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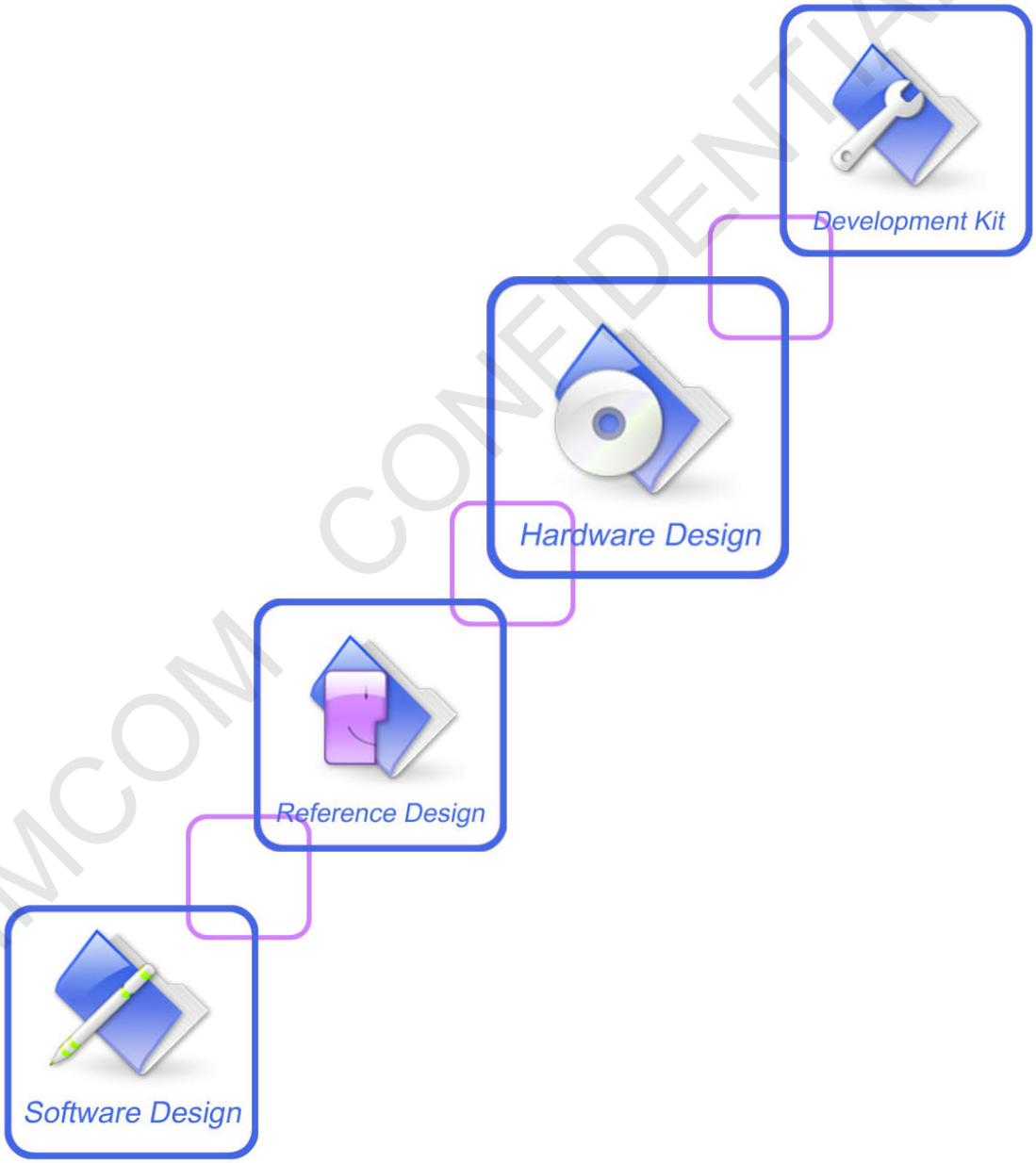
SIM7500JE-B2B_Hardware Design_V1.01



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Revision History

Data	Version	Description of change	Author
2016-10-11	1.00	Original	Zhang Xiaojun
2016-12-26	1.01	Modify VBUS Minimum Voltage from 3.6V to 3.0V Modify Table 12, Table 13 and Table 12, Modify Figure 20 Add the Figure of product label	Zhang Xiaojun

1 Introduction

This document describes electronic specifications, RF specifications, function interface, mechanical characteristic and testing conclusions of the SIMCom SIM7500JE-B2B module. With the help of this document and other SIM7500JE-B2B software application notes, user guides, customers can understand and use SIM7500JE-B2B module to design and develop applications quickly.

1.1 Product Outline

In this document, the entire radio band configuration of SIM7500JE-B2B series is described in the following table.

Table 1: SIM7500JE-B2B series frequency bands

Standard	Frequency	SIM7500JE-B2B
LTE-FDD	BAND 1	✓
	BAND 3	✓
	BAND 8	✓
Category		CAT 1
GNSS		✓

With a tiny configuration of 47.5*36.2*6.7 mm and integrated functions, SIM7500JE-B2B can meet almost any space requirement in customers' application, such as industrial handhelds, machine-to-machine, vehicle applications, etc..

The SIM7500JE-B2B provides RF and GNSS antenna interface with antenna connector. The antenna connector is U.FL-LP（V）-040 ,vended by HRS

There are 80 pins on SIM7500JE-B2B, which provide most application interfaces for customers' board.

1.2 Hardware Interface Overview

The physical interface to the mobile application is integrated into an 80 pins board-to-board connector, which provides all hardware interfaces between the module and customers' boards except the RF antenna interface. Sub-interfaces are described in detail in the next chapter, which includes:

- **Power Supply**
- **USB Interface**
- **Serial Interface**
- **Analog Audio Interfaces**
- **SIM Interface**
- **ADC**
- **Sink Current Source**
- **I2C Interface**

1.3 Hardware Diagram

The block diagram of the SIM7500JE-B2B Embedded module is described in the Figure 1.

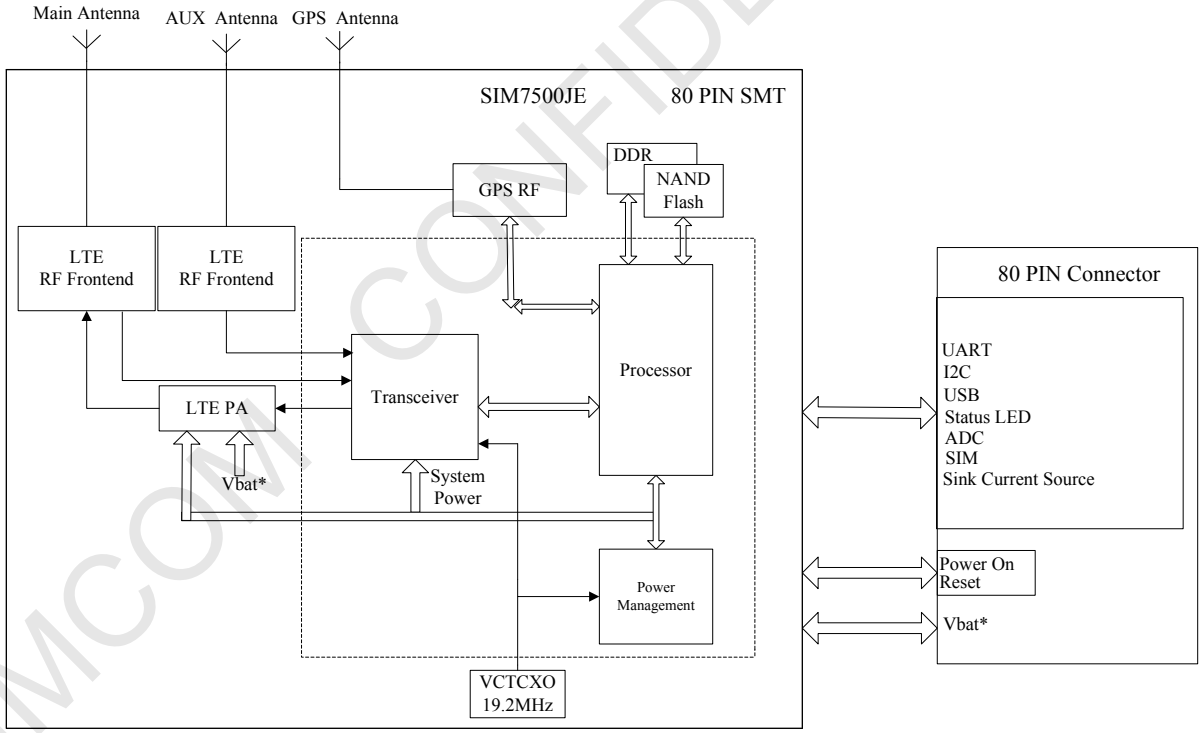

Figure 1: SIM7500JE-B2B functional architecture

1.4 Functional Overview

Table 2: General Feature

Feature	Implementation
Power supply	Single supply voltage 3.4～4.2V
Transmission data	● LTE Category 1: 10 Mbps (DL) ● LTE Category 1: 5 Mbps (UL)
GNSS	● Mobile-Assisted mode ● Mobile-based mode ● Standalone mode
SMS	● MT, MO, CB, Text and PDU mode ● SMS storage: SIM card ● Support transmission of SMS alternatively over CSD or GPRS. Customers can choose preferred mode.
SIM interface	Support identity card: 1.8V, 3V.
Serial interface	● Serial Port standard or null modem mode on Serial Port Interface ● Serial Port can be used to control module by sending AT command
USB	Support USB2.0 Slave mode
Phonebook management	Support phonebook types: SM, FD, LD, RC, ON, MC.
SIM application toolkit	Support SAT class 3, GSM 11.14 Release 98 Support USAT
Timer function	Programmable by AT command
Physical characteristics	Size: 47.5*36.2*6.7mm Weight:8.8g
Firmware upgrade	Firmware upgrade over USB interface
Temperature range	● Operation temperature: -30°C to +80°C ● Storage temperature :-40°C to +85°C ● Storage temperature :-45°C to +90°C

2 Package Information

2.1 Pin Configuration

All hardware interfaces which connect SIM7500JE-B2B to customers' application platform are integrated into 80 pins Board-to-Board Connector.

Table 3: Board-to-Board Connector pin description

Pin No.	Define	Pin No.	Define
1	VBAT	80	GND
2	VBAT	79	GND
3	VBAT	78	GND
4	VBAT	77	GND
5	VBAT	76	GND
6	VBAT	75	GND
7	VBAT	74	GND
8	VBAT	73	GND
9	NC	72	NC
10	NC	71	STATUS
11	CURRENT_SINK	70	NC
12	NC	69	NC
13	ADC	68	NETLIGHT
14	NC	67	NC
15	V_BATTERY	66	FLIGHTMODE
16	V_BATTERY	65	I2C_SCL
17	V_BATTERY	64	I2C_SDA
18	NC	63	UART_RTS
19	NC	62	UART_CTS
20	NC	61	UART_RXD
21	NC	60	UART_RI
22	NC	59	UART_DCD
23	NC	58	UART_TXD
24	GND	57	UART_DTR
25	NC	56	GND
26	NC	55	NC

27	USIM_RESET	54	NC
28	USIM_CLK	53	NC
29	USIM_DATA	52	NC
30	V_USIM	51	USB_DP
31	POWER_ON	50	USB_DM
32	GND	49	USB_VBUS
33	NC	48	GND
34	NC	47	RESET
35	NC	46	NC
36	NC	45	NC
37	NC	44	NC
38	NC	43	NC
39	GND	42	GND
40	GND	41	GND

2.2 Pin description

Table 4: Pin description

Pin name	I/O	Description	Comment
Power Supply			
VBAT		Power supply voltage	
GND		Ground	
V_BATTERY		Connected with battery	If it is unused, keep open.
Power on/off			
POWER_ON	I	System power on/off control input, active low.	Default 0.8V
USIM interface			
V_USIM	O	Voltage Supply for SIM card Support 1.8V or 3V SIM card	All signals of SIM interface should be protected against ESD/EMC.
USIM_DATA	I/O	SIM Data Output/Input	
USIM_CLK	O	SIM Clock	
USIM_RESET	O	SIM Reset	
USB			
USB_VBUS	I	USB power supply input	They are compliant with the USB 2.0 specification. If it is unused, keep open.
USB_DP	I/O	Plus (+) line of the differential, bi-directional USB signal to/from the peripheral device.	

USB_DM	I/O	Minus (-) line of the differential, bi-directional USB signal to/from the peripheral device.	
Serial interface			
UART_RXD	I	Receive Data	UART_RXD has been pulled down with a 12kR resistor to ground in the module. If it is unused, keep open.
UART_TXD	O	Transmit Data	
UART_RTS	O	Request to send	
UART_CTS	I	Clear to Send	
UART_RI	O	Ring Indicator	
UART_DTR	I/O	DTE get ready	
UART_DCD	O	Carrier detects	
I2C interface			
I2C_SDA	I/O	I2C data	Pulled up with a 2.2kR resistor to 1.8V internally. If it is unused, keep open.
I2C_SCL	O	I2C clock output	
GPIOs			
NETLIGHT	O	Output PIN as LED control for network status.	If it is unused, keep open.
FLIGHTMODE	I	Input PIN as RF operating control.	
STATUS	O	Output PIN as operating status indicating of module.	
Other interface			
RESET	I	System reset control input, active low.	RESET has been pulled up to 1.8V via a resistor internally.
CURRENT_SINK	I	Current source of ground-referenced current sink	Refer to 3.9.1
ADC	I	Analog Digital Converter Input	Refer to 3.9.3

2.3 Product label

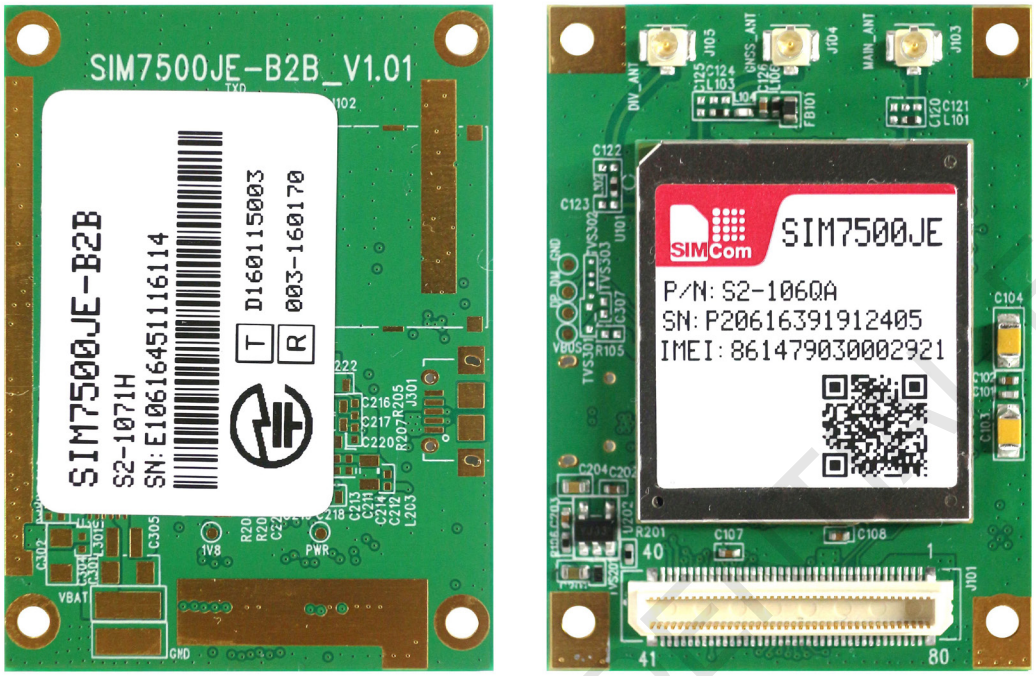

Figure 2: Product label

2.4 Package Dimensions

The following figure shows mechanical dimensions of SIM7500JE-B2B.

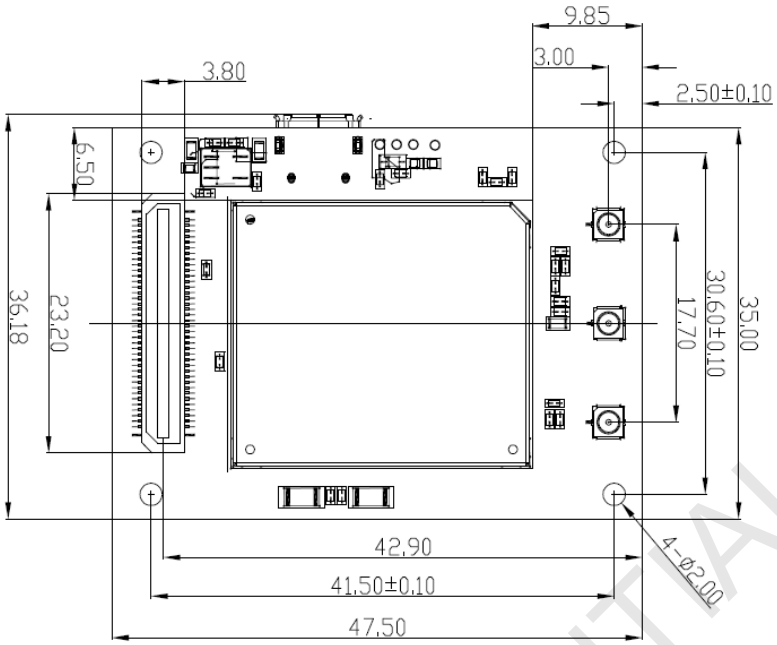

Figure 3: Top dimensions (Unit: mm)

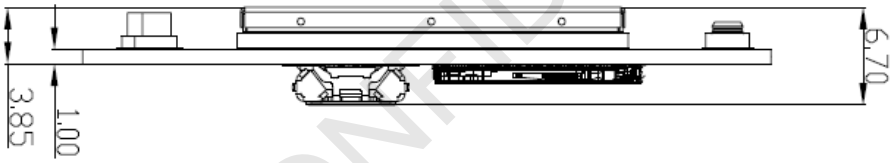

Figure 4: Side dimensions (Unit: mm)

2.5 Board-to-board connector

We recommend customers to adopt Panasonic AXK770247G as the board to board connector in their own PCB to connect with SIM7500JE-B2B. These high density SMT connectors are designed for parallel PCB-to-PCB applications. They are ideal for using in VCRs, notebook PCs, cordless telephones, mobile phones, audio/visual and other telecommunications equipment where reduced size and weight are important.

Following are parameters of Panasonic AXK580147YG for more details, customers can login http://industrial.panasonic.com/ac/e/ for more information.

NOTE：The height of Mated height is 3.0mm.

Mechanical dimensions of the Panasonic 80pin connector

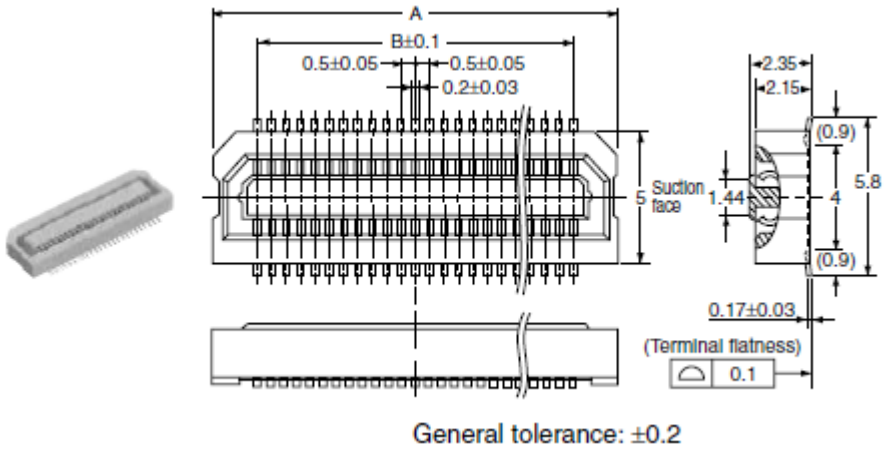

Figure 5: Panasonic AXK580147YG board-to-board connector pin side

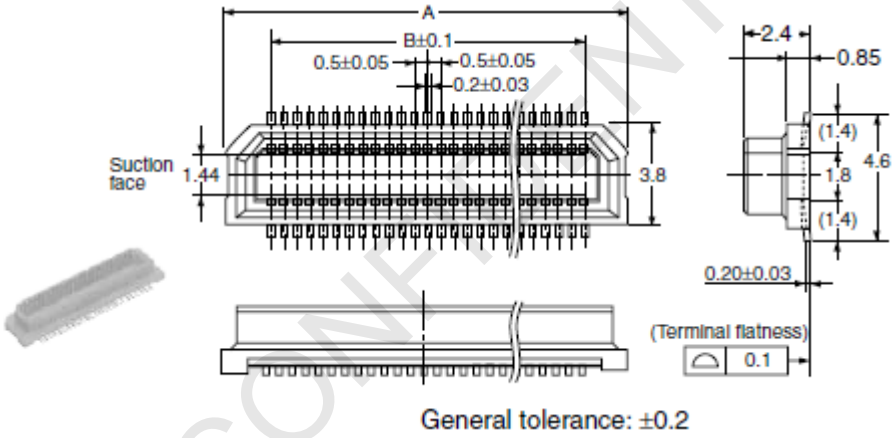

Figure 6: Panasonic AXK680347YG board-to-board connector pin side

NOTE：The connector AXK680347YG is used in SIM7500JE-B2B side and AXK580147YG is used in pin side (host board side).

2.6 RF connector and adapter cable

The RF connector in the module side is an ultra small surface mount coaxial connector (Part Number: U.FL-R-SMT, vended by HRS). It has high performance with wide frequency range, surface mountable and reflows solderable. Following are parameters (Figure 7). Certainly customer can visit http://www.hirose-connectors.com/ for more information.

To get good RF performance in customers' design, SIMCom suggests customer to use the matching RF adapter cable which is also supplied by HRS (Part Number: U.FL-LP（V）-040), the following figure (Figure 8) is the dimensions of U.FL series RF adapter cable. Customers can contact SIMCom for more information.

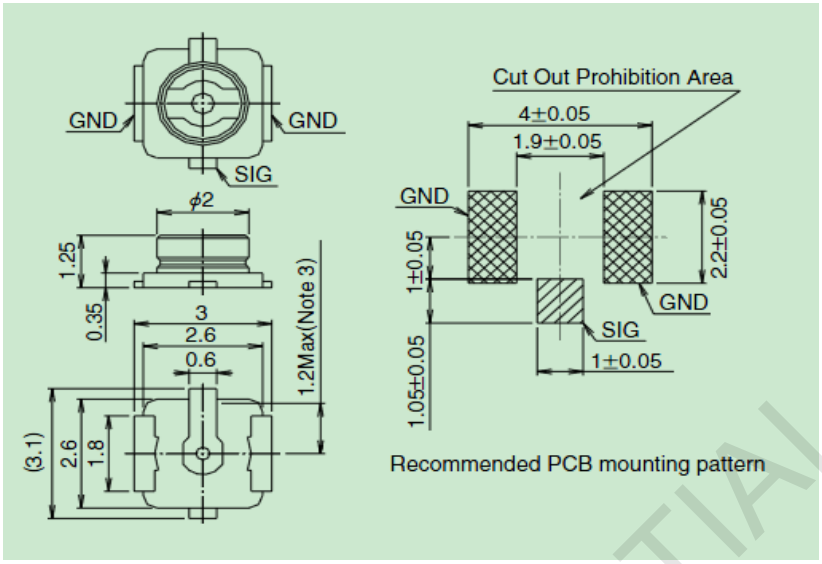

Figure 7: U.FL-R-SMT (Unit: mm)

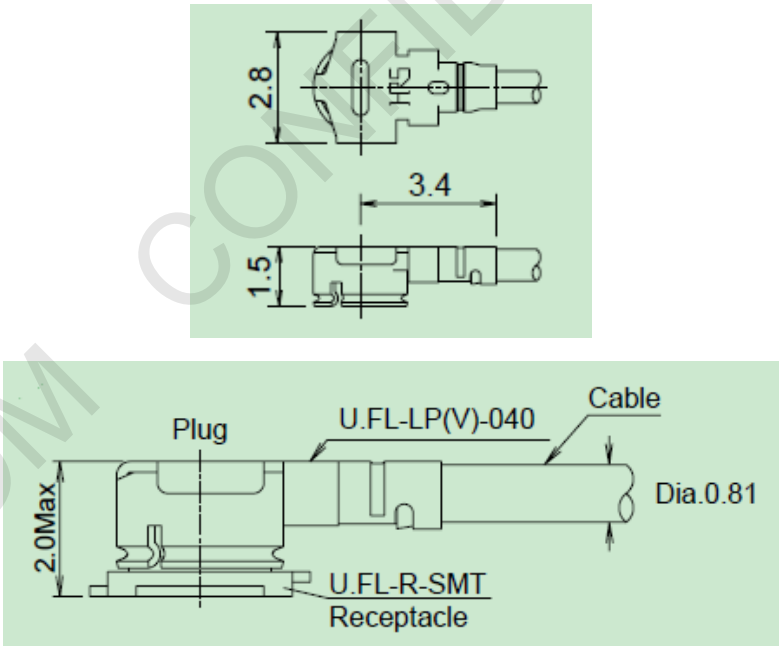

Figure 8: U.FL series RF adapter cable (Unit: mm)

3 Application Interface Specification

3.1 Power Supply

Make sure that the voltage on the VBAT pins will never drop below 3.4V.

Table 5: VBAT Pins electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
VBAT	Module power voltage	3.4	3.8	4.2	V
$I_{VBAT(peak)}$	Module power peak current in normal mode.	1.0	-	A	A
$I_{VBAT(average)}$	Module power average current in normal mode	Please refer to the table 34			
$I_{VBAT(sleep)}$	Power supply current in sleep mode				
$I_{VBAT(power-off)}$	Module power current in power off mode.	-	-	20	uA

3.1.1 Design Guide

Mostly, customers connect the VBAT pins with one power supply. Make sure that the input voltage at the VBAT pin will never drop below 3.4V even during high power transmitting when the current consumption rises up to 1A. If the power voltage drops below 3.3V, the module may be shut down automatically. Using a large tantalum capacitor (above 100uF) will be the best way to reduce the voltage drops. If the power current cannot support up to more than 1A, customers must introduce larger capacitor (typical 1000uF) to storage electric power.

For the consideration of RF performance and system stability, another large capacitor (above 100uF) should be located at the VBAT pin and some multi-layer ceramic chip (MLCC) capacitors (0.1uF) need to be used for EMC because of their low ESR in high frequencies. Note that capacitors should be put beside VBAT pins as close as possible. Also customers should minimize the PCB trace impedance from the power supply to the VBAT pins through widening the trace to 80 mil or more on the board.

There are three sections about how to design and optimize users' power systems.

3.1.2 Power supply Design Guide

We recommend DCDC or LDO is used for the power supply of the module, make sure that the peak current of power components can rise up to more than 1A. The following figure is the reference design of +5V input power supply. The designed output for the power supply is 4.1V, here a linear regulator can be used.

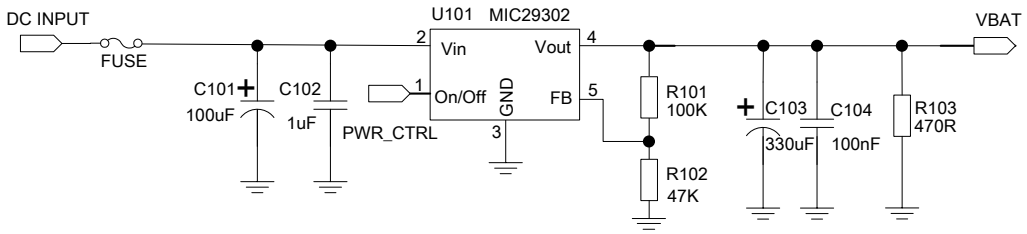

Figure 9: Reference circuit of the LDO power supply

If there is a big difference between the input voltage and the desired output (VBAT), a switching converter power will be preferable because of its better efficiency, especially at the high current situation. The following figure is the reference circuit. Note that DCDC may deprave RF performance because of ripple current intrinsically.

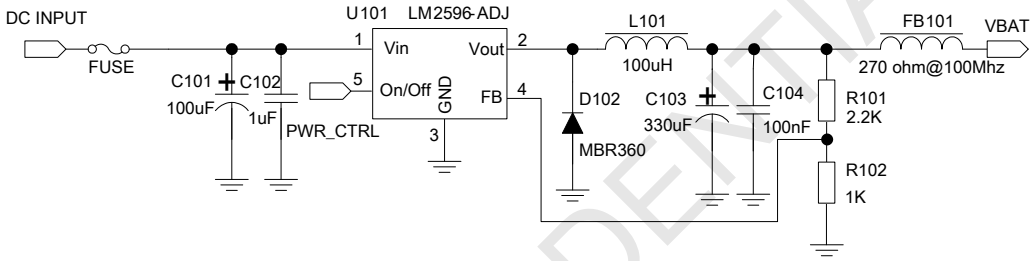

Figure 10: Reference circuit of the DCDC power supply

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 under-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 under-voltage power-off function.
Note: Under-voltage warning function and under-voltage power-off function are disabled by default. For more information about these AT commands, please refer to Document [1].

3.2 Power on/Power off/Reset Function

3.2.1 Power on

Module can be powered on by pulling the PWRKEY pin down to ground.
The PWRKEY pin has been pulled up to dVDD internally, so you does not need to pull it up externally. It is strongly recommended to put a100nF capacitor and an ESD protection diode close to the PWRKEY pin. Please refer to the following figure for the recommended reference circuit.

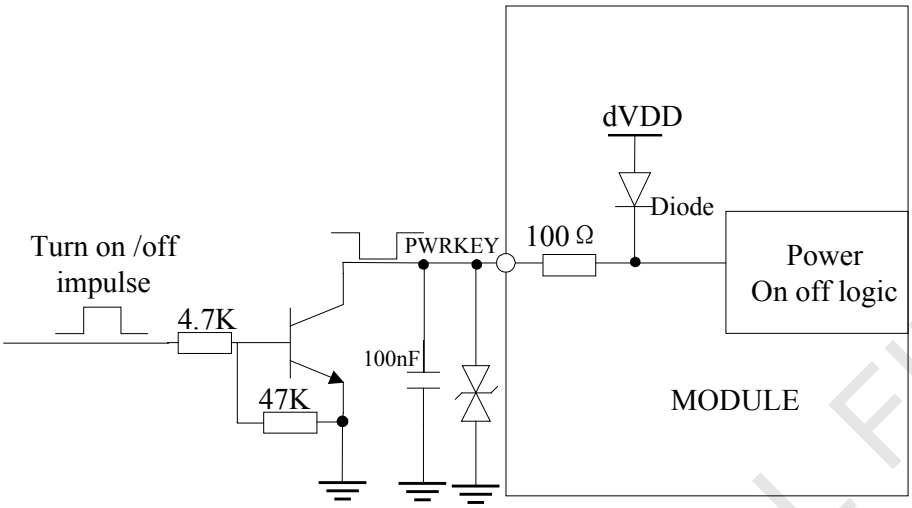

Figure 11: Reference Power on/off Circuit

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

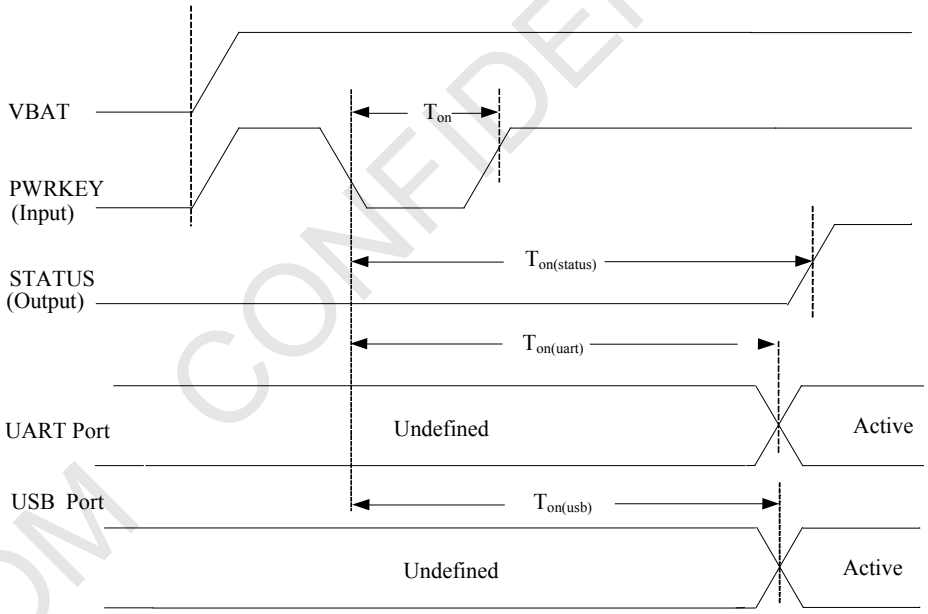

Figure 12: Power on timing sequence

Table 6: Power on timing and electronic characteristic

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{on}	The time of active low level impulse of PWRKEY pin to power on module	100	500	-	ms
$T_{on(status)}$	The time from power-on issue to STATUS pin output high level(indicating power up ready)	12	13	-	s

$T_{on(uart)}$	The time from power-on issue to UART port ready	11	12		s
$T_{on(usb)}$	The time from power-on issue to USB port ready	11	12		s
V_{IH}	Input high level voltage on PWRKEY pin	0.6	0.8	1.8	V
V_{IL}	Input low level voltage on PWRKEY pin	-0.3	0	0.5	V

3.2.2 Power off

The following methods can be used to power off Module.

- Method 1: Power off Module by pulling the PWRKEY pin down to ground.
- Method 2: Power off Module by AT command "AT+CPOF".
- Method 3: Over-voltage or under-voltage automatic power off. The voltage range can be set by AT command "AT+CPMVT".
- Method 4: Over-temperature or under-temperature automatic power off.

Note: If the temperature is outside the range of -30~+80℃, some warning will be reported via AT port. If the temperature is outside the range of -40~+85℃, Module will be pow

For details about "AT+CPOF" and "AT+CPMVT", please refer to Document [1].

These procedures will make modules disconnect from the network and allow the software to enter a safe state and save data before modules are powered off completely.

The power off scenario by pulling down the PWRKEY pin is illustrated in the following figure.

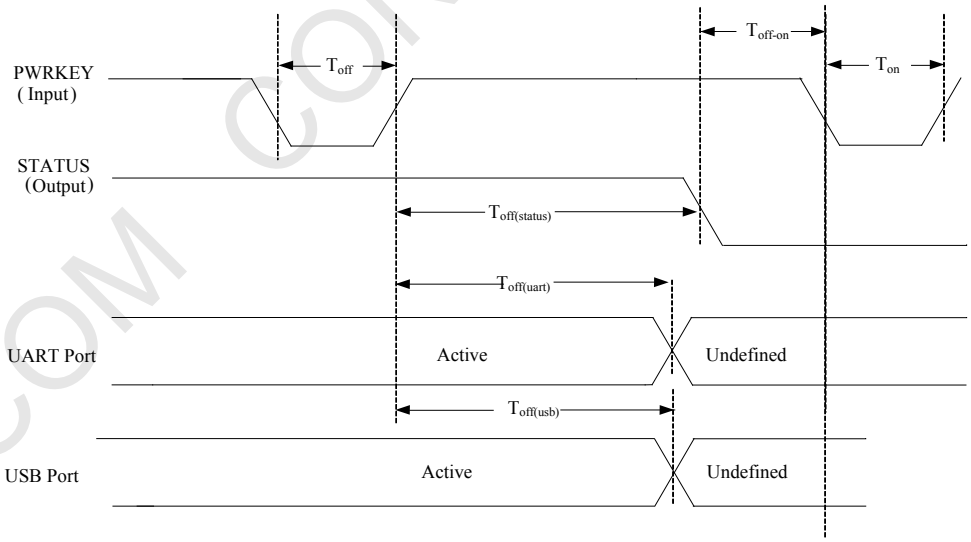

Figure 13: Power off timing sequence

Table 7: Power off timing and Electronic Characteristic

Symbol	Parameter	Time value			Unit
		Min.	Typ.	Max.	
T_{off}	The active low level time pulse on PWRKEY pin to power off module	2.5	--	--	s
$T_{off(status)}$	The time from power-off issue to STATUS pin output low level(indicating power off)*	25	26	-	s
$T_{off(uart)}$	The time from power-off issue to UART port off	14	15	-	s
$T_{off(usb)}$	The time from power-off issue to USB port off	27	28	-	s
T_{off-on}	The buffer time from power-off issue to power-on issue	0	-	-	s

3.2.3 Reset Function

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

Note: This function is only used as an emergency reset when AT command "AT+CPOF" and the PWRKEY pin all have lost efficacy.

The RESET pin has been pulled up to 1.8V internally, so it does not need to be pulled up externally. It is strongly recommended to put a100nF capacitor and an ESD protection diode close to the RESET pin. Please refer to the following figure for the recommended reference circuit.

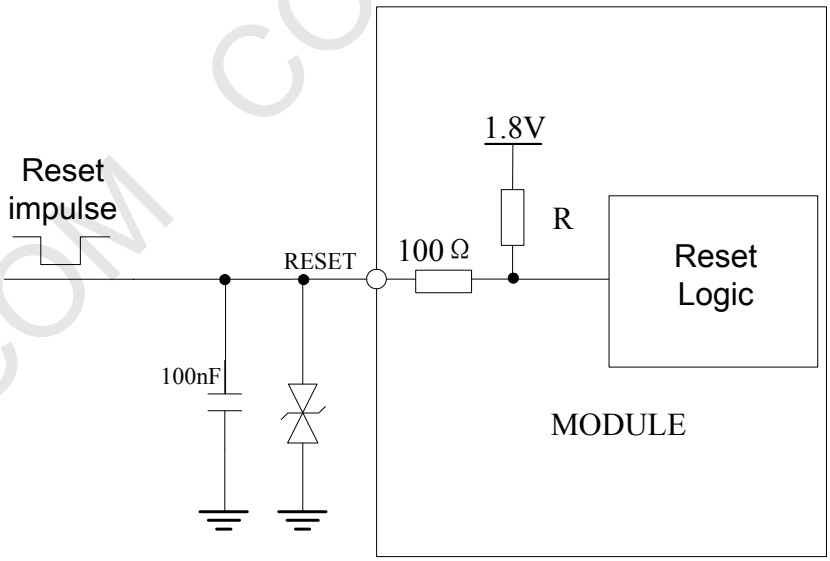

Figure 14: Reference reset circuit

Table 8: RESET pin electronic characteristic

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

3.3 UART Interface

SIM7500JE-B2B provides a UART (universal asynchronous serial transmission) port. It consists of a flexible 7-wire serial interface. The module is as the DCE (Data Communication Equipment) and the client PC is as the DTE (Data Terminal Equipment). AT commands are entered and serial communication is performed through UART interface.

In order to prevent the UART signals of the module damaged due to voltage spikes or ESD, some resistors can be added on UART signals. The values of resistors are adjusted according to the actual circuit. The resistors should be placed close to the module.

The application circuit is in the following figures.

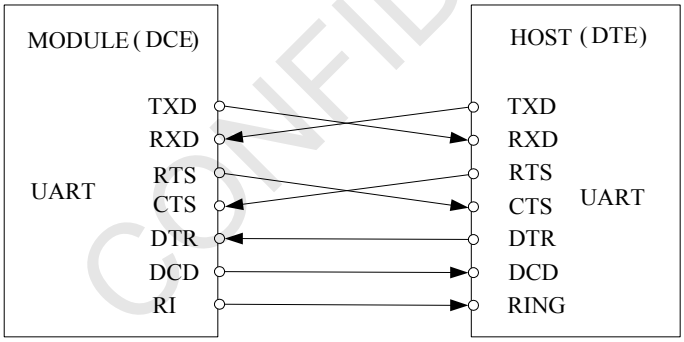

Figure 15: Full modem

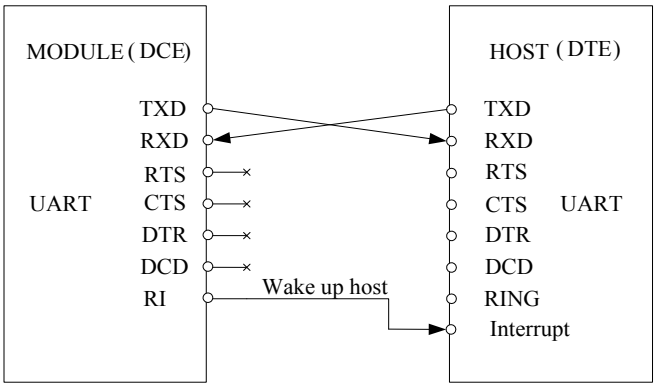

Figure 16: Null modem

The Module UART is 1.8V voltage interface. If user's UART application circuit is a 3.3V voltage interface, the level shifter circuits should be used for voltage matching. The TXB0108RGYR provided by Texas Instruments is recommended. The following figure shows the voltage matching reference design.

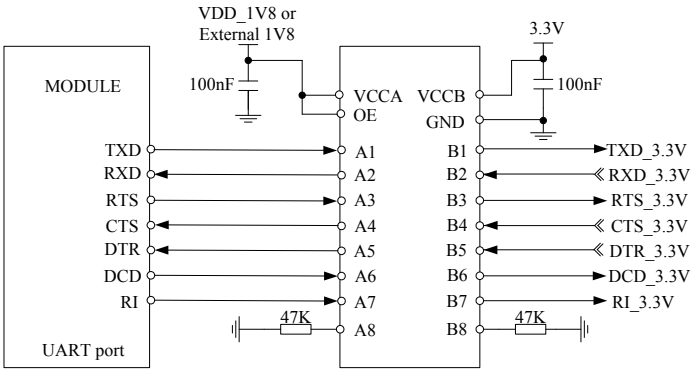

Figure 17: Reference circuit of level shift

To comply with RS-232-C protocol, the RS-232-C level shifter chip should be used to connect Module to the RS-232-C interface, for example SP3238ECA, etc.

Note: Module supports the following baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 3200000, 3686400, 4000000bps. The default band rate is 115200bps.

3.3.1 Pin Description

Table 9: Pin description

Pin type	Pin name	Pin No.	I/O	Active voltage	Default Status
UART	UART_RXD	61	I	High/Low	Pull-Down
	UART_TXD	58	O	High/Low	Pull-Up
	UART_RTS	63	O	High/Low	
	UART_CTS	62	I	High/Low	Pull-Up
	UART_DTR	57	I	High/Low	Pull-Up
	UART_DCD	59	O	High/Low	
	UART_RI	60	O	High/Low	

More pin information refers to chapter 2.2.

Table 10: Logic level

Parameter	Min.	Typ.	Max.	Unit
Logic low input	1.17	1.8	2.1	V
Logic high input	-0.3	0	0.63	V
Logic low output	1.35	-	1.8	V
Logic high output	0	-	0.45	V

3.3.2 Application Guide

If UART port is used in Null Modem, the pin “RI” can be used as an interrupt signal to HOST. Normally it will keep high logic level until certain condition such as receiving SMS, voice call (CSD, video) or URC reporting, then “RI” will change to low logic level to inform the master (client PC). It will stay low until the master clears the interrupt event with AT command.

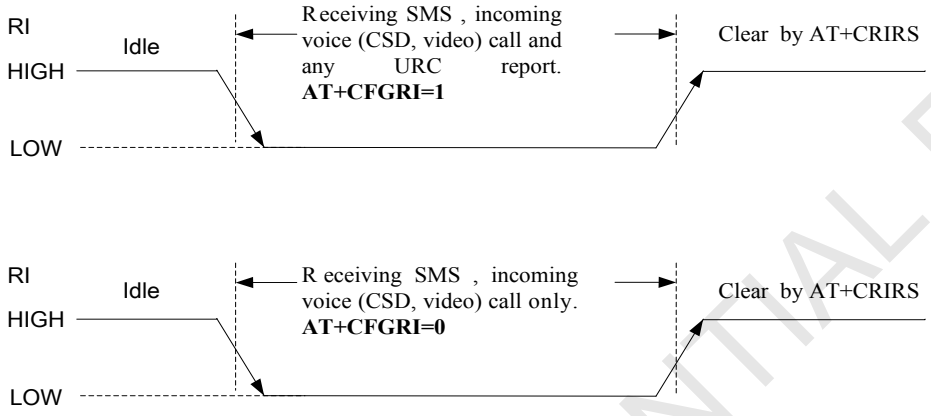

Figure 18: RI behaviour in NULL Modem

If Full Modem is used to establish communication between devices, the pin “RI” is another operation status. Initially it keeps high, when a voice call or CSD call comes, the pin “RI” will change to low for about 5900ms, then it will return to high level for 100ms. It will repeat this procedure until this call is answered or hung up.

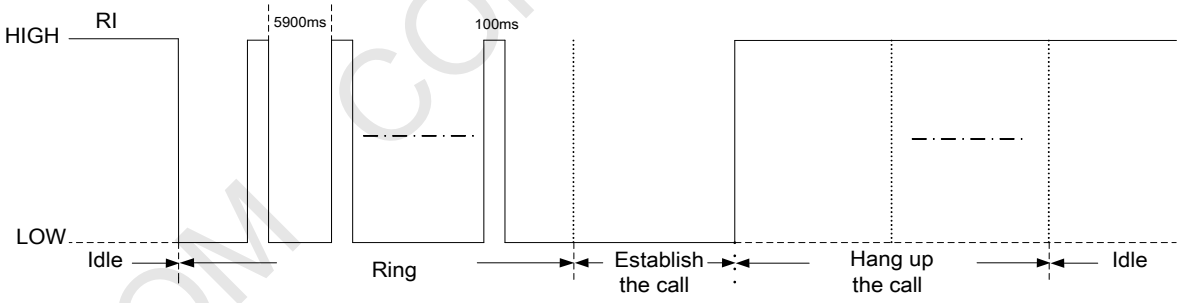

Figure 19: RI behaviour in FULL Mode

3.4 USIM Interface

SIM7500JE-B2B allows the mobile equipment to attach to LTE network. Both 1.8V and 3.0V SIM Cards are supported.

3.4.1 Pin description

Table 11: Electronic characteristic

Pin name	3.0V mode			1.8V mode		
	Min	Typ	Max	Min	Typ	Max
V_USIM	2.7	3.00	3.3	1.65	1.8	2.0
USIM_RESET	0.8* V_USIM	3.00	V_USIM	0.8* V_USIM	1.8	V_USIM
USIM_CLK	0.7* V_USIM	3.00	V_USIM	0.8* V_USIM	1.8	V_USIM
USIM_DATA	0.7* V_USIM	3.00	V_USIM	0.8* V_USIM	1.8	V_USIM

Table 12: Pin description、

Pin name	Pin	Description
USIM_CLK	28	USIM Card Clock
USIM_RESET	27	USIM Card Reset
USIM_DATA	29	USIM Card data I/O, which has been pulled up with a 22kR resistor to V_USIM in module. Do not pull up or pull down in users' application circuit.
V_USIM	30	USIM Card Power output depends automatically on USIM mode，one is 3.0V±10%, another is 1.8V±10%. Current is less than 50mA.

3.4.2 Application Guide

It is recommended to use an ESD protection component such as ST (www.st.com) ESDA6V1W, Note that the SIM peripheral circuit should be close to the SIM card socket. The reference circuit of the 8-pin SIM card holder is illustrated in the following figure.

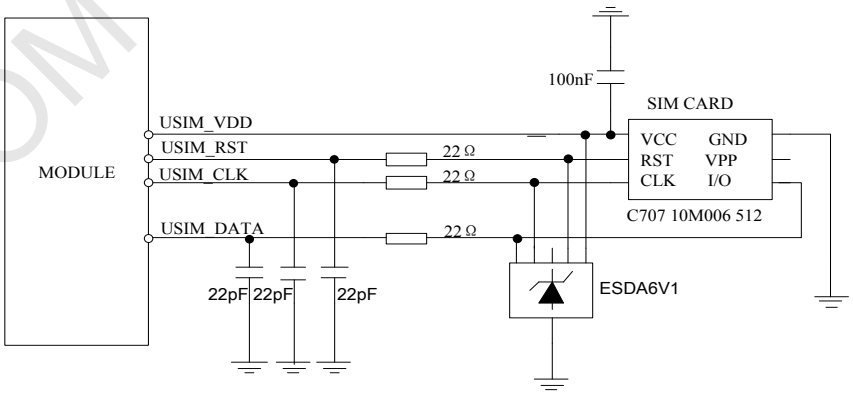

Figure 20: USIM interface reference circuit

Note: USIM_DATA has been pulled up with a 100KΩ resistor to USIM_VDD in module. A 100nF capacitor on USIM_VDD is used to reduce interference. For more details of AT commands about SIM, please refer to document [1].

3.4.3 Recommend Components

For 6 pins USIM socket, SIMCom recommend to use Amphenol C707 10M006 512 2. User can visit http://www.amphenol.com for more information about the holder.

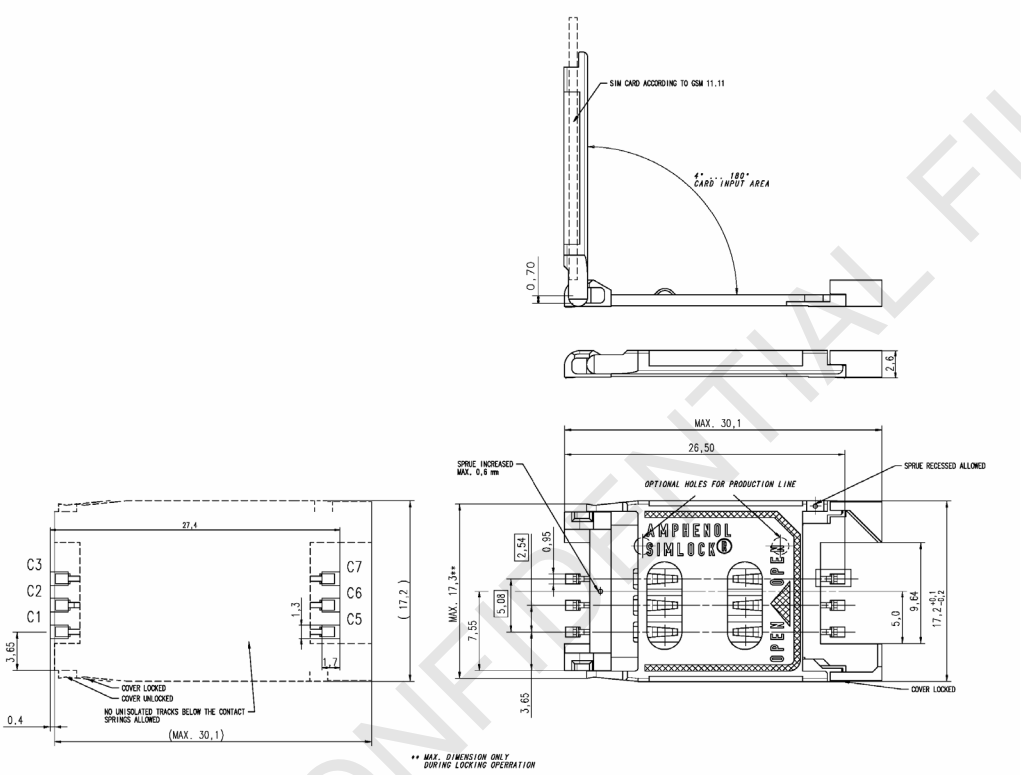

Figure 21: Amphenol SIM card socket

Table 13: Amphenol USIM socket pin description

Pin	Signal	Description
C1	USIM_VDD	SIM Card Power supply, it can identify automatically the SIM Card power mode，one is 3.0V±10%, another is 1.8V±10%.
C2	USIM_RST	SIM Card Reset.
C3	USIM_CLK	SIM Card Clock.
C5	GND	Connect to GND.
C6	VPP	Connect to USIM_VDD
C7	USIM_DATA	SIM Card data I/O.

3.5 I2C Interface

I2C is used to communicate with peripheral equipments and can be operated as either a transmitter or receiver, depending on the device function. Use AT Commands “AT+CRIIC and AT+CWIIC” to read/write

register values of related peripheral equipments connected with I2C interface.

3.5.1 Pin Description

Table 14: Pin description

Pin name	Pin No.	Function
I2C_SDA	64	Serial interface data input and output
I2C_SCL	65	Serial interface clock input

3.5.2 Signal Description

Both SDA and SCL are bidirectional lines, connected to a positive supply via a pull-up resistor respectively. When the bus is free, both lines are high.

3.5.3 Design Guide

For SIM7500JE-B2B, the data on the I2C bus can be transferred at rates up to 400kbps. The number of peripheral devices connected to the bus is solely dependent on the bus capacitance limit of 400pF. Note that PCB traces length and bending are in users' control to minimize load capacitance.

Note：SDA and SCL have pull-up resistors in module. So, two external pull up resistors are not needed in application circuit.

"AT+CRIIC and AT+CWIIC" AT commands could be used to read/write register values of the I2C peripheral devices. For more details about AT commands please refer to document [1].

3.6 USB Interface

SIM7500JE-B2B module contains a USB interface. This interface is compliant with the USB2.0 specification. The USB2.0 specification requires hosts such as the computer to support all three USB speeds, namely low-speed (1.5Mbps), full-speed (12Mbps) and high-speed (480Mbps). USB charging and USB-OTG is not supported.

Table 15: Electronic characteristic

Pin name	Pin No.	Input voltage scope(V)		
		Min	Typ	Max
USB_VBUS	49	3.0	5.0	5.25
USB_DM	50	They are compliant with the USB 2.0 specification.		
USB_DP	51			

3.6.1 Application Guide

Currently SIM7500JE-B2B supports the USB suspend and resume mechanism which can help to save power. If no transaction is on USB bus, SIM7500JE-B2B will enter suspend mode. When some events such as voice call or receiving SMS happen, SIM7500JE-B2B will resume normal mode automatically.

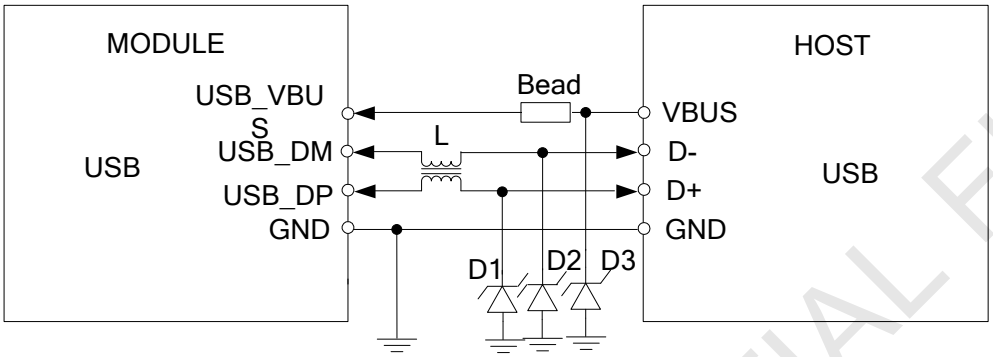

Figure 22: USB interface

Because of the high bit rate on USB bus, more attention should be paid to the influence of the junction capacitance of the ESD component on USB data lines. Typically, the capacitance should be less than 1pF. It is recommended to use an ESD protection component such as ESD9L5.0ST5G provided by On Semiconductor (www.onsemi.com).
D3 is suggested to select the diode with anti-ESD and voltage surge function, or customer could add a ZENER diode for surge clamping. The recommend diodes list please refer to table 7.
L is recommended (MURATA) DLW21SN371SQ2L.

3.7 GPIO Interface

SIM7500JE-B2B provides a limited number of GPIO pins. All GPIOs can be configured as inputs or outputs. User can use AT Commands to read or write GPIOs status. Refer to ATC document for details.

3.7.1 Pin Description

Table 16: Electronic characteristic

Pin name	DC Characteristics		
	Min	Typ	Max
NETLIGHT	-0.3	1.8	2.1
FLIGHTMODE	-0.3	1.8	2.1
STATUS	-0.3	1.8	2.1

Table 17: Pin description

Pin name	Pin No.	I/O	Function
NETLIGHT	68	O	Output PIN as LED control for network status. If it is unused, left open.
FLIGHTMODE	66	I	Input PIN as RF operating control. H: Normal Mode L:Flight Mode If it is unused, left open.
STATUS	71	O	Output PIN as operating status indicating of module. H: Power on L: Power off If it is unused, left open.

Note: The output driver current of GPIOs is 2mA

3.7.2 Application Guide

Network status

NETLIGHT is used to control Network Status LED; application circuit is shown below.

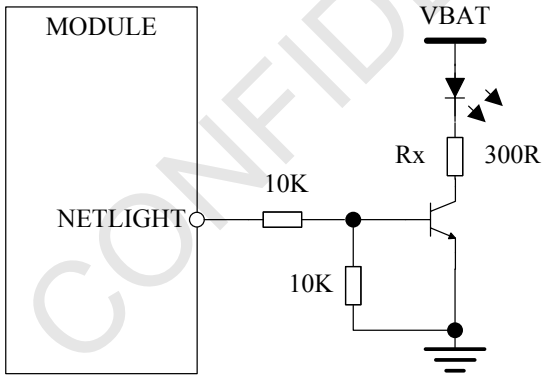

Figure 23: Application circuit

Note: The value of resistor Rx depends on LED characteristic.

Table 18: LED status

LED Status	Module Status
Always On	Searching Network
200ms ON, 200ms OFF	Data Transmit/ Registered network
Off	Power off / Sleep

Flight mode control

Flight mode controls SIM7500JE-B2B module to enter or exit the Flight mode. In Flight mode, SIM7500JE-B2B closes RF function to prevent interference with other equipments or minimize current

consumption. Bidirectional ESD protection component is suggested to add on FLIGHTMODE.

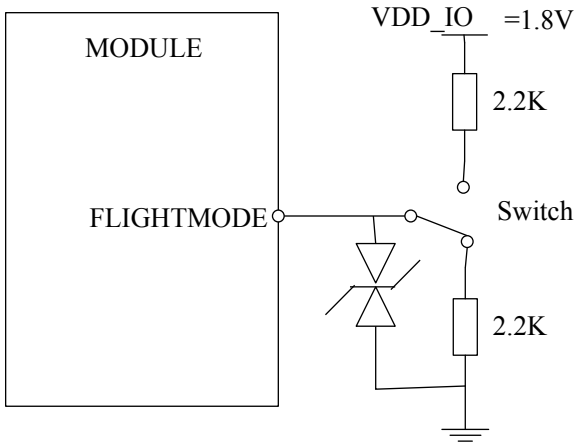

Figure 24: Flight mode switch

Table 19: Control status

FLIGHTMODE Pin Status	Module operation
Input Low Level	Flight Mode: RF is closed
Input High Level	AT+CFUN=0: RF is closed AT+CFUN=1:RF is working

Note :FlightMode can't be used when Module is in sleep mode.

3.8 GNSS

SIM7500JE-B2B merges GNSS satellite and network information to provide a high-availability solution that offers industry-leading accuracy and performance. This solution performs well, even in very challenging environmental conditions where conventional GNSS receivers fail, and provides a platform to enable wireless operators to address both location-based services and emergency mandates.

3.8.1 Technical specification

- Tracking sensitivity: -159 dBm（GPS）/-158 dBm（GLONASS）
- Cold-start sensitivity: -148 dBm
- Accuracy (Open Sky): 2.5m (CEP50)
- TTFF (Open Sky) : Hot start <1s, Cold start<35s
- Receiver Type: 16-channel, C/A Code
- GPS L1 Frequency: 1575.42±1.023MHz
- GLONASS: 1597.5~1605.8 MHz
- Update rate: Default 1 Hz
- GNSS data format: NMEA-0183

- GNSS Current consumption : 100mA ((WCDMA/LTE Sleep ,in total on VBAT pins)
- GNSS antenna: Passive/Active antenna

Note: If the antenna is active type, the power should be given by main board, because there is no power supply on GPS antenna pad. If the antenna is passive, it is suggested that the external LNA should be used.

3.8.2 Operate Mode

SIM7500JE-B2B supports both A-GPS and S-GPS, and then provides three operating modes: mobile-assisted mode, mobile-based mode and standalone mode. A-GPS includes mobile-assisted and mobile-based mode.

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

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

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

This combination of GNSS measurements and available network information provides:

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

Therefore, while network solutions typically perform poorly in rural areas and areas of poor cell geometry/density, and while unassisted, GNSS-only solutions typically perform poorly indoors. The SIM7500JE-B2B GNSS solution provides optimal time to fix, accuracy, sensitivity, availability, and reduced network utilization in both of these environments, depending on the given condition.

3.8.3 Application Guide

Users can adopt an active antenna or a passive antenna as GNSS signal transceiver.
In active antenna circuit, SIM7500JE-B2B provides DC 3.3V (Output of LDO) for active antenna.

GNSS can be used by NMEA port. User can select NMEA as output through UART or USB. NMEA sentences are automatic and no command is provided. NMEA sentences include GSV, GGA, RMC, GSA, and VTG. Before using GNSS, user should configure SIM7500 series in proper operating mode by AT

command. Please refer to related document for details. SIM7500 series can also get position location information through AT directly.

Note: GNSS is closed by default, it could be started by AT+CGPS. The AT command has two parameters, the first is on/off, and the second is GNSS mode. Default mode is standalone mode.
AGPS mode needs more support from the mobile telecommunication network. Please refer to document [24] for more details.

3.9 Multi-functional interface

SIM7500JE-B2B merges functions for various applications. It can enrich users' design and lower the cost of users' hardware.

3.9.1 Sink Current Source

The ISINK pin is VBAT tolerant and intended to drive some passive devices such as LCD backlight, white LED, etc. Its output current can be up to 40 mA and be set by the AT command "AT+ CLEDITST".

Table 20: Electronic characteristic

Symbol	Description	Min.	Typ.	Max.	Unit
V_{ISINK}	Voltage tolerant	0.5	-	VBAT	V
I_{ISINK}	Current tolerant	0	-	40	mA

Since the driver is ground-referenced current sink, the operating device it drives must form a current path between the VDD pin and the CURRENT_SINK pin. The following figure is for users reference.

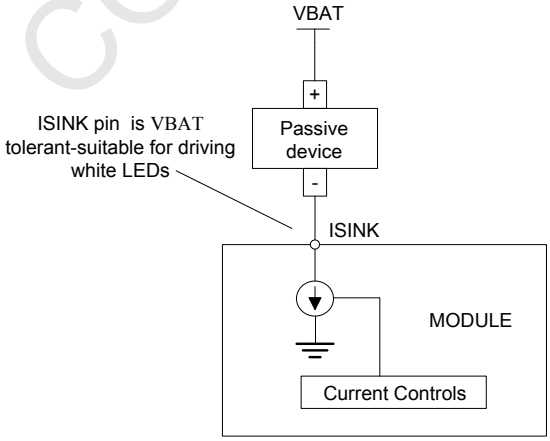

Figure 25: Current drive

Note: The sinking current can be adjusted to meet the design requirement through the AT command "AT+ CLEDITST =<0>, <value>".The "value" ranges from 0 to 8, on behalf of the current from 0mA to 40mA by 5mA step.

3.9.2 Reset Function

SIM7500JE-B2B also has a RESET pin (PIN4) to reset the module. This function is used as an emergency reset only when AT command "AT+CPOF" and the POWER_ON pin has no effect. User can pull the RESET pin to ground, then the module will reset.

The RESET pin has been pulled up to 1.8V internally, so it does not need to be pulled up externally. It is strongly recommended to put a100nF capacitor and an ESD protection diode close to the RESET pin. Please refer to the following figure for the recommended reference circuit.

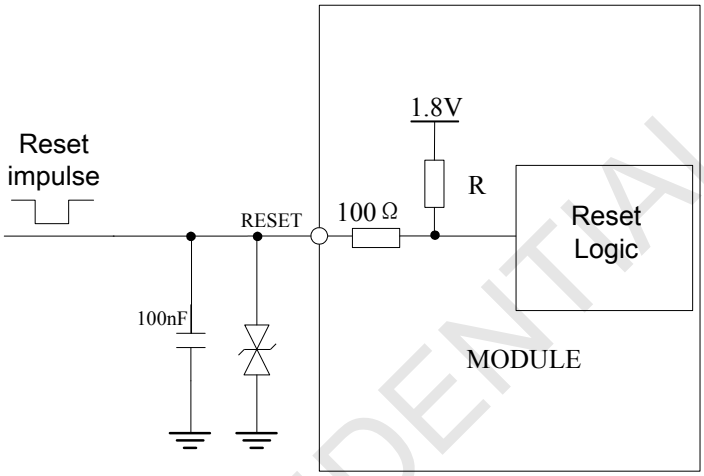

Figure 26: Reset circuit

Table 21: RESET pin electronic characteristic

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

3.9.3 ADC

Module has 1 dedicated ADC pins named ADC. They are available for digitizing analog signals such as battery voltage and so on. These electronic specifications are shown in the following table.

Table 22: ADC Electronic Characteristics

Characteristics	Min.	Typ.	Max.	Unit
Resolution	–	15	–	Bits
Input Range	0.1		1.7	V
Input serial resistance	1	–	–	MΩ

Note: "AT+CADC" can be used to read the voltage of the ADC pins, for more details, please refer to document [1].

4 RF Specification

4.1 RF Specification

Table 23: Conducted transmission power

Frequency	Max	Min
LTE-FDD B1	23dBm +/-2.7dB	<-40dBm
LTE-FDD B3	23dBm +/-2.7dB	<-40dBm
LTE-FDD B8	23dBm +/-2.7dB	<-40dBm

Table 24: Operating frequencies

Frequency	Receiving	Transmission
LTE-FDD B1	1920 ~1980 MHz	2110 ~2170 MHz
LTE-FDD B3	1710 ~1785 MHz	1805 ~1880 MHz
LTE-FDD B8	880 ~915 MHz	925~960 MHz
GNSS	1574.4 ～1576.44 MHz	-
GLONASS	1598 ～1606 MHz	-
BD	1559 ～1563 MHz	

Table 25: Conducted receive sensitivity

E-UTRA band	3GPP standard				Test value	3GPP standard		Duplex
	1.4 MHz	3MHz	5MHz	10MHz	10 MHz	15 MHz	20 MHz	
1	-	-	-100	-97	-101.3	-95.2	-94	FDD
3	-101.7	-98.7	-97	-94	-100	-92.2	-91	FDD
8	-102.2	-99.2	-97	-94	-99.8	-	-	FDD

4.2 Antenna Design Guide

The RF interface has an impedance of 50Ω. To suit the physical design of individual applications SIM7500JE-B2B offers two alternatives:

- Recommended approach: antenna connector on the component side of the PCB
- Antenna pad and grounding plane placed on the bottom side.

To minimize the loss on the RF cable, it needs to be very careful to choose RF cable. We recommend that the insertion loss should meet the following requirement:

Table 26: Trace Loss

Frequency	Loss
700MHz-960MHz	<0.5dB
1710MHz-2170MHz	<0.9dB
2300MHz-2650MHz	<1.2dB

5 Reliability and Operating Characteristics

5.1 Electronic Characteristics

Absolute maximum rating for digital and analog pins of SIM7500JE-B2B are listed in the following table:

Table 27: Absolute maximum ratings

Parameter	Min.	Max.	Unit
Voltage at VBAT	-0.5	6.0	V
Voltage at VBUS	-0.5	6.3	V
Voltage at digital pins (RESETGPIO,I2C,UART)	-0.3	2.1	V
Voltage at digital pins :SIM	-0.3	3.05	V
Voltage at PWRKEY	-0.3	1.8	

Table 28: Recommended operating ratings

Parameter	Min.	Typ.	Max.	Unit
Voltage at VBAT	3.4	3.8	4.2	V
Voltage at VBUS	3.0	5	5.25	V

Table 29: 1.8V Digital I/O characteristics

Parameter	Description	Min.	Typ.	Max.	Unit
V_{IH}	High-level input voltage	1.17	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	0	0.63	V
V_{OH}	High-level output voltage	1.35	-	1.8	V
V_{OL}	Low-level output voltage	0	-	0.45	V
I_{OH}	High-level output current(no pull down resistor)	-	2		mA
I_{OL}	Low-level output current(no pull up resistor)	-	-2	-	mA
I_{IH}	Input high leakage current (no pull down resistor)	-	-	1	uA
I_{IL}	Input low leakage current(no pull up resistor)	-1	-	-	uA

Table 30: Operating temperature

Parameter	Min.	Typ.	Max.	Unit
Normal operation temperature	-30	25	80	℃
Extended operation temperature*	-40	25	85	℃
Storage temperature	-45	25	90	℃

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

5.2 Operating Mode

The following table summarizes the various operating modes, each operating modes will be referred to in the following chapters.

5.2.1 Operating Modes Overview

Table 31: Operating Modes Overview

Mode		Function
Normal operation	LTE Sleep	In this case, the current consumption of module will be reduced to the minimal level and the module can still receive paging message and SMS.
	LTE Idle	Software is active. Module is registered to the network, and the module is ready to communicate.
	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, antenna.
	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.
	LTE 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 SIM 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 FLIGHTMODE pin can be used to set the module to flight mode without removing the

	power supply. In this mode, the RF part of the module will not work but the serial port and USB port are still accessible. The power consumption in this mode is lower than normal mode.
Power off	Module will go into power off mode by sending the AT command "AT+CPOF" or by pulling down the PWRKEY 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 not accessible.

5.2.2 Minimize Power Consumption

There are two modes that SIM7500JE-B2B achieves low power consumption.

Sleep mode

In sleep mode, the current consumption of module will be reduced to the minimal level, and module can still receive paging message and SMS.
Several hardware and software conditions must be satisfied together 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 and refer to Document [26] for more details.

Minimum functionality mode

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

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

If SIM7500JE-B2B has been set to minimum functionality mode, the module will firstly enter sleep mode, then the RF function and SIM card function will be closed. In this case, the serial port is still accessible, but RF function or SIM card will be unavailable. When SIM7500JE-B2B is in minimum functionality or flight mode, it can return to full functionality by the AT command "AT+CFUN=1".
Note: For flight mode, please refer to Chapter3.7.2

5.3 Current Consumption

The current consumption in suspended mode without USB connection is listed in the table below. Here, "suspended mode" means that SIM7500JE-B2B is connected to USB bus, but it does not transfer data.

Table 32: Current consumption

GNSS	
GNSS supply current (AT+CFUN=0,with USB connection)	@ -140dBm， Tracking Typical:50mA
LTE Sleep/Idle mode	
LTE supply current (without USB connection)	Sleep mode Typical: 1.8 mA Idle mode Typical: 13.6mA
LTE Data	
LTE-FDD B1	@5 MHz 22.2dBm Typical: 476 mA @10 MHz 22.7dBm Typical: 485 mA @20 MHz 22.38dBm Typical: 530 mA
LTE-FDD B3	@5 MHz 22.2dBm Typical: 513 mA @10 MHz 22.7dBm Typical: 516 mA @20 MHz 22.38dBm Typical: 560 mA
LTE-FDD B8	@5 MHz 22.2dBm Typical: 474 mA @10 MHz 22.7dBm Typical: 476 mA

5.4 EMC and ESD Notes

EMC tests should be performed to detect any potential problems. Possible harmful emissions radiated by the application to the RF receiver in the receiver band. RF emissions interfere with audio input/output. It is recommended to shield the sensitive components and trace with common ground and customers can add beads where necessary.

Normally SIM7500JE-B2B is mounted on customer host board. Although some ESD components have been added in SIM7500JE-B2B, to prevent ESD, customers should put some ESD components on customers' board. The ESD components should be placed beside the connectors which human body might touch, such as SIM card holder, audio jacks, switches, keys, etc. The following table is the ESD performance of SIM7500JE-B2B, tested with SIMCom EVB.

Table 33: The ESD performance measurement table (Temperature: 25 ℃, Humidity: 45%)

Part	Contact discharge	Air discharge
GND	+/-6K	+/-12K
VBAT	+/-5K	+/-10K
Antenna port	+/-5K	+/-10K
USB	+/-4K	+/-8K

Appendix

A. Related Documents

Table 34: Related documents

SN	Document name	Remark
[1]	SIM7500 _ATC_V1.00	SIM7500 _ATC_V1.00
[2]	ITU-T Draft new recommendationV.25ter	Serial asynchronous automatic dialing and control
[3]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile (MS) conformance specification
[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
[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]	Audio Application Note V1.01	Audio Application Note V1.01
[15]	PCM Application Note V1.02	PCM Application Note V1.02
[16]	Sleep Application Note	Sleep_Application_Note
[17]	Waking up Application Note	Waking_up_Application_Note
[18]	Module secondary-SMT-UGD	SMT Note

B. Terms and Abbreviations

Table 35: 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
FCC	Federal Communications Commission (U.S.)
FD	SIM fix dialing phonebook
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
I2C	Inter-Integrated Circuit
IMEI	International Mobile Equipment Identity
Inorm	Normal Current
Imax	Maximum Load Current
kbps	Kilo bits per second
Li-Ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCS	Personal Communication System, also referred to as GSM 1900
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock

Rx	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service
SPI	serial peripheral interface
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
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value
SM	SIM phonebook
NC	Not connect
EDGE	Enhanced data rates for GSM evolution
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
ZIF	Zero intermediate frequency
WCDMA	Wideband Code Division Multiple Access
VCTCXO	Voltage control temperature-compensated crystal oscillator
USIM	Universal subscriber identity module
UMTS	Universal mobile telecommunications system
UART	Universal asynchronous receiver transmitter

C. Safety Caution

Table 36: Safety caution

Marks	Requirements
	When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive to not operate normally for RF energy interference.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forget to think much of these instructions may lead to the flight safety or offend against local legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle.
	GSM cellular terminals or mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, for example no mobile fee or a invalid SIM card. While you are in this condition and need emergent help, please remember using emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call. Also, some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

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