A7908E-M2
Hardware Design

LTE Module

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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 A7908E-M2 to design and develop quickly.

1.1 Document Overview

Technical information for the module is primarily covered by the documents listed in Table 1. All documents must be studied for a thorough understanding of the device and its applications.

Table 1: A7908E-M2 Document Overview

NO.	Document	Description
1	A7908E-M2 Hardware Design_V1.00 (This document)	Mainly introducing interface functions, Recommend circuit, PCB layout guideline, packaging and other hardware components, as well as the use of AT commands
2	SIMCOM_Module_Thermal_Design_Guide_V1.XX	Introduces the thermal design part of the Module design, for reference only
3	A7908E-M2_Module_Schematic&Layout_checklist_V1.XX	A7908E-M2 Module peripheral circuit schematic and PCB checklist
4	A7908E-M2 Antenna Port Mapping and Design Guide_V1.XX	Antenna design guidelines for transmitter and receiver system
5	A7908E-M2_Hardware_Reference_Design_V1.XX	Module peripheral circuit schematic diagram reference design
6	MOD_A7908E-M2_75	Recommended packaging

1.2 Product Outline

A7908E-M2 is a multi-band LTE-FDD / LTE-TDD / HSPA + module that supports CA and MIMO for class 6.

The supported radio frequency bands are described in the table2.

Table 2: A7908E-M2 frequency bands

Standard	Frequency bands
WCDMA	B1/B5/B8
LTE-FDD	B1/B3/B5/B7/B8/B20/B28/B32
LTE-TDD	B38/B40/B41/B42/B43

With a physical dimension of 42.0*30.0*2.3mm, A7908E-M2 can meet PCI Express M.2 Specification, and can meet almost any space requirement in users' applications.

A7908E-M2 has almost all common interface integrated, such as USB2.0, USB3.0,PCIe, (U)SIM , UART, I2C, PCM/I2S,GPIOs, and ANTs etc.

1.3 Hardware Block Diagram

The block diagram of A7908E-M2 is shown as below:

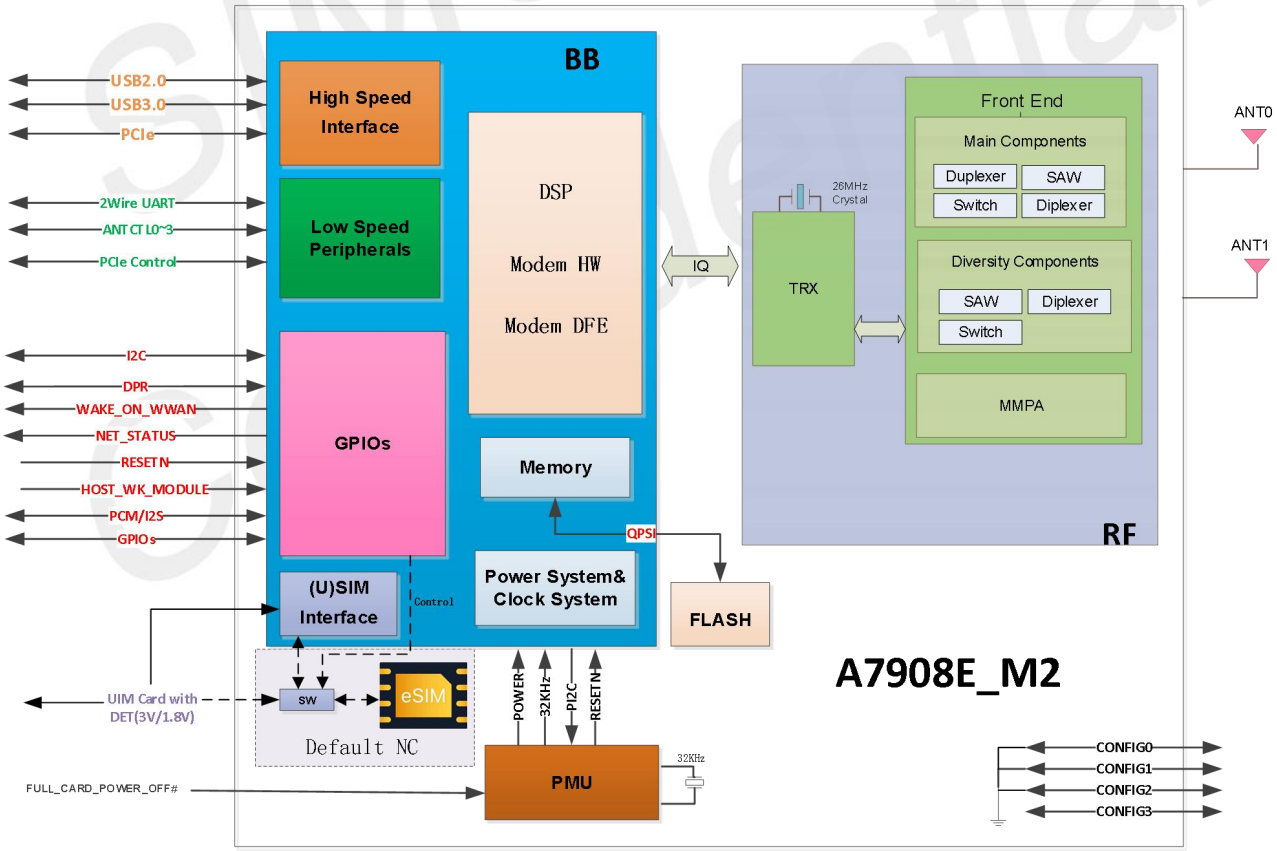


Figure 1: A7908E-M2 block diagram

1.4 Functional Overview

Table 3: General features

Feature	Implementation
Power supply	VBAT:3.135～4.4V Typical supply voltage: 3.8V
Power consumption	Power off current: <100uA Current in sleep mode :2.6mA
Transmitting power	LTE-TDD Power Class 3 (23 dBm ± 2dB) LTE-FDD Power rating 3 (23 dBm ± 2dB) WCDMA Power rating of 3 (24 dBm + 1 / -3dB)
Data Transmission Throughput	FDD / TDD LTE Category 6 supports the CA and MIMO technology The uplink supports the QPSK, 16-QAM modulation mode Downlink supports the QPSK, 16-QAM, 64-QAM modulation mode FDD: Maximum rate of 300Mbps (down) / 50Mbps (up) TDD:Maximum rate 220Mbps (down) / 30Mbps (up)
Antenna	Main Antenna(ANT0) Diversity Antenna(ANT1)
USIM interface	Support identity card: 1.8V/ 3V Support (U)SIM card and ESIM both options,External (U)SIM is used by default.
Digital audio interface *	A PCM interface that can also be configured for an I2S interface with a dedicated master clock
PCIe interface	1 lane PCIe interface, support for PCIe Gen 2.0 (host mode) Maximum communication rate of up to 5 Gbps
UART interface	The A7908E-M2 hardware is configured as the normal serial port communication function by default
I2C interface	Compliance with the I2C specification Rates of up to 400 Kbps
USB	Support for full-function USB 3.0 and USB2.0.Support full speed, high speed mode
Firmware upgrade	Firmware upgrade over USB interface
Physical characteristics	Size:42*30*2.3mm Weight: 6±0.2g
Temperature range	Normal operation temperature:-30°C ~ +70°C(Compliance with the 3 GPP specification) Non operation temperature:-40°C ~ +85°C Storage temperature:-40°C ~ +90°C

NOTE

1. * means under developing/on-going/planning, contact the SIMCom Support team for more details.
2. 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.

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2 Packaging 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.

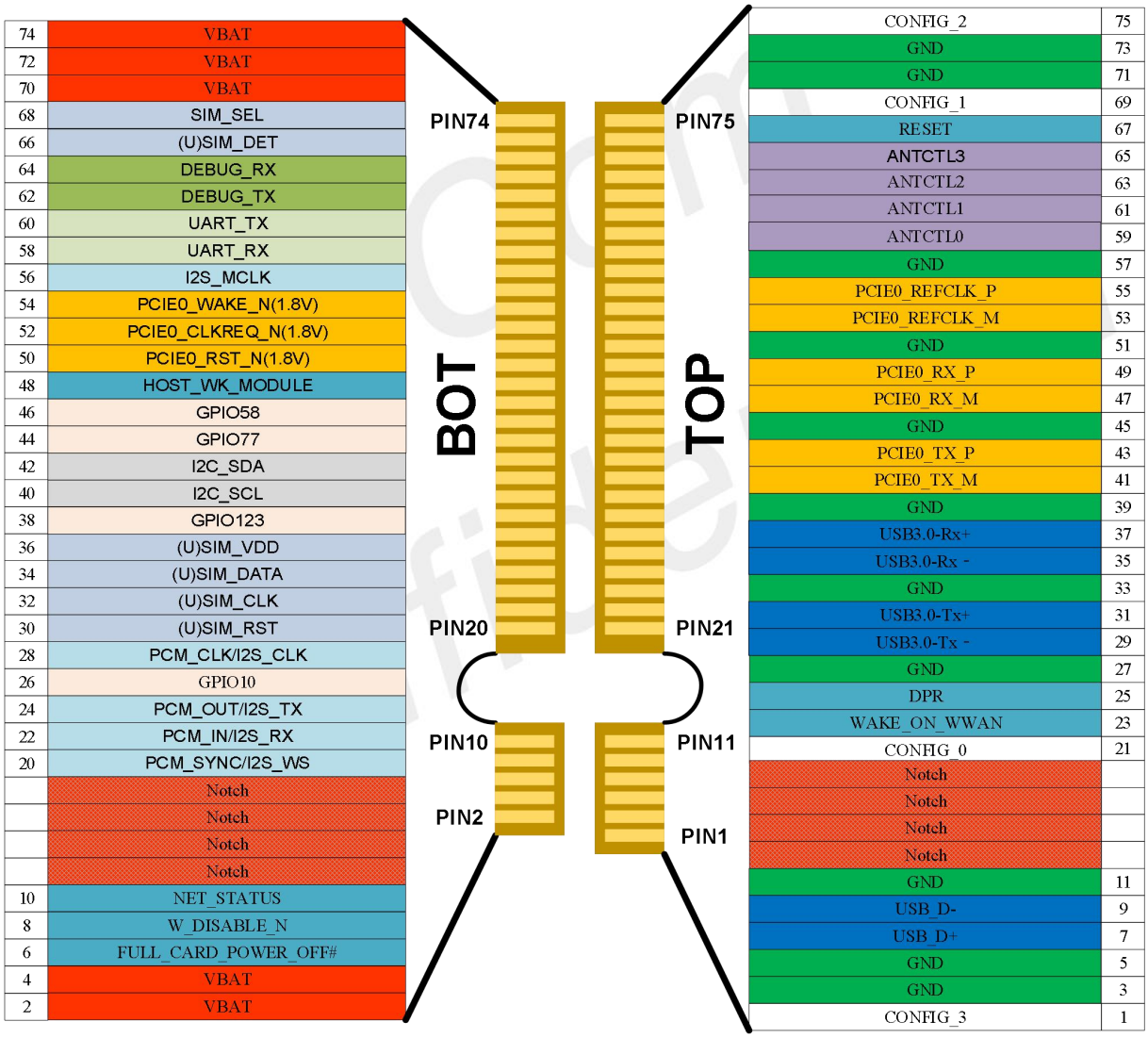


Figure 2: Pin assignment

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
pdpukp	pd: = default pull-down, programmable pu: = default pull-up, programmable kp: = default hold, programmable

Table 5: IO parameters definition

Voltage domain	Parameter		Min	Typ	Max
1.8V	VDD=1.8V				
	VOH	High level output	1.6V	-	-
	VOL	Low level output	-	-	0.2V
	VIH	High level input	1.26V	1.8V	2.V
	VIL	Low level input	-0.3V	0	0.54V
	Rpu	Pull up resistor	55KR	79KR	121KR
	Rpd	Pull down resistor	51KR	87KR	169KR
3.3V	VCC=3.3V				
	VOH	High level output	2.4V	-	-
	VOL	Low level output	-	-	0.4V
	VIH	High level input	2V	-	3.6V
	VIL	Low level input	-0.3V	0V	0.8V
	Rpu	Pull up resistor	26KR	47KR	72KR
	Rpd	Pull down resistor	27KR	54KR	267KR

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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 3.8V.	These pins need to be all joined together to provide sufficient overflow capability
GND	3,5,11,27,33,39,45,51,57,71,73			Ground	
System Control				
FULL_CARD_POWER_OFF#	6		DI,PD	Module power on / off input signal H: Module powers on. L: Module powers off.	Can be driven by either 1.8V or 3.3V GPIO
RESET	67	1.8V	DI,PU	System reset control input, active low.	RESET has been pulled up to 1.8V internally
W_DISABLE_N	8	1.8V	DI	WWAN RF Disable, active low	If unused, please keep open.
WAKE_ON_WWAN	23		OD	WWAN to wake up the host. It is active low.	If unused, please keep open.
HOST_WK_MODULE	48	1.8V	DI	HOST_WK_MODULE to wake up the module,and it is active low	If unused, please keep open.
Configuration pins				
CONFIG_0	21		GND	Connect to ground	A7906E-M2 module is configured as the WWAN USB3.0 interface type
CONFIG_1	69		GND	Connect to ground	
CONFIG_2	75		GND	Connect to ground	
CONFIG_3	1		NC	Not connected	
USB2.0/USB3.0				
USB_D+	7		AIO	Positive line of the differential, bi-directional USB signal.	
USB_D-	9		AIO	Negative line of the differential, bi-directional USB signal.	
USB3.0_Tx-	29		AO	USB3.0 transmit data negative	
USB3.0_Tx+	31		AO	USB3.0 transmit data positive	
USB3.0_Rx-	35		AI	USB3.0 receive data negative	
USB3.0_Rx+	37		AI	USB3.0 receive data positive	
PCIe interface				

PCIE_TX_M	41		AO	PCIe transmit data negative	Support PCIe Gen 2.0 (HOST mode) with rates up to 5 Gbps,If unused, please keep open
PCIE_TX_P	43		AO	PCIe transmit data positive	
PCIE_RX_M	47		AI	PCIe receive data negative	
PCIE_RX_P	49		AI	PCIe receive data positive	
PCIE_REFCLK_M	53		AIO	PCIe reference clock negative	
PCIE_REFCLK_P	55		AIO	PCIe reference clock positive	
PCIe assistant interface					
PCIE_RST_N	50		DI	PCIe reset signal Active low	Default 1.8V voltage domain, PCIE_CLKREQ_N and PCIE_WAKE_N required pull up external, If unused, please keep open
PCIE_CLKREQ_N	52		DIO	PCIe reference clock request signal Active low	
PCIE_WAKE_N	54		DIO	PCIe wake up control Active low	
(U)SIM interface					
USIM_VDD	36	1.8/3.3V	PO	Power supply for (U)SIM card	1.8/3.0V Voltage domain, (U)SIM interfaces should be protected against ESD, If unused, please keep open External (U) SIM is used by default and SIM_SEL keep open . please contact the SIMCom team for internal ESIM or switching functions
USIM_DATA	34	1.8/3.3V	DIO	(U)SIM card data, which has been pulled up to (U)SIM_VDD internally	
USIM_CLK	32	1.8/3.3V	DO	(U)SIM clock control	
USIM_RST	30	1.8/3.3V	DO	(U)SIM reset control	
USIM_DET	66	1.8V	DI	(U)SIM card detect, which has been pulled up to 1.8V internally	
SIM_SEL	68	1.8V	DI	The USIM / ESIM switch control signal	
Antenna control interface					
ANTCTL0	59	1.8V	DO	Antenna tuner control0	1.8V voltage domain. If unused, please keep open
ANTCTL1	61	1.8V	DO	Antenna tuner control1	
ANTCTL 2	63	1.8V	DO	Antenna tuner control2	
ANTCTL3	65	1.8V	DO	Antenna tuner control3	
Audio Interface *					
PCM_CLK/I2S_CLK	28	1.8V	DO	PCM/I2S clock output	1.8V voltage domain, also can be used as PCM interface, If unused, please keep open.
PCM_IN/I2S_RX	22	1.8V	DI	PCM/I2S data input	
PCM_OUT/I2S_TX	24	1.8V	DO	PCM/I2S data output	
PCM_SYNC/I2S_WS	20	1.8V	DO	PCM/I2S word alignment select	

I2S_MCLK	56	1.8V	DO	I2S master clock	
I2C interface					
I2C_SDA	42	1.8V	DIO	I2C data signal	1.8V voltage domain, Internal pulled up to 1.8V. If unused, please keep open
I2C_SCL	40	1.8V	DO	I2C clock signal	
UARTinterface[2]					
UART_TX	60	1.8V	DO	Hardware configures as normal communication UART(AT command) signal function by default	
UART_RX	58	1.8V	DI		
DEBUG_UARTinterface					
DEBUG_RX	64	1.8V	DI	DEBUG_UART intput	
DEBUG_TX	62	1.8V	DO	DEBUG_UART output	
GPIO interface					
GPIO58	46	1.8V	DIO	GPIO	
GPIO77	44	1.8V	DIO	GPIO	
GPIO123	38	1.8V	DIO	GPIO	
GPIO10	26	1.8V	DI	GPIO	
Other pins					
NET_STATUS	10	1.8V	OD	Network status indicator lamp for control signal	
DPR*	25	1.8V	DI	DPR (Dynamic Power Reduction) signal is used for SAR (Specific Absorption Rate) sensor interrupt input	
Notch					
Notch	12, 13, 14, 15, 16, 17, 18, 19			Notch	

NOTE

1. * is in development, contact the SIMCom Support team for more details.
2. The 60pin and 58pin hardware support ordinary serial port communication (AT instruction) function by default.

2.3 Package Dimensions

The mechanical dimensions of A7908E-M2 are shown in the following figure.

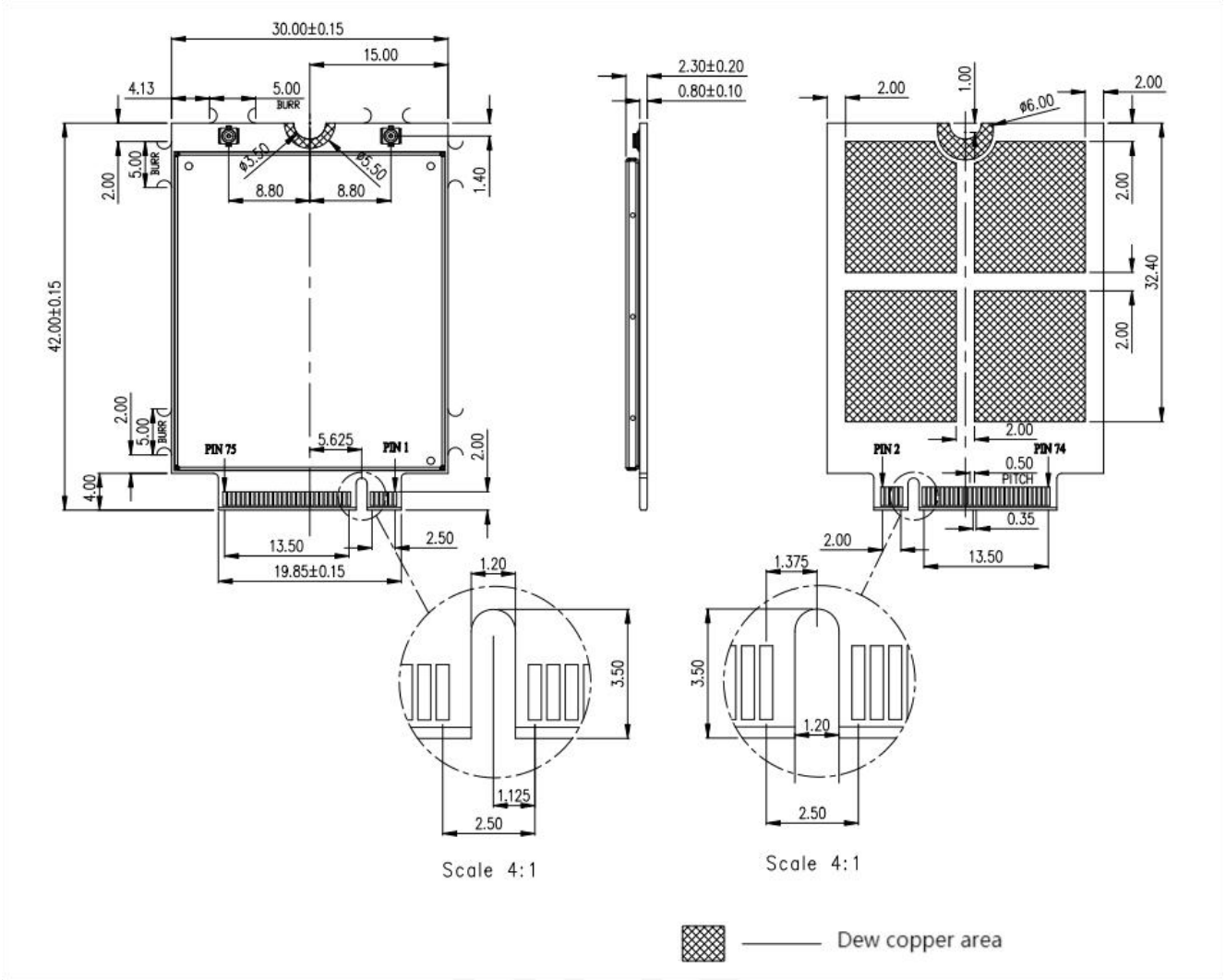


Figure 3: Dimensions of A7908E-M2 (Unit: mm)

NOTE

1.The above tolerance dimensions do not include burr areas.

3 Interface Application

3.1 Power Supply

The recommended power supply of A7908E-M2 is 3.8V and the voltage ranges from 3.135 V to 4.4 V. The A7908E-M2 has 5 power pins and 11 ground pins, to ensure the A7908E-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	3.8	4.4	V
I_{peak}	Module power peak current in normal mode.	-	2	3	A
I_{sleep}	Module power current in sleep mode.(AT+CFUN=0)	-	2.6	-	mA
$I_{leakage}$	Module power current in power off mode.	-	50	100	uA

3.1.1 Power Supply Design Guide

When using a 3.8V power supply, the peak current can reach 2A at the maximum emission power. In order to ensure that the supply voltage of the module is not less than 3.135V in an extreme environment, such as a weak signal environment, and considering the voltage drop and conversion efficiency, it is strongly recommended that the DC-DC or LDO output current capacity selected in the design is not less than 3A.

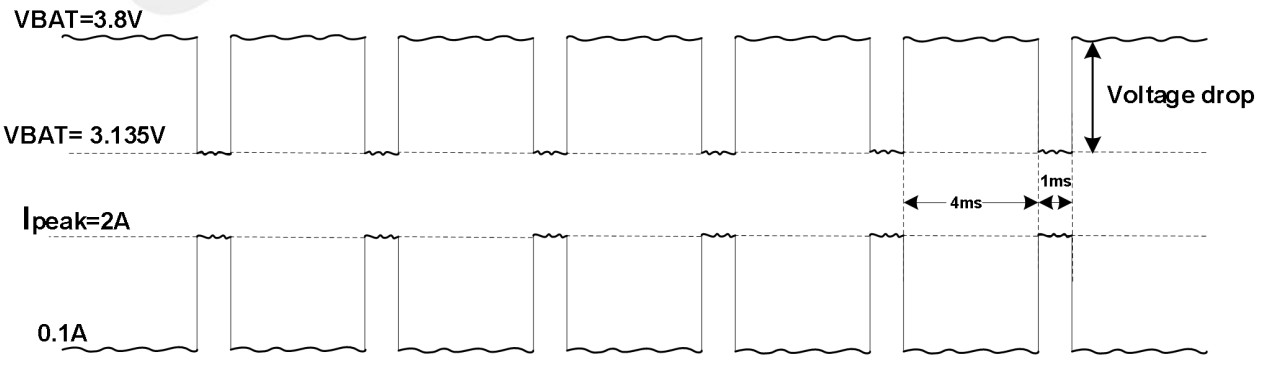


Figure 4: Maximum current consumption of the module at the maximum emission power

NOTE

The test condition:
1. The total capacitor on the VBAT network is quite 420 uF.
2. The Ipeak and pressure drop data in Table 7 and Figure 4 are theoretical values, and the power supply voltage of the module is 3.8V. The actual data is connected with the SIMCom EVB connected instrument(TBD) .

To reduce the pressure drop, ensure that the total capacitance on the VBAT network is not less than 420 uF as shown in the VBAT supply network reference circuit.

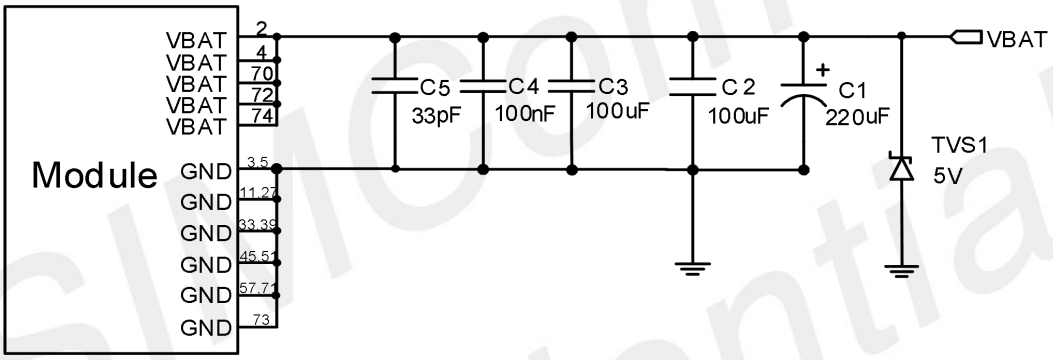


Figure 5: Power supply application circuit

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 3.0 mm to minimize PCB trace impedance.

Table 8: Description of the VBAT and the GND

Pin name	Pin no.	Electrical description		Description	Comment
VABT	2,4,70,72, 74		PI	Power supply Range: 3.135～4.4V Typical: 3.8V	These pins should be connected together to withstand sufficent current
GND	3,5,11,27, 33,39,45,51,57,71 ,73			Ground	

NOTE

1. C1 is 220 μF tantalum capacitor (ESR=0.7Ω).
2. C4 and C5 are multi-layer ceramic chip (MLCC) capacitors from 33pF to 1uF with low ESR in high frequency band, which can be used for EMC performance.
3. TVS1 is used for surge protection.

Table 9: Recommended TVS1 diode list

No.	Manufacturer	Part Number	VRWM	Package
1	Js-ele	ESDBW5V0A1	5V	DFN1006-2L
2	Way-on	WS05DPF-B	5V	DFN1006-2L
3	WILL	ESD56151W05	5V	SOD-323
4	Will semi	ESD5611N	5V	DFN1006-2L
5	Will semi	ESD56151W05	5V	SOD-323

Power supply and ground wiring criteria:

- Both VBAT and reflux routing paths should be as short and wide as possible to minimize the pressure drop.
- The width of the VBAT routing shall not be less than 3.0mm.
- These capacitances are placed as close as possible to the VBAT pin.
- The VBAT routing path shall be through the TVS diode, Zener diode and capacitors, and then to the VBAT pin. The small capacitors shall be placed close to the VBAT pins.
- The PCB design must have a primary ground formation as the primary reference ground plane for most signals.

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 3A.

The following figure shows the linear regulator reference circuit with 5V input and 3.8V output.

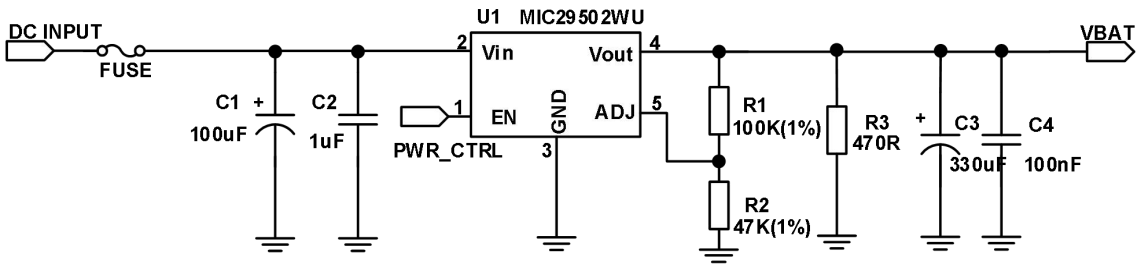


Figure 6: Linear regulator reference circuit

NOTE

1.An additional minimum load of R3 is required in figure6, to ensure it works in light load in hibernation and shutdown mode. For details on the minimum load, please refer to the MIC29502WU specification.

The following figure shows the switching mode power supply reference circuit with 5~ 12V input and 3.8V output.

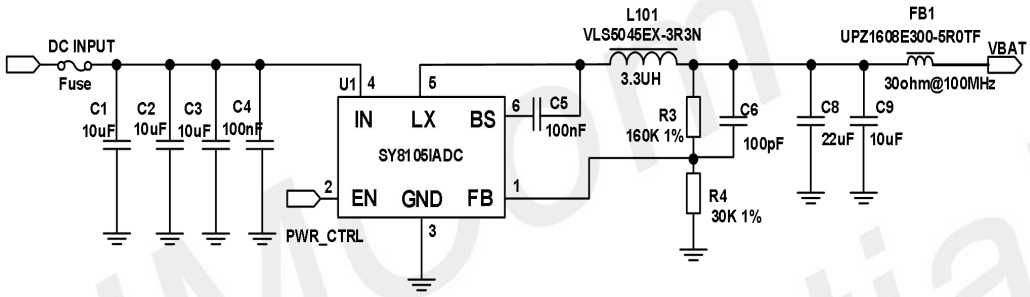


Figure 7: Switch the power supply reference circuit

NOTE

1. It is suggested to strictly follow the DC power supply design guidance to avoid the influence of radio frequency and electromagnetic interference on the power supply.
2. PWR _ CTRL signal is recommended to the host and can be controlled.

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.And this feature is turned off by default, so please contact the SIMCom team for use.

NOTE

1. For more information about these AT commands, please refer to Document [1].
2. If the Full_Card_Power_Off # signal remains at a high level, the module will automatically turn on after the undervoltage shutdown program.

3.2 Module power-on and off

Driving the FULL _ CARD _ POWER _ OFF # pin to the high level, the A7908E-M2 will automatically turn on the power. It can be powered by either 1.8V or 3.3V GPIO. The module boot / shutdown reference circuit is shown in the figure figure.

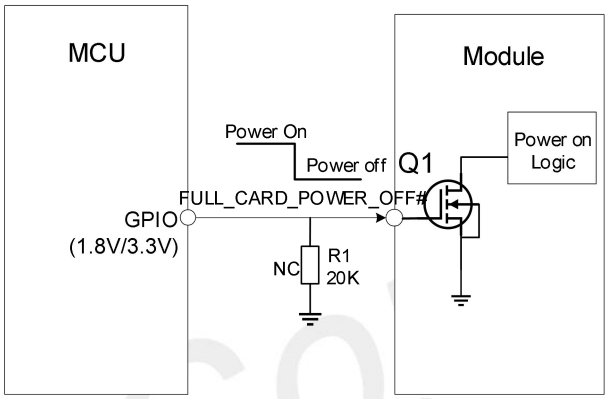


Figure 8: Reference power on/off circuit

Table 10: Description of the FULL_CARD_POWER_OFF#

Pin name	Pin no.	Electrical description		Description	Comment
FULL_CARD_POWER_OFF#	6		DI,PD	Module power on / off input signal High level:, High level:, the module is power-on Low level:, module shut off	Can be driven by 1.8V or 3.3V GPIO

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.

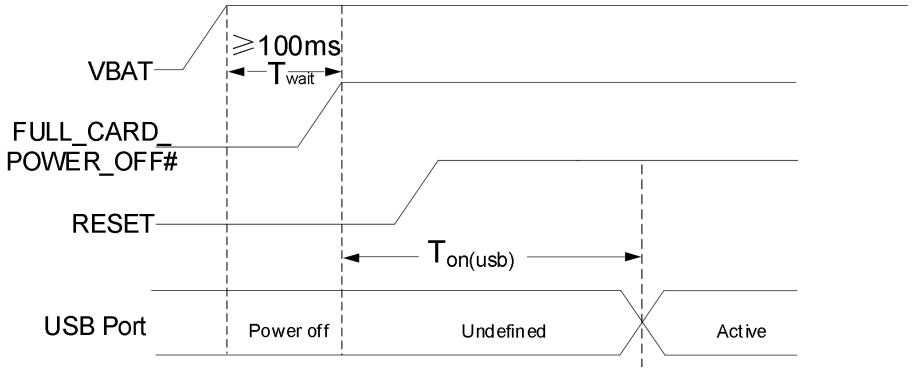


Figure 9: Power on timing sequence

Table 11: 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	-	20	-	s
V_{IH}	Input high level voltage on Full_Card_Power_Off# pin	1.2	1.8/3.3	4.4	V
V_{IL}	Input low level voltage on Full_Card_Power_Off# pin	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.

NOTE

1.For more information on AT + CPOF, refer to the appendix document [1].
2.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.

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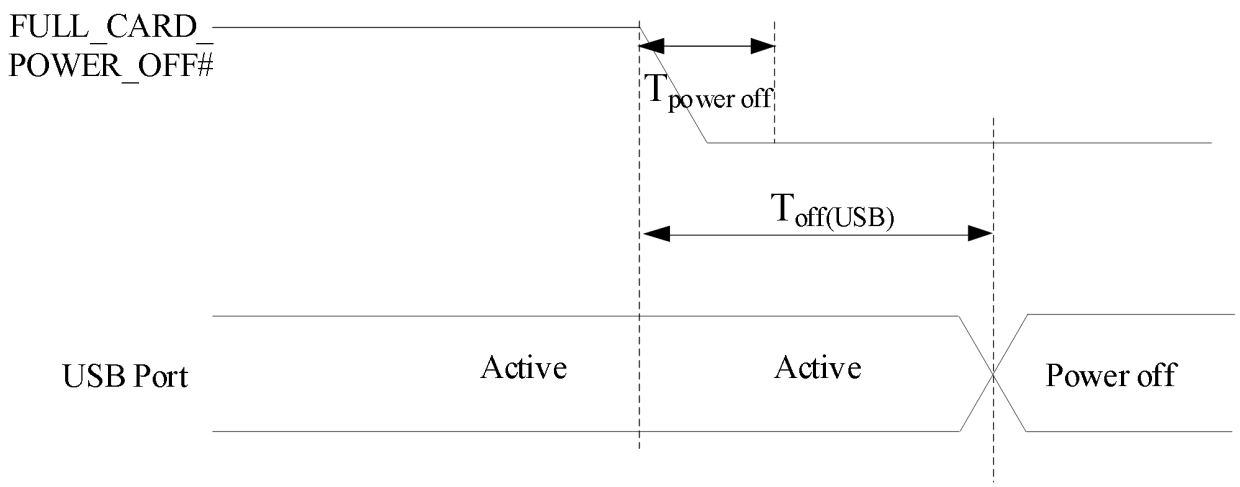


Figure 10: Power off timing sequence

Table 12: 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	-	5	-	s
$T_{Power\ off}$	The time from FULL_CARD_POWER_OFF# pulled down to module enters the shutdown process	-	500	-	ms

3.3 Reset Function

Module can be reset by pulling the RESET pin to low level.

The RESET signal has been pulled internally up to 1.8V, so no external pull-up is required. Please refer to the following figure for the recommended reference circuit.

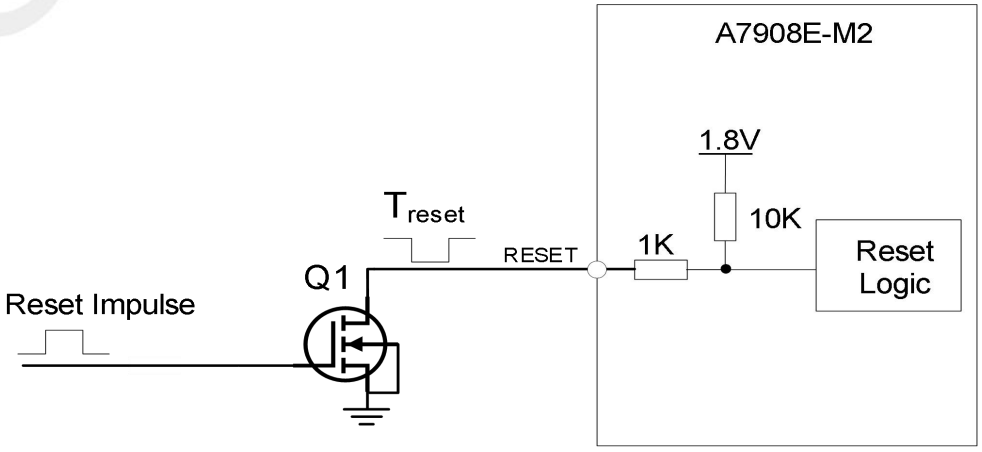


Figure 11: Reference reset circuit

Table 13: Description of the RESET

Pin name	Pin no.	Electrical description		Description	Comment
RESET	67		DI,PU	System reset control input, active low.	RESET has been pulled up to 1.8V internally

The reset timing of the module is shown in the following figure.

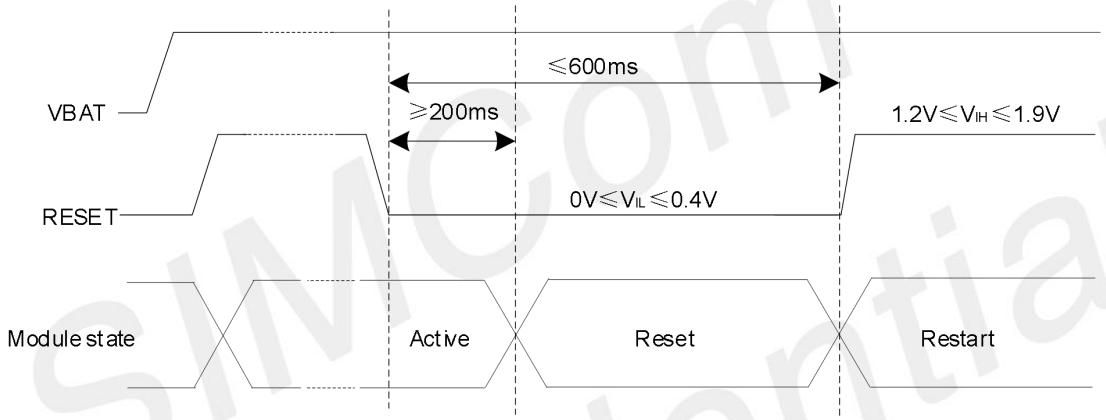


Figure 12: Module reset timing

Table 14: RESET pin electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
T_{reset}	The active low level impulse time on RESET pin to reset module	200	-	600	ms
V_{IH}	Input high level voltage	1.2	-	1.9	V
V_{IL}	Input low level voltage	0	-	0.4	V

3.4 I2C Interface

Module provides an I2C interface compatible with I2C specification V2.1, with clock rate up to 400 Kbps. The following figure shows the I2C bus reference design.

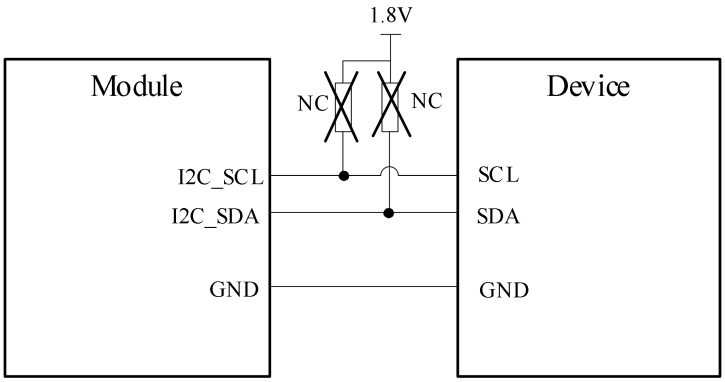


Figure 13: I2C reference circuit

Table 15: Description of I2C

Pin name	Pin no.	Electrical description	Description	Comment
I2C_SDA	42	DIO	I2C data signal	1.8V voltage domain, Internal pulled up to 1.8V. If unused, please keep open
I2C_SCL	40	DO	I2C clock signal	

3.5 WAKE_ON_WWAN*

The WAKE_ON_WWAN 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 WAKE_ON_WWAN will change to low logic level to inform the host (client PC), the pulse time is 1 second.

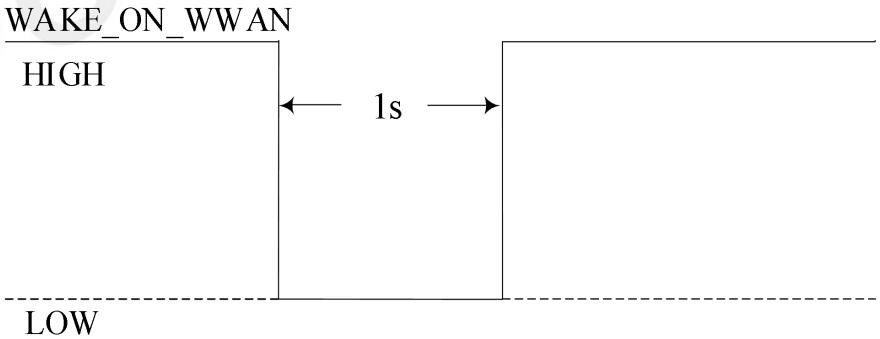


Figure 14: WAKE_ON_WWAN behavior（SMS and URC report etc.）

WAKE_ON_WWAN Reference circuit is recommended in the following figure.

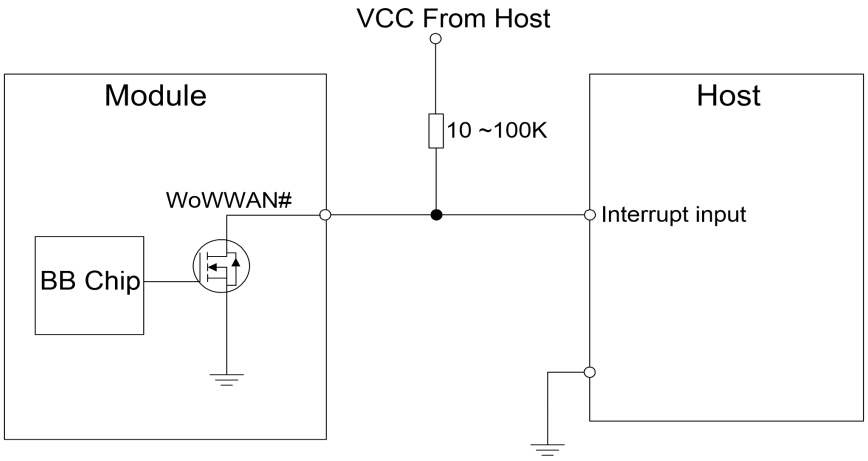


Figure 15: WAKE_ON_WWAN reference circuit

Table 16: Description of WAKE_ON_WWAN

Pin name	Pin no.	Electrical description	Description	Comment
WAKE_ON_WWAN	23	OD	WWAN to wake up the host. It is active low.	If unused, please keep open.

NOTE

* means under developing/on-going/planning, contact the SIMCom Support team for more details.

3.6 USB Interface

A7908E-M2 supports USB interface and complies with USB 3.0 and 2.0 specifications. Customers can choose either USB3.0 or USB2.0 as needed.Support SuperSpeed, high-speed, full-speed mode, support low-speed mode in Host mode, and not support low-speed mode in Device mode.

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.The reference schematic is as following:

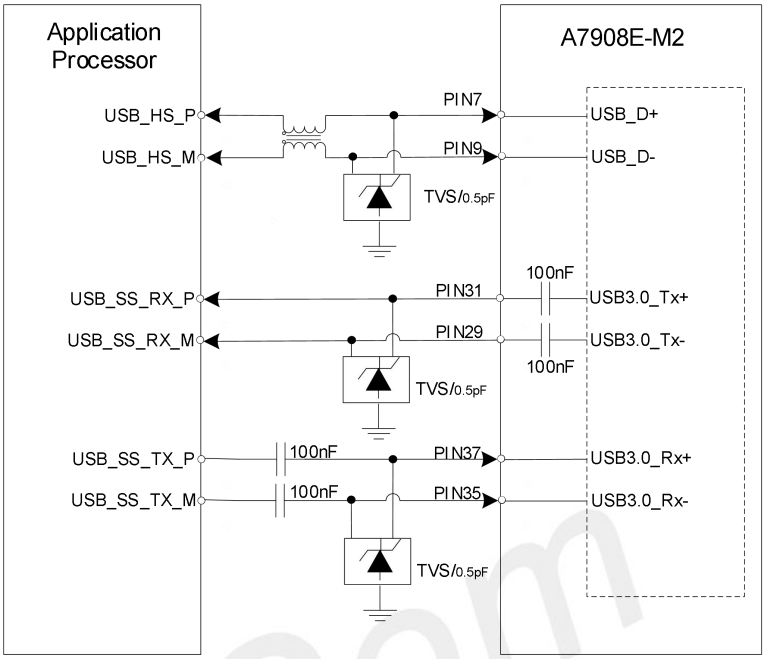


Figure 16: USB reference circuit

Table 17: Description of USB

Pin name	Pin no.	Electrical description		Description	Comment
USB_D+	7		AIO	Positive line of the differential, bi-directional USB signal.	
USB_D-	9		AIO	Negative line of the differential, bi-directional USB signal.	
USB3.0_Tx-	29		AO	USB3.0 transmit data negative	
USB3.0_Tx+	31		AO	USB3.0 transmit data positive	
USB3.0_Rx-	35		AI	USB3.0 receive data negative	
USB3.0_Rx+	37		AI	USB3.0 receive data positive	

Table 18: The TVS protection tube is recommended by the USB interface

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

USB HS D+/D- layout guidelines:

- Require differential trace impedance is 90±10% Ω.
- The intra-lane length mismatch of the differential signal lanes is less than 1mm.
- Gap from other signals keeps 3xline width.

- External components should be placed near the USB connector.
- Trace routes away from other sensitive signals (RF, audio, and 38.4M XO).
- The TVS diode should be placed close to the USB pins of M.2 connector.
- Maximum PCB trace length cannot exceed 100mm outside of module, the shorter trace and more better.

USB SS TX/RX layout guidelines:

- Require differential trace impedance is 90±10% Ω.
- The intra-lane length mismatch of the differential signal lanes is less than 500um.
- Gap from other signals keeps 4xline width.
- Gap between Rx-to-Tx keeps 4xline width.
- External components should be placed near the USB connector.
- Trace routes away from other sensitive signals (RF, especially 2.4 GHz).
- The TVS diode should be placed close to the USB pins of M.2 connector.
- Route differential pairs in the inner layers with a solid GND reference to have good impedance control and to minimize discontinuities.
- Keep isolation between the Tx pair, Rx pair, and DP/DM to avoid crosstalk.
- If core vias are used, use no more than two core vias per signal line to limit stubs.

3.7 PCIe Interface

A7908E-M2 supports PCIe Gen2 interface and does not support EP mode. In the customer's design, the PCIE 0 _ CLKREQ _ N and PCIE 0 _ WAKE _ N signals need to be pulled up to 1.8V by a 100K resistance.

The following figure is the PCIe reference circuit.

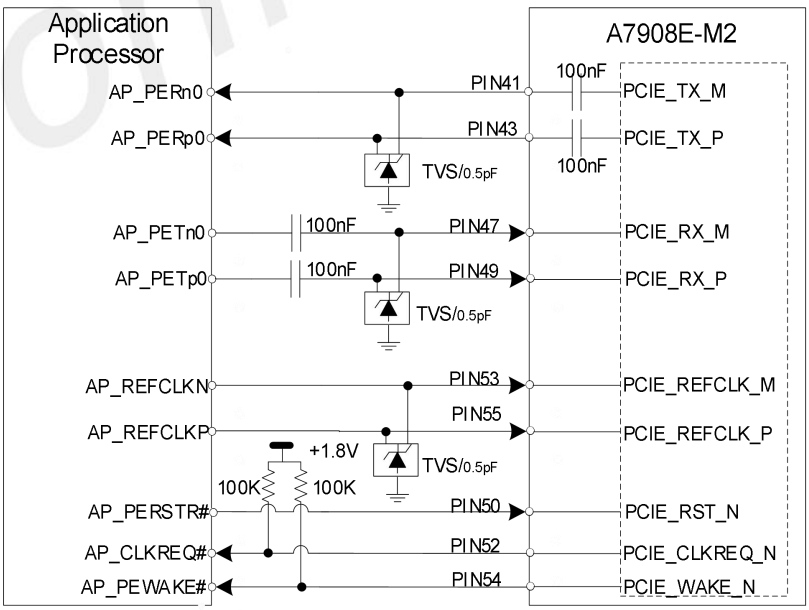


Figure 17: PCIe interface reference circuit

NOTE

1. "*" means under development.
2. The AC capacitors of AP_PETn0 and AP_PETp0 should be closed to AP.
3. The voltage domain of PCIe assistant signals is 1.8V.

Table 19: Description of PCIe interface

Pin Name	Pin No.	Electrical Description	Functional Description	Comment
PCIE_TX_M	41	AIO	PCIE transmit data negative	
PCIE_TX_P	43	AIO	PCIE transmit data positive	
PCIE_RX_M	47	AIO	PCIE receive data negative	
PCIE_RX_P	49	AIO	PCIE receive data positive	
PCIE_REFCLK_M	53	AIO	PCIE reference Clock. Negative signal of differential pair	
PCIE_REFCLK_P	55	AIO	PCIE reference Clock. Positive signal of differential pair	
PCIE_RST_N	50	DI	A functional reset to the Add-In module active low	Default 1.8V voltage domain, PCIE _ CLKREQ _ N and PCIE _ WAKE _ N signals require external pull-up, EP mode is not supported, and remain suspended if not used
PCIE_CLKREQ_N	52	DIO	PCIe reference clock request signal active low	
PCIE_WAKE_N	54	DIO	PCIe wake up signal active low	

Table 20: PCIe interface recommended TVS diode list

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

PCIe interface layout guidelines:

- Differential walk impedance of 90 ± 10% Ω is required.
- The line length difference within the differential signal group shall be less than 500um.
- Keep the spacing with the other signals at 4 times the line width.
- The spacing between the Tx and Rx signal line groups is maintained at 4 times the line width.
- Keep away from other sensitive signals
- The TVS diode shall be placed near the PCIe pin of the M.2 connector.
- All other sensitive / high speed signals and circuits must be protected against interference with PCIe

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signals.

- The PCIe signal must be protected away from the noise signal (clock, SMPS).
- Each set of differential signal lines must be covered.
- The maximum PCB routing length outside the module should not exceed 150mm, and the shorter the routing, the better.

3.8 USIM Interface

A7908E-M2 provides (U) SIM interface, 1.8V or 3.0V dual voltage domain, with external (U) SIM by default. In addition, ESIM and its switching switch are reserved internally, which can be used instead. If you need to use this function, please contact the SIMCom team.

Table 21: USIM electronic characteristic in 1.8V mode (USIM_VDD=1.8V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	1.6	1.8	-	V
V_{IH}	High-level input voltage	1.26	-	2	V
V_{IL}	Low-level input voltage	-0.3	0	0.54	V
V_{OH}	High-level output voltage	1.6	-	-	V
V_{OL}	Low-level output voltage	0	-	0.2	V

Table 22: USIM electronic characteristic 3.0V mode (USIM_VDD=3V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
USIM_VDD	LDO power output voltage	2.4	3.0	-	V
V_{IH}	High-level input voltage	2	-	3.05	V
V_{IL}	Low-level input voltage	-0.3	0	0.8	V
V_{OH}	High-level output voltage	2.4	-	-	V
V_{OL}	Low-level output voltage	-	-	0.4	V

NOTE

The location of ESIM is reserved within A7908E-M2 project, compatible with USIM signal.Contact the SIMCom Support team for more details.

The module realizes the (U) SIM card hot plugging function through the (U) SIM_DET detection pin.The (U)SIM_DET pin is pulled up internally.

The following figure is the (U)SIM reference circuit.

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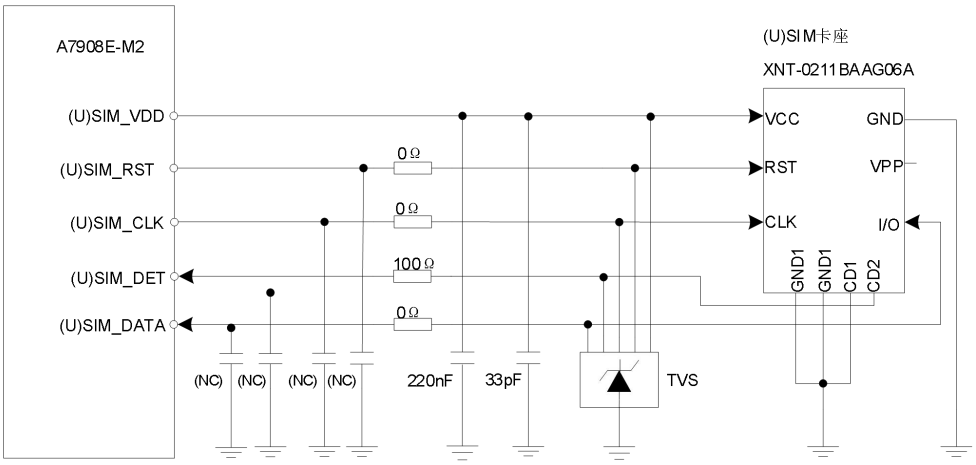


Figure 18: (U)SIM interface reference circuit

In default,after inserting the (U) SIM card, the (U) SIM_DET changes from high to low level. The descending edge indicates the (U) SIM card operation inserted. After removing the (U) SIM card, the (U) SIM_DET will change from low to high level. This rising edge indicates the pull-out (U) SIM card operation.Without the (U) SIM card hot-swap feature, the customer can keep the (U) SIM_DET pin disconnected. For the SIM card detection logic to reverse, it can be configured through dts. Please contact the SIMCom team for more information.

Table 23: Description of (U)SIM interface

Pin name	Pin no.	Electrical description	Description	Comment
(U)SIM_VDD	36	PO	Power supply for (U)SIM card	1.8/3.0V voltage domain, (U)SIM interfaces should be protected against ESD, If unused, please keep open
(U)SIM_DATA	34	DIO	(U)SIM card data, which has been pulled up to (U)SIM_VDD via a 4.7KR resistor internally	
(U)SIM_CLK	32	DO	(U)SIM clock control	
(U)SIM_RST	30	DO	(U)SIM reset control	
(U)SIM_DET	66	DI	(U)SIM card detect, which has been pulled up to 1.8V internally	
(U)SIM_SEL	68	DI	The USIM / ESIM switch control signal	External (U) SIM is used by default and SIM_SEL keep open. please contact the SIMCom team for internal ESIM or switching functions.

Recommended ESD protection tubes and (U) SIM card holders are shown in the following table.

Table 24: (U)SIM interface recommended (U)SIM card holder and TVS diode list

NAME	Manufacturer	Part Number
TVS	ST	ESDA6V1-5W6
(U)SIM socket	Suntech	XNT-0211BAAG06A

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.
-

3.9 PCM interface

The A7908E-M2 provides a PCM interface that can be used with an external audio codec.

NOTE

1. For more information on the PCM AT instruction, please refer to the appendix document [1].

The following figure is the external codec reference design circuit.

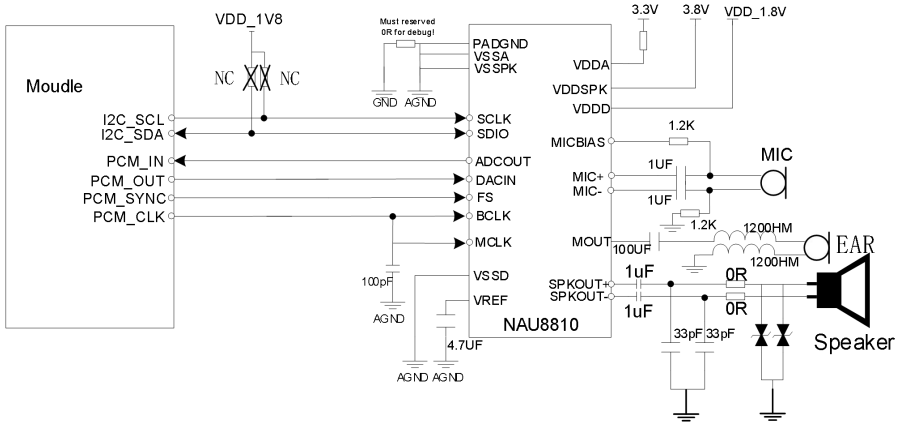


Figure 19: Audio codec diagram circuit

Table 25: Definition of PCM interface

Pin name	Pin no.	Electrical description	Description	Comment
PCM_CLK	28	DO	PCM clock output	1.8V voltage domain, also can be used as I2S interface, If unused, please keep open
PCM_DIN	22	DI	PCM data input	
PCM_OUT	24	DO	PCM data output	
PCM_SYNC	20	DO	PCM sync	

The I2S interface is multiplexing with PCM interface. The default audio interface of the module is PCM.

Table 26: The I2S interface is multiplexing with PCM interface

PCM interface	I2S interface
PCM_DIN	I2S_RX
PCM_OUT	I2S_TX
PCM_SYNC	I2S_WA
PCM_CLK	I2S_CLK
-	I2S_MCLK

Audio layout guidelines:

Analog input

- 0.2mm trace widths; 0.2mm spacing between other signals trace.
- Pseudo differential route for MIC.
- Isolate from noise sources, such as antenna, RF signals, SMPS, clocks, and other high speed signals.

Analog output

- Isolate from noise sources such as antenna, RF signals, SMPS, clocks, and other high speed signals.
- Speaker output signal – route as differential pair with 0.5mm trace widths.

Audio power and GND

- Recommend add magnetic bead on AVDD net reserved for debug.
- VDD cannot directly use VBAT as the power supply.
- AGND need add GND via to the main GND plane directly.

3.10 DPR interface

DPR (Dynamic Power Reduction) signal is used by A7908E-M2 to assist in meeting regulatory SAR

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(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 27: 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

NOTE

* means under developing/on-going/planning, contact the SIMCom Support team for more details.

3.11 CONFIG Pins

These signals provide the means to indicate the specific configuration of the module. A7908E-M2 is configured as WWAN-USB3.0

Table 28: 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 29: 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	NC	NC	GND	WWAN – PCIe	1
GND	GND	GND	NC	WWAN – USB 3.0	0
GND	NC	GND	NC	WWAN – USB 3.0	1

3.12 NET_STATUS interface

NET_STATUS is open drain output and is used to allow A7908E-M2 to provide network status via NET_STATUS which will be provided by the host.

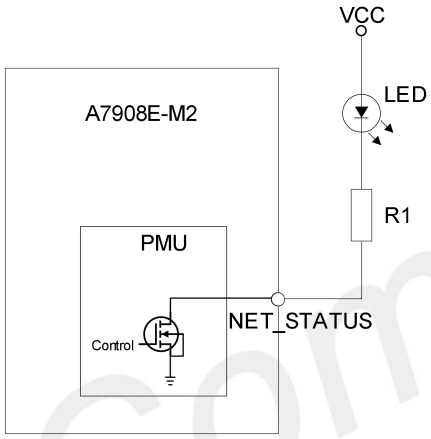


Figure 20: NET_STATUS reference circuit

Table 30: NET_STATUS interface

Pin name	Pin no.	Electrical description		Description	Comment
NET_STATUS	10		OD	Network status indicator lamp for control signal	

NOTE

The value of the resistor named “R1” depends on the LED characteristic.

The timing sequence is as followed:

Table 31: NET_STATUS pin status

NET_STATUS pin status	Module status
Always On	Searching Network; Call Connect
200ms ON, 200ms OFF	The data connection is established, or the network is registered.
800ms ON, 800ms OFF	2G/3G registered network
OFF	Power off; Sleep mode

3.13 W_DISABLE_N interface

The W_DISABLE_N pin controls A7908E-M2 to enter or exit the flight mode, when the W_DISABLE_N signal is asserted to low level, all RF functions would be disabled. When the W_DISABLE_N 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.

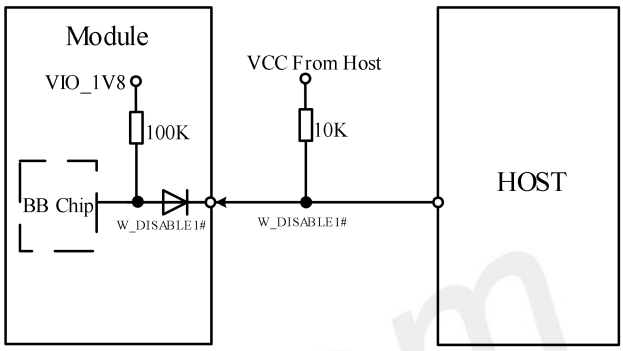


Figure 21: Flight mode switch reference circuit

Table 32: Description of the W_DISABLE_N

Pin name	Pin no.	Electrical description	Description	Comment
W_DISABLE_N	8	DI	WWAN RF Disable, active low	If unused, please keep open.

Table 33: W_DISABLE_N interface

W_DISABLE_N 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)

3.14 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 34: 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	63	DO	Antenna tuner control2	
ANTCTL3	65	DO	Antenna tuner control3	

NOTE

1. "*" indicates that it is under development, please contact the SIMCom support team for more details.

3.15 UART interface

The A7908E-M2 hardware defaults to normal communication (AT instruction) UART.The maximum bandwidth rate is 3.6Mbps.

Table 35: UART interface

Pin Name	Pin No.	Electrical Description		Description	Comments
UART_TX	60		DO	Hardware configures as normal communication UART(AT command) signal function by default	
UART_RX	58		DI		

The UART interface reference design is shown in the figure figure.

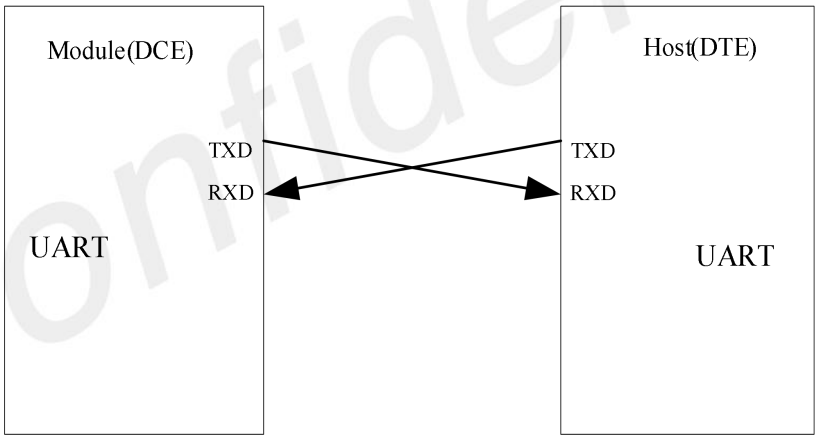


Figure 22: The UART interface reference design

The UART level of A7908E-M2 is 1.8V. If the serial communication with 3.3V is required, it is recommended to use the level conversion IC. The level conversion IC reference design circuit is shown in the following figure.

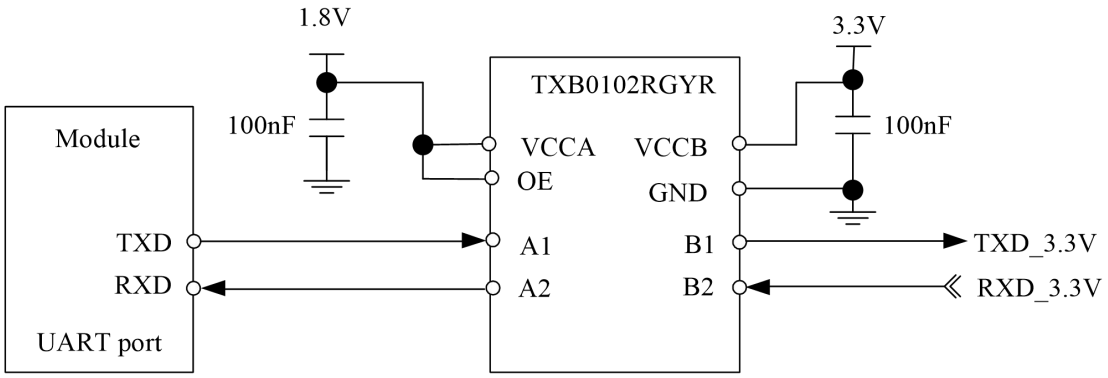


Figure 23: Reference circuit of level shift

3.16 FORCE DOWNLOAD & GET DEBUG LOG

A7908E-M2 reserve test points to facilitate customers to use the forced download function. At the same time, we can also read the debugging log.



Figure 24: Test point location

Table 36: Test point status

Test point	Pin name	Electrical description	Description	Comments
A	RESET	DI,PU	System reset control input Active low	RESET has been pulled up to 1.8V internally
B	GND	-	GND	
C	FORCE_USB_BOOT	DI	Connect to GND enter to force download function	
D	DEBUG_TX	DO	Debug UART TX	1.8V voltage domain
E	DEBUG_RX	DI	Debug UART RX	
F	USB_D-	DIO	Differential USB bi-directional data negative	
G	USB_D+	DIO	Differential USB bi-directional data positive	

3.16.1 Forcing USB Boot

During development or factory production, a boot from the USB port can be forced by using test point of FORCED_USB_BOOT. We can short circuit test points B and C of the module forces the module to boot from the USB_HS port.

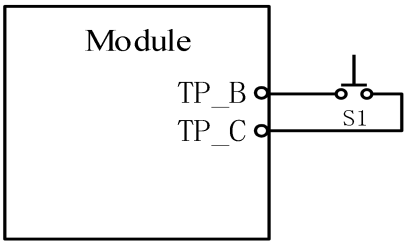


Figure 25: Forcing USB Boot

3.16.2 Get UART log

During development we need get UART LOG to analyze problems. We can obtain log on PC through serial port tool.Reserved test points D and E are recommended,and DEBUG_UART defaults to 115200 baud rate.

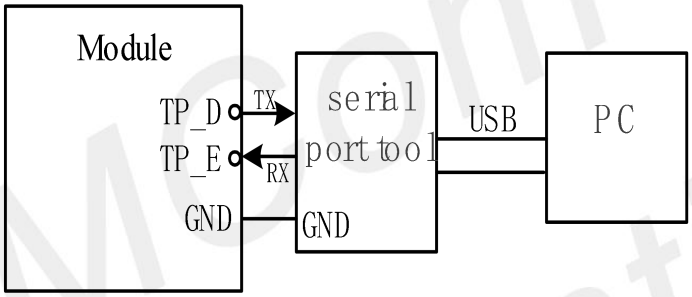


Figure 26: UART LOG

3.17 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 recommended reference circuit for the HOST _ WK _ MODULE pin is shown in the following figure.

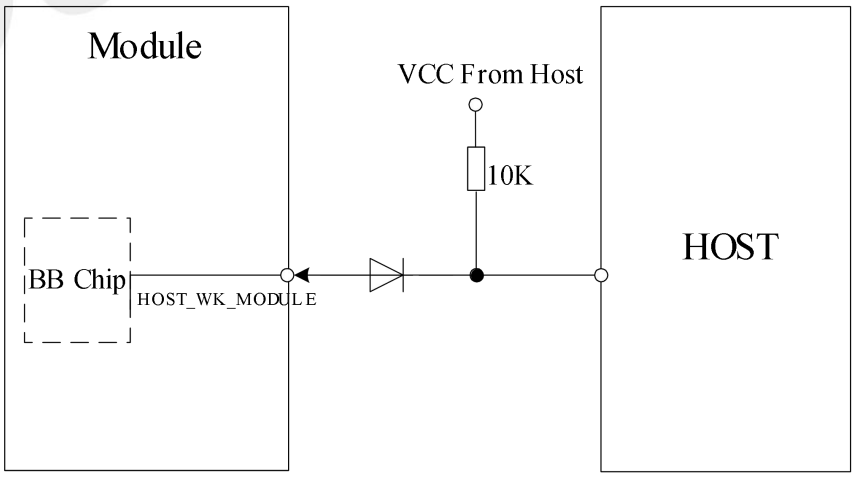


Figure 27: HOST _WK_MODULE interface recommended reference circuit

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Table 37: Definition of HOST_WK_MODULE

Pin Name	Pin No.	Electrical Description		Functional Description	Comment
HOST_WK_MODULE	48	1.8V	DI,PU	Pull down this signal to wake up module from sleep mode.active low.	If unused, please keep open.

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4 Antenna Interfaces

A7908E-M2 provides a main antenna interface and a diversity antenna interface. The antenna ports have an RF impedance of 50Ω.

4.1 Antenna Definitions

Table 38: Antenna port definitions

FUNCTIONS	ANT0	ANT1
3G/4G LB/MHB TRX	✓	
3G/4G LB/MHB DIV		✓

4.1.1 WCDMA/LTE Operating Frequency

Table 39: A7908E-M2 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	703~748 MHz	758~803 MHz	FDD
LTE B32		1452~1496 MHz	FDD
LTE B38	2570 ~2620 MHz	2570 ~2620 MHz	TDD
LTE B40	2300 ~2400 MHz	2300 ~2400 MHz	TDD
LTE B41	2496 ~2690 MHz	2496 ~2690 MHz	TDD
LTE B42	3400 ~3600 MHz	3400 ~3600 MHz	TDD
LTE B43	3600~3800 MHz	3600 ~3800MHz	TDD

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NOTE

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

4.1.2 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 A7908E-M2. The dimension of the connector on A7908E-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:

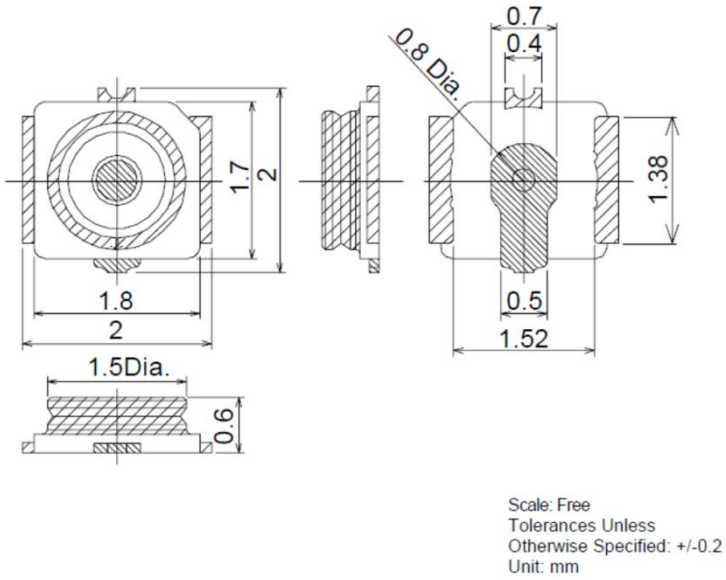


Figure 28: RF connector

The major specifications of the RF connector as below:

Table 40: 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)

To get best RF performance, the RF plug connector should be designed to match the receptacle 20449-001E-03. The following figure shows the mechanical information of RF coaxial cables.

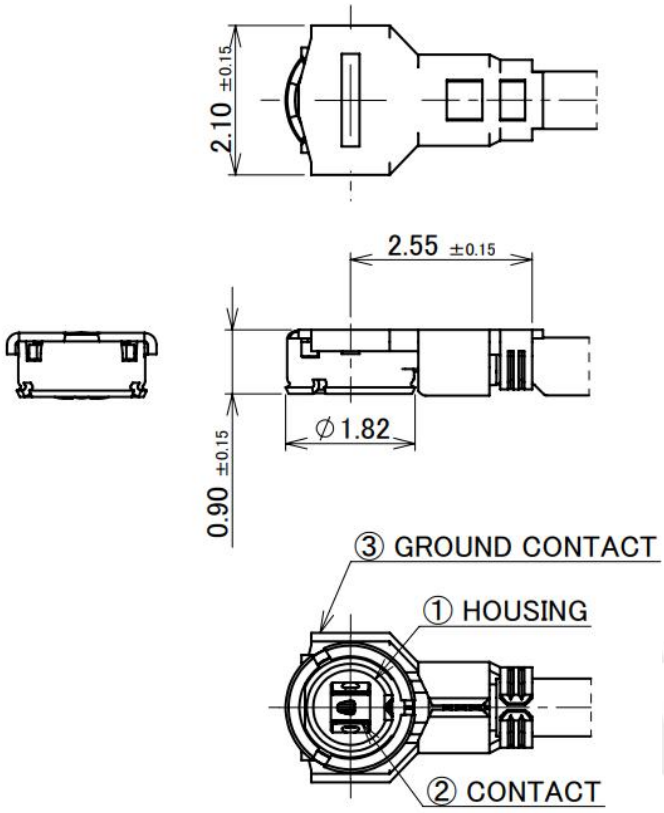


Figure 29: Mechanical information of RF plug

4.1.3 RF Cable Assembly Operation

RF cables correct pull and push operation as shown in the following figure.

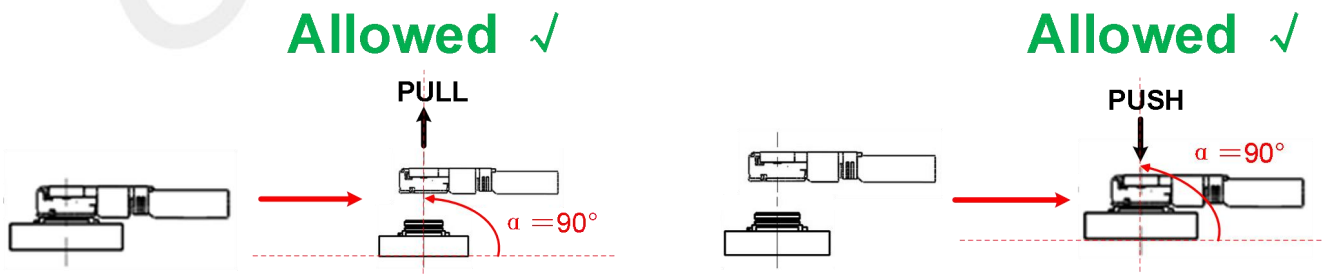


Figure 30: RF cable correct pull and push operation

RF cables error pull and push operation as shown in the following figure.

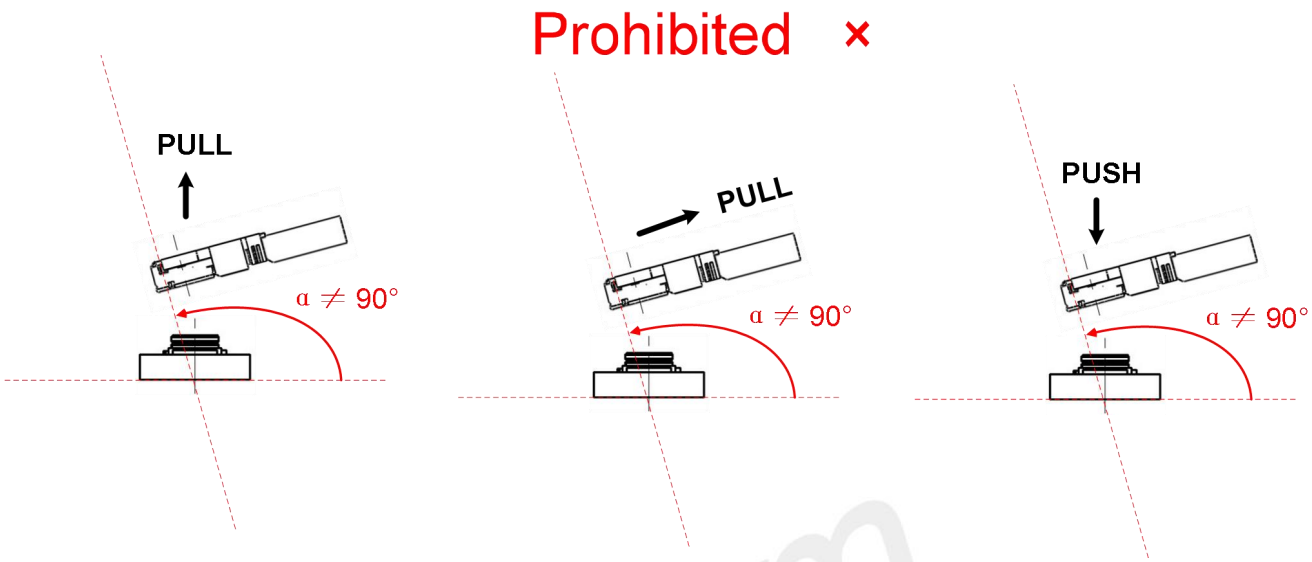


Figure 31: RF cable error pull and push operation

Use RF cable tool correct pull and push operation as shown in the following figure, for more details, please visit https://www.i-pex.com.

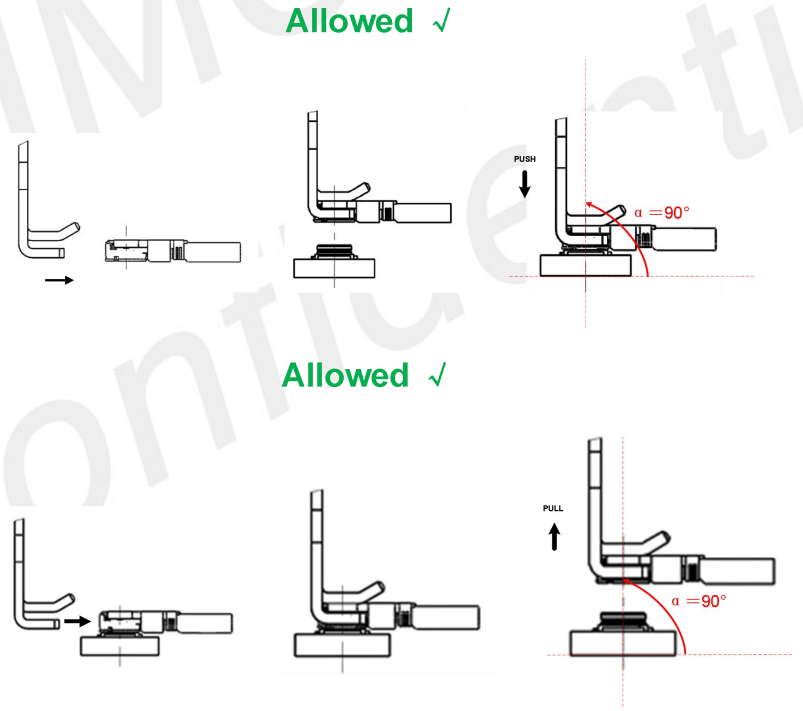


Figure 32: Use RF cable tool correct pull and push operation

Use RF cable tool error pull and push operation as shown in the following figure, for more details, please visit https://www.i-pex.com.

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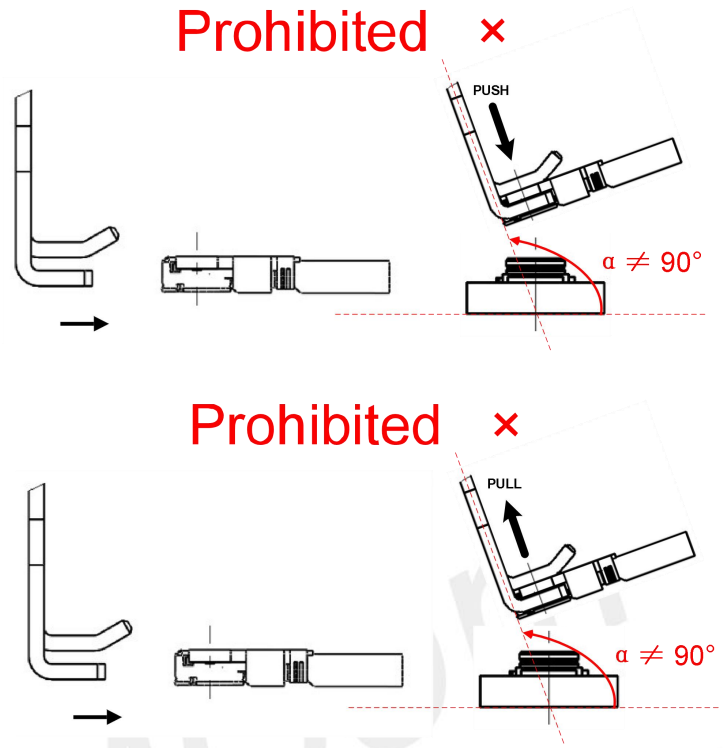


Figure 33: Use RF cable tool error pull and push operation

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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 41: Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT pins	-	-	4.7	V
Voltage at digital pins (GPIO,I2C,UART, I2S)	-	-	2	V
Voltage at digital pins (USIM)	-	-	3.05	V
Voltage at FULL_CARD_POWER_OFF#	-	-	4.4	V
Voltage at RESET	-	-	1.9	V

5.2 Operating conditions

Table 42: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.135	3.8	4.4	V

Table 43: 1.8V Digital I/O characteristics*

Parameter	Description	Min.	Typ.	Max.	Unit
V_{IH}	High-level input voltage	1.26	-	2	V
V_{IL}	Low-level input voltage	-0.3	-	0.54	V
V_{OH}	High-level output voltage	1.6	-	-	V
V_{OL}	Low-level output voltage	-	-	0.2	V
I_{IL}	Input low leakage current(no pull up resistor)	-	-	10	uA

Table 44: Operating temperature

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

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5.3 Operating Mode

5.3.1 Operating Mode Definition

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

Table 45: 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_DISABLE_N 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

The module can set the selection of three different functional modes by the AT instruction.

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 46: Current consumption on VBAT Pins (VBAT=3.8V)

.Description	Condition.	Typical	Unit
Power off mode	Power off	50	uA
Sleep mode	(AT+CFUN=0)	2.6	mA
Idle mode	WCDMA	60	mA
	LTE FDD	60	mA
	LTE TDD	60	mA

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HSDPA data			
WCDMA B1	@Power	22.5dBm	Typical: 600 mA
WCDMA B5	@Power	22.7dBm	Typical: 550 mA
WCDMA B8	@Power	22.5dBm	Typical: 570 mA
LTE data			
LTE-FDD B1	@5MHz	23.0dBm	Typical: 715 mA
	@10MHz	23.0dBm	Typical: 700 mA
	@20MHz	23.0dBm	Typical: 705 mA
LTE-FDD B3	@1.4MHz	23.0dBm	Typical: 700 mA
	@5MHz	23.0dBm	Typical: 702 mA
	@10MHz	23.0dBm	Typical: 696 mA
	@20MHz	23.0dBm	Typical: 685 mA
LTE-FDD B5	@1.4MHz	23.0dBm	Typical: 600 mA
	@5MHz	23.0dBm	Typical: 605 mA
	@10MHz	23.0dBm	Typical: 575 mA
LTE-FDD B7	@5MHz	23.0dBm	Typical: 775 mA
	@10MHz	23.0dBm	Typical: 782 mA
	@20MHz	23.0dBm	Typical: 799 mA
LTE-FDD B8	@1.4MHz	23.0dBm	Typical: 607 mA
	@5MHz	23.0dBm	Typical: 610 mA
	@10MHz	23.0dBm	Typical: 578 mA
LTE-FDD B20	@5MHz	23.0dBm	Typical: 596 mA
	@10MHz	23.0dBm	Typical: 581 mA
	@20MHz	23.0dBm	Typical: 606 mA
LTE-FDD B28	@3MHz	23.0dBm	Typical: 702 mA
	@5MHz	23.0dBm	Typical: 704 mA
	@10MHz	23.0dBm	Typical: 689 mA
	@20MHz	23.0dBm	Typical: 705 mA
LTE-TDD B38	@5MHz	23.0dBm	Typical : 388 mA
	@10MHz	23.0dBm	Typical : 385 mA
	@20MHz	23.0dBm	Typical : 392 mA
LTE-TDD B40	@5MHz	23.0dBm	Typical : 416 mA
	@10MHz	23.0dBm	Typical : 431 mA
	@20MHz	23.0dBm	Typical : 407 mA
LTE-FDD B41	@5MHz	23.0dBm	Typical : 389 mA
	@10MHz	23.0dBm	Typical : 388 mA
	@20MHz	23.0dBm	Typical : 396 mA
LTE-TDD B42	@5MHz	23.0dBm	Typical : 393 mA
	@10MHz	23.0dBm	Typical : 408 mA
	@20MHz	23.0dBm	Typical : 416 mA
LTE-TDD B43	@5MHz	23.0dBm	Typical : 405 mA
	@10MHz	23.0dBm	Typical : 423 mA
	@20MHz	23.0dBm	Typical : 416 mA

5.5 RF Output Power

The following table shows the RF output power of A7908E-M2 module.

Table 47: 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

Table 48 Conducted Receive Sensitivity

Band	Main(typ)	Div(typ)
WCDMA B1	-110	-110dBm
WCDMA B5	-109dBm	-110dBm
WCDMA B8	-109dBm	-110dBm
LTE-FDD B1(5M)	-100dBm	-101.2dBm
LTE-FDD B3(5M)	-99dBm	-99dBm
LTE-FDD B5(5M)	-99dBm	-100dBm
LTE-FDD B7(5M)	-98dBm	-98.5dBm
LTE-FDD B8(5M)	-99.8dBm	-102dBm
LTE-FDD B20(5M)	-99dBm	-101dBm
LTE-FDD B28(5M)	-99.5dBm	-99dBm
LTE-TDD B38(5M)	-100.2dBm	-99dBm
LTE-TDD B40(5M)	-100.0dBm	-98.6dBm
LTE-TDD B41(5M)	-100dBm	-98dBm
LTE-TDD B42(5M)	-102dBm	-102dBm
LTE-TDD B43(5M)	-102.0dBm	-102dBm

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

Part	Contact discharge	Air discharge
VBAT,GND	+/- 4KV	+/- 8KV
Antenna port	+/- 4KV	+/- 8KV
Full_Card_Power_Off#	+/- 3KV	+/- 6KV
USB	+/- 3KV	+/- 6KV
RESET_N	+/- 0.5KV	+/- 2KV
USIM Card	+/- 0.5KV	+/- 2KV
Other GPIOs	+/- 0.5KV	+/- 2KV

NOTE

test condition:

1. There are the surge protective diodes and the ESD protective diodes outside the module.
2. The data in Table Table 49 were tested using the SIMCom EVB.

5.8 RTC

Module supports RTC functions, it can track or record the current date and time by sending "AT+CCLK?". There is an independent 32K crystal oscillator , and the RTC logic requires VBAT power supply to PMU to generate the RTC clock, so the power supply for VBAT should not be turned off. Module can enter the RTC mode even in shutdown or sleep mode as long as keep the power supply for VBAT always on.The following figure shows A7908E-M2 RTC block diagram.

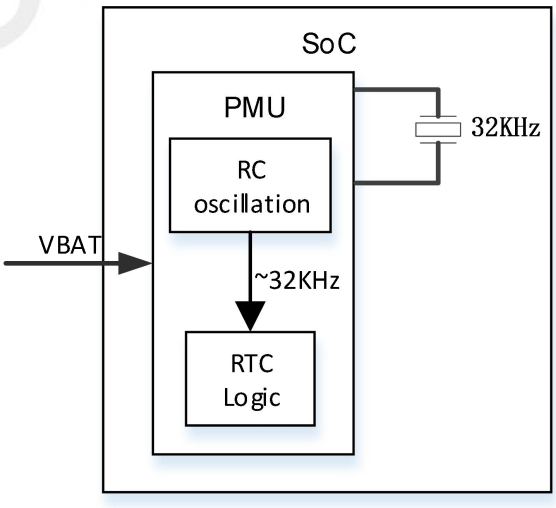


Figure 34: A7908E-M2 RTC block diagram

Table 50: A7908E-M2 RTC characteristics

Operating conditions	RTC time accuracy	VBAT current consumption
VBAT=3.8V Module shutdown	+/- 1.5s within 24h(normal temperature)	7uA (Typical)

NOTE

1. Module can enter the RTC mode even in shutdown or sleep mode as long as keep the power supply for VBAT always on.
2. The data in Table 50 are the test results at normal temperature.

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6 Connect A7908E-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.

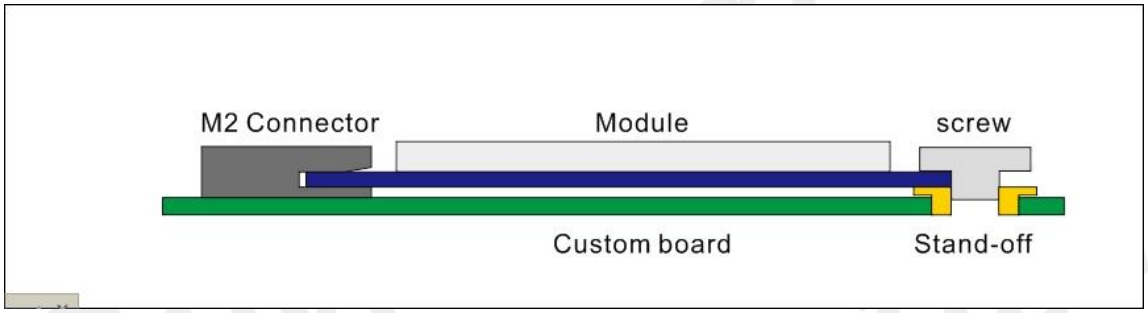


Figure 35:Equipment diagram

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7 Thermal Design

In order to ensure that A7908E-M2 can maintain maximum working performance for a long time under high temperature or extreme conditions, heat dissipation design is very important, it is strongly recommended that customers add copper exposed area to the main PCB board directly below the module cooling area, and add thermal conductivity material between the module and the main PCB board. The thermal design ,heat dissipation area and size at the bottom of the module is shown in the following figure in millimeters, and the recommended heat dissipation area size is 30.4mm * 26mm.

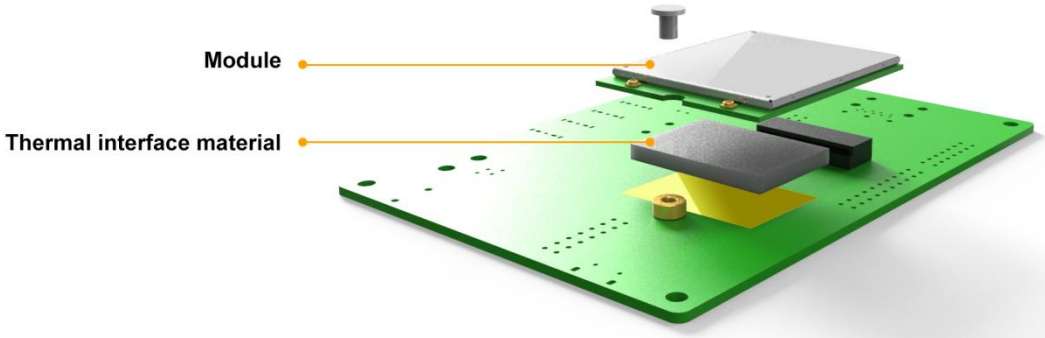


Figure 36: Thermal design

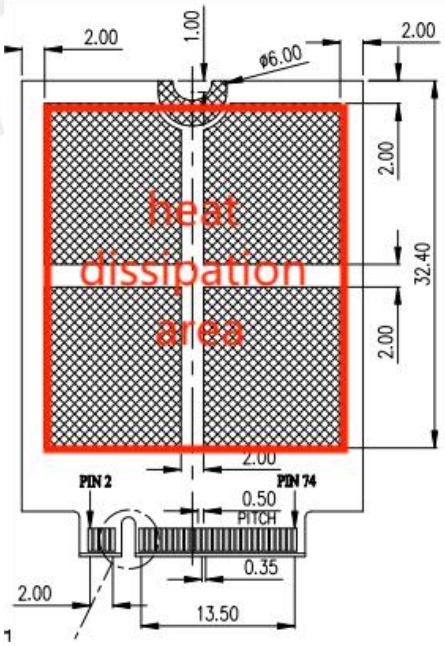


Figure 37: heat dissipation area

There are some suggestions to improve heat dissipation performance:

- Ensure that the module is kept away from the heat source, such as battery, power supply, AP, etc.
- Ensure that the mounting hole of the module is fully connected to the ground of the main PCB.
- Add enough through-holes to the main PCB, preferably with solid copper and stacked overhole materials.
- Ensure maximum air flow around the module.
- On the front of the module, it is recommended to connect the cooling material to the customer's equipment to improve the heat dissipation. The greater the heat dissipation area, the better the effect.
- Choose an efficient heat dissipation material, such as heat conduction pipe, graphite sheet, etc.

Table 51: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

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8 Package Information

8.1 Top and Bottom View of Module

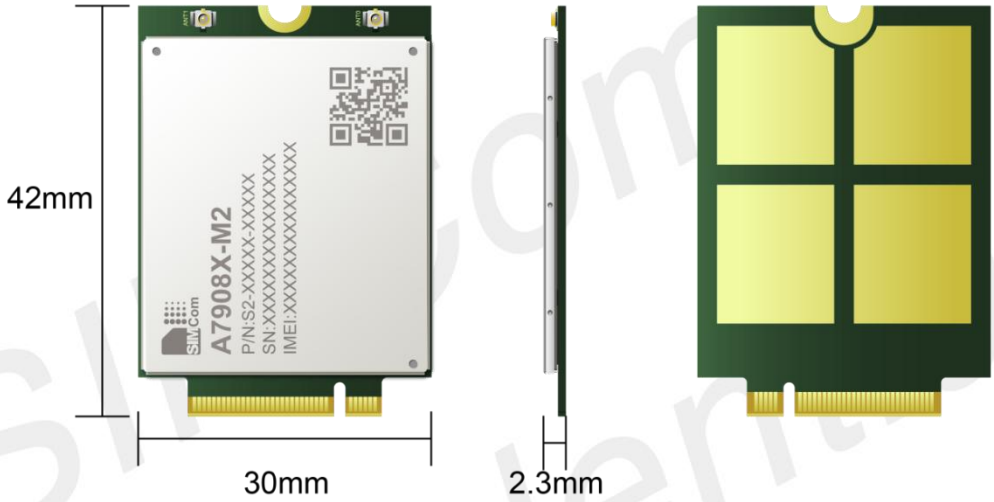


Figure 38: Top and bottom view of module (bottom side reserved ground plane for thermal)

8.2 Label information

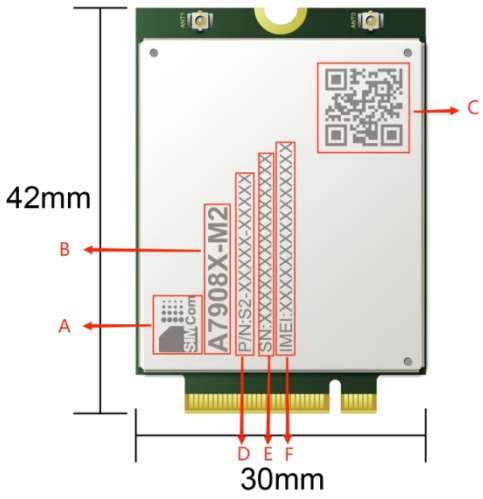


Figure 39: Label information

Table 52: 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

NOTE

FIGS. 38 and 39 are the effect drawings of the module, for reference only, please refer to the actual appearance of the product.

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9 Packaging

Module support tray packaging.

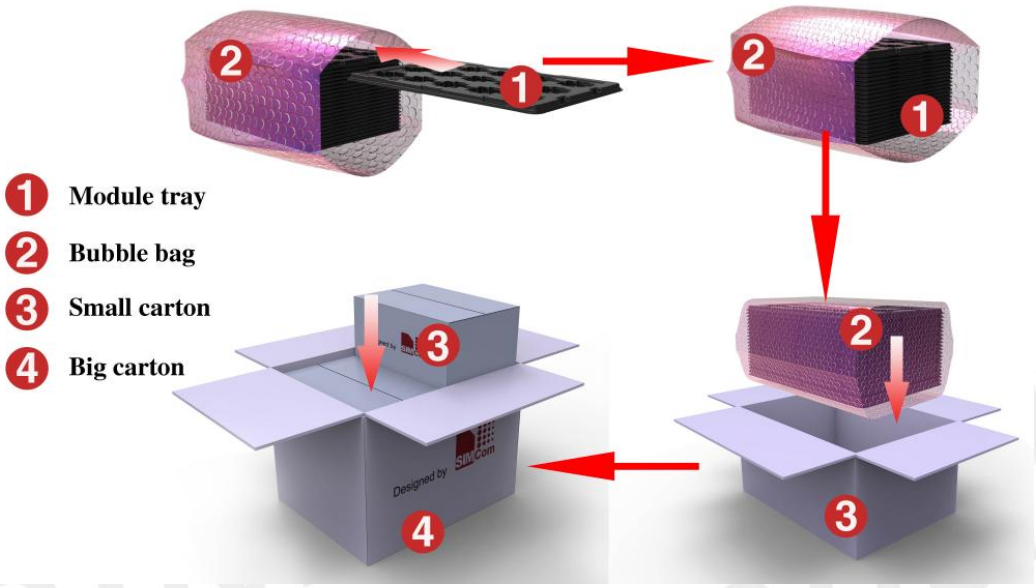


Figure 40: packaging diagram

Module tray drawing：

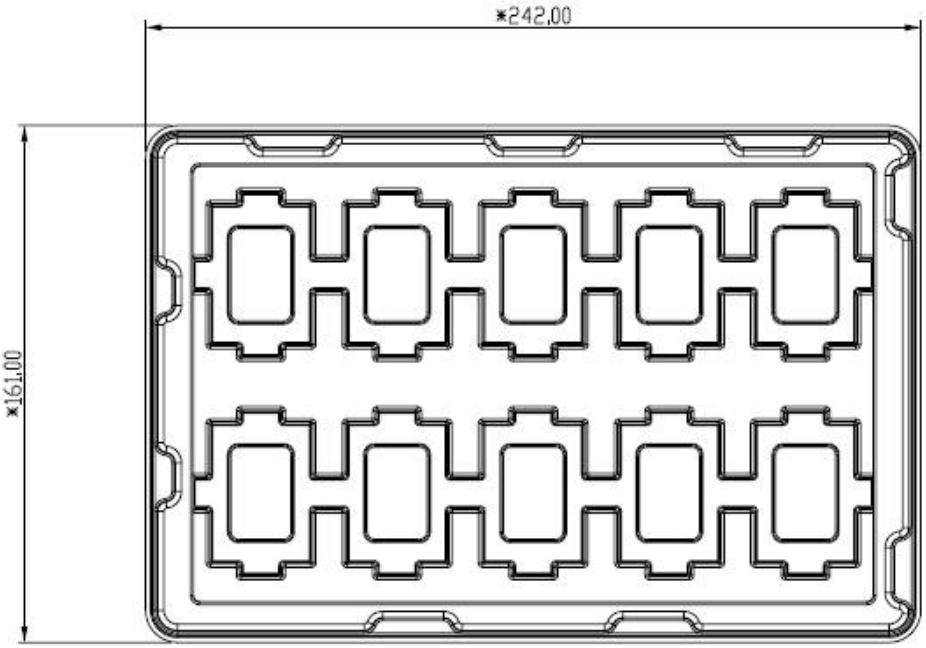


Figure 41: Tray drawing

Table 53: Tray size

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

Small carton drawing：

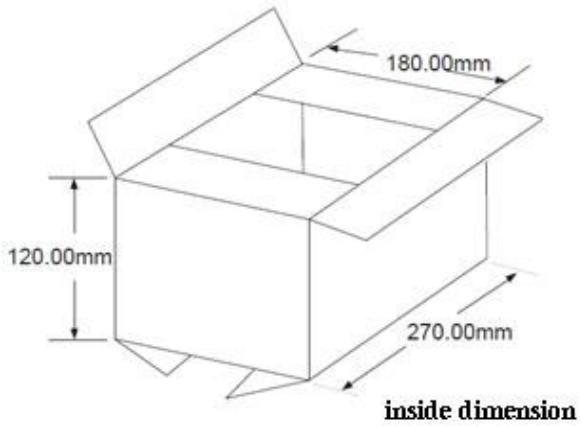


Figure 42: Small carton drawing

Table 54: Small Carton size

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

Big carton drawing：

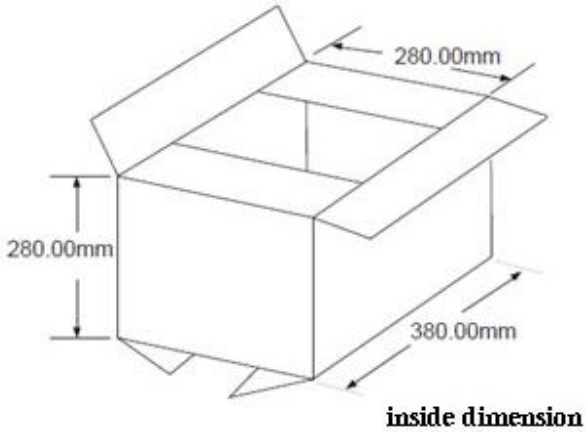


Figure 43: Big carton drawing

Table 55: Big Carton size

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

10 Appendix

10.1 Coding Schemes and Maximum Net Data Rates over Air Interface

Table 56: 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

10.2 Related Documents

Table 57: Related Documents

NO.	Title	Description
[1]	A7908E-M2 Series_AT Command Manual	AT Command Manual
[2]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[3]	3GPP TS 38.401	NG-RAN; Architecture description
[4]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[5]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[6]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[7]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[8]	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
[9]	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

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[10]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[11]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[12]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[13]	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)
[14]	3GPP TS 38.101	NR radio transmission and reception technical specification
[15]	A7908E-M2_Antenna Port Mapping and Design Guide	Antenna design guidelines

10.3 Terms and Abbreviations

Table 58: 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

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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

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UMTS	Universal mobile telecommunications system
UART	Universal asynchronous receiver transmitter

10.4 Safety Caution

Table 59: 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.

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