WCDMA B19	@Power 23dBm Typical: 650mA
LTE data	
LTE-FDD B1	@5MHz 22.8dBm Typical: 700mA @10MHz 23.0dBm Typical: 700mA @20MHz 23.9dBm Typical: 750mA
LTE-FDD B2	@5MHz 21.5dBm Typical: 700mA @10MHz 21.5dBm Typical: 700mA @20MHz 22.5dBm Typical: 700mA
LTE-FDD B3	@5MHz 22.5dBm Typical: 750mA @10MHz 22.5dBm Typical: 750mA @20MHz 23.5dBm Typical: 800mA
LTE-FDD B4	@5Mbps 21.5dBm Typical: 700mA @10Mbps 21.5dBm Typical: 700mA @20Mbps 22.5dBm Typical: 750mA
LTE-FDD B5	@5Mbps 23.3dBm Typical: 700mA @10Mbps 23.4dBm Typical: 700mA @20Mbps 22.1dBm Typical: 700mA
LTE-FDD B7	@5Mbps 23.0dBm Typical: 700mA @10Mbps 23.1dBm Typical: 700mA @20Mbps 23.1dBm Typical: 800mA
LTE-FDD B8	@5Mbps 23.1dBm Typical: 750mA @10Mbps 23.4dBm Typical: 750mA
LTE-FDD B12	@5Mbps 23.3dBm Typical: 700mA @10Mbps 23.4dBm Typical: 750mA
LTE-FDD B13	@5Mbps 23.3dBm Typical: 750mA @10Mbps 23.4dBm Typical: 750mA
LTE-FDD B17	@5Mbps 23.3dBm Typical: 700mA @10Mbps 23.4dBm Typical: 700mA
LTE-FDD B18	@5Mbps 23.3dBm Typical: 750mA @10Mbps 23.4dBm Typical: 750mA @15Mbps 22.1dBm Typical: 700mA
LTE-FDD B19	@5Mbps 23.3dBm Typical: 750mA @10Mbps 23.4dBm Typical: 750mA @15Mbps 22.1dBm Typical: 700mA
LTE-FDD B20	@5Mbps 21.8dBm Typical: 750mA @10Mbps 21.8dBm Typical: 750mA @20Mbps 21.8dBm Typical: 750mA
LTE-FDD B25	@5Mbps 21.5dBm Typical: 700mA @10Mbps 21.5dBm Typical: 700mA @20Mbps 22.5dBm Typical: 700mA
LTE-FDD B26	@5Mbps 23.3dBm Typical: 700mA @10Mbps 23.4dBm Typical: 700mA

	@20Mbps 22.1dBm Typical: 650mA
LTE-FDD B28	@5Mbps 21.8dBm Typical: 700mA @10Mbps 21.8dBm Typical: 700mA @20Mbps 21.8dBm Typical: 700mA
LTE-FDD B29	N/A
LTE-FDD B30	@5Mbps 21.5dBm Typical: 900mA @10Mbps 21.5dBm Typical: 900mA @20Mbps 22.5dBm Typical: 900mA
LTE-FDD B32	N/A
LTE-FDD B66	@5Mbps 21.5dBm Typical: 700mA @10Mbps 21.5dBm Typical: 700mA @20Mbps 22.5dBm Typical: 700mA
LTE-TDD B38	@5Mbps 23.2dBm Typical : 750mA @10Mbps 23.3dBm Typical : 750mA @20Mbps 23.3dBm Typical : 750mA
LTE-TDD B39	@5Mbps 22.9dBm Typical : 650mA @10Mbps 23.0dBm Typical : 650mA @20Mbps 22.9dBm Typical : 650mA
LTE-TDD B40	@5Mbps 22.9dBm Typical : 750mA @10Mbps 23.0dBm Typical : 750mA @20Mbps 22.9dBm Typical : 750mA
LTE-TDD B41	@5Mbps 23.1dBm Typical : 750mA @10Mbps 23.1dBm Typical : 750mA @20Mbps 23.0dBm Typical : 750mA

5.5 RF Output Power

The following table shows the RF output power of SIM7912G-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 SIM7912G-M2 module.

Table 34:SIM7912G-M2 Conducted RF Receiving Sensitivity

Frequency	Primary (Typ.)	Diversity (Typ.)	SIMO1(Typ.)	SIMO2(Worst Case)
WCDMA B1	-110	--111	TBD	-106.7dBm

WCDMA B2	-109	-111	TBD	-104.7dBm
WCDMA B3	-110	-111	TBD	-103.7dBm
WCDMA B4	-110	-111	TBD	-106.7 dBm
WCDMA B5	-111	-111	TBD	-104.7dBm
WCDMA B8	-111	-111	TBD	-103.7dBm
WCDMA B9	-111	-111	TBD	-105.7dBm
WCDMA B19	-111	-111	TBD	-106.7dBm
LTE-FDD B1(10M)	-99.5	-97	TBD	-96.3dBm
LTE-FDD B2(10M)	-98	-98.5	TBD	-94.3 dBm
LTE-FDD B3(10M)	-98	-98	TBD	-93.3dBm
LTE-FDD B4(10M)	-97.5	-98	TBD	-96.3dBm
LTE-FDD B5(10M)	-98	-100	TBD	-94.3dBm
LTE-FDD B7(10M)	-97.5	-97.5	TBD	-94.3dBm
LTE-FDD B8(10M)	-99	-100	TBD	-93.3dBm
LTE-FDD B12(10M)	-99	-98	TBD	-93.3dBm
LTE-FDD B13(10M)	-98	-100	TBD	-93.3dBm
LTE-FDD B17(10M)	-98	-100	TBD	-93.3dBm
LTE-FDD B18(10M)	-98	-100	TBD	-96.3dBm
LTE-FDD B19(10M)	-98	-100	TBD	-96.3dBm
LTE-FDD B20(10M)	-99	-100	TBD	-93.3dBm
LTE-FDD B25(10M)	-97.5	-98.5	TBD	-92.8dBm
LTE-FDD B26(10M)	-99	-100	TBD	-93.8 dBm
LTE-FDD B28(10M)	-98	-100	TBD	-94.8dBm
LTE-FDD B29(10M)	N/A	N/A	N/A	N/A
LTE-FDD B30(10M)	-96.5	-97.5	TBD	-95.3dBm
LTE-FDD B32(10M)	N/A	N/A	N/A	N/A
LTE-FDD B66(10M)	-97.5	-97	TBD	-95.8 dBm
LTE-FDD B38(10M)	-96.5	-96	TBD	-96.3dBm
LTE-FDD B39(10M)	-98	-98.5	TBD	-96.3dBm
LTE-FDD B40(10M)	-100	-97	TBD	-96.3dBm
LTE-FDD B41(10M)	-98	-97	TBD	-94.3dBm

NOTE

The data in above table are gotten at static condition.

1. SIMO is a smart antenna technology that uses a single antenna at the transmitter side and multiple (two for SIM7912G-M2) antennas at the receiver side, which can improve Rx performance.
2. 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	+/-4K	+/-8K
Antenna port	+/-4K	+/-8K
FUL_CARD_POWER_OFF#	+/-2K	+/-4K
USB	+/-2K	+/-4K
RESET_N	+/-2K	+/-4K
UIM Card	+/-2K	+/-4K
Other PADs	+/-2K	+/-4K

6 Top and Bottom View of Module

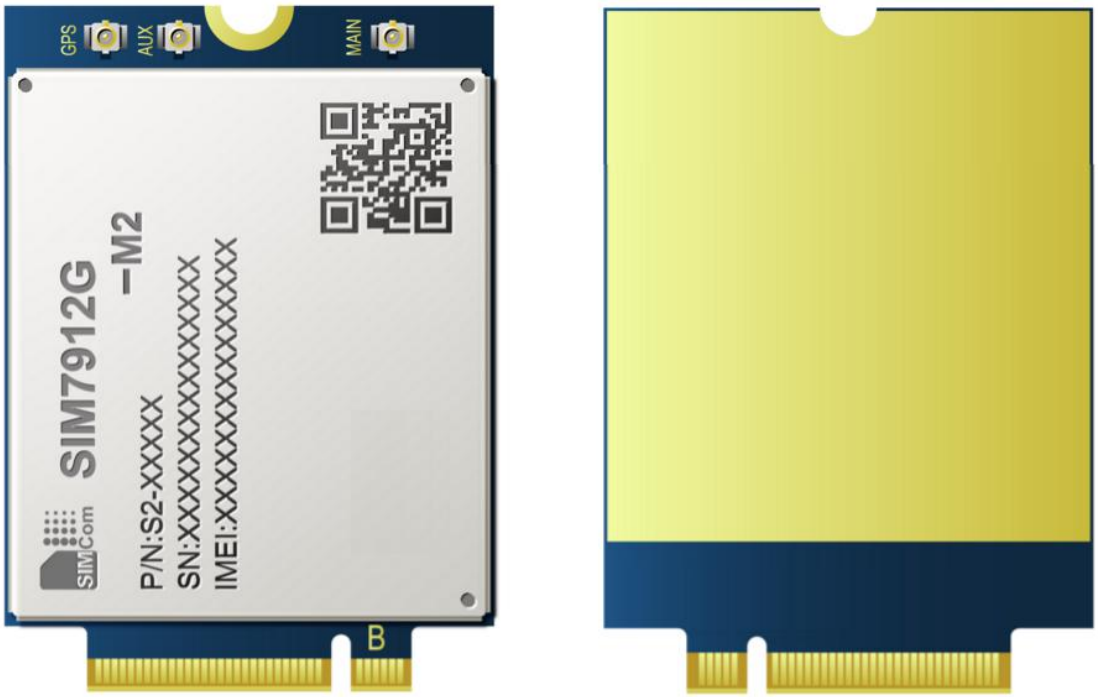

Figure 25: Top and bottom view of Module

NOTE

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

7 Package

Module support tray packaging.

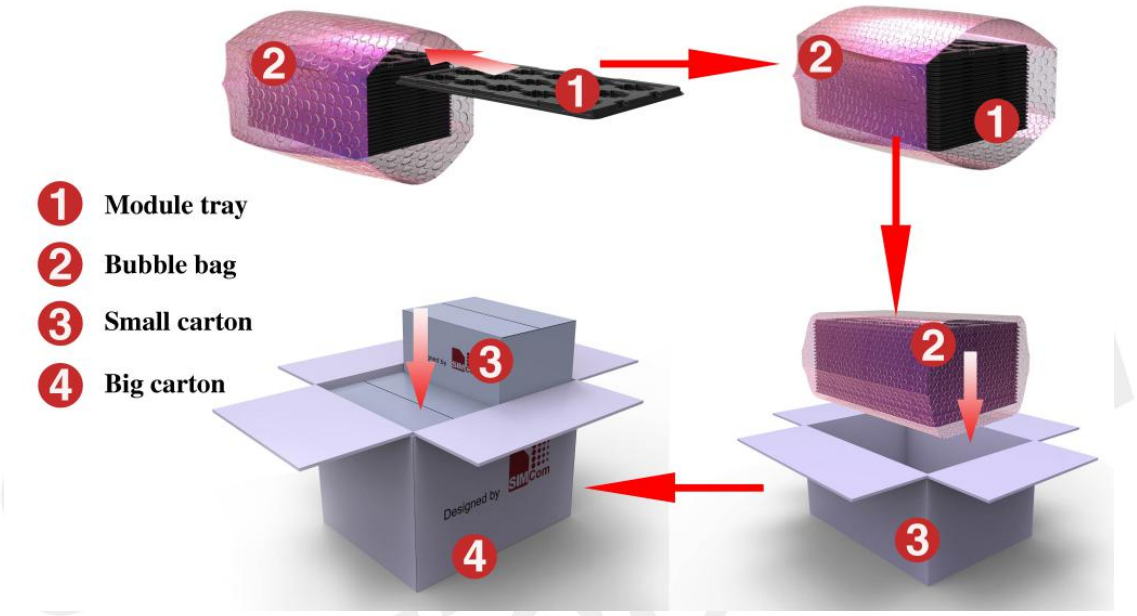

Figure 26: packaging diagram

Module tray drawing：

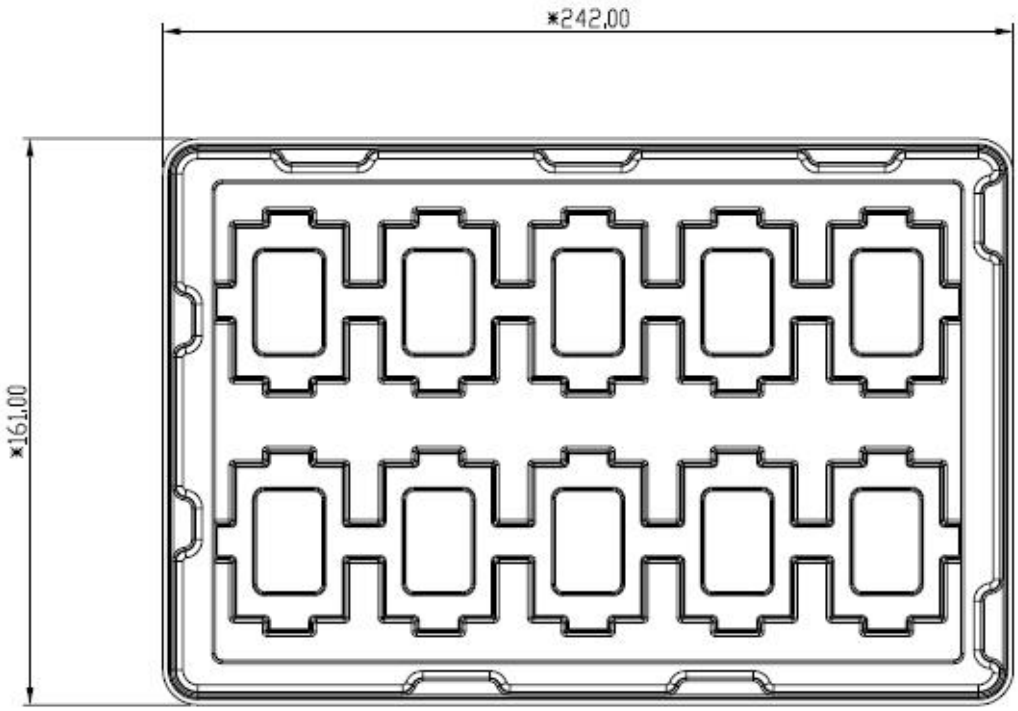

Figure 27: Tray drawing

Table 36: Tray size

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

Small carton drawing：

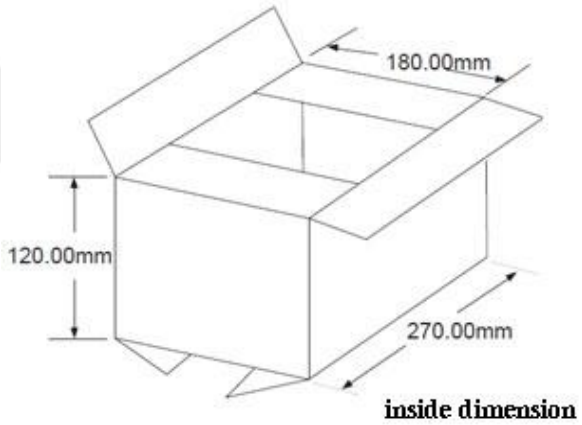

Figure 28: Small carton drawing

Table 37: Small Carton size

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

Big carton drawing：

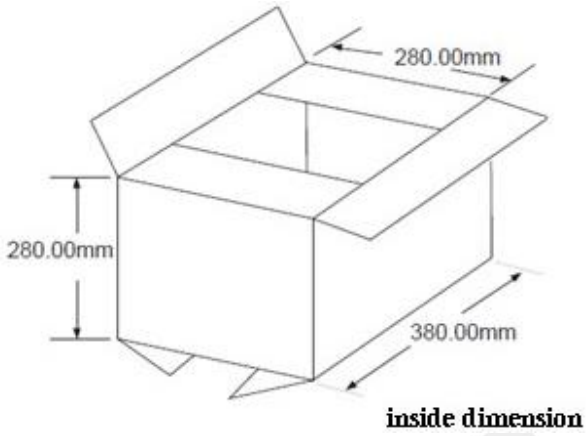

Figure 29: Big carton drawing

Table 38:Big Carton size

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

8 Appendix

8.1 Coding Schemes and Maximum Net Data Rates over Air Interface

Table 39: 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		
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
Category 7	300Mbps	QPSK/16QAM/64QAM
Category 8	300Mbps	QPSK/16QAM/64QAM
Category 9	450Mbps	QPSK/16QAM/64QAM
Category 10	600Mbps	QPSK/16QAM/64QAM
Category 11	600Mbps	QPSK/16QAM/64QAM/256QAM
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

8.2 Related Documents

Table 40: Related Documents

NO.	Title	Description
[1]	SIM7912G-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+); 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

8.3 Terms and Abbreviations

Table 41: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

8.4 Safety Caution

Table 42: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.