E7080 Series Hardware Design

LPWA Module

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1 Introduction

The document describes the hardware interfaces of the E7080 series.

With this document, user can quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. This document, coupled with application notes and user guides, makes it easy to design and set up mobile applications with the module.

1.1 Document Overview

The documents listed in Table 1 primarily cover the module's technical information. Read the following documents to learn more about the device and its applications.

Table 1: E7080 Series Documents Overview

NO.	Document	Dsecription
[1]	E7080_Hardware_Design (This document)	Mainly introducing interface functions, recommend circuit, PCB layout guidelines, packaging and other hardware components, as well as the use of AT commands
[2]	E7080_Reference_Design	Reference circuit applications
[3]	8EC000-E7080-TE_V1.01_SCH&PCB	TE SCH&PCB PDF Document
[4]	SIMCOM EVB Kit User Guide	SIMCOM_EVB SCH&PCB PDF Document
[5]	MOD_E7080_77	Reference Package (Pads)
[6]	E7080_AT_Command_Manual	AT Command Manual
[7]	SIMCom Module - SMT Patching Process Instruction Manual	This mainly introduces the surface mount technology for module production, the requirements for steel mesh production, reflow soldering, desoldering and rework, etc.
[8]	E7080_TE kit_User Guide	Module Secondary SMT Guidelines

NOTE

The document versions in the table may be earlier versions and the contents may change at any time, please contact SIMCom FAE for the latest version.

1.2 Product Outline

E7080 Series is a high-performance, low-power, multi-band NB-IoT、GNSS wireless communication module. The module series offers two versions for users to choose from: single NB and NB+GNSS, When E7080 enters the PSM mode, GNSS can work normally. It is compatible with the 3GPP R14 protocol and NMEA-0183 ICOE Protocol. The module integrates various communication protocol stacks, including China Mobile OneNET, China Telecom CTWing, and AEP OC, making it convenient for customer applications.

The module adopts LGA+LCC packaging, with a total of 77 pins, and dimension of only 17.6mm ×15.7mm × 2.4mm. It is compatible with the Y7080E and SIM7080G packaging. This allows it to meet the demands of terminal devices for small-sized modules to the greatest extent, while also helping customer reduce product size and cost. The module can be widely used in IoT products such as smart metering, location tracking, and door magnetic monitoring.

For detailed frequency band descriptions, please refer to Table 2 below:

Table 2: E7080 Series Frequency Band

Network Type	Band Category	E7080	E7080(NB only)
LTE-HD-FD	LTE-FDD B1	✓	✓
	LTE-FDD B3	✓	✓
	LTE-FDD B5	✓	✓
	LTE-FDD B8	✓	✓
	LTE-FDD B20	✓	✓
	LTE-FDD B28	✓	✓
GNSS	GPS	✓	-
	GLONASS	✓	-
	BeiDou	✓	-
	Galileo	✓	-

NOTE

When E7080 enters PSM mode, GNSS can operate independently.

1.3 Hardware Interface Overview

The interfaces are described in detail in the next chapters include:

- Power Supply
- 3*UART
- SIMcard
- ADC
- VDD_EXT
- SPI
- I2C
- NETLIGHT
- LTE
- GNSS

1.4 Module Characteristics and Differences

Table 3: Main Characteristics and Differences

Features	E7080(NB only)	E7080
Power Supply	Supply voltage range:2.1V~4.5V Typical Voltage:3.6V	Supply voltage range:3.0V~4.5V Typical Voltage:3.6V
GNSS Function	GNSS not supported	GNSS (GPS,GLONASS,BDand Galileo) NMEA-0183
Current Consumption	PSM：TBD uA@3.6V	PSM：2.1 uA @3.6V GNSS Idle：See Table 47 for details.
BAND	Reference Table 2	
Transmission Power	PC3	
Data Transmission	NB2: Single-Tone; Uplink:158.5kbps;Downlink:126.8kbps	
SIM Interface	Support SIM single card Support 1.8/3.0V SIM card (power supply below 2.8 V, only 1.8V SIM card are supported)	
GPIO Interface	Default voltage domain of 3.0V, supports changing the voltage domain through instructions (1.8/3.0V)	3.0V voltage range Does not support command to change voltage field
I2C	Version 2.0	
SPI	● Support Master/Slave mode ● Maximum Configurable Maximum Clock: 25.6MHz	
ADC	12bit conversion accuracy Voltage detection range: 0~1.5V	
UART	Main_UART: Used for AT command communication, Data transmission and firmware upgrade. Default: 115200bps. DBG_UART: Used for firmware debugging.	Main_UART: Used for AT command communication, Data transmission and firmware upgrade. Default: 115200bps. DBG_UART: Used for firmware debugging ,LOG data transfer
Firmware Upgrade	Firmware upgrade via UART/FOTA	
Physical Dimensions	Size:17.6*15.7*2.4±0.1mm Weight: 1.30±0.3 g	
Temperature	Operating Temperature:-30℃~+80℃ Extended Operating Temperature:-40℃~+85℃ Storage Temperature:-45℃~+90℃	

[1] When working in the normal operating temperature range, the related performance of the module meets the requirements of 3GPP standard;
[2] When the operating temperature range is extended, the module can still maintain the normal working state, with voice, short message, data transmission, emergency call and other functions; There will be no unrecoverable failure; The radio frequency spectrum and network are basically unaffected. Only the values of individual indicators such as output power may be outside the range of the 3GPP standard. When the temperature returns to the normal operating temperature range, the indicators of the module still meet the 3GPP standard.

NOTE

1. For E7080 (NB only), if the supply voltage is lower than 2.2V, some RF performance will not meet the 3GPP protocol requirements. When the supply voltage of E7080 is lower than 3.0V, GNSS will not function properly.
2. When the module operating temperature is out of the normal operating temperature range, the performance may slightly deviate from the 3GPP specification, and the module RF performance will meet the 3GPP specification again when the temperature returns to the normal operating temperature range.

1.5 Module Block Diagram

The following figure shows the main functional architecture within the module

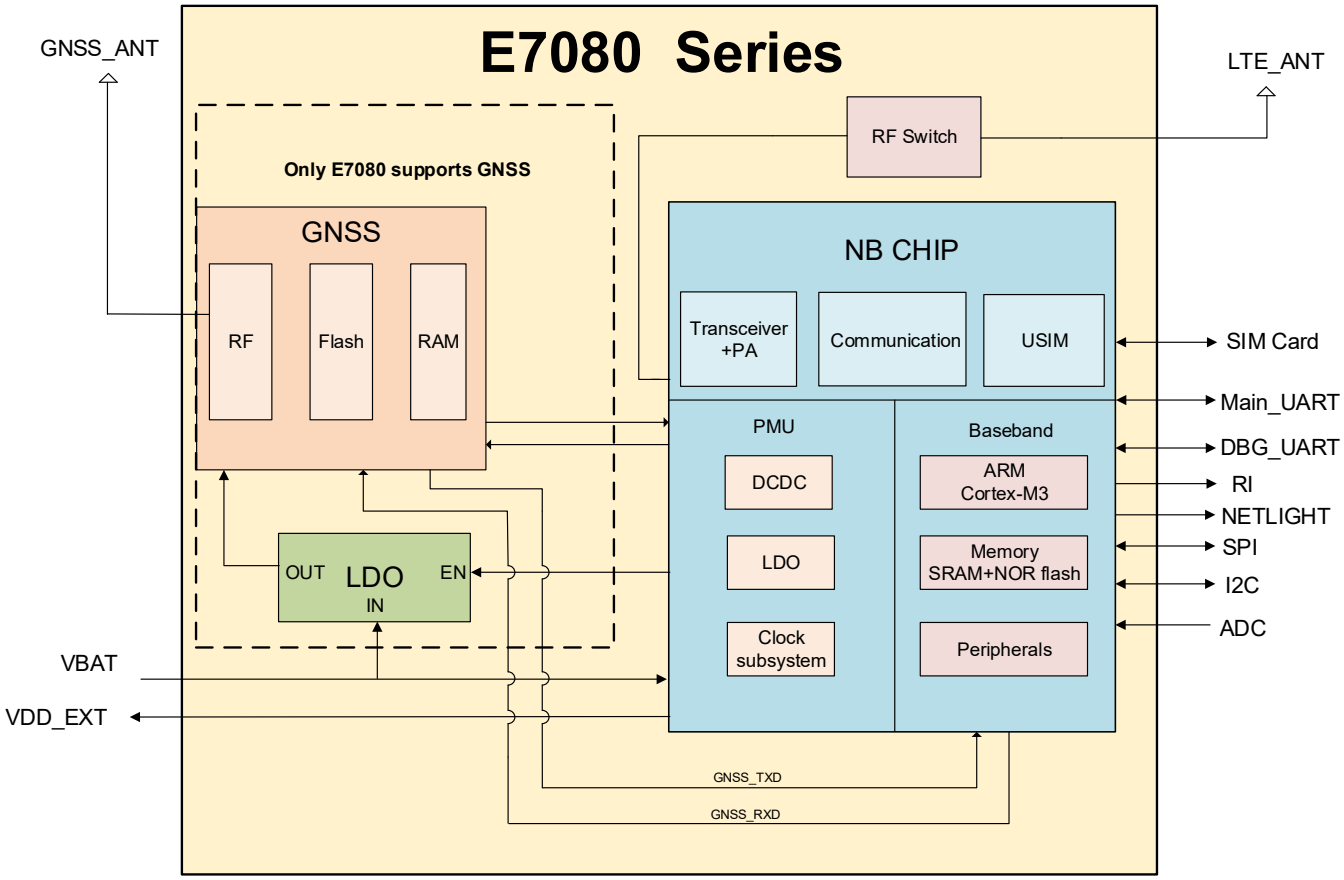


Figure 1: Module Block Diagram

2 Package Information

2.1 Pin Assignment Overview

The module has a total of 77 pins, providing all the hardware interfaces of the module. The following picture shows the top view pinouts of two different models.

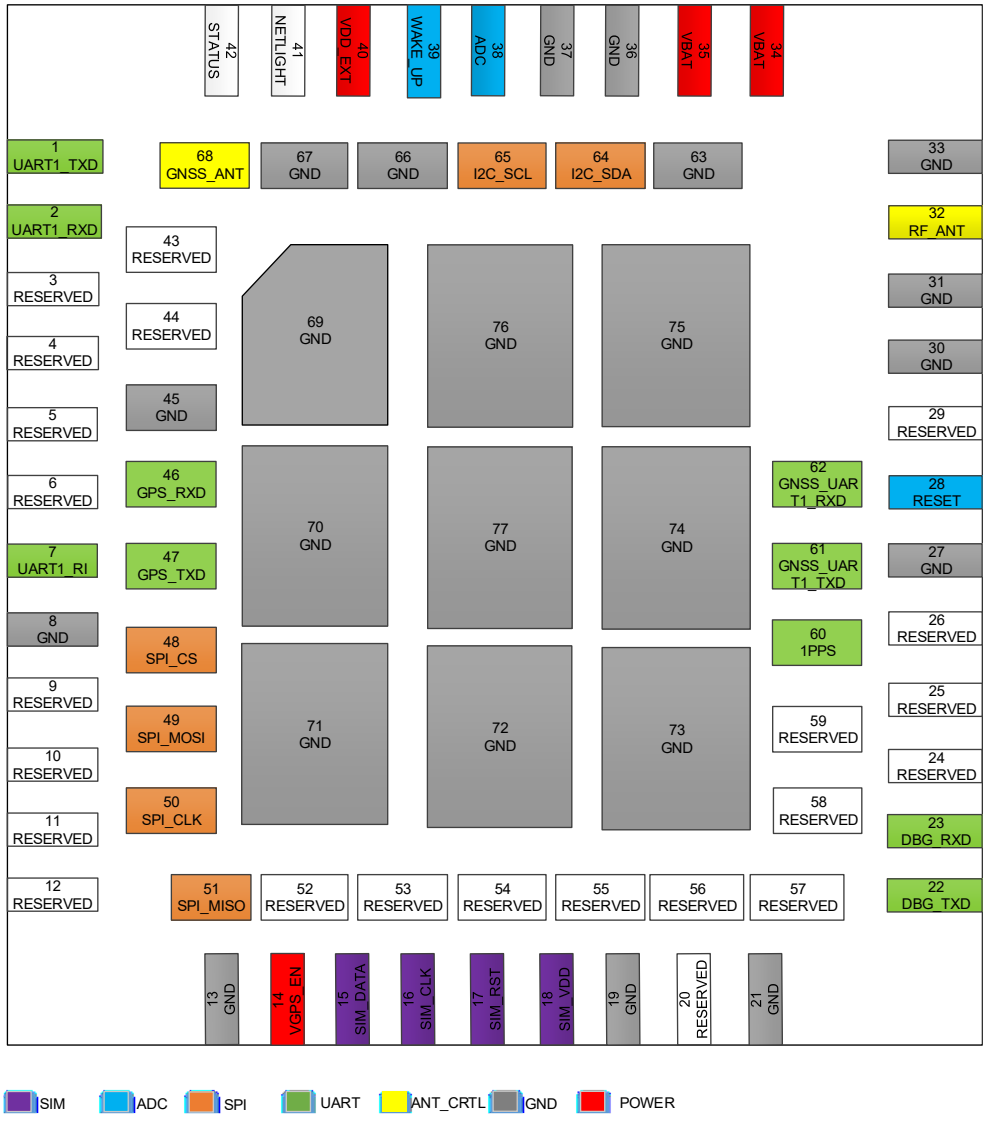


Figure 2: E7080 module pin diagram

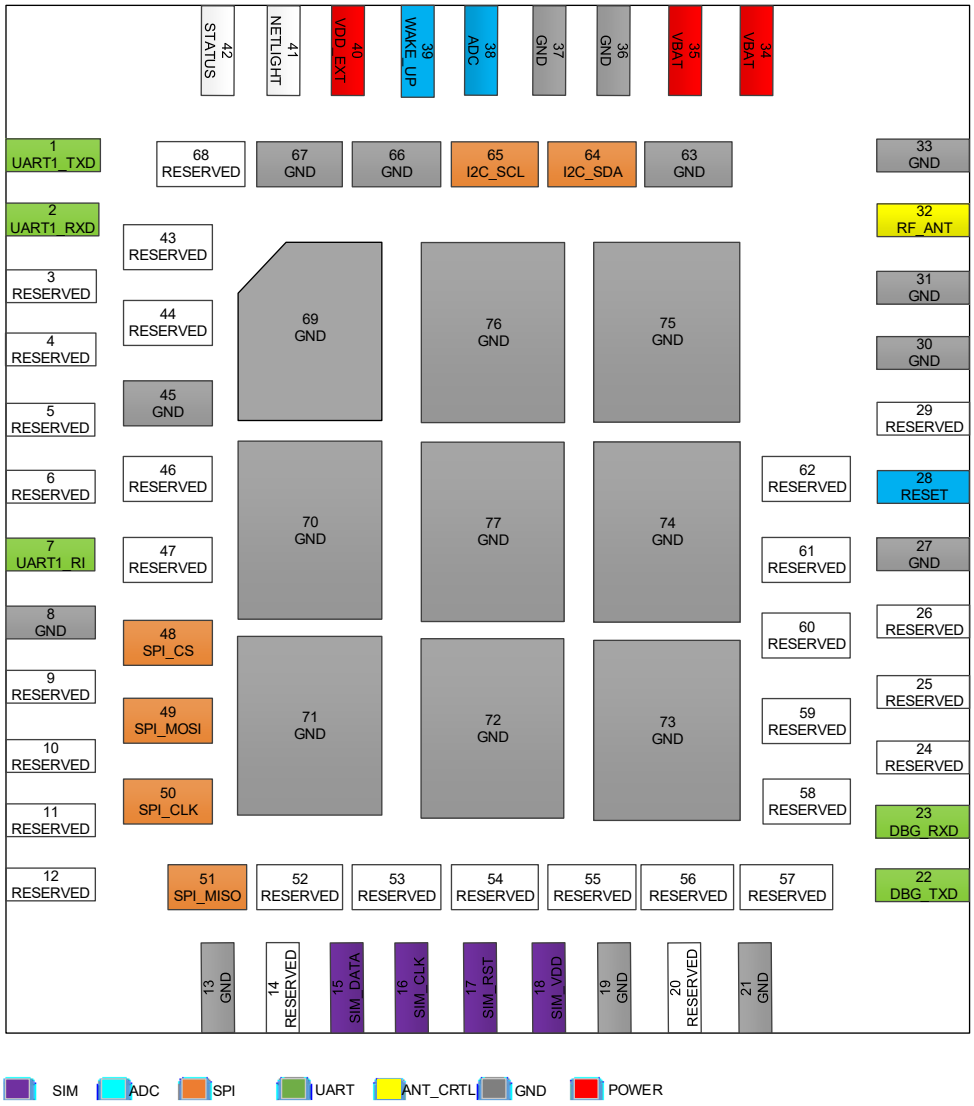


Figure 3: E7080(NB only) module pin diagram

Table 4: Pin definition

No.	PIN name		No.	PIN name	
	E7080	E7080(NB only)		E7080	E7080(NB only)
1	UART1_TXD	UART1_TXD	40	VDD_EXT	VDD_EXT
2	UART1_DXD	UART1_DXD	41	NETLIGHT	NETLIGHT
3	RESERVED	RESERVED	42	STATUS	STATUS
4	RESERVED	RESERVED	43	RESERVED	RESERVED
5	RESERVED	RESERVED	44	RESERVED	RESERVED
6	RESERVED	RESERVED	45	GND	GND
7	UART1_RI	UART1_RI	46	GPS_RXD	RESERVED
8	GND	GND	47	GPS_TXD	RESERVED
9	RESERVED	RESERVED	48	SPI_CS	SPI_CS

10	RESERVED	RESERVED	49	SPI_MOSI	SPI_MOSI
11	RESERVED	RESERVED	50	SPI_CLK	SPI_CLK
12	RESERVED	RESERVED	51	SPI_MISO	SPI_MISO
13	GND	GND	52	RESERVED	RESERVED
14	VGPS_EN	RESERVED	53	RESERVED	RESERVED
15	SIM_DATA	SIM_DATA	54	RESERVED	RESERVED
16	SIM_CLK	SIM_CLK	55	RESERVED	RESERVED
17	SIM_RST	SIM_RST	56	RESERVED	RESERVED
18	SIM_VDD	SIM_VDD	57	RESERVED	RESERVED
19	GND	GND	58	RESERVED	RESERVED
20	RESERVED	RESERVED	59	RESERVED	RESERVED
21	GND	GND	60	1PPS	RESERVED
22	DBG_TXD	DBG_TXD	61	GNSS_UART1_TXD	RESERVED
23	DBG_RXD	DBG_RXD	62	GNSS_UART1_RXD	RESERVED
24	RESERVED	RESERVED	63	GND	GND
25	RESERVED	RESERVED	64	I2C_SDA	I2C_SDA
26	RESERVED	RESERVED	65	I2C_SCL	I2C_SCL
27	GND	GND	66	GND	GND
28	REST	REST	67	GND	GND
29	V_BACKUP	V_BACKUP	68	GNSS_ANT	RESERVED
30	GND	GND	69	GND	GND
31	GND	GND	70	GND	GND
32	RF_ANT	RF_ANT	71	GND	GND
33	GND	GND	72	GND	GND
34	VBAT	VBAT	73	GND	GND
35	VBAT	VBAT	74	GND	GND
36	GND	GND	75	GND	GND
37	GND	GND	76	GND	GND
38	ADC	ADC	77	GND	GND
39	WAKE_UP	WAKE_UP			

2.2 Pin Description

Table 5: IO parameters definition

Pin type	Description
PI	Power input
PO	Power output
AI	Analog input
AIO	Analog input/output
I/O	Bidirectional 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

Table 6: Pin description

Pin Name	Pin No.	I/O	Description	Comment
VBAT	34,35	PI	Module power input, Recommended Value: 3.6V	Both pins need to be connected together to provide sufficient overcurrent capability.
VDD_EXT	40	PO	Power Output	If unused, keep it open.
GND	8,13,19,21,27,30,31, 33,36,37,45,63,66,67, 69,70,71,72,73,74,75, 76,77	-	Ground	-
System Control				
WAKEUP	39	DI,PU	External interrupt pin; used to wake up the module in PSM mode, active low	-
SIM interface				
SIM_DATA	15	I/O,PU	SIM Card data I/O	The SIM card interface needs to be properly protected against static electricity.
SIM_RST	16	DO	SIM Reset	
SIM_CLK	17	DO	SIM clock	
SIM_VDD	18	PO	SIM card power supply	
Reset Interface				
RESET	28	DI	Reset module, low active	-

UART Interface				
DBG_RXD	23	DI	Debugging Serial Data Reception	For software debugging
DBG_TXD	22	DO	Debugging Serial Data Transmission	
UART1_RXD	2	DI	MAIN_UART data reception	The main serial port is used for sending AT commands. The default baud rate is 115200 bps and it supports firmware download.
UART1_TXD	1	DO	MAIN_UART Data Transmission	
UART1_RI	7	DO	Ringer indication output	If unused, keep it open.
I2C				
I2C_SDA	64	I/O	I2C data input/output	If unused, keep it open, or else pull them up via 4.7KΩ resistors to the VDD_EXT.
I2C_SCL	65	DO	I2C clock output	
SPI				
SPI_CS	48	DO	Chip Select Signal	If unused, keep it open
SPI_MOSI	49	DO	Master Data Output	
SPI_SCLK	50	DO	Bus Clock Output	
SPI_MISO	51	DI	Master Data Input	
Network Status				
NETLIGHT	41	DO	Network Status Indicator	-
RF Interface				
RF_ANT	32	AIO	LTE Antenna	-
GNSS_ANT*	68	AIO	GNSS Antenna	If unused, keep it open
Other interface				
ADC	38	AI	Universal analog to digital converter interface	If unused, keep it open
RESERVED	3,4,5,6,9,10,11,12,20, 24,25,26,43,44,52,53, 54,55,56,57,58,59	-	Reserve pin	-

NOTE

1. All the reserved feet should remain in an elevated position.
2. SIM_DATA must be connected to SIM_VDD through a 20KΩ pull-up resistor.

2.3 Mechanical Information

The figure below shows the packaging dimensions of the module:

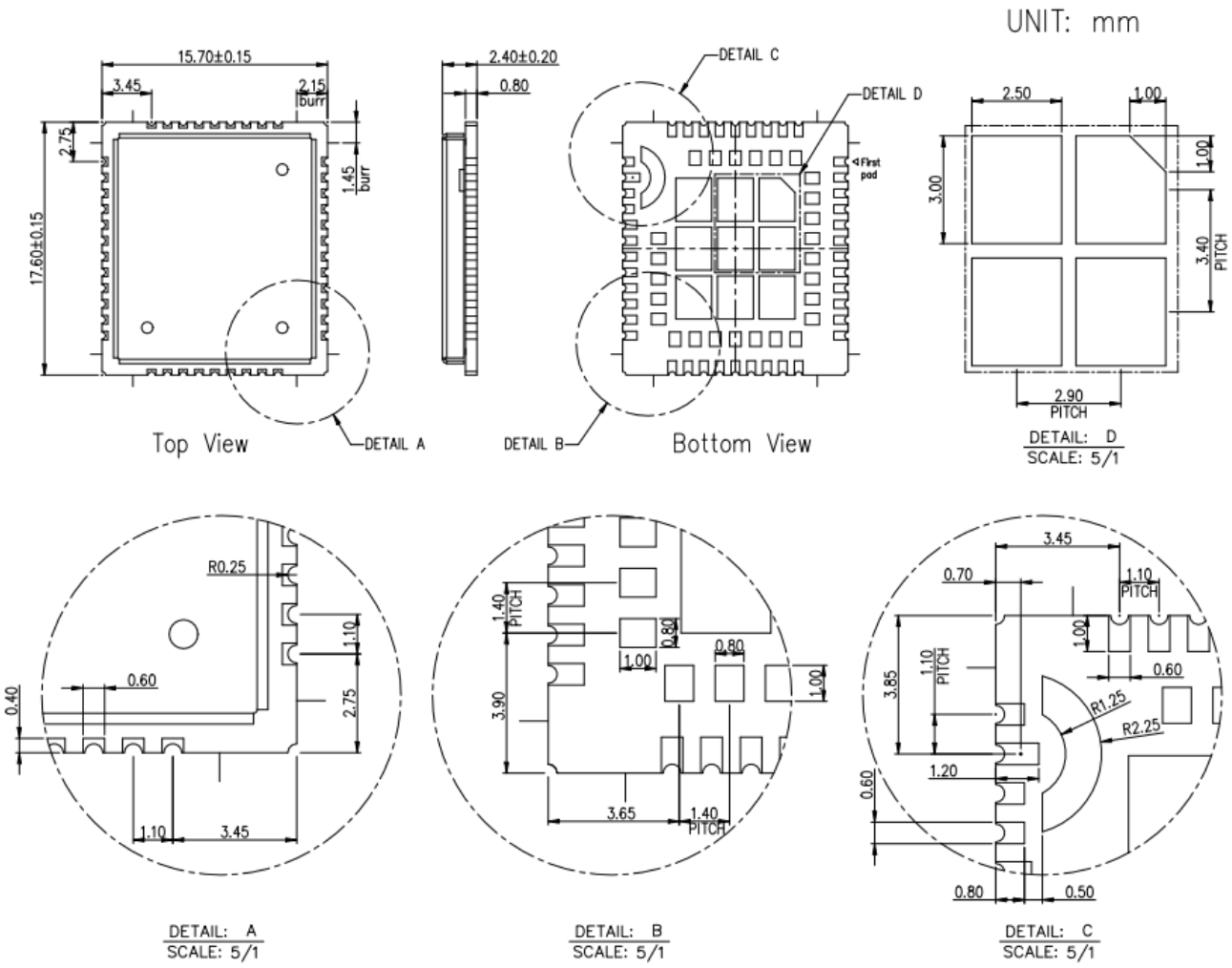


Figure 4: Dimensions (Unit: mm)

NOTE

Tolerances do not include burr areas. To facilitate subsequent soldering repairs, it is recommended that the distance between the module and other components on the PCB be at least 3mm.

3 Interface Application

3.1 Power Supply

The module PIN 34 and 35 serve as the VBAT power input. The module supplies power to the internal RF and baseband circuits through these two pins. To ensure the module can start up normally, please connect all the pins.

Table 7: VBAT Electrical Parameters

Pin Name		Description	Min.	Typ.	Max.	Unit
VBAT	E7080(NB only)	Module supply input voltage	2.1	3.6	4.5	V
	E7080	Module supply input voltage	3.0	3.6	4,5	V
$I_{VBAT(peak)}$		Module NB-IoT mode peak current consumption	-	-	800	mA
$I_{VBAT(PSM)}$		Current in PSM mode	-	2.1	-	uA
$I_{VBAT(sleep)}$		Current in Sleep mode @ DRX = 1.28 S		1.7		mA
		Current in Sleep mode @ DRX = 2.56 S		1.5		mA
		Current in Sleep mode @ eDRX = 81.82S		78		uA
		Current in Sleep mode @ eDRX = 1633.84S		45		uA

During PCB design, attention should be paid to the trace impedance of the VBAT power supply. When the module operates under high-power conditions with a large load current, voltage drop caused by trace impedance increases accordingly. Theoretical DC impedance can be estimated using a DC impedance simulation tool or the following formula:

$$R_{\text{trace}} = \rho \cdot \frac{L}{A} = \rho \cdot \frac{L}{W \cdot T}$$

R_{trace}: DC resistance of the trace (Ohm)
ρ: Resistivity of copper, approximately $1.68\times10^{-8}\,\Omega\cdot m$ at room temperature (increases with temperature)
L: Trace length (meters)
A: Cross-sectional area of the trace (square meters)
W: Trace width (meters)
T: Copper thickness (meters)

If there are vias along the PCB trace, their DC resistance must also be considered. When multiple vias are used, calculate the total resistance as parallel resistance. The DC resistance of a single via can be calculated using the following formula:

$$R_{\text{via}} = \rho \cdot \frac{L}{A} = \frac{4\rho L}{\pi \left(D_{\text{outer}}^2 - D_{\text{inner}}^2\right)}$$

R_{via}: DC resistance of the via (Ohm)
ρ: Resistivity of copper, approximately $1.68\times10^{-8}\,\Omega\cdot m$ at room temperature (increases with temperature)
L: Via depth (meters)
A: Cross-sectional area of the via (square meters)
D_{outer}: Outer diameter of the via (meters)
D_{inner}: Inner diameter of the via (meters)

NOTE

The resistivity of copper increases with temperature. Therefore, in high-temperature environments, the impedance of the VBAT power trace will be higher.

3.1.1 Power Supply Design Guide

In the design process, special attention must be paid to the design of the power supply section to ensure that even when the module's current consumption reaches an instantaneous maximum, the VBAT does not fall below Minimum operating voltage. If the voltage falls below Minimum operating voltage, the module may be under-voltage and cause the system to operate abnormally.

The design of the power supply has a critical impact on the performance of the module. To ensure better power supply performance, it is recommended to place the following combination of capacitors close to VBAT. To prevent surge and static damage to the module, it is recommended that a high power TVS be connected in parallel to the VBAT pin of the module, and if a voltage regulator is selected, special attention should be paid to the static power consumption of the regulator.

The reference circuit for the VBAT input is shown in the following figure.

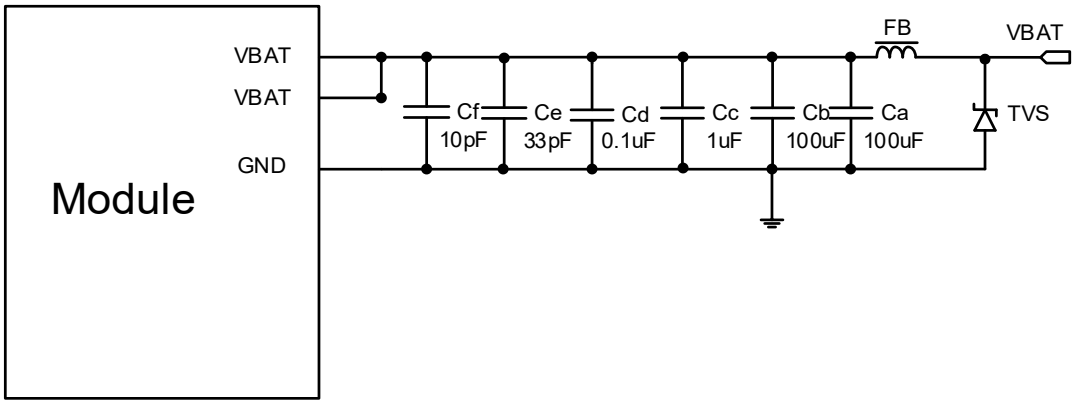


Figure 5: VBAT supply application circuit

Table 8: Recommended TVS diode list

No.	Manufacturer	Part Number	V_{RWM}	V_C(max)	P_{pp}(max)	C_J(max)	Package
1	WILL	ESD56301D05	5V	9.5V	1500W	700pF	DFN1610-2L
2	WILL	ESD56301D04-2/TR	4.85V	11V	2000W	480pF	DFN1610-2L
3	WAYON	WS2057KP	5V	12V	2040W	700pF	DFN1610-2L
4	WAYON	WS4.5DPHXM	4.85V	11V	2255W	700pF	DFN1610-2L

NOTE

When selecting TVS, pay attention to the clamping voltage for surge protection, the clamping voltage should not be higher than 10V for 100V surge input.

Power and ground wiring guidelines:

- Both VBAT and return paths should be as short and wide as possible to minimize the voltage drop. The user's VBAT alignment width on the board should be no less than 0.7mm to ensure the overcurrent capability of the alignment.
- These capacitors are placed as close as possible to the VBAT pins.
- The VBAT alignment path should go through the TVS diode and capacitor and then to the VBAT pin. Small capacitors should be placed close to the VBAT pin.
- The PCB design must have a primary ground plane as the primary reference ground plane for most signals.

3.1.2 Recommended Power Supply Circuit

In terms of design, the MCU must have the function of powering off the module. During the normal operation of the module, it is prohibited to forcibly power off the module. Only when the module is shut down normally or when an abnormal situation occurs preventing normal shutdown or restart, can the module be powered off. It is recommended to choose LDO or DC-DC chips with enable pins. When the input power is greater than 5V, DC-DC chips are recommended; when the input power is less than 5V, LDO power supply is recommended.

It is recommended that a switching mode power supply is used. The following figure shows the DC-DC regulator reference circuit:

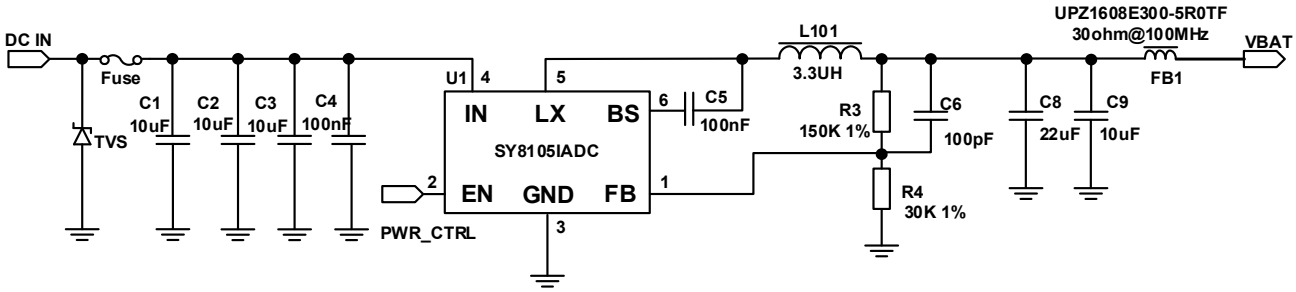


Figure 6: Recommended Circuits for Switching Power Supply

When the VBAT power is turned off, the voltage should decrease rapidly within 50ms. To avoid voltage anomalies, when the VBAT is lower than the minimum value, the system must power on the VBAT at a voltage which lower than 100mV for at least 2 second to restart the system.

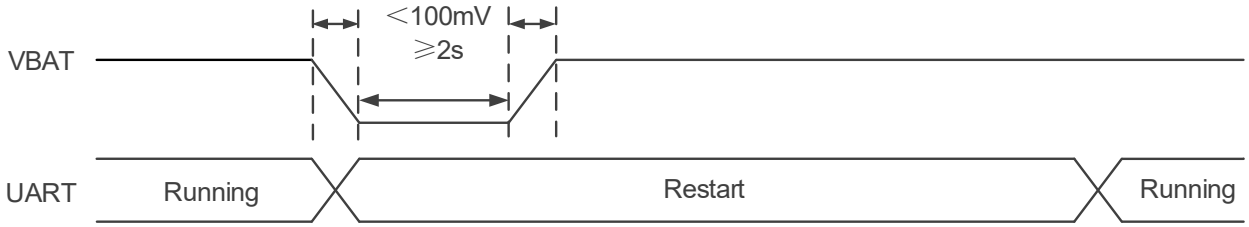


Figure 7: Power-Off and Power-On Restart Sequence

3.1.3 Voltage Monitor

AT command 'AT+CBC' can be used to monitor VBAT voltage.

NOTE

For details of at commands, please refer to document [1].

3.2 Power on/Power off/Reset Function

3.2.1 Power on

The module automatically starts after power-on

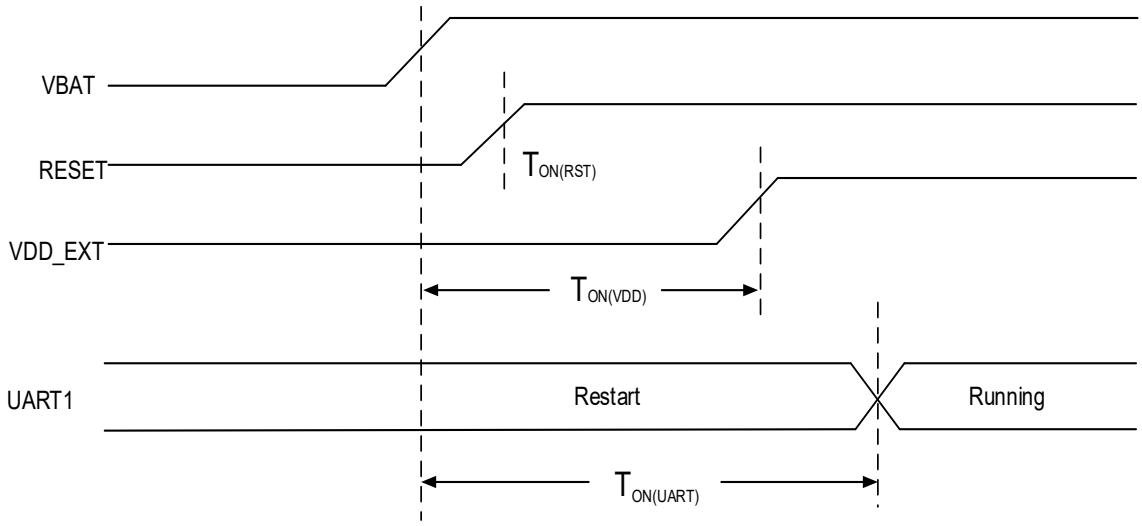


Figure 8: Power-on Timing

Table 9: Power-on Timing

Symbol	Parameter	Min.	Typ.	Max.	Unit
$T_{ON(RST)}$	VBAT power-up to RST high time	-	6	-	ms
$T_{ON(VDD)}$	VBAT power-up to VDD_EXT high time	-	270	-	ms
$T_{ON(UART)}$	VBAT power-up to VDD_EXT high time	-	750	-	ms

NOTE

1. RESET automatically rises to a high level after VBAT power-up due to an internal pull-up.
2. The system automatically turns on after the VBAT voltage rises above Minimum operating voltage. The voltage dither of VBAT after turning on the system cannot be lower than Minimum operating voltage or below, otherwise the system will be abnormal and the system can be reset by RESET.

3.2.2 Power off

During the normal operation of the module, it is not recommended to control the module shutdown by directly cutting off the power supply. In order to avoid the situation of FALSH damage caused by the direct power failure, it is recommended that the customer firstly closes the module software and saves the data through the AT command before disconnecting the power supply of VBAT.

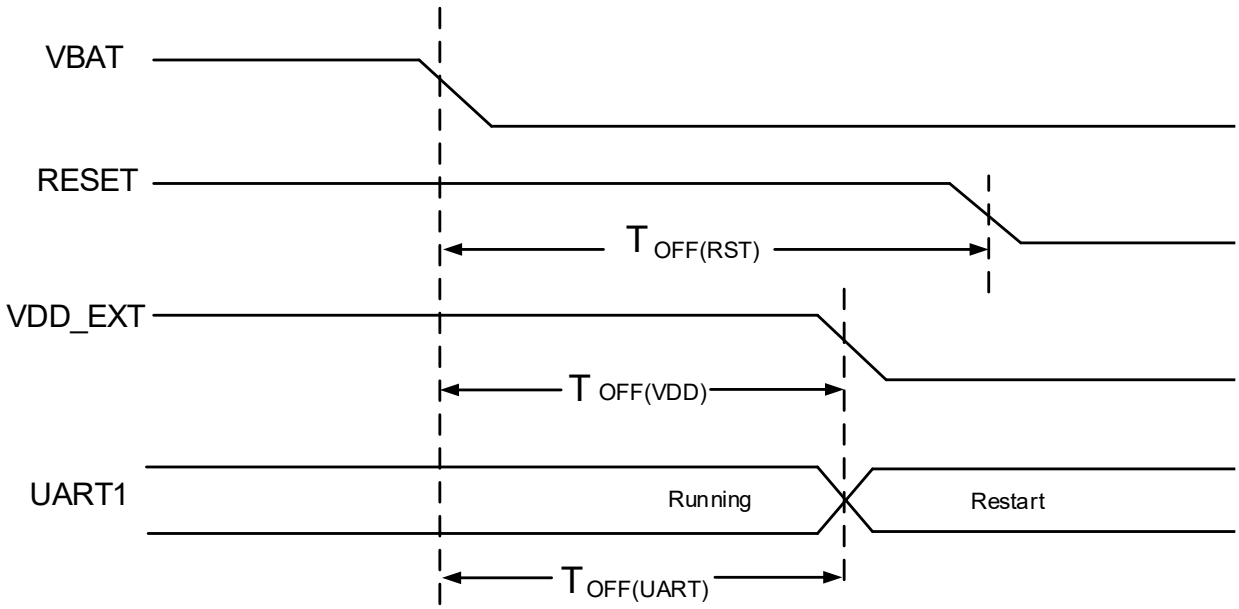


Figure 9: Power-off Timing

Table 10: Power-off Timing

Symbol	Parameter	Min.	Typ.	Max.	Unit
$T_{OFF(RST)}$	VBAT power-off to RST low time	-	60	-	ms
$T_{OFF(VDD)}$	VBAT power-off to VDD_EXT low time	-	20	-	ms
$T_{OFF(UART)}$	Shutdown time (judged by UART)	-	20	-	ms

NOTE

Customer circuit design must have the master can control the module power-off function, the module can be normal shutdown or restart prohibit the use of the module, only the module has an abnormality caused by the inability to shut down or restart normally, only can the module power-off.

3.2.3 Reset Function

The module is reset by driving the RESET pin to a low-level pulse.

Table 11: RESET Interface Pin Definition

Pin Name	Pin No.	Type	Description	Note
RESET	28	DI,PU	System reset control input, active low.	If unused, keep it open.

The module can be reset by pulling down the reset pin to a low level. It is recommended to add TVS diode near the module pin for ESD performance. The recommended circuit is shown as follows

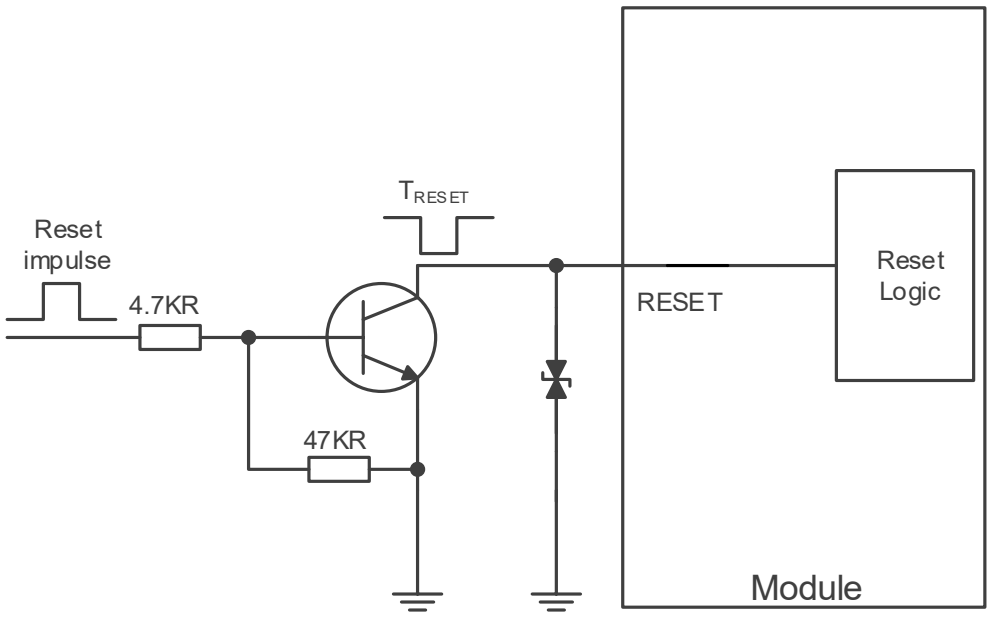


Figure 10: Triode Controlled Reset Reference Circuit

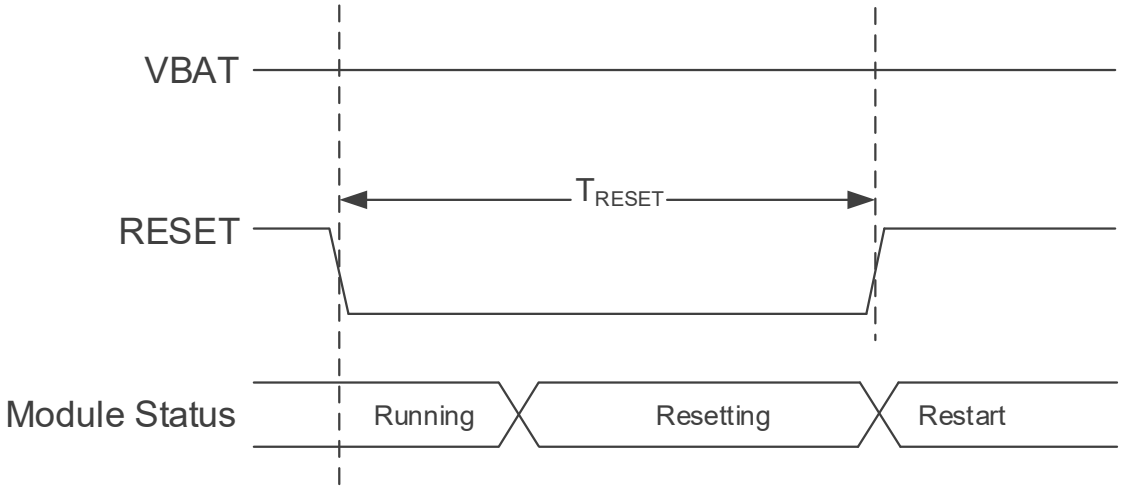


Figure 11: Reset Timing Sequence

Table 12: RESET Electric Parameter

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{RESET}	Restart low level pulse width	2	2.5	-	S
V_{IH}	RESET pin input high voltage	0.7*VBAT	-	VBAT	V
V_{IL}	RESET pin input low voltage	0	0	0.3*VBAT	V

NOTE

1.It is recommended to use the reset pin only in case of emergency, such as the module is not responding. The reset time is recommended to be 2.5s.

2. Please do not connect a capacitor with a capacitance greater than 10PF in parallel on the RESET terminal. Otherwise, if the module detects a low level during power-on, it will automatically start up. Also, be cautious of the junction capacitance of the TVS diode. If the junction capacitance is too large, the same risk will occur.

3.3 WAKE_UP

The module wakes up by driving the WAKE_UP pin to a low-level pulse..

Table 13: WAKE_UP Interface Pin Definition

Pin Name	Pin No.	Type	Description	Note
WAKE_UP	39	DI,PU	External interrupt pin; used to wake up the module in PSM mode, with low level as the trigger signal	-

When the module is in a dormant state, lowering the WAKE_UP pin can wake up the module. This pin has been internally pulled up to VBAT within the module. It is recommended to add a TVS diode at the module pin to enhance the anti-static capability. Refer to the circuit diagram below:

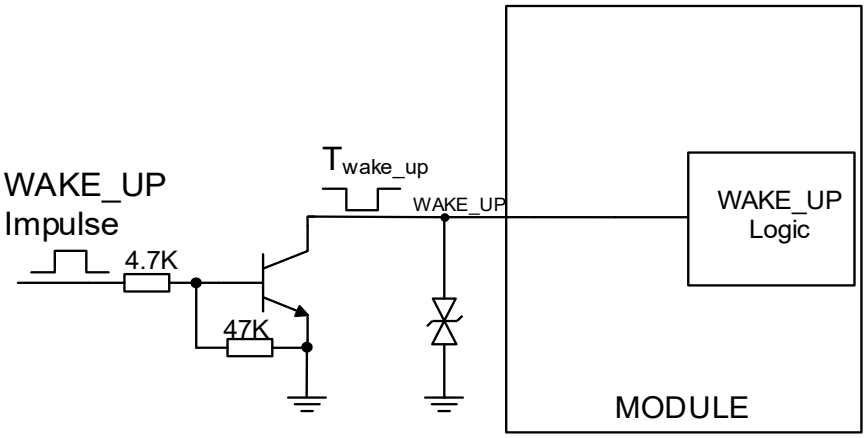


Figure 12: Triode Controlled Reset Reference Circuit

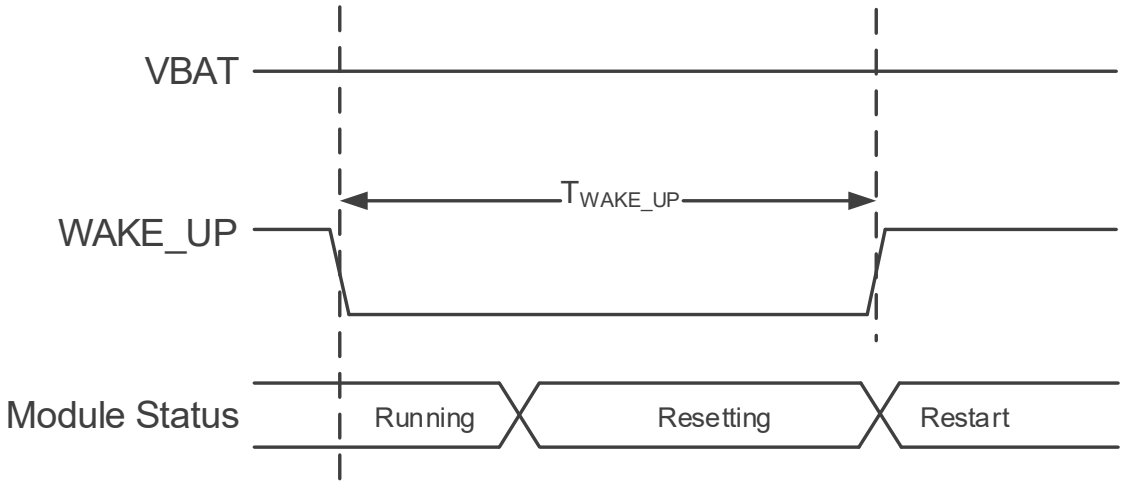


Figure 13: WAKE_UP Timing Sequence

Table 14: WAKE_UP Electric Parameter

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{RESET}	Restart low level pulse width	2	2.5	-	S
V_{IH}	WAKE_UP pin input high voltage	0.7*VBAT	-	VBAT	V
V_{IL}	WAKE_UP pin input low voltage	0	0	0.3*VBAT	V

3.4 Control of GPIO power domain*

Only E7080(NB only) supports GPIO power domain selection.

NOTE

Software control to be developed

3.5 UART Interfaces

The E7080 series provides the following serial ports: UART1, DBG_UART, of which UART1 supports low power wake-up. The serial port pins are defined as follows:

Table 15: UART Information

Interface Type	Support Baud Rate (bps)	Default Baud Rate (bps)	Function Description
UART1	4800~3.6M	115200	Data transmission and AT command transmission
DBG_UART1	9600~3.6M	115200	Used for log output.
GNSS_UART1	9600~3.6M	115200	Defaultly used for GNSS transmission

Table 16: UART Definitions

PIN Name	PIN	I/O	Description	Comment
UART1_RXD	2	DI	Main serial Port Data Reception	The main serial port is used for AT commands, and data transmission supports a fixed baud rate.
UART1 _TXD	1	DO	Main Serial Port Data Transmission	
DBG_RXD	23	DI	Debugging Serial Data Reception	For LOG capture and software debugging
DBG_TXD	22	DO	Debugging Serial Data Transmission	
UART1_RI	7	DO	Ringer alert (DCE sends a signal to notify the DTE when there is a URC output or a short message is received)	If unused, keep it open.
GNSS_UART1_RXD	62	DI	GNSS Port Data Reception	If unused, keep it open.
GNSS_UART1_TXD	661	DO	GNSS Port Data Transmission	

Table 17: UART electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
V_{IH}	input high voltage	0.7*VDD_EXT	-	-	V
V_{IL}	input low voltage	-	-	0.2* VDD_EXT	V
V_{OH}	output high voltage	0.8*VDD_EXT	-	-	V
V_{OL}	output low voltage	-	-	0.15* VDD_EXT	V

NOTE

The power domain of the E7080(NB only) can be configured as 1.8/3.0V. The E7080 supports only the 3.0V power domain.

3.5.1 UART Design Guide

The module is directly connected to the main control unit (with interface level matching), using a 2-wire serial port. The reference design is shown in the following figure:

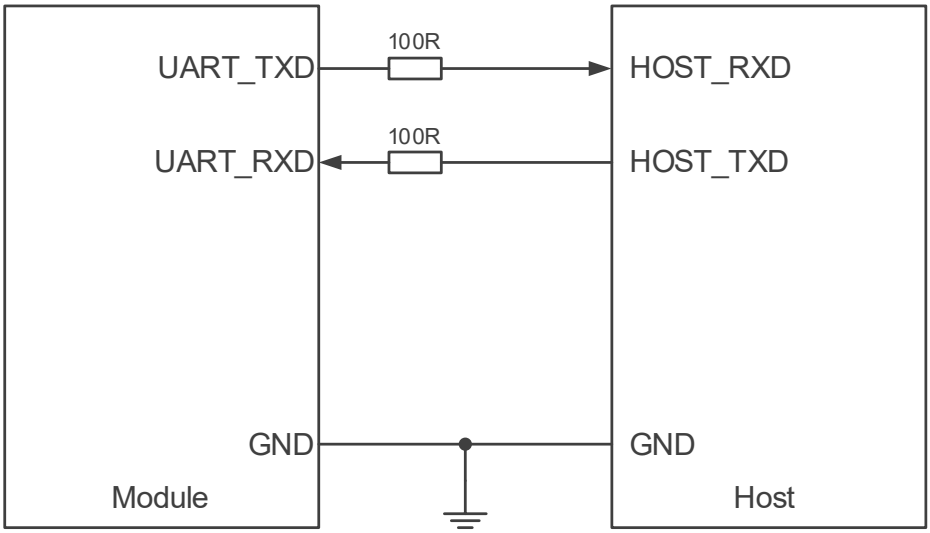


Figure 14: Serial Port Connection Diagram (NULL Mode)

When the modules and the main controller are connected using level conversion chips (and the interface levels do not match), the reference design is as shown in the following figure:

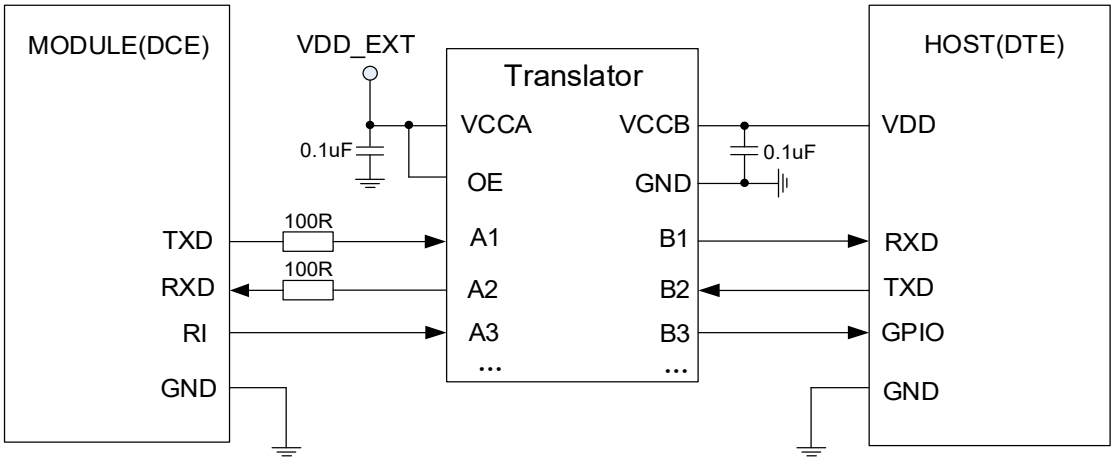


Figure 15: Level-Shifter IC Conversion Circuit

The following figure shows the use of triode for level shifter circuits. The circuit with dotted line can refer to the circuit with solid line TXD and RXD, and attention shall be paid to the direction of signal.

The recommended triode model is MMBT3904.

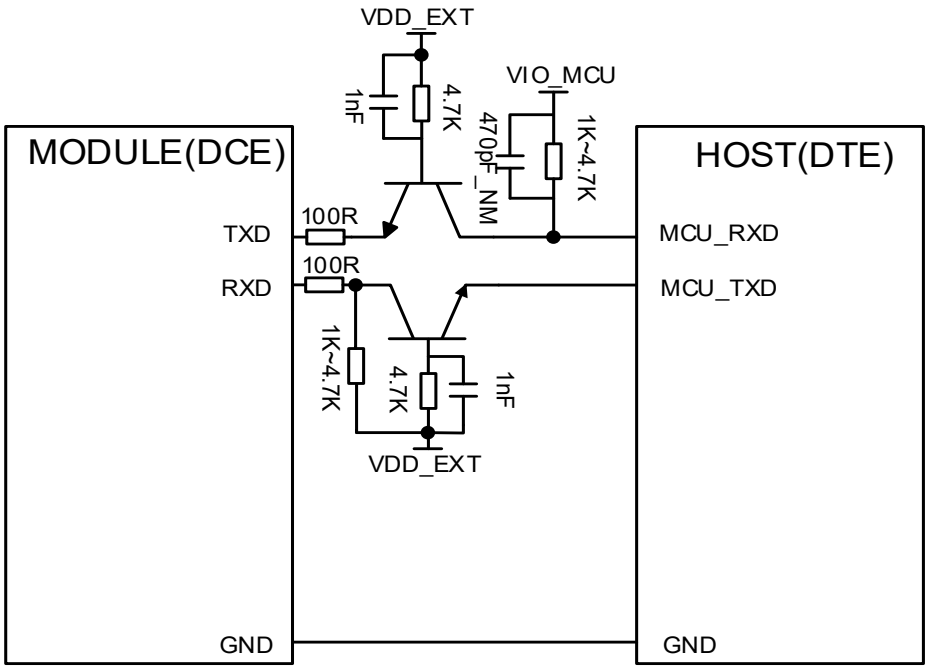


Figure 16: Triode Level Conversion Circuit

NOTE

1.After the module enters PSM, if the UART serial port is externally pulled up, it will cause continuous leakage. For customers who adopt the serial port direct connection design, it is recommended that after the module enters PSM, the MCU control should actively pull down the UART port of the module.
2. When the serial port levels do not match, it is recommended to use an integrated IC for level conversion. The transistor conversion circuit has a low rate and may cause data transmission failure.
3. It is recommended to connect a 100-ohm resistor between the TXD and RXD pins near the module end to prevent damage to the module pins caused by static electricity or surges.

3.5.2 RI Description

The RI pin can be used as an interrupt to wake up the host. Normally, the RI pin outputs a high level. When a short message or URC report is received, the RI pin outputs a low level for 120ms (for short messages) or 60ms (for URC), and then returns to the high level state: the RI pin will output a low level.

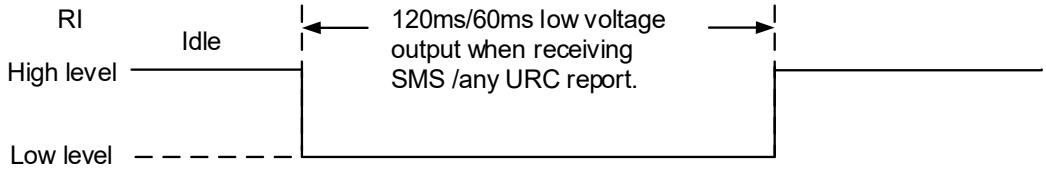


Figure 17: Level Change on RI (SMS，URC，Incoming Call)

3.6 ADC

The module provides one ADC interface, and the ADC detection range is 0 to 1.5V. The following are the main characteristics of the converter:

Table 18: ADC Interface Definition

PIN Name	PIN	I/O	Description	Comment
ADC	38	AI	General analog-to-digital converter channel	If unused, keep it open.

Table 19: ADC Electronic Characteristics

Characteristic	Min.	Typ.	Max.	Unit
Resolution	-	12	-	bits
input voltage range	0	-	1.5	mV
input impedance		Hi-Z		

To improve the sampling accuracy of the ADC, the following principles should be followed during PCB design:

- The ADC input signal line should be as short as possible to minimize signal attenuation.
- The wiring is designed to avoid high-frequency clock circuits, RF circuits and DCDC circuits, thereby reducing signal interference.
- The wiring should be kept away from other power signals and analog signals, and it is prohibited to run parallel with the signal lines of adjacent layers.
- The entire ADC wiring process requires proper signal isolation. Complete ground signal isolation should be ensured for both the same layer and adjacent layers.
- Uniform through-holes are evenly placed on both sides of the ADC wiring, which can reduce signal interference.
- The ADC circuit and wiring are kept away from high-power heat-generating components, thereby reducing the impact of temperature rise on the sampling accuracy of the ADC.

3.7 SIM Interface

The module supports SIM cards with voltages of 1.8V and 3.0V. The power supply for the SIM card interface is provided by the internal voltage regulator of the module. The normal voltage values are 3.0V or 1.8V.

Table 20: SIM Interface Definition

Pin Name	No.	Type	Description	Note
SIM_DATA*	15	DIO,PU	SIM data signal.	This pin has been pull-up with 4.7KΩ resistor to USIM_VDD internally.
SIM_RST	17	DO,PU	SIM reset signal.	-
SIM_CLK	16	DO,PU	SIM clock signal.	-
SIM_VDD	18	PO	SIM card power	The module can automatically identify 1.8V/3.0V SIM cards.

Table 21: SIM Electronic Characteristic in 1.8V Mode (V_{SIM_VDD} =1.8V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{SIM_VDD}	LDO power output voltage	1.62	1.8	1.98	V
V_{IH}	High-level input voltage	0.7* V_{SIM_VDD}	-	V_{SIM_VDD} +0.4	V
V_{IL}	Low-level input voltage	-0.4	0	0.25* V_{SIM_VDD}	V
V_{OH}	High-level output voltage	V_{SIM_VDD} -0.4	-	V_{SIM_VDD}	V
V_{OL}	Low-level output voltage	0	0	0.2	V

Table 22: SIM Electronic Characteristic in 3.0V Mode (V_{SIM_VDD} =3.0V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{SIM_VDD}	LDO power output voltage	2.7	3.0	3.3	V
V_{IH}	High-level input voltage	0.7* V_{SIM_VDD}	-	V_{SIM_VDD} +0.4	V
V_{IL}	Low-level input voltage	-0.4	0	0.25* V_{SIM_VDD}	V
V_{OH}	High-level output voltage	V_{SIM_VDD} -0.45	-	V_{SIM_VDD}	V
V_{OL}	Low-level output voltage	0	0	0.3	V

3.7.1 SIM Card Reference Design

The SIM interface is susceptible to external electrostatic interference. Appropriate TVS devices should be placed near the external SIM card slot for electrostatic protection. The recommended TVS model is ESD9L5.0ST5G.

The reference circuit is shown in the following figure.

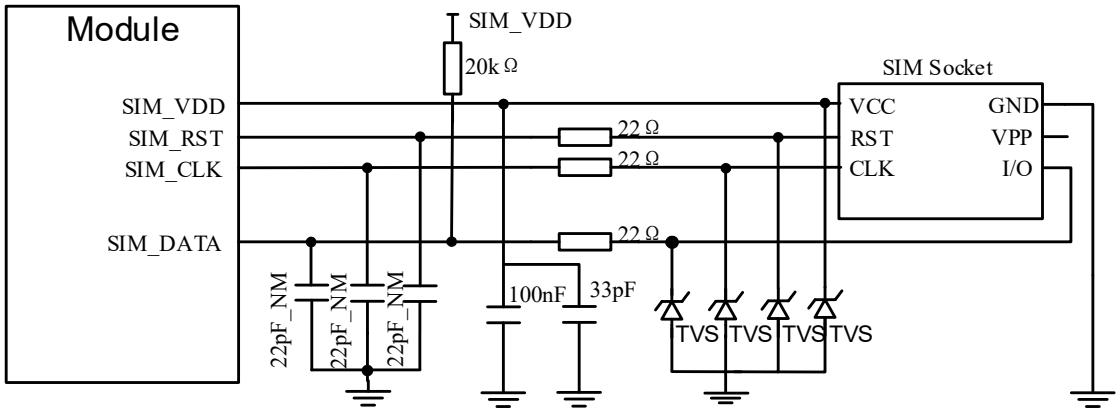


Figure 18: SIM Interface Reference Circuit

NOTE

1. SIM_DATA must be connected to SIM_VDD via a 20KΩ pull-up resistor.
2. The 100nF decoupling capacitor on the SIM_VDD should be retained as per the recommendation.

3.7.2 SIM Card Signal Wiring Guideline

The SIM card circuit is prone to interference, which may lead to card unrecognition or card drop issues. Therefore, when designing, please follow the following principles:

- During the PCB layout stage, it is essential to ensure that the SIM card slot is kept away from the main antenna.
- The SIM card wiring should be kept as far away as possible from the RF lines, VBAT lines and high-speed signal lines. At the same time, the SIM card wiring should not be too long.
- The GND of the SIM card slot should be well connected to the GND of the module, ensuring that the GND potentials of both are the same.
- To prevent SIM_CLK from interfering with other signals, it is recommended that SIM_CLK be protected by being encapsulated in a separate package.
- It is recommended to place a 100nF capacitor near the SIM card slot on the SIM_VDD signal line.

- Place the TVS near the SIM card slot. The parasitic capacitance of this TVS should not exceed 33pF. For example, ESD9L5.0ST5G.
- Connecting a 22Ω resistor in series between the SIM card slot and the module can enhance the ESD protection performance.
- To ensure the smoothest wiring, it is recommended to use a single-channel TVS and place the various pins close to the socket.
- The SIM_CLK signal is of great significance. Customers must ensure that the rising and falling edges of the SIM_CLK signal are shorter than 40ns; otherwise, there may be problems such as card recognition failures..

3.8 I2C

The module provides a set of hardware I2C protocol interfaces, supporting standard mode at 100 Kbps and high-speed mode at 400 Kbps.

The I2C reference circuit is shown below:

Table 23: I2C Interface Pins Definition

Pin Name	No.	Type	Description	Note
I2C_SCL	65	DO	I2C clock output	If unused, keep it open. A 4.7 kΩ pull-up resistor to VDD_EXT is required during use.
I2C_SDA	64	OD	I2C data IO	

The I2C interface uses open-drain outputs. Please refer to the schematic below for the recommended circuit.

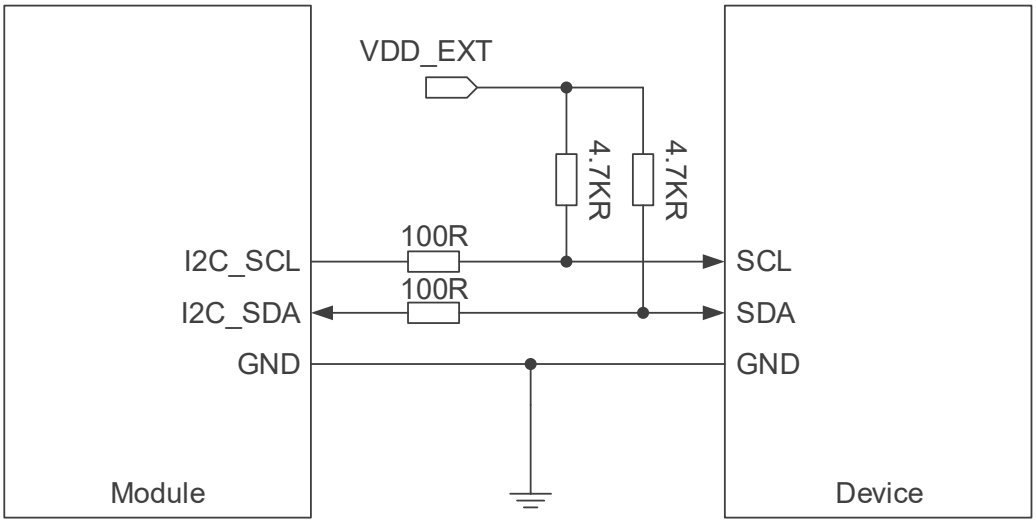


Figure 19: I2C reference circuit

NOTE

1. The SCL and SDA pins require pull-up resistors. The pull-up power supply must be the VDD_EXT output of the module..
2.It is recommended to connect a 100Ω resistor in series on the I2C signal line near the module end, which can reduce the overshoot phenomenon on the signal line.

3.9 SPI

The module supports a set of 4-bit (MISO, MOSI, CS, CLK) SPI interfaces, and also supports both SPI master mode and SPI slave mode. Its configurable clock frequency can reach up to 25.6 MHz.

Table 24: SPI Interface Pins Definition

Pin Name	No.	Type	Description	Note
SPI_CLK	50	DO	SPI clock output	If unused, keep it open.
SPI_CS	48	DO	SPI chip select signal	
SPI_MOSI	49	DO	SPI bus output	
SPI_MISO	51	DI	SPI bus INtput	

The reference circuit for the main module is as follows:

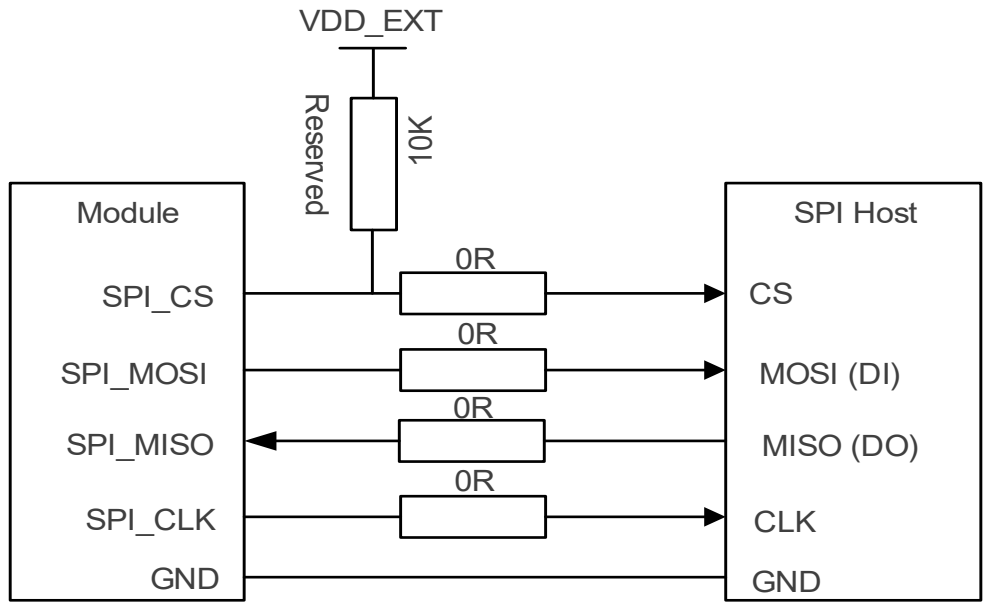


Figure 20: SPI Master Mode Reference Circuit

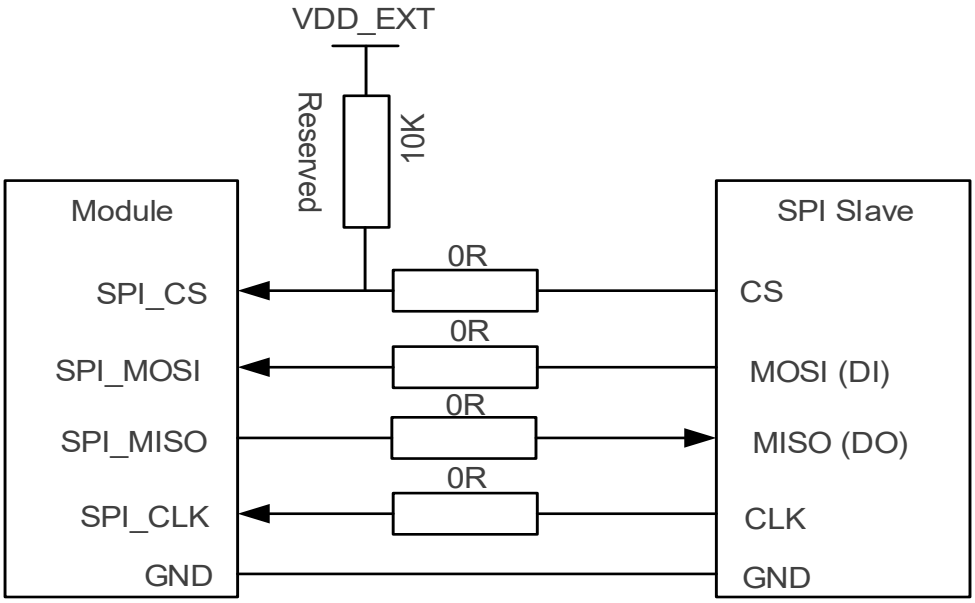


Figure 21: SPI originates from the mode reference circuit

3.10 NETLIGHT Status Indication

The NETLIGHT pin is used to control Network Status LED, its reference circuit is shown in the following figure.

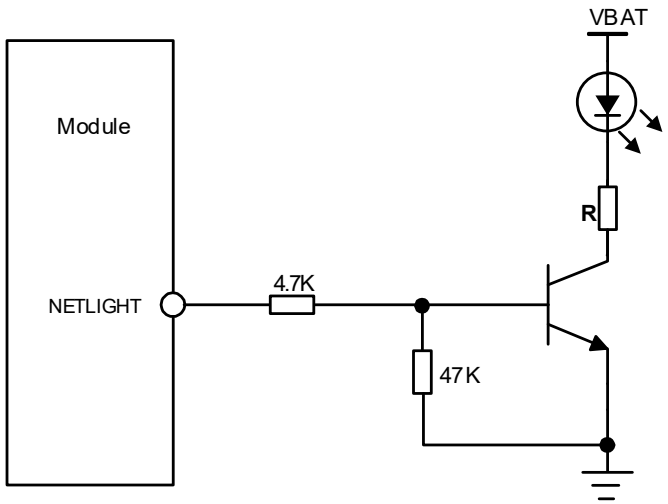


Figure 22: NETLIGHT reference circuit

Table 25: NETLIGHT operation Status

NETLIGHT status	Module status
Quick flashing 64ms/ 800ms	Search status
Slow flashing 64ms / 2000ms	Connected state
Extinguish	Enter power off/IDLE/PSM or other states

NOTE

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

3.11 GNSS

The E7080 is internally integrated with GNSS functionality and supports the NEMA-0183 ICOE Protocol standard. The E7080 combines GNSS (GPS/GLONASS/BEIDOU/GALILEO) satellite and network information, providing a highly available solution with industry-leading accuracy and performance. This solution performs well even in challenging environments where traditional GNSS receivers fail, and it provides a platform for wireless operators to handle location-based services and emergency tasks simultaneously.

The module offers a highly integrated, stable and reliable positioning solution. The relevant information of the module's GNSS is as follows.

- Supports GPS/GLONASS/BEIDOU/GALILEO navigation systems.
- The GNSS function is set to be disabled by default. To enable the GNSS and data transmission functions, you need to send the AT commands 'AT+CGNSSPWR=1' and 'AT+CGNSSTST=1'
- The customer only needs to complete the design of the GNSS antenna part. The transmission function has already been implemented within the module. The customer can directly obtain the data through the serial port interface.

Table 26: GNSS Interface Definition

Pin Name	No.	Type	Description	Note
GNSS_UART1_RXD	62	DI	GNSS Data Reception	The power domain is 3.0V.
GNSS_UART1_TXD	61	DO	GNSS Data Transmission	
1PPS*	60	DO	Pulse clock synchronization signal	The micro-pulse signal can be used for precise

				timing.
GNSS_ANT	68	AI	GNSS antenna	Antenna design refers to Chapter 4.5

The common instructions for GNSS are as shown in the table below.

Table 27: Common GNSS Commands List

指令	功能
AT+CGNSSPWR	=1 打开 GNSS 功能 =0 关闭 GNSS 功能
AT+CGNSSTST	=1 定位数据透传到 UART
AT+CGPSCOLD	冷启动 GPS
AT+CGPSWARM	温启动 GPS
AT+CGPSHOT	热启动 GPS
AT+CGPSINFO	获取 GPS 定位信息
AT+CGNSSINFO	获取 GNSS 定位信息

NOTE

1.E7080 (NB only) does not support GNSS function.
2.The current software does not support the 1PPS function by default. If you need to use the 1PPS function, please contact SIMCOM FAE to customize the software version.

4 RF Specifications

4.1 LTE RF Specifications

Table 28: LTE-NB Conducted transmission power

Frequency	Power	Min.
LTE-FDD B1	23 dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23 dBm +/-2.7dB	<-40dBm
LTE-FDD B5	23 dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23 dBm +/-2.7dB	<-40dBm
LTE-FDD B20	23 dBm +/-2.7dB	<-40dBm
LTE-FDD B28	23 dBm +/-2.7dB	<-40dBm

NOTE

The above maximum power values are single-tone test results. For multi-tone power test results, refer to 3GPP Maximum Power Back off Section.

Table 29: Maximum Power Reduction (MPR) for UE category NB1 Power Class 3

Modulation	QPSK		
Tone positions for 3 Tones allocation	0-2	3-5 and 6-8	9-11
MPR	≤ 0.5 dB	0.5 dB	≤ 0.5 dB
Tone positions for 6 Tones allocation	0-5	6-11	
MPR	≤ 1 dB	≤ 1 dB	
Tone positions for 12 Tones allocation	0-11		
MPR	≤ 2 dB		

Table 30: E-UTRA operating bands

E-UTRA	UL Freq.	DL Freq.	Duplex Mode
1	1920 ~1980 MHz	2110 ~2170 MHz	HD-FDD
3	1710 ~1785 MHz	1805 ~1880 MHz	HD-FDD
5	824 ~849 MHz	869 ~894 MHz	HD-FDD
8	880 ~915 MHz	925 ~960 MHz	HD-FDD
20	832 ~862 MHz	791 ~821 MHz	HD-FDD
28	703 ~748 MHz	758 ~803 MHz	HD-FDD

Table 31: CAT-NB Reference sensitivity

BAND	REFSENS (dBm) 3GPP Request	REFSENS Typical (dBm)
1	-108.2	-115
3	-108.2	-114.5
5	-108.2	-116
8	-108.2	-116
20	-108.2	-116
28	-108.2	-116

4.2 LTE Antenna Design Guide

Please refer to the following table for the recommended antenna design requirements.

Table 32: LTE Antenna Requirements

Parameter	Requirement
operating band	See table 34 and table 35
Direction	Omni Directional
Gain	> -3dBi (Avg)
Input impedance	50 ohm
Efficiency	> 50 %
Maximum input power	50W
VSWR	< 2
Isolation	>20dB
PCB insertion loss(<1GHz)	<0.5dB
PCB insertion loss(1GHz~2.2GHz)	<1dB
PCB insertion loss(2.3GHz~2.7GHz)	<1.5dB

4.3 GNSS Radio Frequency Parameters

Table 33: GNSS operating frequency

Type	Frequency
GPS L1	1575.42±1.023MHz
GLONASS L1	1601.7±6.75MHz
BeiDou BiI	1561.098±2.046MHz
GALILEO E1	1575.42±1.023MHz

Table 34: GNSS Performance Table (Typical Values)

@-130dBm		GPS	GPS+Gal	GPS+GLO	GPS+BD
C/N0		42	TBD	43/42	43/42
Tracking (dbm)		-168	TBD	-167	-167
Re-acquisition (dbm)		-159	TBD	-159.5	-159.5
Autonomous (dbm)		-149	TBD	-149	-149
TTFF /s	Cold start	≤20s@-130dB	TBD	≤19s@-130dBm	≤20s@-130dBm
		≤26s@-140dBm	TBD	≤24s@-140dBm	≤29s@-140dBm
	Hot start	≤0.7s@-130dBm	TBD	≤0.6s@-130dBm	≤0.6s@-130dBm
		≤0.7s@-140dBm	TBD	≤0.6s@-140dBm	≤0.6s@-140dBm
	Warm start	≤20s@-130dBm	TBD	≤19s@-130dBm	≤20s@-130dBm
		≤20s@-140dBm	TBD	≤19s@-140dBm	≤20s@-140dBm

Table 35: Main characteristics of GNSS

Parameter	Description	Performance			
		Min	Type	Max	Unit
Horizontal Position Accuracy[1]	Automatic position	-	1	-	m
Velocity Accuracy[2]	Without Aid	-	0.1	-	m/s
Timing Accuracy	RMS	-	20	-	ns
Dynamic Performance	Maximum Altitude	-	-	18000	m
	Maximum Velocity	-	-	500	m/s
	Maximum Acceleration	-	-	4	G
Receiver	Channels	-	L1:64	-	-
	Update rate	-	1	10	Hz
	Protocol support	NMEA-0183, PAIR Protocol			

4.4 Requirements for GNSS Antenna

Table 36: GNSS antenna requirements

Passive	Recommended standard
Operating band	L1: 1559~1609MHZ
Direction	Hemisphere, face to sky
Input impedance	50 ohm
Maximum input power	50W
VSWR	<2
Plan category	RHCP or Linear
Passive antenna gain	0dBi
Active antenna gain	-2dBi
Active antenna noise figure	<1.5
Built-in antenna LNA gain	20dB(Typ.)
Total antenna gain	<18 dB
Coaxial insertion loss	<1.5dB

NOTE

If an active antenna is used, an additional power supply is required for the antenna. The GNSS_ANT of E7080 does not provide power. If a passive antenna is used, it is recommended to add an LNA to improve performance.

4.5 LTE/GNSS Antenna Reference Design

4.5.1 Passive Antenna for LTE/GNSS

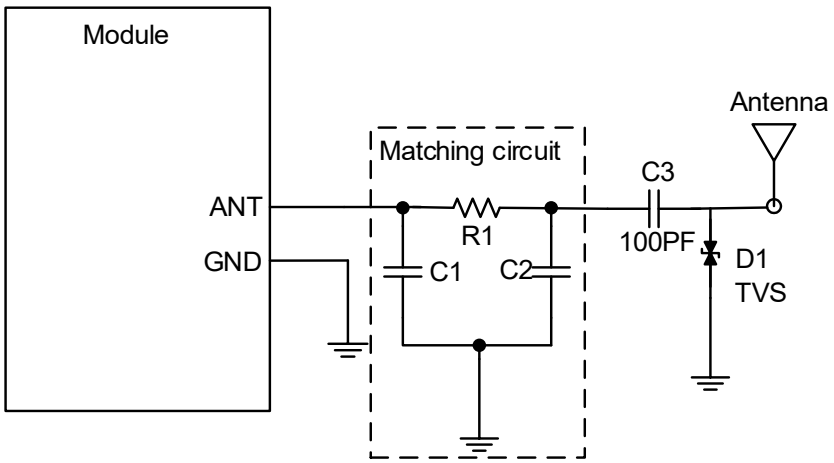


Figure 23: Passive antenna reference circuit

The matching circuit R1 is set to default 0Ω. C1 and C2 are reserved in their default positions. Their specific values are determined by antenna optimization and are usually provided by the antenna manufacturer.

The antenna port is highly prone to electrostatic interference. To prevent the internal components of the module from being damaged by static electricity, C3 defaults to attaching a 100pF capacitor to enhance the ESD protection capability. D1 suggests selecting appropriate bidirectional TVS protection devices and placing them close to the antenna, especially paying attention to the influence of the TVS junction capacitance value on the RF signal. The recommended TVS models are as follows:

Table 37: Recommended TVS model for RF antenna

No.	Vendor	Device	V_{RWM}	V_C(max)	Ppp(max)	C_J(Typ.)	Package
1	BILLSEMI	BLE5V0CR05UB	5V	40V	NA	0.05pF	DFN1006-2

Table 38: Recommended TVS model for GNSS antenna

No.	Vendor	Device	V_{RWM}	V_C(max)	Ppp(max)	C_J(max)	Package
1	WAYON	WE05DGCF-B	5V	23V	70W	0.3pF	DFN1006-2

4.5.2 GNSS Active Antenna Reference

If the GNSS uses an active antenna, an external LDO power supply is required. The design can be carried out according to the diagram below.

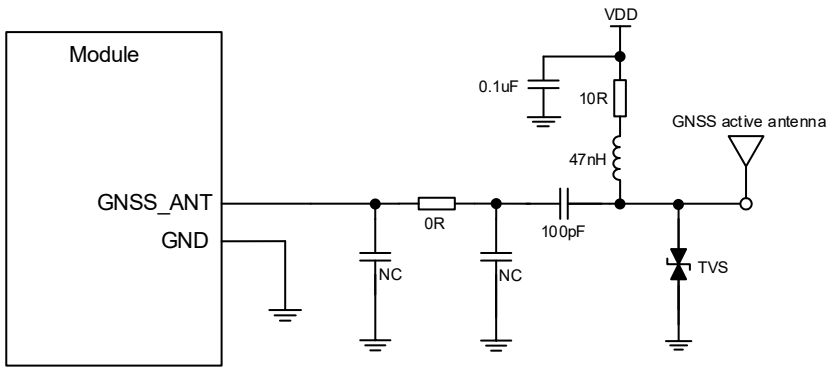


Figure 24: Active antenna reference circuit

NOTE

1.GNSS is set to be disabled by default, but it can be enabled via an instruction.
2.GNSS adopts an active antenna design by default, with a 100pF blocking capacitor connected in series. For customers using a passive antenna solution, it is recommended to disconnect the power supply path to prevent damage to the module caused by using a passive antenna.
3.There may be parallel inductors at the internal antenna of the module, which may exhibit a short-circuit-like phenomenon. This is a normal occurrence. If you have any doubts, please consult the SIMCOM FAE.

4.6 PCB Routing Design

When making PCB traces, users should pay attention to the impedance design of the connection between the module's ANT port and the antenna mounting PCB trace, maintaining a 50Ω impedance. The trace length is recommended to be within 20mm and should be kept away from interference signals such as power and clock.

If using IPEX connectors for impedance control, it is necessary to ensure that the projection area is hollowed out and there is a layer reference.

If using SMA connectors for impedance control, it is necessary to ensure that the edge of the RF signal pad and the GND copper foil are at least 1.2mm apart.

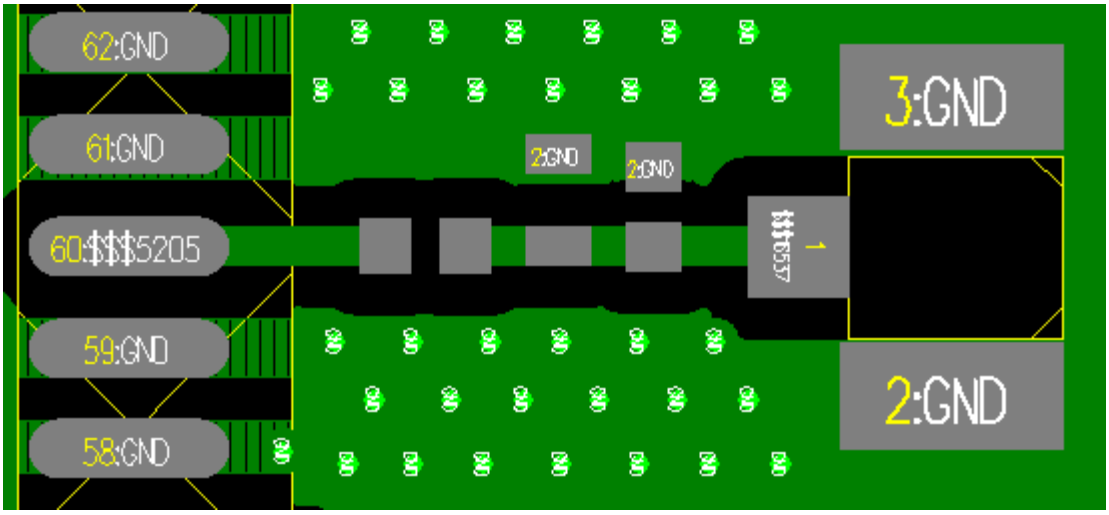


Figure 25: IPEX reference for PCB traces

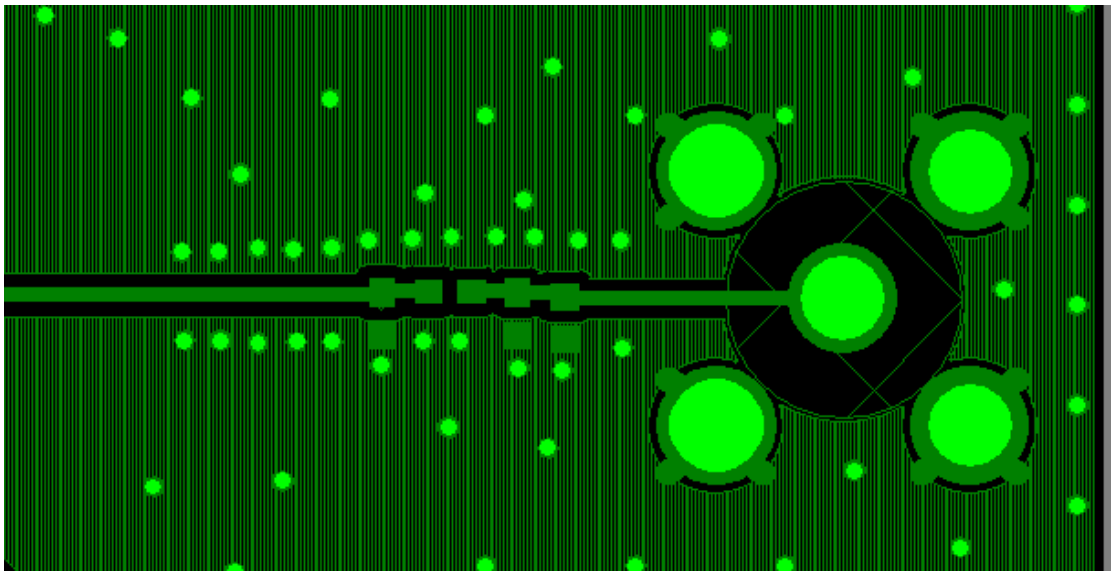


Figure 26: SMA reference for PCB traces

5 Electrical Specifications

5.1 Limit parameters

The table below shows the absolute maximum values under abnormal operating conditions. Exceeding these limits may cause permanent damage to the module.

Table 39: Absolute maximum rating

Parameter	Min.	Typ.	Max.	Unit
Voltage on VBAT	-0.3	3.6	5.0	V
Voltage at digital pins (GPIO,UART,RESET,I2C)	-0.3	-	3.6	V
RST,WAKEUP.SIM	-0.3	-	3.6	V
ADC	-0.3	-	3.6	V

NOTE

Data is based on the maximum voltage that the pin level can withstand when the module is powered on but not turned on. If these limit values are exceeded, the module leakage current will increase or the module will be permanently damaged. When VBAT is not powered on, it is prohibited to provide voltage on other PIN pins (such as IO, ADC), otherwise it will cause cross-current or damage the module.

5.2 Operating Condition

Table 40: Recommended Operating Rating

Parameter		Min.	Typ.	Max.	Unit
VBAT Voltage	E7080(NB only)	2.1	3.6	4.5	V
	E7080	3.0	3.6	4.5	V

Table 41: Digital I/O Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit
V_{IH}	High-level input voltage	0.7* VDD_EXT	-	-	V
V_{IL}	Low-level input voltage	-	-	0.2* VDD_EXT	V
V_{OH}	High-level output voltage	0.8* VDD_EXT	-	-	V
V_{OL}	Low-level output voltage	-	-	0.15* VDD_EXT	V

Table 42: Operating Temperature

Parameter	Min.	Typ.	Max.	Unit
Normal operation temperature	-35	25	+75	℃
Extended operation temperature*	-40	25	+85	℃
Storage temperature	-45	25	+90	℃

NOTE

Performance may deviate slightly from the 3GPP specification when the module operating temperature is outside of the normal operating temperature range and the module RF performance will again meet the 3GPP specification when the temperature returns to the normal operating temperature range.

5.3 Operating Mode

5.3.1 Operating Mode Definition

The table below briefly introduces the various working modes that will be mentioned in the subsequent chapters.

Table 43: Operating mode Definition

Mode Function		Definition
Working status	Active	Without turning on the low power mode, the system is in a cyclic waiting state with high power consumption. All functions are normally available and data can be sent and received; the module can switch to Idle mode or PSM mode in this mode.

	Idle	The module is in a light sleep state, the network stays connected, and any interruption can wake up the system. Idle mode can receive paging messages; the module can be switched to Active mode or PSM mode in Idle mode.
	PSM	The module is in power saving mode, the CPU is powered down, only RTC works internally; the network is in non-connected state, unable to receive downlink data; in this mode, the module can wake up to exit from PSM mode and enter into Active mode through the pre-set RTC timer or AT command.

5.3.2 Enhanced Discontinuous Reception (e-DRX)

Enhanced Discontinuous Reception (e-DRX) is based on Discontinuous Reception (DRX) and aims to reduce the system standby power consumption by reducing the number of paging calls to and from the network and extending the time interval between paging calls to and from the network.

If e-DRX is supported on the network side, the module can turn on this function by AT command "AT+CEDRXS".

NOTE

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

5.3.3 Power Saving Mode (PSM)

The module can set PSM function by sending commans, when the condition is satisfied, the module will enter PSM mode automatically. The main purpose of PSM is to reduce the power consumption of the module, and prolong the power supply time of the battery.

The module enters the PSM as follows: when the module establishes a connection with the network side or a Tracking Area Update (TAU), the module applies for entry into the PSM in a request message, and the network side configures the T3324 timer value to be returned to the module in an answer message and starts the reachable timer. When the T3324 timer times out, the module enters the PSM. the module cannot request to enter the PSM when it is connecting for an emergency service or when it is initializing the public data network.

When the module is in PSM mode, it shuts down most of the connectivity activities, including stopping the search for cell messages, cell reselection, etc. However, the T3412 timer (associated with periodic TAU updates) continues to operate.

After the reachable timer times out, the network side will not be able to page the module until the next time the module starts the network presence program or TAU.

There are two ways for the module to exit the PSM, one is when the DTE actively sends uplink data and the module exits the PSM, and the other is when the TAU is activated after the T3412 timer times out and the module exits the PSM.

The power consumption of the module in different operating modes is shown below.

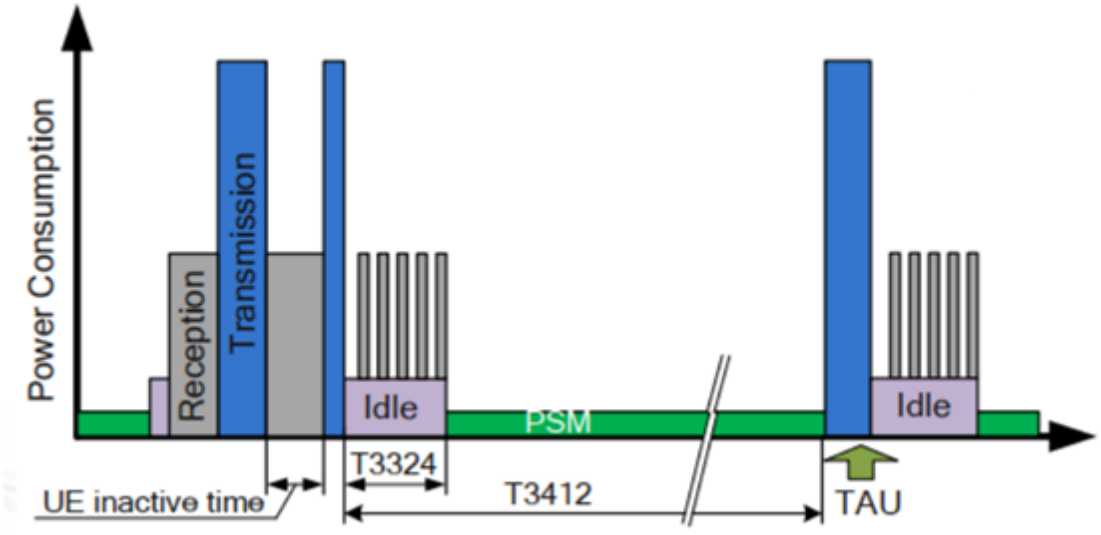


Figure 27: PSM Process State Diagram

NOTE

For PSM test-related instructions, please refer to the AT instruction set.

5.3.4 Quit Power Saving Mode(PSM)

When the module enters PSM mode, it will terminate the network connection and will not be able to respond to user requests. If the user needs to send commands to the module through the serial port, it is necessary to wake up the module first and then send the corresponding AT commands.

Either of the following exits the module from the PSM:

- Wait for the network timer T3412 to time out before the module automatically exits the PSM mode
- Pull down the WAKEUP pin to wake up the module. The module is woken up when the module checks that WAKEUP presents a low level.
- Pull down the RESET pin to wake up the module. At this time, the module is equivalent to restarting, the module will re-register and find the network, and some of the information previously set for the module may be lost and need to be reset.

5.3.5 RTC Mode

The module supports RTC mode. User can set the command 'AT+CCLK? This command is used to record and track the real-time time. The query command returns the current time. The module supports functions such as alarm clock and timer in RTC mode, and can track or record the current date and time by sending AT commands. The module does not have an independent standby RTC power supply, and the RTC logic requires the VBAT power supply to generate an RTC clock for the PMU. Therefore, do not disable the VBAT power supply. When the module is disconnected or in sleep mode, as long as the correct power supply is connected to VBAT, the module can still enter RTC mode.

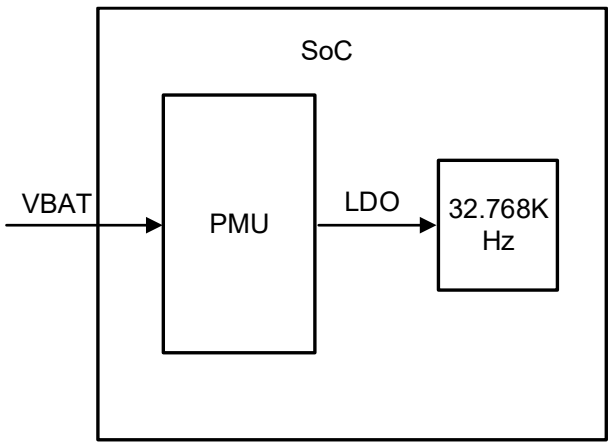


Figure 28: RTC block diagram

Table 44: RTC related parameters

Operating Conditions	RTC Time Accuracy
VBAT=3.6V	+/-1 s within 24H(Typical)

5.4 Current Consumption

Table 45: Current consumption on VBAT Pins (VBAT=3.6V)

Idle Mode	
DRX Mode Consumption	@standby 1.28s (DRX=1.28s) Typical: 1.7mA
	@standby 2.56s (DRX=2.56s) Typical: 1.5mA
Power SavingMode	
PSM supply current	PSM mode Typical: 2.1 uA
e-DRX	
e-DRX mode supply current (Measured in sleep mode)	@PTW=40.96s, eDRX =81.92s, DRX=2.56s , Typical：78 uA
	@PTW=25.6s, eDRX=163.84s, DRX=2.56s, typical：45 uA

Table 46: RF data transmission current consumption

LTE Cat-NB Data transmission	
LTE-FDD B1	@23dbm Typical：117 mA @10dbm Typical：42 mA @0dbm Typical： 27 mA
LTE-FDD B3	@23dbm Typical：99 mA @10dbm Typical：39 mA @0dbm Typical： 20 mA
LTE-FDD B5	@23dbm Typical：97 mA @10dbm Typical：28 mA @0dbm Typical： 18 mA
LTE-FDD B8	@23dbm Typical：100 mA @10dbm Typical：29 mA @0dbm Typical： 18 mA
LTE-FDD B20	@23dbm Typical：100 mA @10dbm Typical：28 mA @0dbm Typical： 19 mA
LTE-FDD B28	@23dbm Typical：94 mA @10dbm Typical：27 mA @0dbm Typical： 18 mA

5.4.1 GNSS Operating Power Consumption

Table 47: VBAT power consumption during GNSS operation

Mode	Positioning system	Condition	Typical value (mA)
GNSS signal generator	GPS	-130dBm/Tracking	30
		-145dBm/Tracking	31
		-130dBm/ Cold start	31
		-145dBm/ Cold start	38
	GPS+BD	-130dBm/Tracking	33
		-145dBm/Tracking	33
		-130dBm/ Cold start	38
		-145dBm/ Cold start	42
	GPS+GLONASS+BD	-130dBm/Tracking	32
		-145dBm/Tracking	34
		-130dBm/ Cold start	36
		-145dBm/ Cold start	38
Actual network passive antenna	GPS	Acquisition	40
		Tracking	32
	GPS+BD	Acquisition	44
		Tracking	42
	GPS+GLONASS+BD	Acquisition	40
		Tracking	33

NOTE

1.The actual network testing conditions should be in an Open Sky environment, with an average value of Top6-CN0 greater than 40 dB.
2. The listed real-world power consumption values do not include the power consumption of the active antenna.

5.5 Electrostatic Protection

The module is an electrostatic-sensitive device, so users must pay attention to electrostatic protection when manufacturing, assembling and operating the module. The electrostatic performance parameters of the module are as follows:

Table 48: The ESD performance measurement table (Temperature: 25℃, Humidity: 45%.)

Part	Contact discharge	Air discharge
VBAT,GND	+/-4 kV	+/-8 kV
Antenna port	+/-4 kV	+/-8 kV
Other pins	+/-0.5 kV	+/-1 kV

NOTE

The data in table above were tested using SIMCom EVB.

6 Manufacturing

6.1 Top and Bottom View

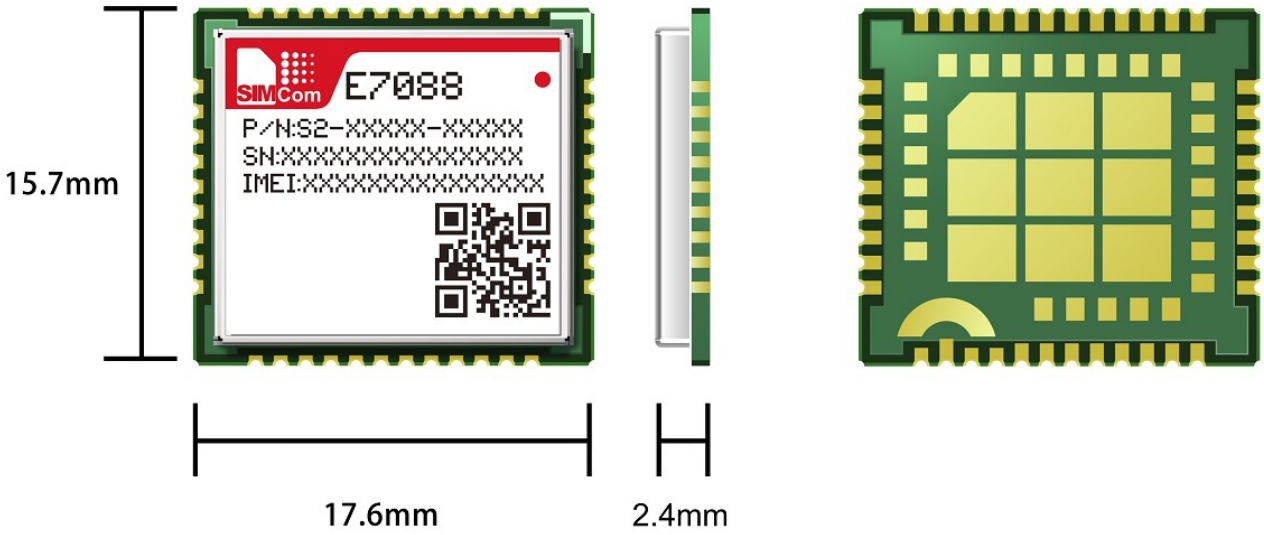


Figure 29: Top and Bottom View

NOTE

The schematic is for reference only, please refer to the actual picture.

6.2 Label Description Information

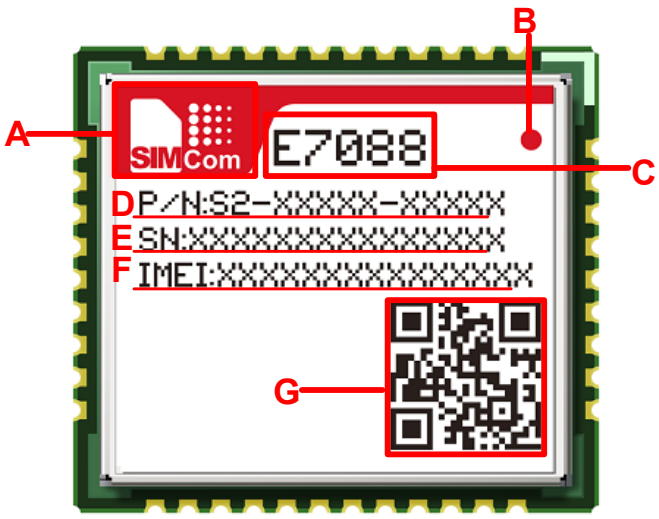


Figure 30: Label information

Table 49: The description of label information

No.	Description
A	LOGO
B	No.1 Pin
C	Project Name
D	Product Code
E	Serial Number
F	International Mobile Equipment Identity
G	QR code

6.3 Moisture Sensitivity Level and Storage conditions

The modules are shipped in vacuum-sealed aluminum foil pouch bags, vacuum packed according to the IPC/JEDEC standard implementation J-STD-020C specification.

- Recommended storage conditions: 23°C±5°C and relative humidity: 35% to 60%.
- Storage period: 12 months (Under recommended storage conditions and in sealed vacuum packaging).

The module meets the humidity sensitivity level 3 (MSL-3), and the storage period after unpacking is shown in table below.

The out-of-bag floor life of the module with MSL-3 is 168 hours. If the workshop temperature is 23℃±5℃ and the relative humidity is less than 60%, the module needs to be unpacked within 168 hours of reflux production or other high temperature operations. Otherwise, the module shall be stored in an environment with relative humidity less than 10% (for example, a moisture-proof cabinet) to keep the product dry.

Table 50: MSL Level

MSL	Out-of-bag floor life	Comment
1	Unlimited	≤+30℃/85% RH
2	1 year	≤+30℃/60% RH
2a	4 weeks	
3	168 hours	
4	72 hours	
5	48 hours	
5a	24 hours	
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.	

Before use, it is necessary to confirm whether the package is in good condition; After unpacking, check the status of humidity indicator card in vacuum bag. The module needs to be baked before use if any of the following conditions occur.

- Explanation Humidity indicator card: 30%, 40%, and 50% of any indicator circle has discolouring
- The module has been un-packed and the module exceeds the humidity sensitivity level corresponding to the exposed workshop time. For example, MSL=3 is 168.
- Packed，but the Shelf Life exceeds 12 months；
- Exceeds the Floor Life；
- Unable to track and determine the status of the module;

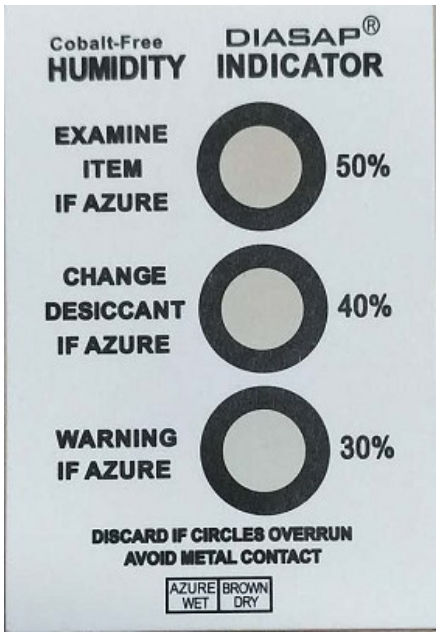


Figure 31: Humidity card

The following conditions also need to be pre-baked.

- The storage temperature and humidity do not meet the recommended storage conditions.
- Vacuum sealed bag leak, bulk materials.
- Before repairing the module.
- After unpacking, the module failed to complete production or storage under the control of humidity sensitive level 3.

6.4 Baking Requirements

If baking is required, proceed according to the requirements in the table below. Preferentially choose a nitrogen-filled oven.

Table 51: Baking requirements

Baking conditions	Baking time	Comment
120°C±5°C, <5% RH	8 hours	Not applicable to original packaging pallets

NOTE

- In order to prevent and reduce the occurrence of poor welding caused by moisture, such as foaming and delamination, the module should be strictly controlled. It is not recommended to expose the module to air for a long time after unpacking the vacuum package。
- Before baking, it is necessary to remove the module from the package and place the bare module on the high temperature resistant device to avoid high temperature damage to the plastic tray or coil; The modules for secondary baking must be welded within 24 hours after baking, otherwise they need to be stored in vacuum packaging or in a drying oven.
- Please pay attention to ESD protection when unpacking and placing modules, such as wearing anti-static gloves.

6.5 Recommended reflow furnace temperature curve

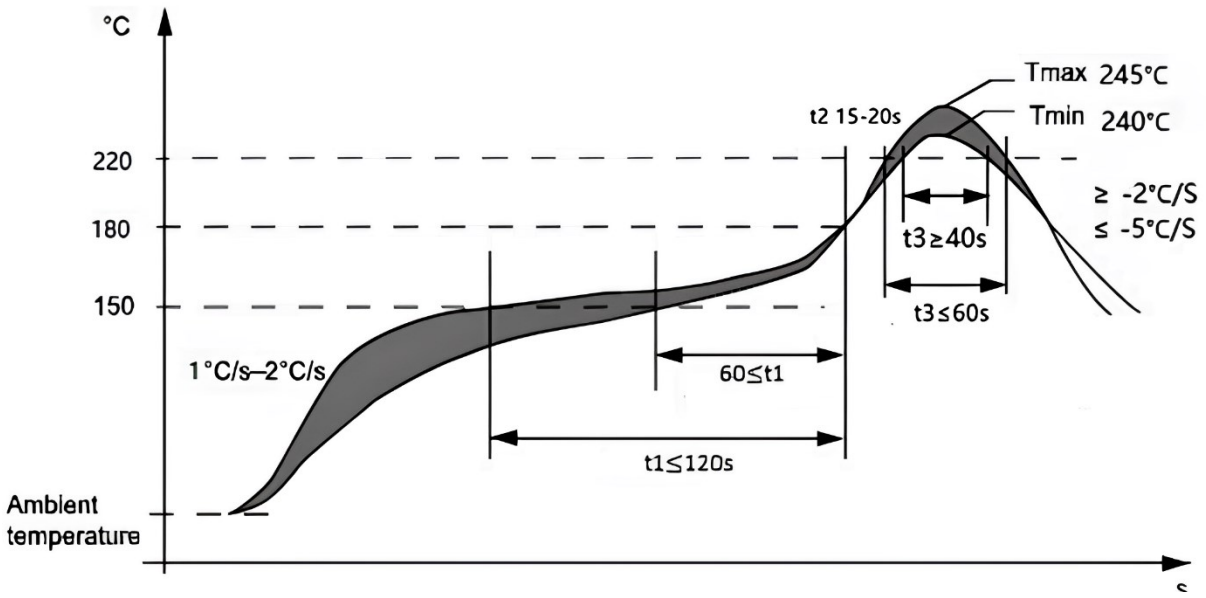


Figure 32: Recommended reflow furnace temperature curve (lead-free)

Table 52: The main board reflux temperature curve requirements (lead-free)

Zone	Time	Parameter
Preheat Zone (Room temperature~150℃)	NA	Heating rate: 1~2℃/s
T1 (150~180℃)	60~120s	/
T2 (180~220℃)	15~20s	/
T3 (≥220℃)	40~60s	Peak temperature: 240~245℃
Cooling Zone	NA	Cooling rate: -2~-5℃/s

NOTE

- The maximum times of refluxes for the module is once.
- Recommended lead-free process.
- In the table above, the temperature testing location includes the solder mask of the module MCU pins, bottom LGA pins, and external LCC pins.
- The actual welding temperature is affected by other external factors, such as the presence of furnace carriers, solder paste, size and thickness of the substrate, and component resistance. Thermal requirements and panel design, etc. Please confirm with our engineering and technical personnel in time if the recommended parameters cannot be reached. Otherwise, the module may be damaged.
- For boards with thickness less than 1.2mm, it is recommended to use board supported by furnace carrier or high Tg to prevent warping and PCB when heated. Deformation, thus affecting module welding. For modules larger than 35.0 mm *35.0 mm and 5G products, it is recommended to use the furnace carrier to pass through the furnace to reduce the cause of the bottom plate and mold. Due to the difference of Tg value of block, the phenomenon of unbalanced thermal stress appears in the process of high temperature welding reflow, resulting in the defect rate of virtual welding and little tin.
- After the module is welded, X-ray and optical inspection methods shall be used to check the welding quality. For specific standards, please refer to relevant standards of IPC-A-610H.
- For more information about shipping and manufacturing, please refer to *Module Secondary SMT Process User Guide.*
- Due to the complexity of the SMT process, in case of uncertainty or processes not mentioned in this document (such as selective wave soldering, ultrasonic welding), please contact SIMCom support team before SMT process starts.

6.6 Recommended PCB Package Size

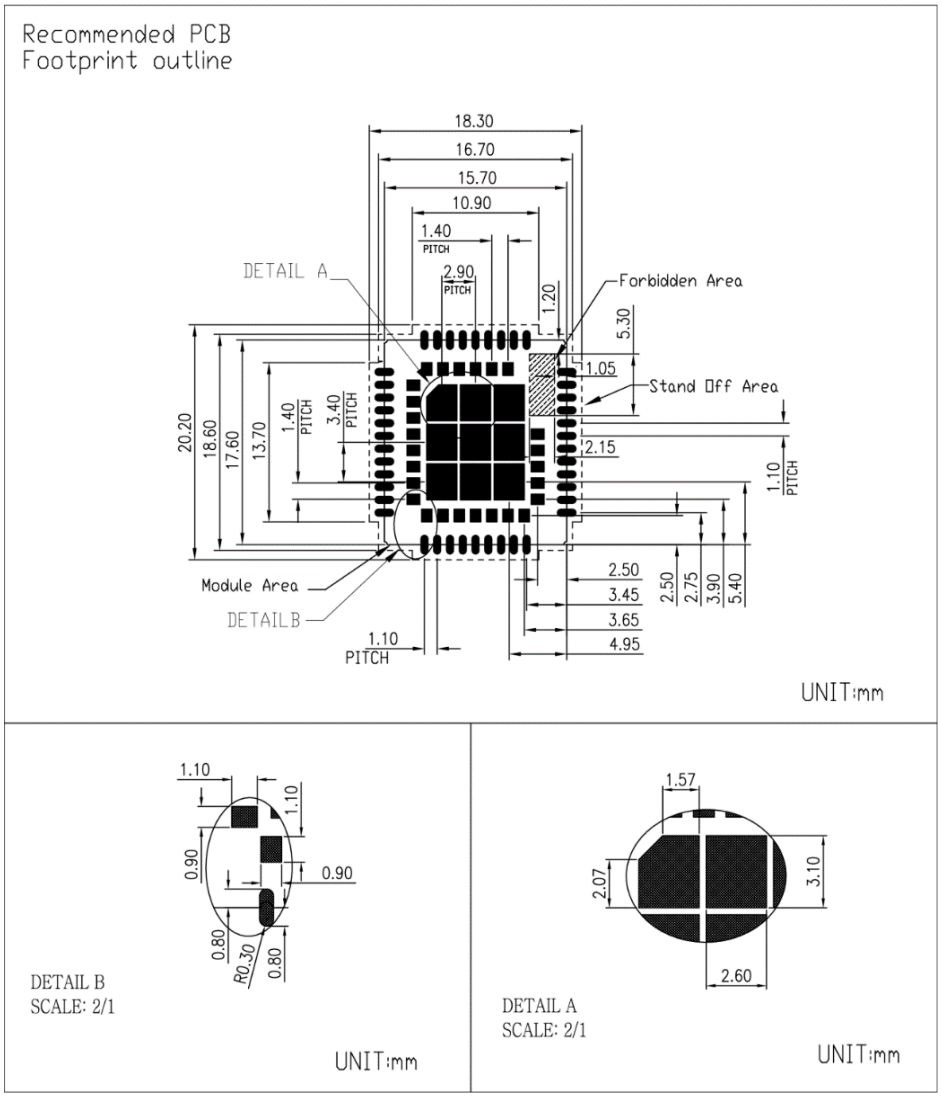


Figure 33: Recommended PCB package size (unit: mm)

6.7 Recommended SMT Stencil

The recommended thickness of the steel mesh is 0.15mm.

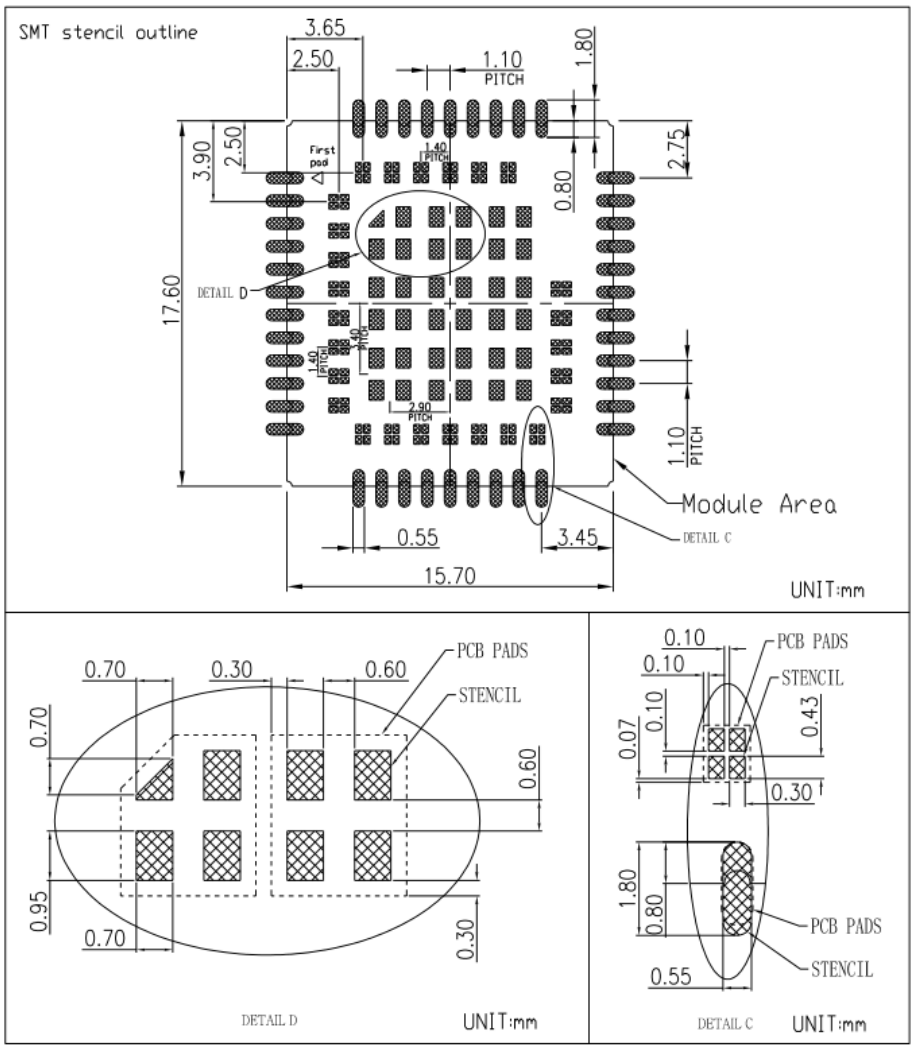


Figure 34: Steel mesh drawings are recommended (Unit: mm)

7 Packaging

The module support tray packaging.

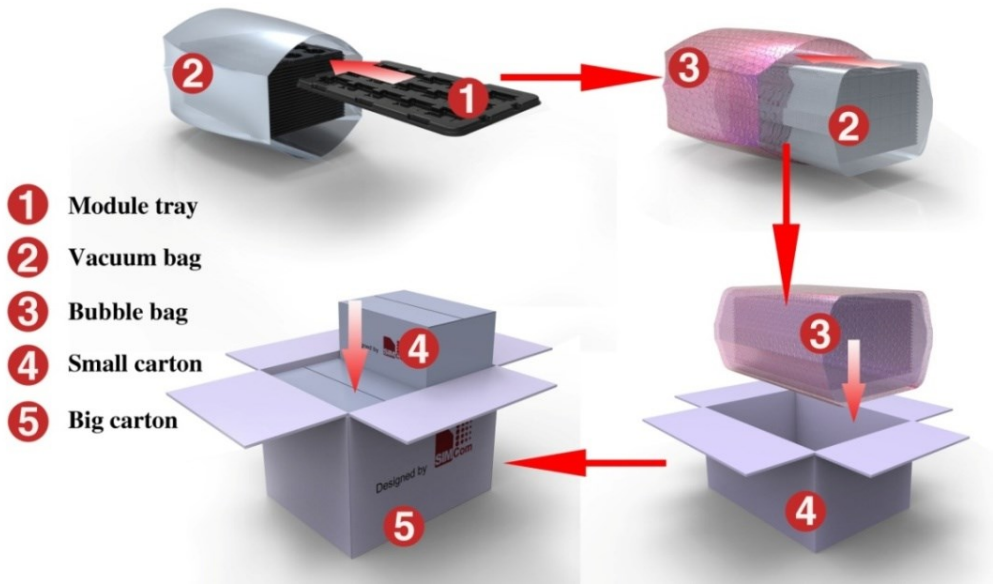


Figure 35: packaging diagram

Below is the size chart of the tray (Module tray):

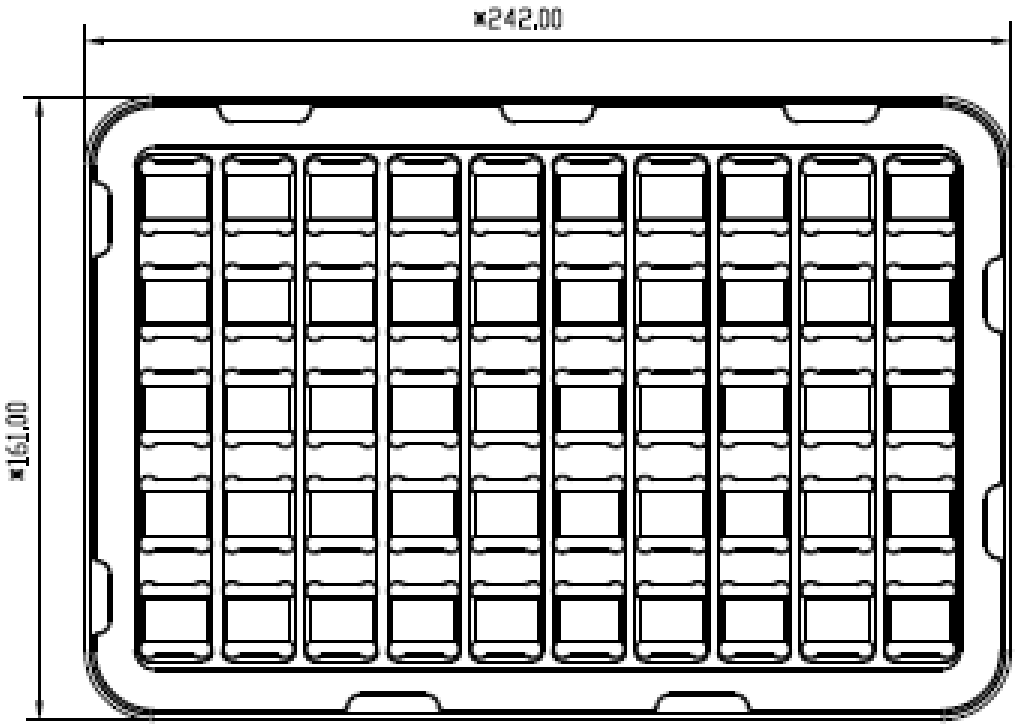


Figure 36: Tray drawing

Table 53: Tray size

Length（±3mm）	Width（±3mm）	Module number
242.0	161.0	50

Small carton drawing：

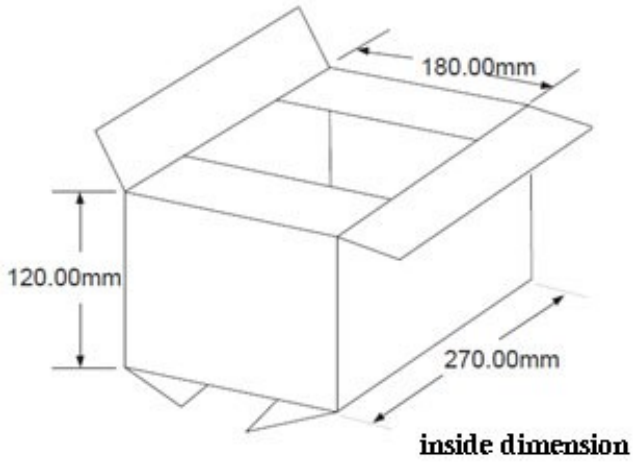


Figure 37: Small carton drawing

Table 54: Small Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Module number
270	180	120	50*20=1000

Big carton drawing：

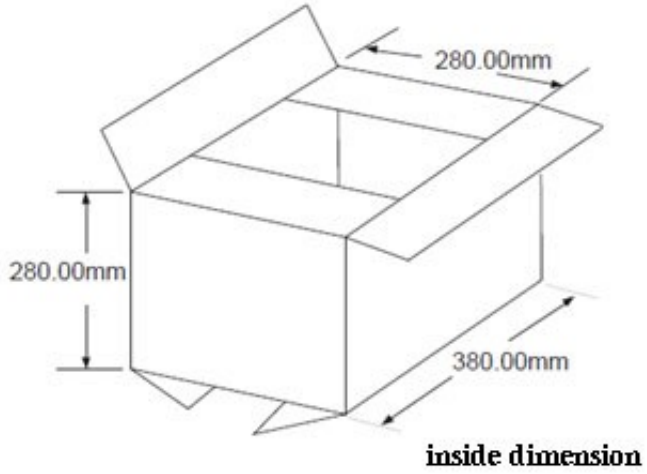


Figure 38: Big carton drawing

Table 55: Big Carton size

Length（±10mm）	Width（±10mm）	Height（±10mm）	Module number
380	280	280	1000*4=4000

8 Appendix

8.1 Related Documents

Table 56: Related Documents

NO.	Title	Description
[1]	E7080 Series AT Command ManualV1.xx	AT Command Manual
[2]	8EC000-E7080-TE_V1.01_SCH&PCB	TE User Manual
[3]	SIMCOM EVB Kit User Guide	EVB Kit User Manual
[4]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[5]	3GPP TS 38.401	NG-RAN: Architecture Description
[6]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[7]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[8]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[9]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[10]	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
[11]	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
[12]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[13]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[14]	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)
[15]	3GPP TS 38.101	NR Radio Transmission and Reception Technical Specifications
[16]	GCF-CC V3.23.1	Global Certification Forum - Certification Standards

8.2 Terms and Abbreviations

Table 57: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
ARP	Antenna Reference Point
BER	Bit Error Rate
BD	BeiDou
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
DAM	Downloadable Application Module
DPO	Dynamic Power Optimization
DRX	Discontinuous Reception
e-DRX	Extended Discontinuous Reception
EFR	Enhanced Full Rate
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
GPS	Global Positioning System
HR	Half Rate
HSPA	High Speed Packet Access
I2C	Inter-Integrated Circuit
IMEI	International Mobile Equipment Identity

LTE	Long Term Evolution
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
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
SMPS	Switched-mode power supply
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
UART	Universal Asynchronous Receiver & Transmitter
VSWR	Voltage Standing Wave Ratio
SM	SIM phonebook
NC	Not connect
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
ZIF	Zero intermediate frequency
SIM	Universal subscriber identity module
UMTS	Universal mobile telecommunications system
UART	Universal asynchronous receiver transmitter
PSM	Power saving mode
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ON	SIM (or ME) own numbers (MSISDNs) list
RC	Mobile Equipment list of received calls
SM	SIM phonebook
NC	Not connect

8.3 Safety Caution

Pay attention to the following safety precautions when using or repairing any terminal or mobile phone containing modules. The user should be informed of the following security information on the terminal device. Otherwise, SIMCom will not be liable for any consequences arising from the user's failure to act on these warnings.

Table 58: 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.