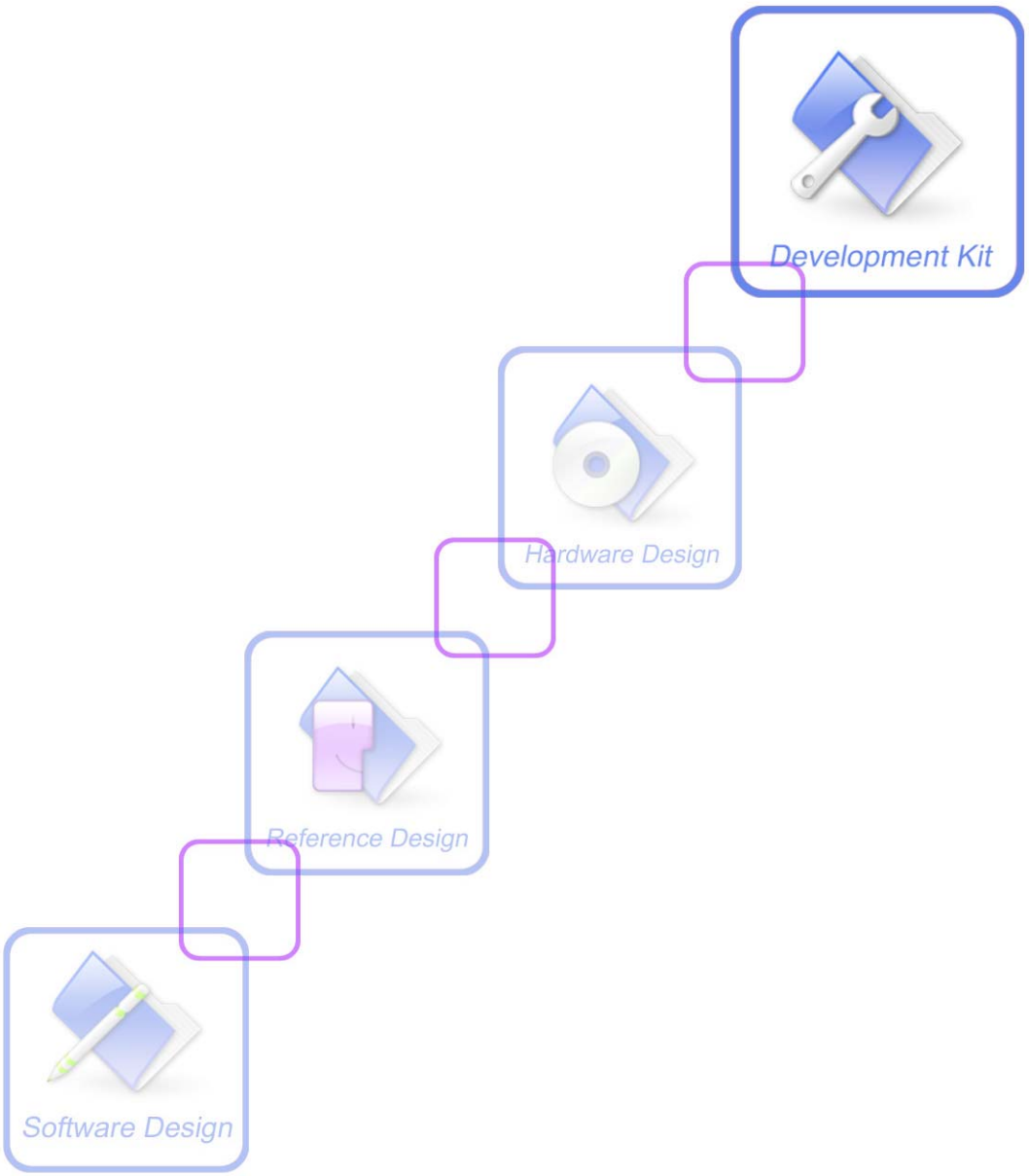
Development Kit Manual

SIM5320AD_EVB_User Guide_V1.01



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Version History

Data	Version	Description of change	Author
2011-04-02	1.01	Origin	3G Team

1 Overview

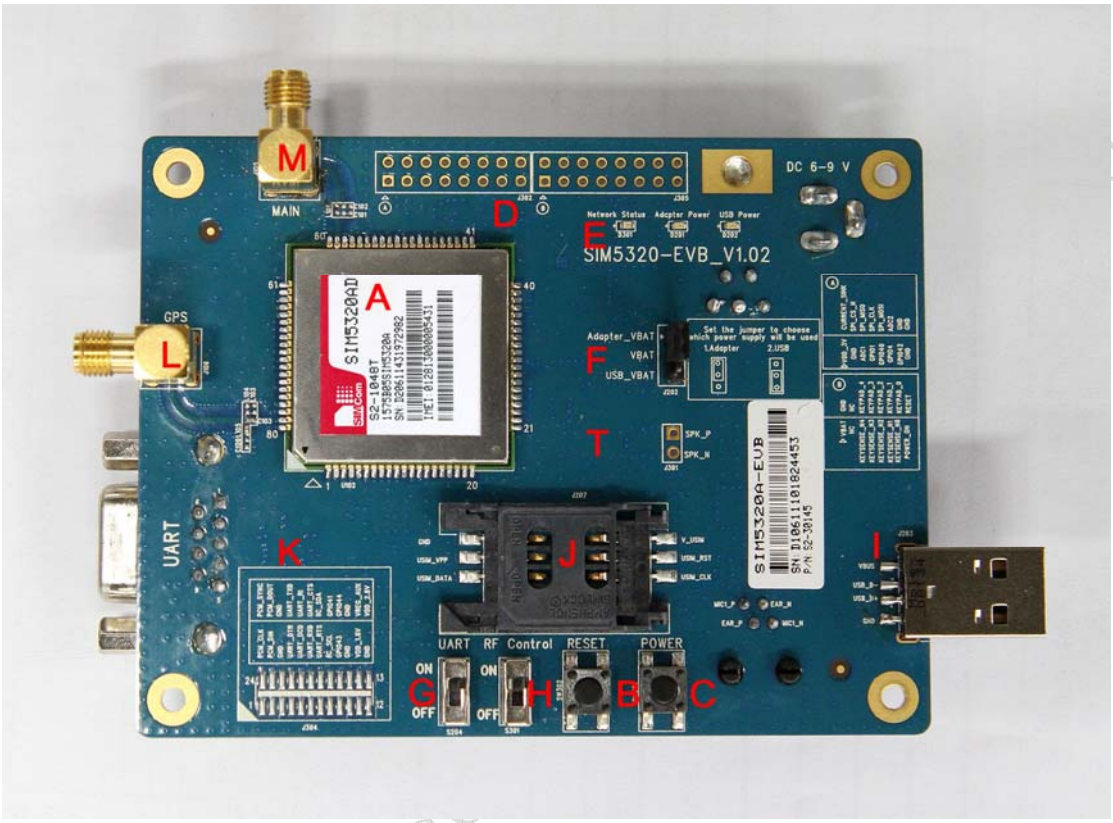
This document gives the usage of SIM5320AD EVB, user can get useful information about the SIM5320AD EVB quickly through this document. All the functions of the SIM5320AD can be used by this board.

NOTE: This document is subject to change without notice at any time.

Table 1:SIM5320AD EVB Key features

Feature	Implementation
Power supply	1: DC 6.0V~9.0V 2: USB 5.0V power supply
functions	□ UART interface □ USB2.0 interface □ SIMCARD interface □ I2C interface □ ADC interface □ POWER_ON key/Reset key □ RF enable/disable (flight mode) switch □ UART Control switch

2 SIM5320AD EVB



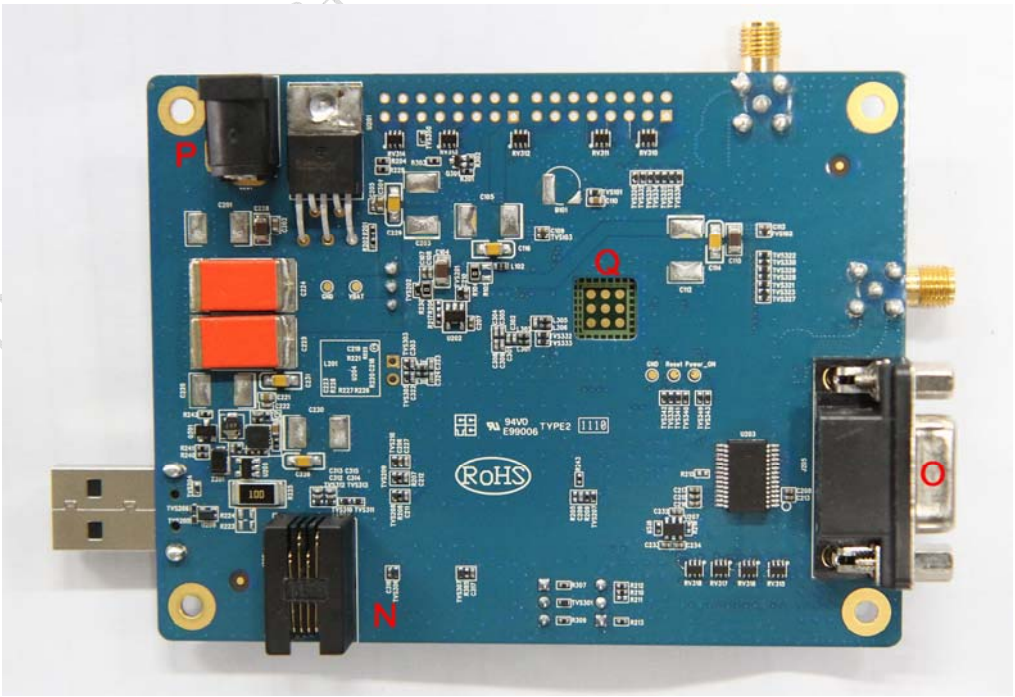


Figure 1: EVB view

A: SIM5320AD module
B: Reset keypad
C: Power on/off keypad
D: IO interface 1（including GPIO, ADC, SPI, etc）
E: LED indicator（including network status，operating status）
F: Power supply selection jumper
G: UART enable/disable switch
H: RF enable/disable (flight mode) switch
I: USB connector
J: SIM card socket
K: IO interface 2（including PCM，GPIO, UART, I2C, etc）
L: GPS antenna SMA
M: Main antenna SMA
O: UART connector
P: Adapter connector
Q: SIM5320AD JTAG test point
T: Speaker interface

All hardware Sub-interfaces included in SIM5320AD EVB are described in detail in following chapters.

3 EVB accessories

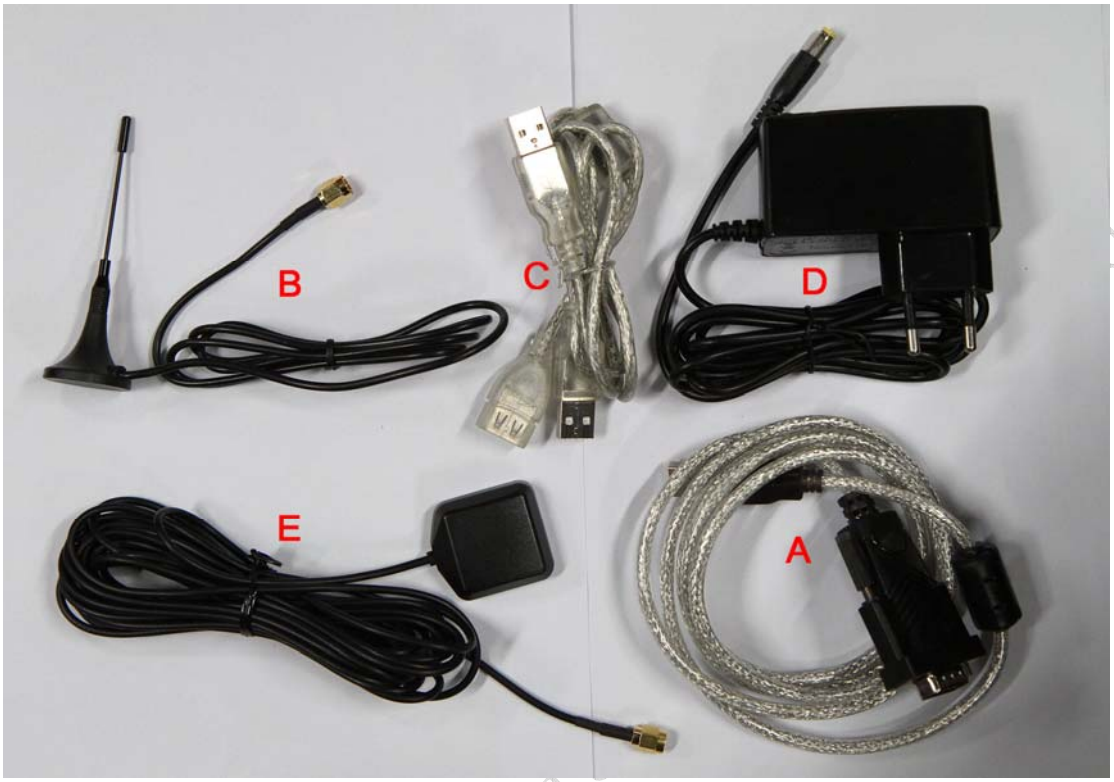


Figure 2: EVB accessory

A: USB to UART cable
B: RF antenna
C: USB cable
D: 6V DC adapter
E: GPS antenna

4 Accessory Interface

4.1 Power Interface

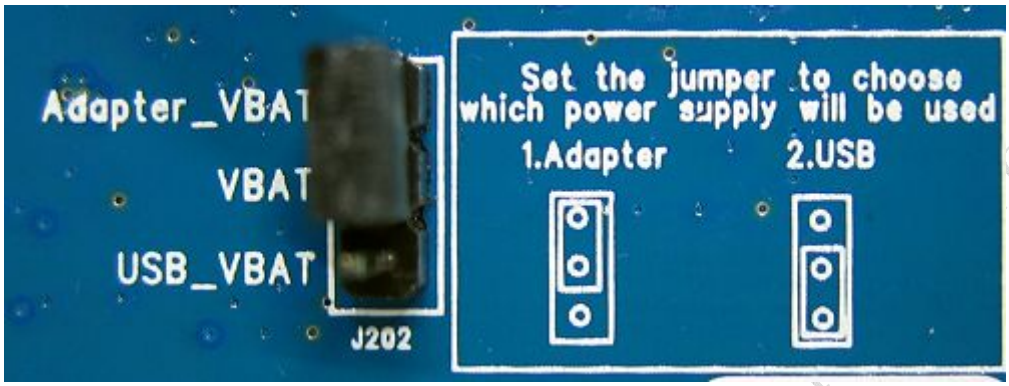


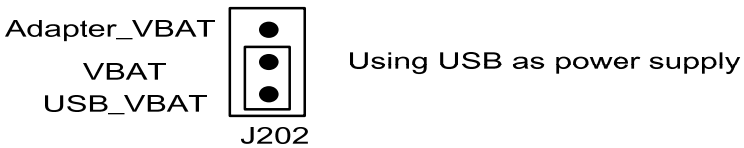
Figure 3: Power selection jumper

Table 2: Power supply

Signal	Input/Output	Description
Adapter_VBAT	O	3.8V/2A DC source input
USB_VBAT	O	3.8V/0.5A DC source input
VBAT	I	DC source input

If user wants to use DC adapter as power supply, Adapter_VBAT should be connected to VBAT on J202 through a jumper as following figure shows.

This board could be powered by USB bus. User should connect the USB pin. USB_VBAT is the USB power out.If user wants to use USB VBUS to power up the module, please connect connector VBAT with connector USB_VBAT as following figure shows.and disconnect Adapter_VBAT.



4.2 SIM card interface

Figure 4: SIM card socket

Table 3: SIM card socket

Pin	Signal	Input/Output	Description
1	V_USIM	O	USIM Card Power output automatic output on USIM mode， one is 3.0V±10%, another is 1.8V±10%. Current is about 10mA.
2	USIM_RESET	O	USIM Card Reset
3	USIM_CLK	O	USIM Card Clock
4	GND		Ground
5	SIM_VPP	O	V_USIM
6	USIM_DATA	I/O	USIM Card data I/O

4.3 Antenna Interface

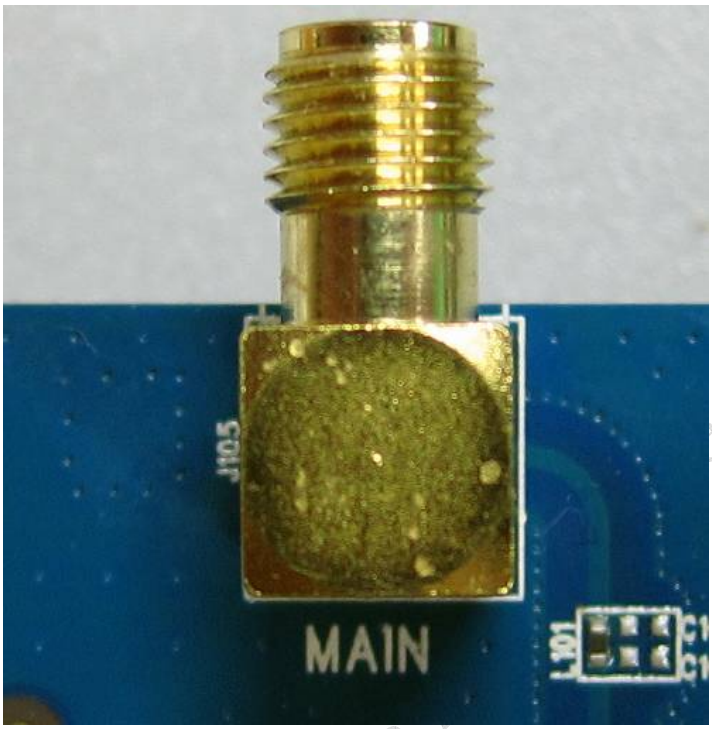


Figure 5: Main Antenna connector

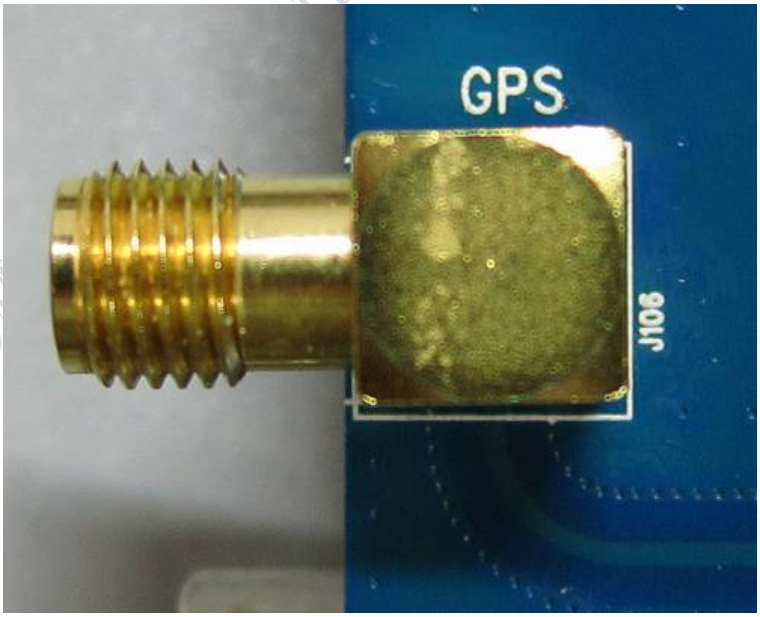


Figure 6: GPS Antenna connector

4.4 RS232 Interface

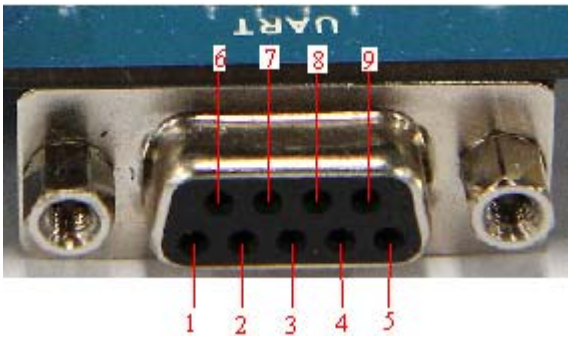


Figure 7: Serial Port

J205 is 9 pins standard RS232 UART interface. It can be connected to a PC directly.

Table 4: Serial Interface

Pin	Signal	I/O	Description
1	DCD	O	Data carrier detection
2	TXD	O	Transmit data
3	RXD	I	Receive data
4	DTR	I	Data Terminal Ready
5	GND		Ground
6	NC		NC
7	RTS	I	Request to Send
8	CTS	O	Clear to Send
9	RI	O	Ring Indicator

4.5 Operating Status LED

Figure 8: Status LED

Table 5: Network status LED

D301 Status	Module Status
Off	Module is not running
On	Module is running, or voice call is connected
800ms On/ Off	Module find the network and registered
200ms On/ Off	Data communication

LED	I/O	Description
D201	O	ADAPTER power indicator
D202	O	USB power indicator

4.6 USB interface

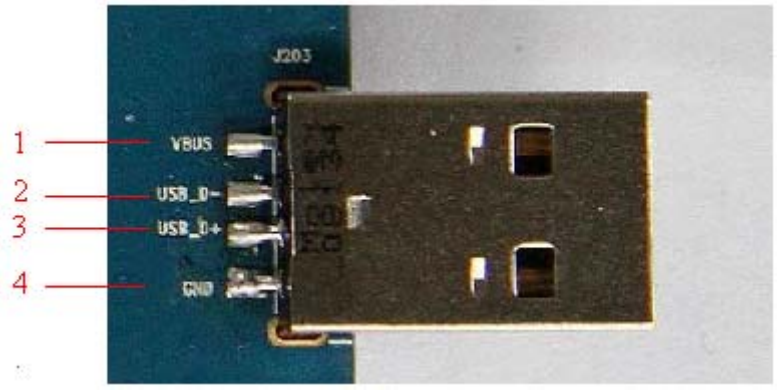


Figure 9: USB Interface

It is a normal 4Pin USB connector.

Table 6: USB interface

Pin	Signal	I/O	Description
1	USB_VBUS	I	5V
2	USB_DM	I/O	D+ line
3	USB_ DP	I/O	D- line
4	GND		Ground

4.7 Switch interface

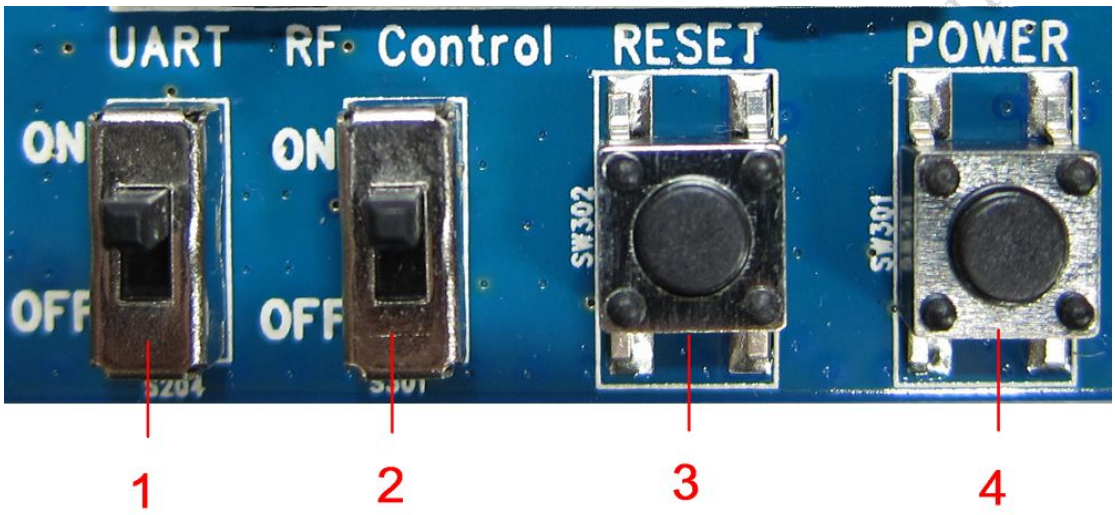
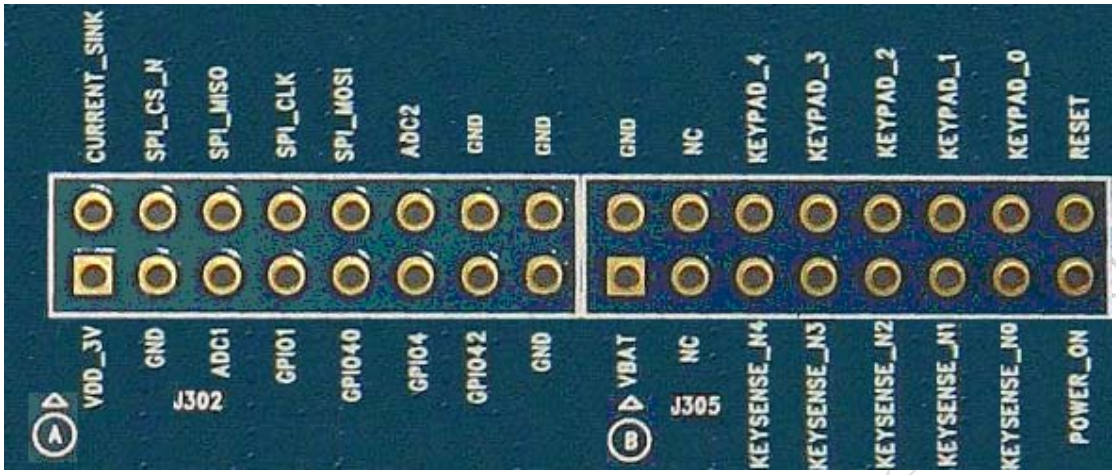


Figure 10: Switch Interface

Table 7: Switch interface

Switch	Signal	I/O	Description
1	RS232 chip SHUTDOWN	I	UART switch
2	GPIO4	I	RF switch (S301) ON : Normal mode OFF : Flight mode
3	RESET	I	Reset the module
4	PWRER_ON	I	Power on the module

4.8 IO interface



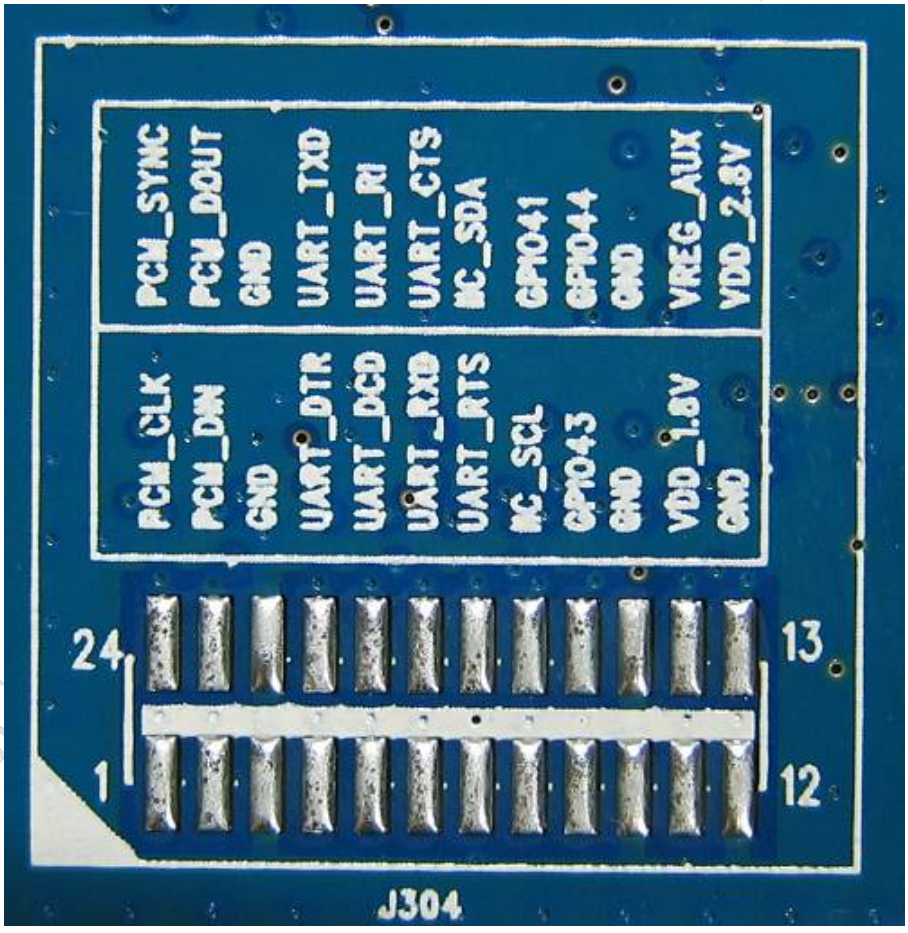


Figure 11: IO Interface

Table 8: IO interface

Signal	I/O	Description
GPIO40	I/O	GPIO
POWER_ON	I	Power on the module
RESET	I	Reset the module
GPIO41	I/O	GPIO
GPIO43	I/O	GPIO
GPIO44	I/O	GPIO
VDD_3V	O	3V power supply
CURRENT_SINK	I	Current sink source
ADC1	I	ADC
GPIO1	O	Network status
GPIO4	I	RF control switch
GPIO42	I/O	GPIO
SPI_CS_N	O	SPI Chip selection
SPI_MISO	I	SPI Master input Slave output
SPI_MOSI	O	SPI Master output Slave input
ADC2	I	ADC
KEYSENSE_N0	I	Bit 0 for sensing key press on pad matrix
KEYSENSE_ N1	I	Bit 1 for sensing key press on pad matrix
KEYSENSE_ N2	I	Bit 2 for sensing key press on pad matrix
KEYSENSE_ N3	I	Bit 3 for sensing key press on pad matrix
KEYSENSE_ N4	I	Bit 4 for sensing key press on pad matrix
KEYPAD_0	O	Bit 0 drive to the pad matrix
KEYPAD_1	O	Bit 1 drive to the pad matrix
KEYPAD_2	O	Bit 2 drive to the pad matrix
KEYPAD_3	O	Bit 3 drive to the pad matrix
KEYPAD_4	O	Bit 4 drive to the pad matrix
I2C_SDA	I/O	I2C data
I2C_SCL	O	I2C clock
GPIO0	I	General input pin for module wake up interrupt.
GPIO2	I	General input pin.
GPIO3	O	General output pin.
GPIO5	O	General output pin.

5 EVB and accessories

The EVB and its accessories are assembled as the figure below.

Figure 12: EVB and accessories

6 Quickly start

6.1 Running

There are two ways to provide power supply to SIM5320AD module: one is to use the 6V power supply provided in the EVB kit; the other is to use USB port of personal computer.

(1) When user use the power supply, if user insert 6V DC source adapter, user should connect ADAPTER_VBAT pin and VBAT pin on the EVB board; then insert a valued SIM card and check if the antenna is connected, and make sure that RF control switch is set to ON; finally press the on/off switch for about 1 second, and then SIM5320AD module will begin running.

(2) Another option is to use USB port of Computer as power supply. To do so, user need to connect USB_VBAT pin and VBAT pin on the EVB board, and make sure that RF control switch is set to ON. Firstly insert the sim card and connect the antenna, then connect the PC with USB-to-USB cable and press the Power_ON button for one second, then SIM5320AD will start running.

User can see the light on the EVB flashing at a certain frequency about 1.25Hz. By the state, user can judge whether the EVB and SIM5320AD is running or not. No function and test can be executed if user has not connected necessary accessories.

NOTE: This EVB board supports USB power supply when user connects USB_VBAT and VBAT together.

6.2 Installing Driver

There are 3 ways to connect the module to user's computer and communicate via HyperTerminal:
(1) Using USB-TO-USB cable;
(2) Using UART-TO-USB cable;
(3) Using UART-TO-UART cable.
In the first case, user need install the module USB driver, which can be got from our FAE or sales; For the UART to USB driver, user may get it from the CD in the EVB kit; If user use UART to UART cable, there are certain points to be noticed. One can use UART to UART cable in EVB kit, if the customers want to use their own UART to UART cable, please make sure that the pin sequences of it is same as those of cable in EVB kit, pin sequences of which are shown in Figure 9.

6.3 Connecting Net and calling

Once user installs the driver, user can follow steps below to connect to Network.

(1) When user use a UART-UART cable, user need to connect the serial port line to the serial port, open the HyperTerminal (AT command windows) on user's Personal computer. The location of the HyperTerminal in windows2000/XP/Vista can be found from START→accessory→ communication→HyperTerminal. Please set the correct Baud Rate and COM port number, the Baud Rate of SIM5320AD is 115200, and the COM port number is based on which UART port user's serial port line is inserted, user should select the port such as COM1 or COM2 etc.

(2) Connect the antenna to the SIM5320AD module using an antenna transmit line, insert SIM card into the SIM card holder, and insert handset into its sockets.

(3) Follow the steps of running which has been mentioned above in Sector 5.1, power on the system, type the AT command from the HyperTerminal, and then the SIM5320AD module will execute its corresponding function. For example, if user type "AT", then it should respond "OK"; if user type "ATI", it should display product identification information.

(4) If user want to use USB to USB cable, user need to connect the cable to USB port of the module and the computer, then follow step 1~3.

(5) If user use UART to USB cable, user need to connect the cable to module serial port and the USB port of the computer, then follow step 1~3.

6.4 Downloading

Connect the USB port line to the USB port, connect the direct current source adapter, run the download program, and choose the correct image, please follow the QDL downloading menu for the operation. Update procedure is described in the figure below.

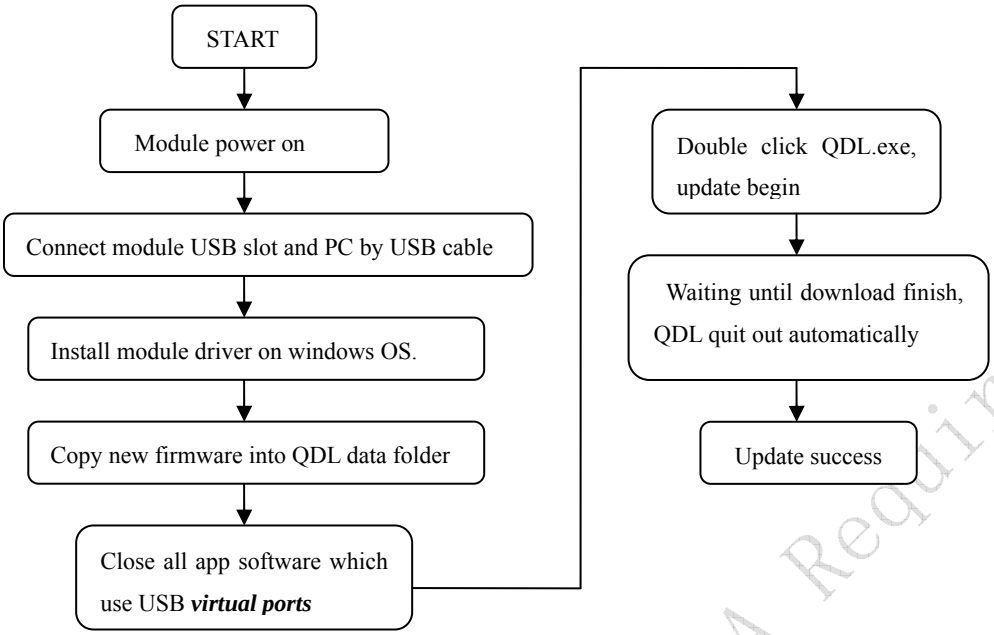


Figure 13: USB interface update procedure

6.5 Turning off

Press the POWER_ON for about 1 second, SIM5320AD module will be turned off.

NOTE: If user uses USB to power on the module, just disconnect the USB cable to turn off.

6.6 Measuring the current consumption

User can measure SIM5320AD current consumption in the sleep mode on our EVB. User need to follow steps.

(1) Remove the jumper from J202, and provide a 3.8V DC power supply (such as: Agilent 66319B) for VBAT on SIM5320AD EVB;

(2) Install a SIM card and a RF antenna;

(3) Shutdown UART by S204;

(4) Remove the USB cable;

(5) Power on SIM5320AD;

SIM5320AD will enter sleep mode automatically. User can measure SIM5320AD current consumption. Test report is described in the figure below.

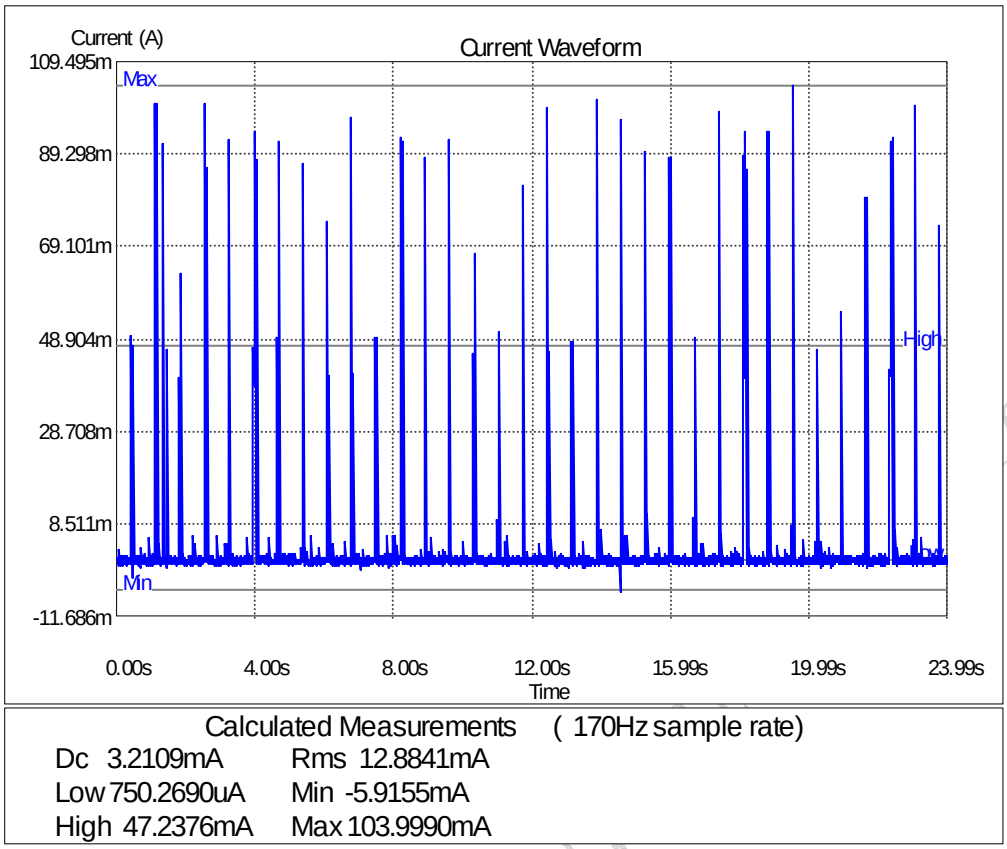


Figure 14: current consumption in the sleep mode

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Hardware Design

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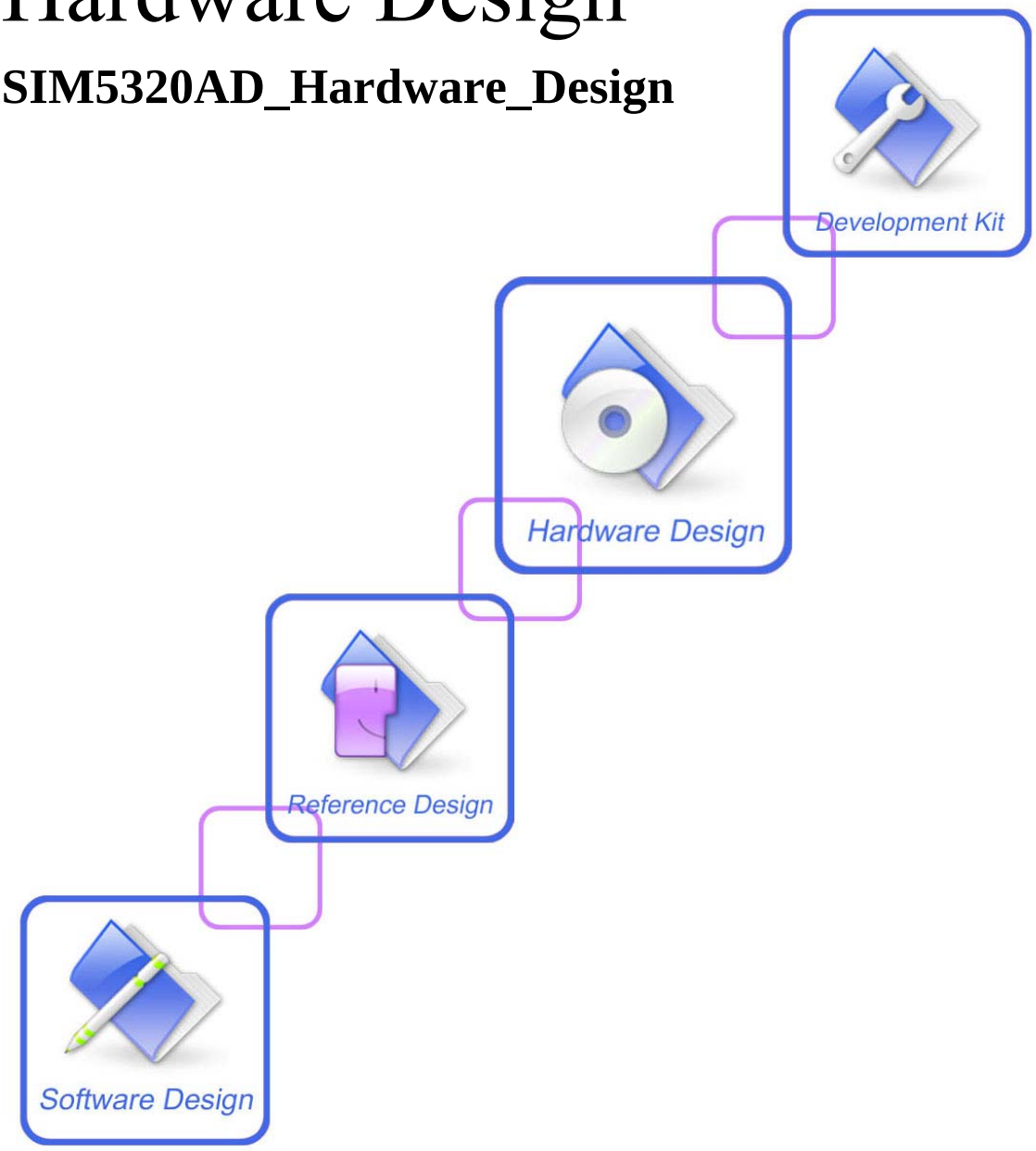

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Compliance Information

FCC Compliance Statement:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
1. This device may not cause harmful interference, and
2. This device must accept any interference received, including
interference that may cause undesired operation. This device must accept any interference received, including interference that may cause
undesired operation. Product that is a radio transmitter is labeled with FCC ID.

FCC Caution:

(1) Exposure to Radio Frequency Radiation. This equipment must be
installed and operated in accordance with provided instructions and the
antenna(s) used for this transmitter must be installed to provide a
separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.
End-users and installers must be provided with antenna installation
instructions and transmitter operating conditions for satisfying RF exposure
compliance.
(2) Any changes or modifications not expressly approved by the grantee
of this device could void the user's authority to operate the equipment.
(3) This Transmitter must not be co-located or operating in conjunction with
any other antenna or transmitter.
(4) Changes or modifications to this unit not expressly approved by the
party responsible for compliance could void the user authority to operate
the equipment.

(1) the modules FCC ID is notvisible when installed in the host, or
(2) if the host is marketed so that end users do not havestraightforward commonly used methods for access to remove the module so that the FCC ID ofthe module is visible; then an additional permanent label referring to the enclosed module:Contains Transmitter Module
FCC ID: UDV-1103022011009
or Contains FCC ID: UDV-1103022011009 mustbe used.

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Revision History

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1 Introduction

This document describes electronic specifications, RF specifications, function interface, mechanical characteristic and testing conclusions of the SIMCom SIM5320AD module. With the help of this document and other SIM5320AD software application notes, user guides, users can quickly understand and use SIM5320AD module to design and develop applications quickly.

1.1 Product Outline

Designed for global market, SIM5320AD is a quad-band GSM/GPRS/EDGE and dual-band UMTS /HSDPA that works on frequencies of GSM 850MHz, EGSM 900 MHz, DCS 1800 MHz, PCS 1900MHz and WCDMA 1900/850MHz. The SIM5320 support HSDPA.User can choose the module based on the wireless network configuration.
With a tiny configuration of 30*30*2.9 mm and integrated functions, SIM5320AD can meet almost any space requirement in users' application, such as Smart phone, PDA phone, industrial handhelds, machine-to-machine, vehicle applications, etc..

There are 80 pins on SIM5320AD, which provide most application interfaces for customers' board.

1.2 Hardware Interface Overview

Sub-interfaces are described in detail in the next chapter, which includes:

- **Power Supply**
- **USB Interface**
- **Serial Interface**
- **SIM Interface**
- **GPIO**
- **ADC**
- **LDO Power Output**
- **Sink Current Source**
- **Keypad Interface**
- **SPI Interface**
- **RTC**
- **I2C Interface**

1.3 Hardware Diagram

The global architecture of the SIM5320AD Embedded module is described in the figure below.

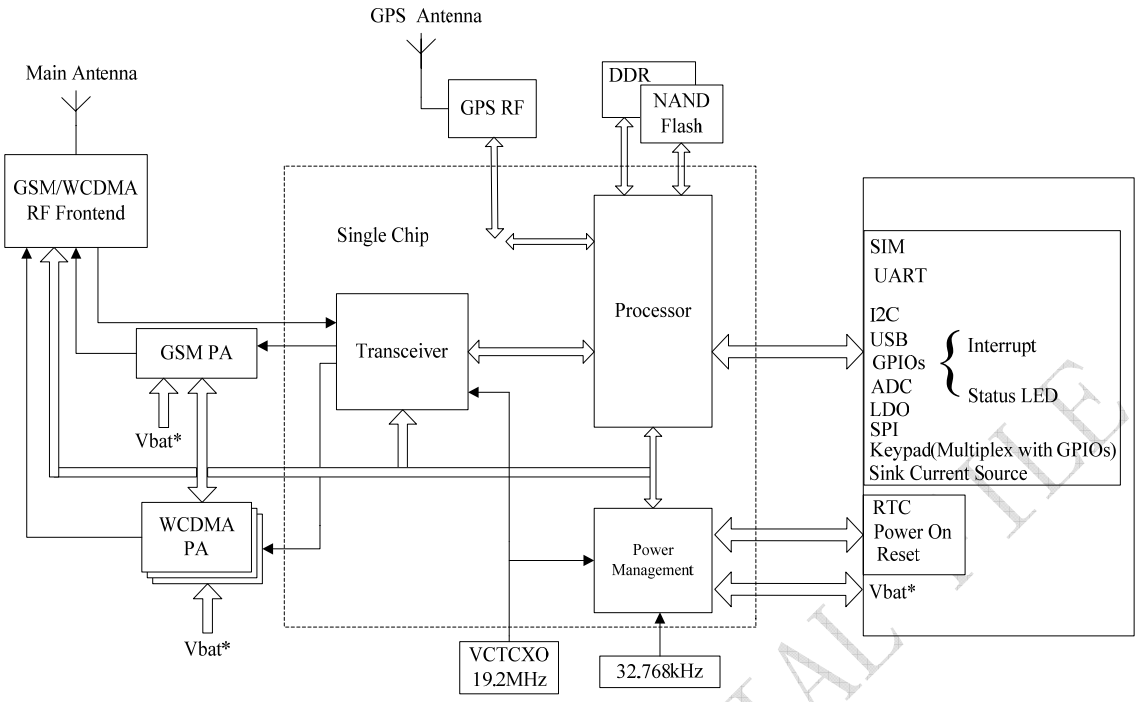


Figure 1: SIM5320AD functional architecture

1.4 Functional Overview

Table 1: General Feature

Feature	Implementation
Power supply	Single supply voltage 3.3～4.2V
Transmission data	● Dual-mode UMTS/HSDPA/EDGE/GPRS operation ● GPRS Class B, multislot class 12 operation, Supports coding scheme: CS1-4 ● EDGE multislot class 12 operation, Supports coding schemes MSC1-9 ● UMTS R99 data rates-384 kbps DL/UL ● HSDPA Category 5/6 -3.6 Mbps Category12-1.8 Mbps ● CSD feature: 9.6, 14.4, 64 kbps UL/DL
GPS	● 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. User 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
Real Time Clock	Support RTC
Timer function	Programmable by AT command
Physical characteristics	Size:30*30*2.9mm Weight:5.6g
Firmware upgrade	Firmware upgrade over USB interface
Temperature range	● Operation temperature: -30°C to +80°C ● Storage temperature -40°C to +85°C

2 Package Information

2.1 Pin Configuration

All hardware interfaces which connect SIM5320AD to customers' application platform are through 80 pins pads (Metal half hole). Figure 2 is SIM5320AD outline diagram.

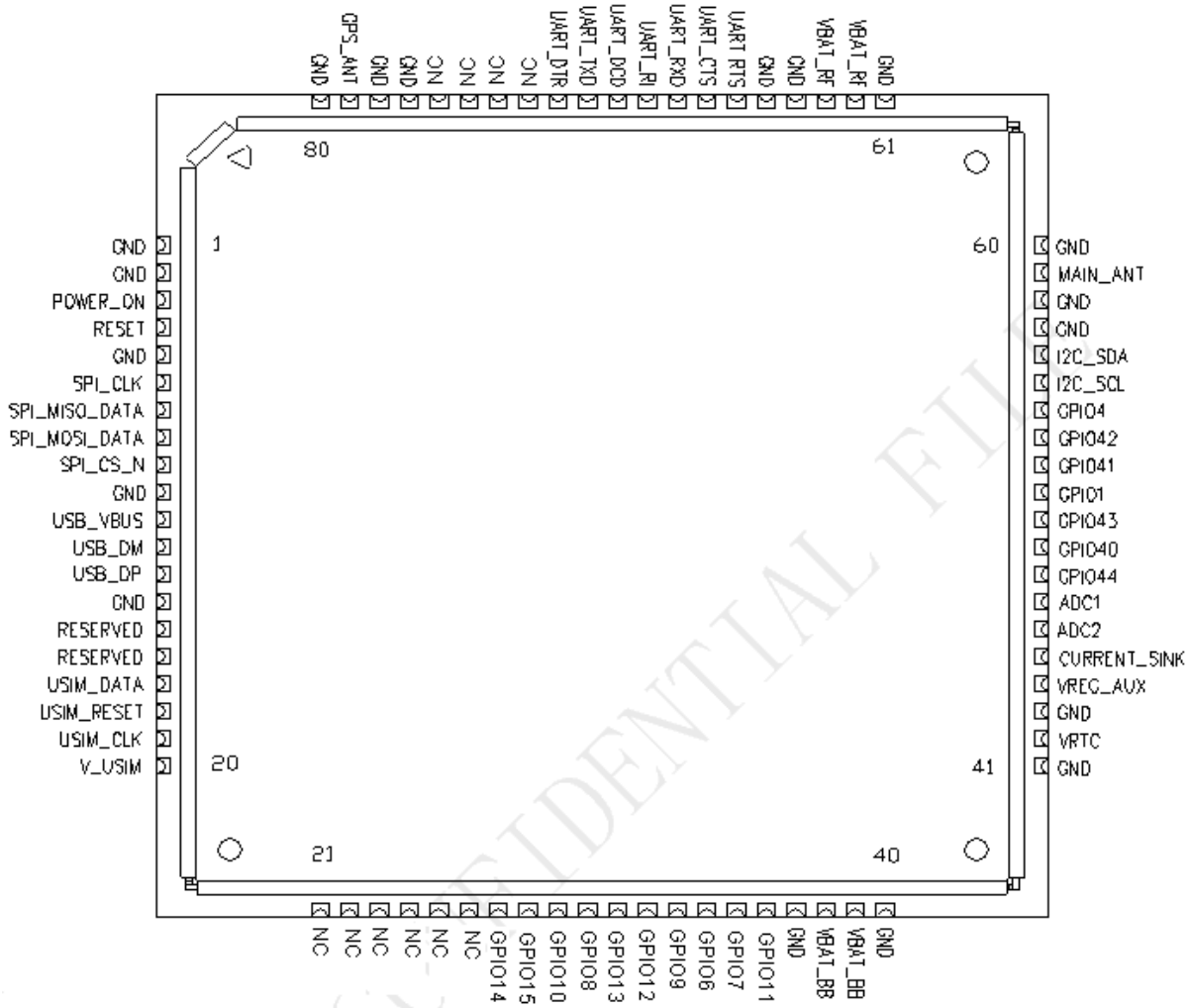


Figure 2: Pin view

Table 2: Pin definition

Pin No.	Define	Pin No.	Define
1	GND	2	GND
3	POWER_ON	4	RESET
5	GND	6	SPI_CLK
7	SPI_MISO_DATA	8	SPI_MOSI_DATA
9	SPI_CS_N	10	GND
11	USB_VBUS	12	USB_DM
13	USB_DP	14	GND
15	RESERVED	16	RESERVED
17	USIM_DATA	18	USIM_RESET
19	USIM_CLK	20	V_USIM
21	NC	22	NC
23	NC	24	NC
25	NC	26	NC
27	GPIO14	28	GPIO15
29	GPIO10	30	GPIO8
31	GPIO13	32	GPIO12
33	GPIO9	34	GPIO6
35	GPIO7	36	GPIO11
37	GND	38	VBAT_BB
39	VBAT_BB	40	GND
41	GND	42	VRTC
43	GND	44	VREG_AUX
45	CURRENT_SINK	46	ADC2
47	ADC1	48	GPIO44
49	GPIO40	50	GPIO43
51	GPIO1	52	GPIO41
53	GPIO42	54	GPIO4
55	I2C_SCL	56	I2C_SDA
57	GND	58	GND
59	MAIN_ANT	60	GND
61	GND	62	VBAT_RF
63	VBAT_RF	64	GND
65	GND	66	UART_RTS

67	UART_CTS	68	UART_RXD
69	UART_RI	70	UART_DCD
71	UART_TXD	72	UART_DTR
73	NC	74	NC
75	NC	76	NC
77	GND	78	GND
79	GPS_ANT	80	GND

2.2 Pin description

Table 3: Pin description

Pin name	I/O	Description	Comment
Power Supply			
VBAT_RF/VBAT_BB		Power supply voltage	
VRTC	I/O	Power supply for RTC	If it is unused, keep open.
VREG_AUX	O	LDO power output	
GND		Ground	
Power on/off			
POWER_ON	I	POWER_ON should be pulled low at least 64ms to power on or 500ms to power off the module.	
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	
SPI interface			
SPI_CLK	O	SPI clock	If it is unused, keep open.
SPI_CS_N	O	SPI chip-select	
SPI_MOSI_DATA	O	SPI (master only) master out/slave in data	
SPI_MISO_DATA	I	SPI (master only) master in/slave out data	
USB			
USB_VBUS	I	USB power supply input	They are compliant with

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 2.6V internally. If it is unused, keep open.
I2C_SCL	O	I2C clock output	
GPIOs			
GPIO6	I/O	General input/output PIN.	All GPIOs.are 1.8V. If it is unused, keep open.
GPIO7	I/O	General input/output PIN.	
GPIO8	I/O	General input/output PIN.	
GPIO9	I/O	General input/output PIN.	
GPIO10	I/O	General input/output PIN.	
GPIO11	I/O	General input/output PIN.	
GPIO12	I/O	General input/output PIN.	
GPIO13	I/O	General input/output PIN.	
GPIO14	I/O	General input/output PIN.	
GPIO15	I/O	General input/output PIN.	
GPIO1	O	Output PIN as LED control for network status.	If it is unused, keep open.
GPIO4	I	Input PIN as RF operating control.	
GPIO40	O	Output PIN as operating status indicating of module.	
GPIO41	I/O	General input/output PIN. It can be used as wake/interrupt signal to host from module	
GPIO43	I/O	General input/output PIN. It can be used as wake/interrupt signal to module from host.	
GPIO44	I/O	General input/output PIN.	
GPIO42	I/O	General input/output PIN.	
Other interface			
RESET	I	System reset in, active low.	

CURRENT_SINK	I	Current source of ground-referenced current sink	Refer to 3.10
ADC1	I	Analog Digital Converter Input	Refer to 3.10
ADC2	I	Analog Digital Converter Input	
MAIN_ANT	I/O	ANT soldering pad	
GPS_ANT	I/O	GPS ANT soldering pad	

2.3 Package Dimensions

The following figure shows mechanical dimensions of SIM5320AD.

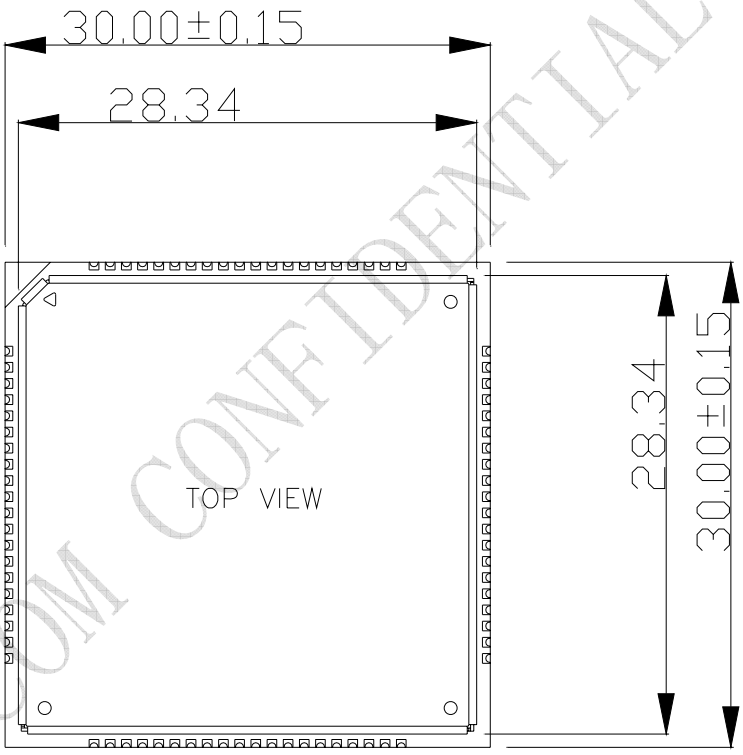


Figure 3: Top dimensions (Unit: mm)

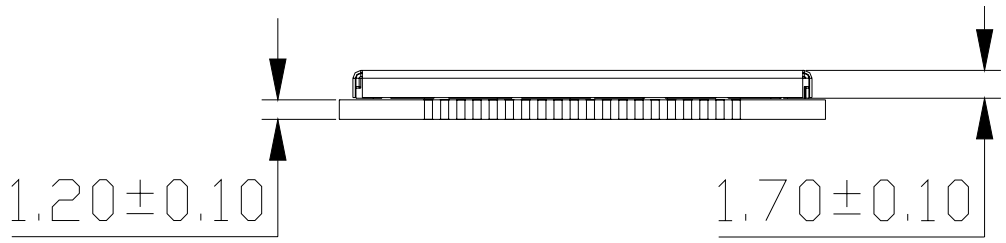


Figure 4: Side dimensions (Unit: mm)

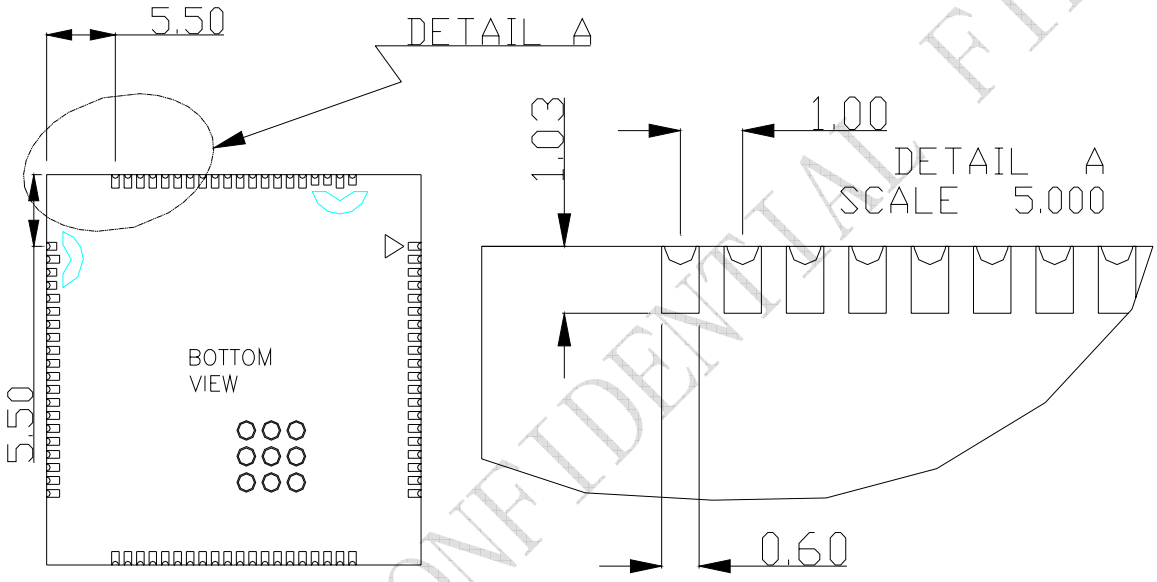


Figure 5: Bottom dimensions (Unit: mm)

2.4 Footprint Recommendation

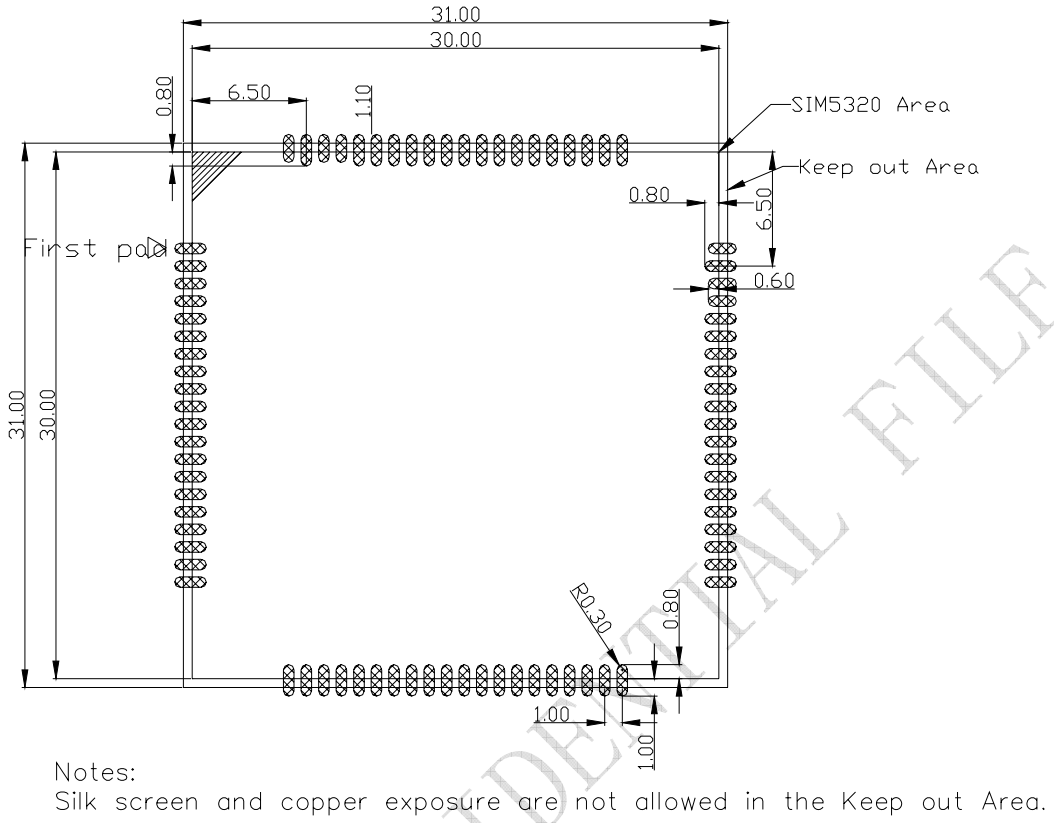


Figure 6: Footprint recommendation (Unit: mm)

3 Application Interface Specification

3.1 Power Supply

The power supply pins of SIM5320AD include VBAT_RF and VBAT_BB. VBAT_RF directly supplies the power to RF PA; VBAT_BB supplies the power to the baseband system. For the VBAT_RF, the ripple due to GSM/GPRS emission burst (every 4.615ms） may cause voltage drop, and the current consumption rises typically to peak of 2A. So the power supply must be able to provide sufficient current up to 2A. The following figure is the VBAT_RF voltage ripple wave at the maximum power transmit phase.

The test condition: VBAT_RF=4.0V, VBAT maximum output current =2A, C_A=100 μF tantalum capacitor (ESR=0.7Ω) and C_B=1μF(Please refer to Figure 36—Application circuit).

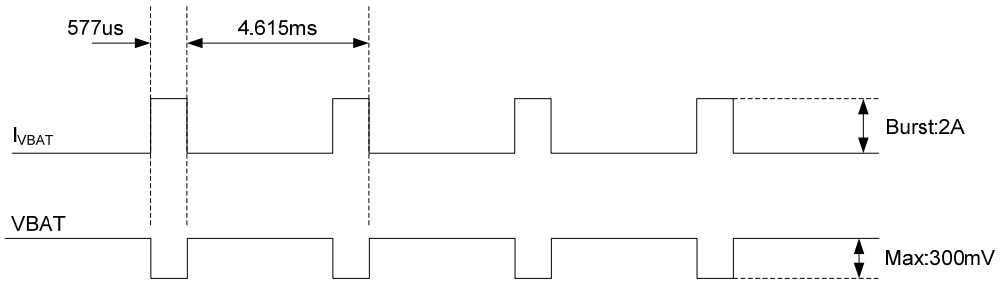


Figure 7: VBAT_RF voltage drop during burst emission (GSM/GPRS)

3.1.1 Power Supply Pin

Two VBAT_RF and two VBAT_BB pins are dedicated to connect the supply voltage.

Table 4: Pin description

Pin type	Pin name	Min	Typ	Max	Unit
POWER	VBAT_RF	3.3	3.8	4.2	V
	VBAT_BB	3.3	3.8	4.2	V

Note: 1.Though the VBAT_RF and VBAT_BB are supplied by the same voltage level, they are different pins. VBAT_RF is for RF section and VBAT_BB is for baseband system.

2. When the module is power off, users must pay attention to the issue about current leakage. Refer to Chapter 3.10.2 Note2.

3.1.2 Design Guide

Mostly, user connects the VBAT_RF and VBAT_BB pins with one power supply. Make sure that the input voltage at the VBAT_BB pin will never drop below 3.3V even during a transmit burst when the current consumption rises up to 2A. 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 2A, users must introduce larger capacitor (typical 1000uF) to storage electric power, especially GPRS multiple time slots emission.

For the consideration of RF performance and system stability, another large capacitor (above 100uF) should be located at the VBAT_RF 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_RF pins as close as possible. Also User 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. The following figure is the recommended circuit.

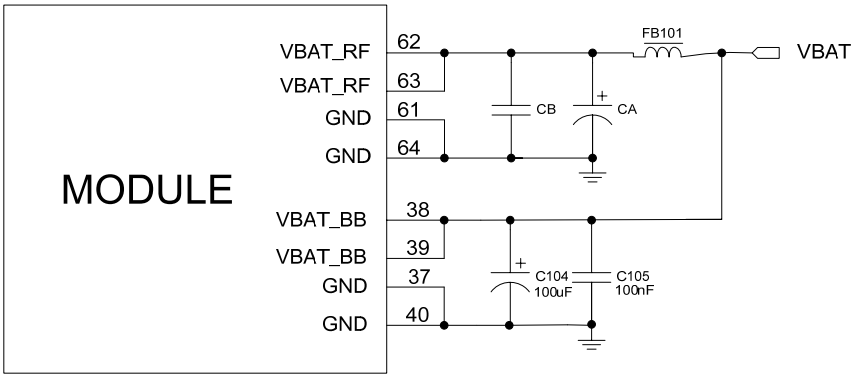


Figure 8: VBAT input application circuit

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

Power supply circuit

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 2A. 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.

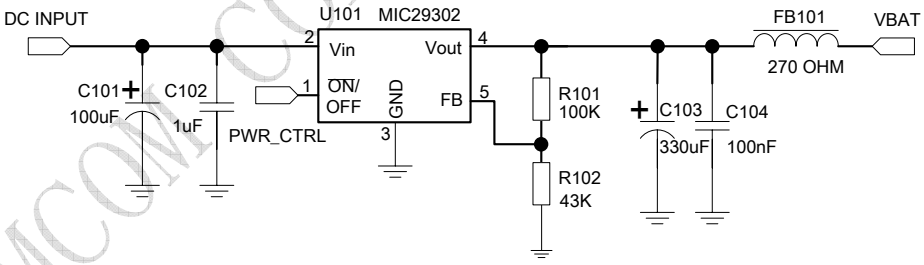


Figure 9: Reference circuit of the LDO power supply

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.

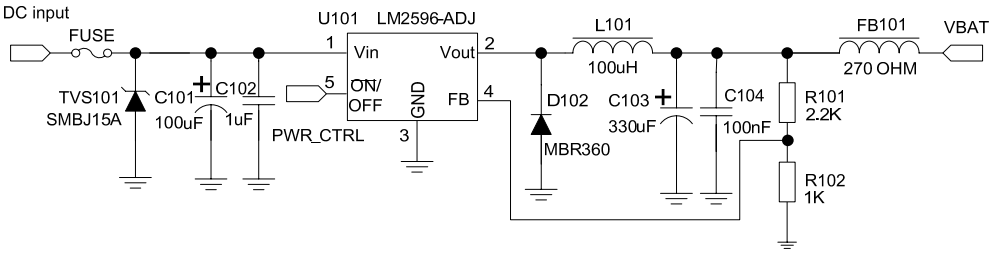


Figure 10: Reference circuit of the DCDC power supply

Voltage monitor

To monitor the power supply voltage, user can use the AT command "AT+CBC", this command has two parameters: the battery status and the voltage value (mV). It will return the capacity percentage and actual value of battery (at the VBAT_BB pin). The voltage is continuously measured at intervals, whenever the measured battery voltage is lower than a specific value set by the AT command "AT+CVALARM". For example, if the voltage value is set to be 3.4V, the following URC will be presented: "warning! voltage is low: 3.3v".

If the voltage is lower than a specific value which is set by the AT command "AT+CPMVT", the module will be powered off automatically and AT commands cannot be executed any more.

Note: ***Under-voltage warning function is disabled by default, user can enable it by the AT command "AT+CVALARM". Auto power off feature is disabled by default, user should set it by the AT command "AT+CPMVT" to an appropriate value. Please refer to Document [1].***

3.1.3 RTC Backup

The module uses RTC (Real Time Clock) to update and maintain inherent time and keeps system alive at no power supply status. The RTC power supply of module can be provided by an external capacitor or a battery (non-chargeable or rechargeable) through the VRTC. The following figures show various reference circuits for RTC back up. The discharge current is less than 10uA. If this feature is used, please refer to the AT commands "AT+CTZU" and "AT +CTZR".

- **External capacitor backup**

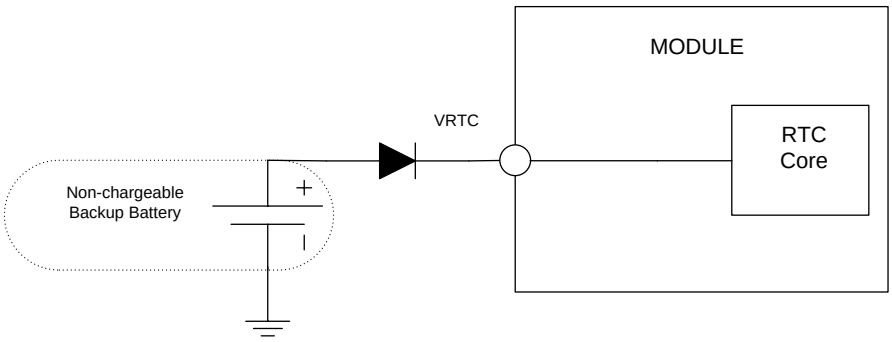


Figure 11: RTC supply from capacitor

- **Non-chargeable battery backup**

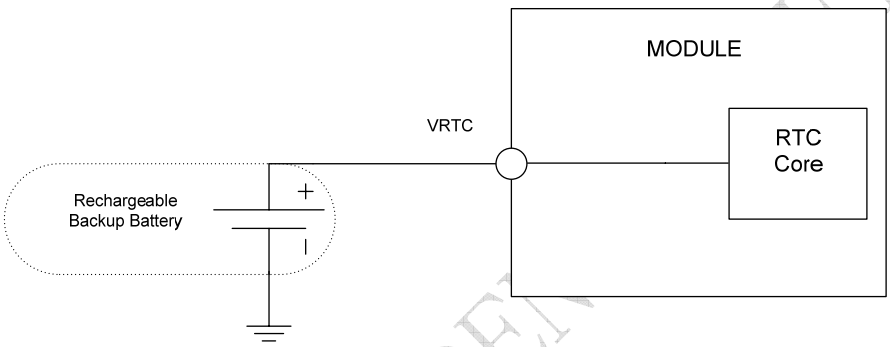


Figure 12: RTC supply from non-chargeable battery

- **Rechargeable battery backup**

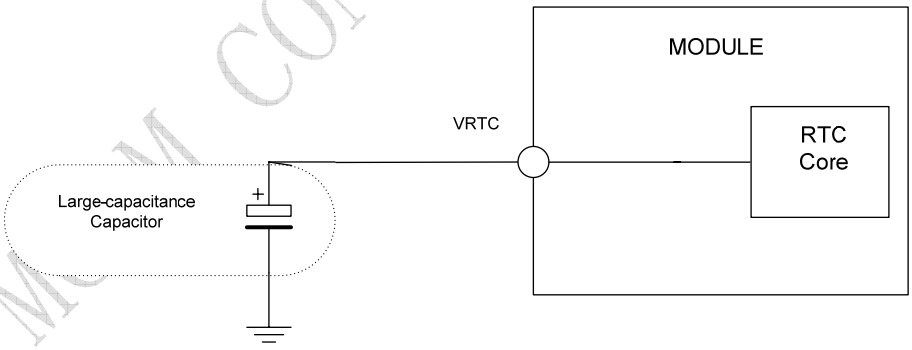


Figure 13: RTC supply from rechargeable battery

Note: The VRTC can be disabled, jus disconnect it in application circuit.

Coin-type rechargeable battery is recommended, such as XH414H-IV01E form Seiko can be used. Typical charge-discharge curves for this battery are shown in the following figure.

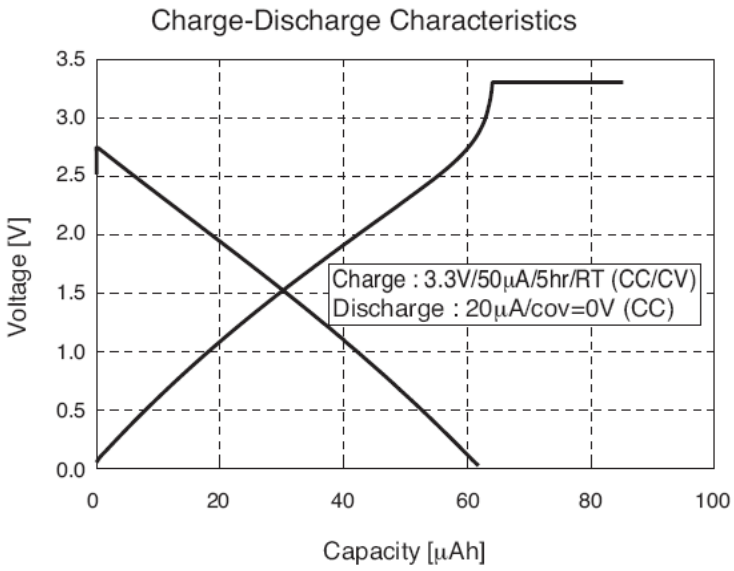


Figure 14: Seiko XH414H-IV01E Charge-Discharge characteristic

3.2 Power on/off Time Sequence

3.2.1 Power on Sequence

SIM5320AD can be powered on by POWER_ON pin, which starts normal operating mode.
POWER_ON pin is pulled up with a 200kR resistor to 1.8V in module. User can power on the SIM5320AD by pulling the POWER_ON pin down for a short time. The power-on scenarios are illustrated in the following figures.

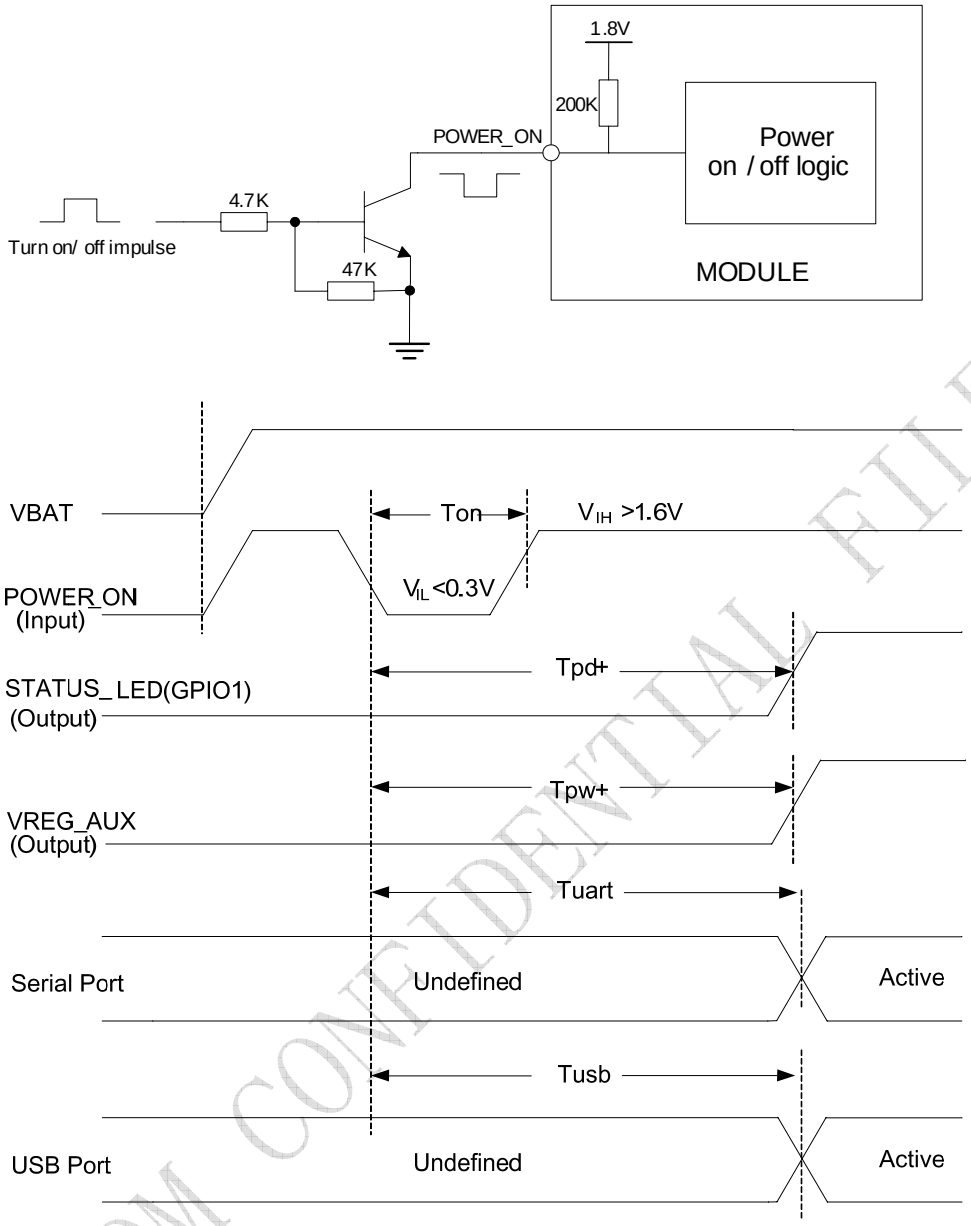


Figure 15: Power on Timing Sequence

Table 5: Power on timing

Parameter	Description	Time value	Unit
Ton	The time to pull POWER_ON down to power on	64< Ton<180	ms
TpD+	The time to indicate connecting with the network	>5.5	s
Tpw+	The time to indicate the module is powered on completely	>4.5	s
Tuart	The time to enable UART	>4.7	s
Tusb	The time to enable USB	>9	s

Automatic power on

If user needs to power on SIM5320AD automatically whenever the VBAT pins are connected to the power supply, then POWER_ON pin is just pulled to ground by a resistance in circuit directly. The following is the reference circuit.

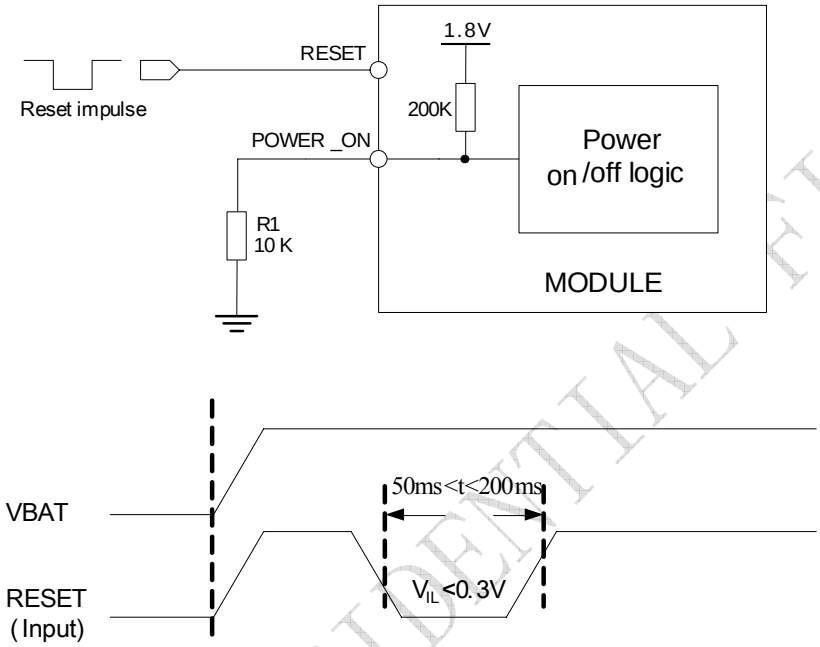


Figure 16: Application circuit

Note: After automatically powering on the module by pulling down POWER_ON pin to ground anytime, USB/UART may not communicate normally with host, so it is suggested that SIM5320AD should be reset by RESET pin.

3.2.2 Power off Sequence

The following methods can be used to power down SIM5320AD. These procedures will make module disconnect from the network and allow the software to enter a safe state, and then save data before completely powering the module off.

- Method 1: Power off SIM5320AD by pulling the POWER_ON pin down
- Method 2: Power off SIM5320AD by AT command

User can power off the SIM5320AD by pulling POWER_ON down for a specific time. The power off scenario is illustrated in the following figure.

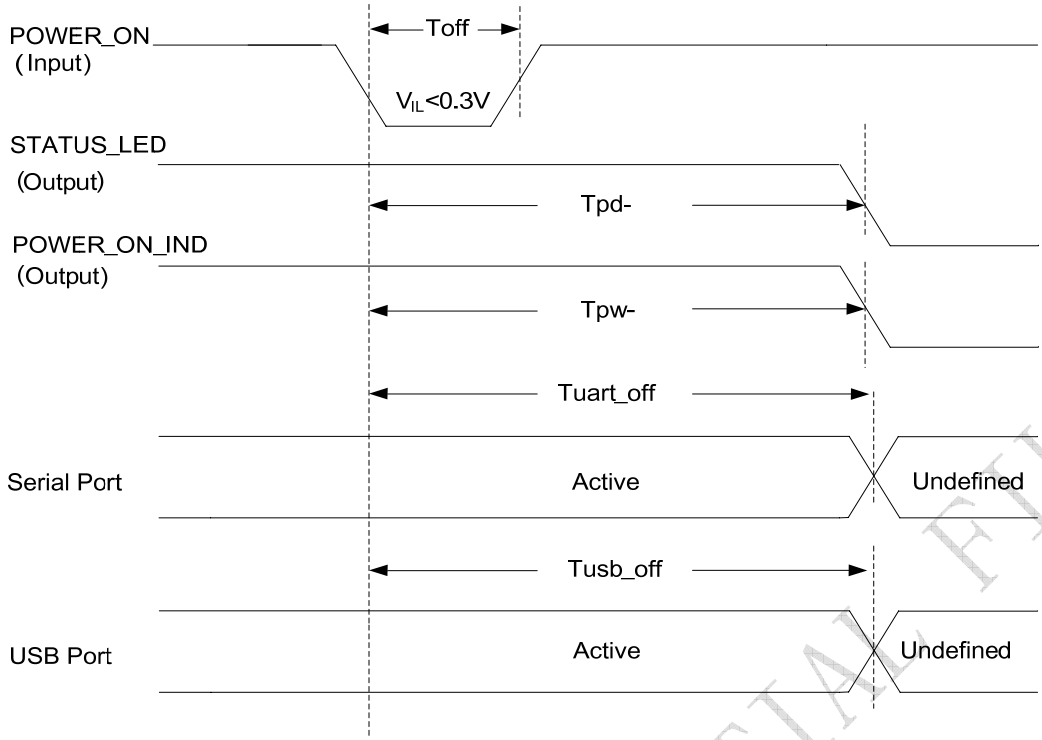


Figure 17: Power off timing sequence

Table 6: Power off timing

Parameter	Description	Time value	Unit
Toff	The time pulling POWER_ON down to power off	0.5< Toff<5	s
TpD-	The time to indicate disconnecting from the network	>7	s
Tpw-	The time to indicate the module power off completely	>7.5	s
Tuart_off	The time to disable UART	>6	s
Tusb_off	The time to disable USB	>7.5	s

User can also use the AT command "AT+CPOF" to power down the module. After that, the AT commands cannot be executed any longer. The module enters the POWER DOWN mode, only the RTC is still active. For details, refer to *Document [1]*.

3.3 UART Interface

SIM5320AD 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. The application circuit is in the following figures.

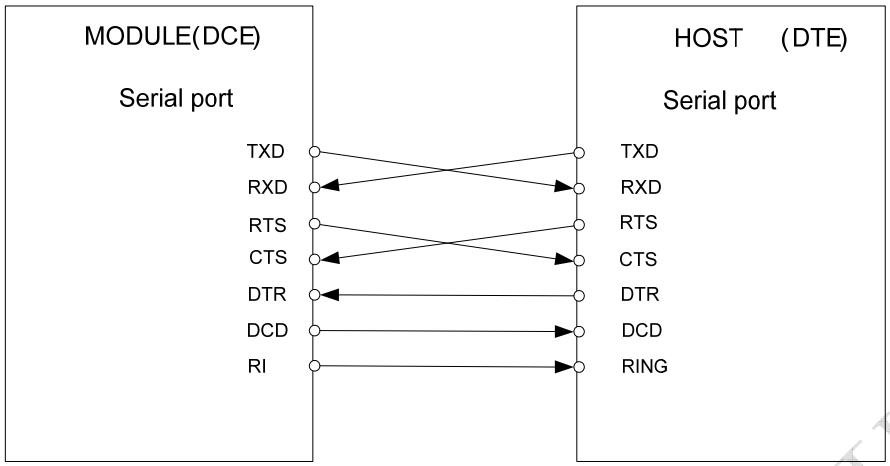


Figure 18: Full modem

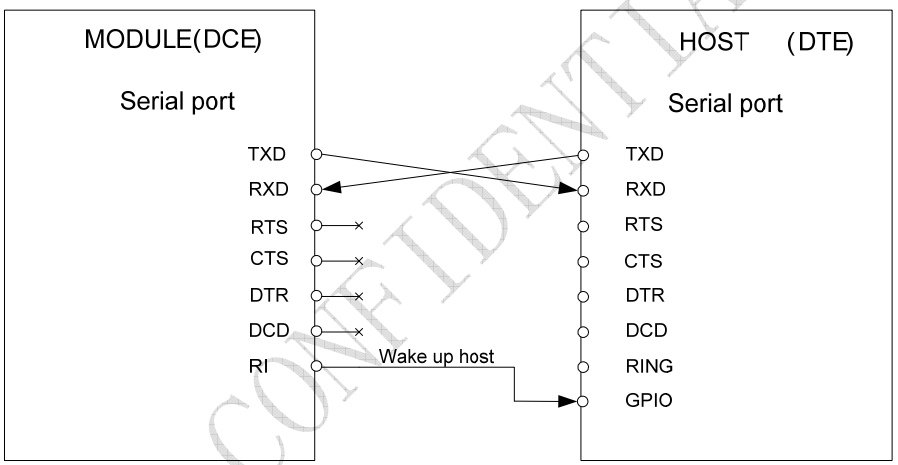


Figure 19: Null modem

3.3.1 Pin Description

Table 7: Pin description

Pin type	Pin name	Pin No.	I/O	Active voltage	Default Status
UART	UART_RXD	68	I	H	Pull-Down
	UART_TXD	71	O	H	Pull-Up
	UART_RTS	66	O	H	

	UART_CTS	67	I	H	Pull-Up
	UART_DTR	72	I	H	Pull-Up
	UART_DCD	70	O	H	
	UART_RI	69	O	H	

More pin information refers to chapter 2.2.

Table 8: Logic level

Parameter	Min	Max	Unit
Logic low input	0	0.3*VDD_EXT	V
Logic high input	0.7 *VDD_EXT	VDD_EXT +0.3	V
Logic low output	GND	0.2	V
Logic high output	VDD_EXT -0.2	VDD_EXT	V

Note: VDD_EXT (=2.6V) is e reference voltage in module internal interface.
All pins of all serial ports have 8mA driver capacity.

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.

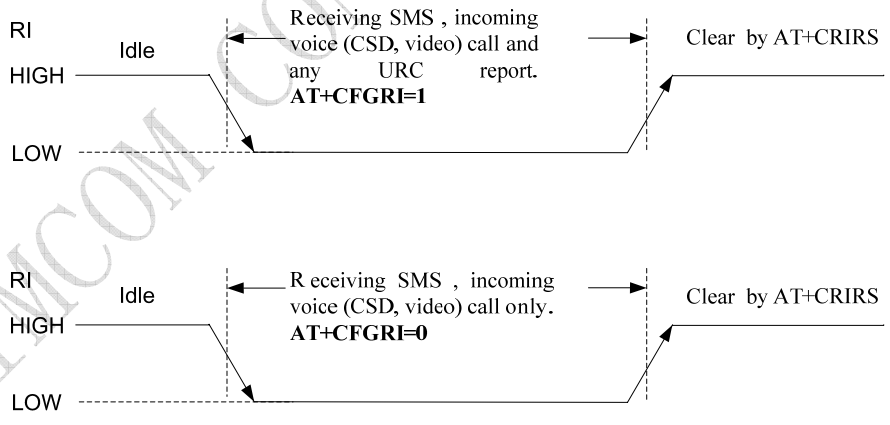


Figure 20: RI behaviour in NULL Modem

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.

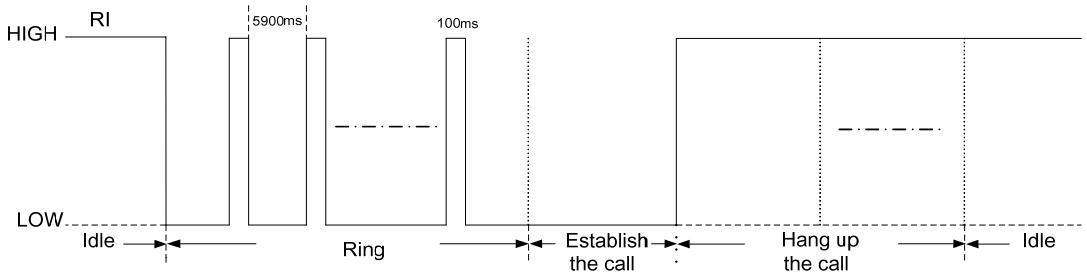


Figure 21: RI behaviour in FULL Modem

To comply with RS-232 protocol, the RS-232 level shifter chip should be used to connect SIM5320AD to the RS-232-C interface. In this connection, the TTL level and RS-232 level are converted mutually. SIMCom recommends that user uses the SP3238ECA chip with a full modem. For more information please refers to the RS-232 chip datasheet.

Note: SIM5320AD supports the communication rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600, 3200000, 3686400, 4000000bps. Default rate is 115200bps.

3.4 USIM Interface

The USIM provides the required subscription verification information to allow the mobile equipment to attach to a GSM or UMTS network. Both 1.8V and 3.0V SIM Cards are supported.

3.4.1 Pin description

Table 9: 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 10: Pin description

USIM_DATA	17	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	20	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) ESDA6V1W5 or ON SEMI (www.onsemi.com) SMF05C. 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.

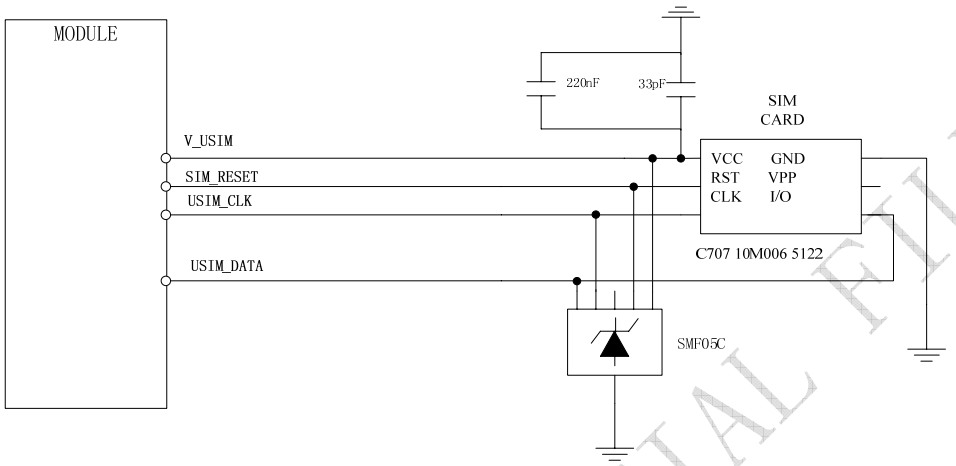


Figure 22: USIM interface reference circuit

Note: USIM_DATA has been pulled up with a 22kR resistor to V_USIM in module. A 220nF shut capacitor on V_USIM is used to reduce interference. Use AT Commands to get information in USIM card. For more detail, 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.

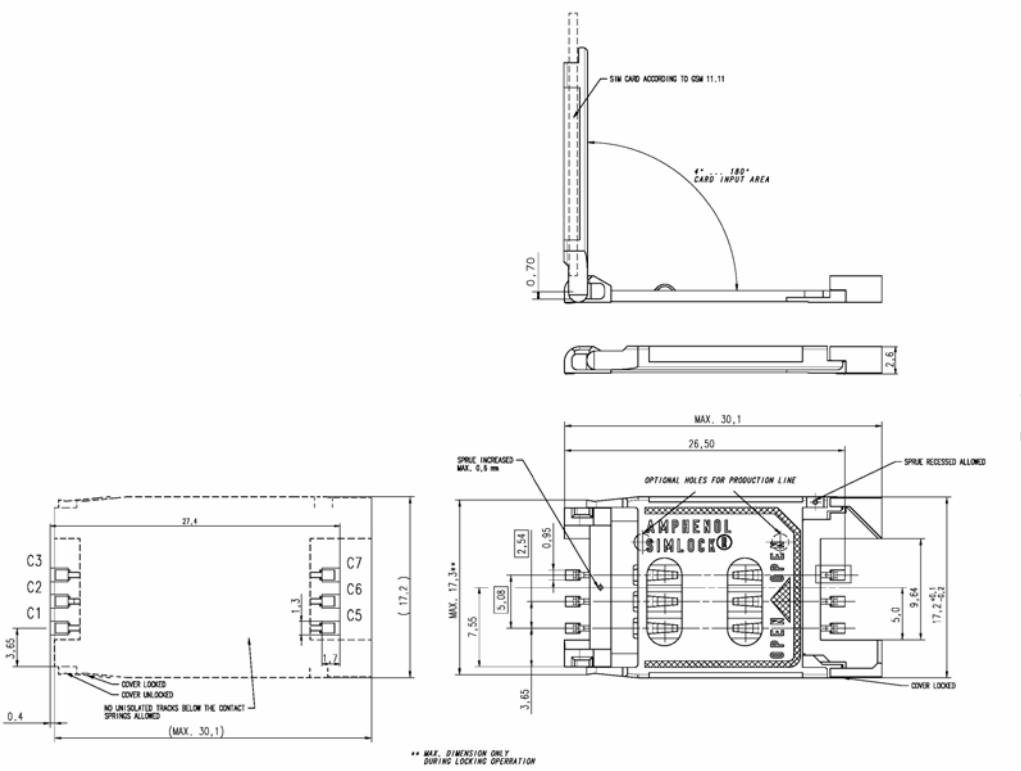


Figure 23: Amphenol SIM card socket

Table 11:: 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 12: Pin description

Pin name	Pin No.	Function
I2C_SDA	56	Serial interface data input and output
I2C_SCL	55	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 SIM5320AD, 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：I2C_SDA and I2C _SCL have been pulled up with two 2.2kR resistors to 2.6V level in module. So there is no need to pull them up in users' application circuit.

3.6 USB Interface

SIM5320AD 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 13: Electronic characteristic

Pin name	Pin No.	Input voltage scope(V)		
		Min	Typ	Max
USB_VBUS	11	4.4	5.0	5.25
USB_DP	13	They are compliant with the USB 2.0 specification.		
USB_DM	12			

3.6.1 Application Guide

Currently SIM5320AD supports the USB suspend and resume mechanism which can help to save power. If no transaction is on USB bus, SIM5320AD will enter suspend mode. When some events such as voice call or receiving SMS happen, SIM5320AD will resume normal mode automatically.

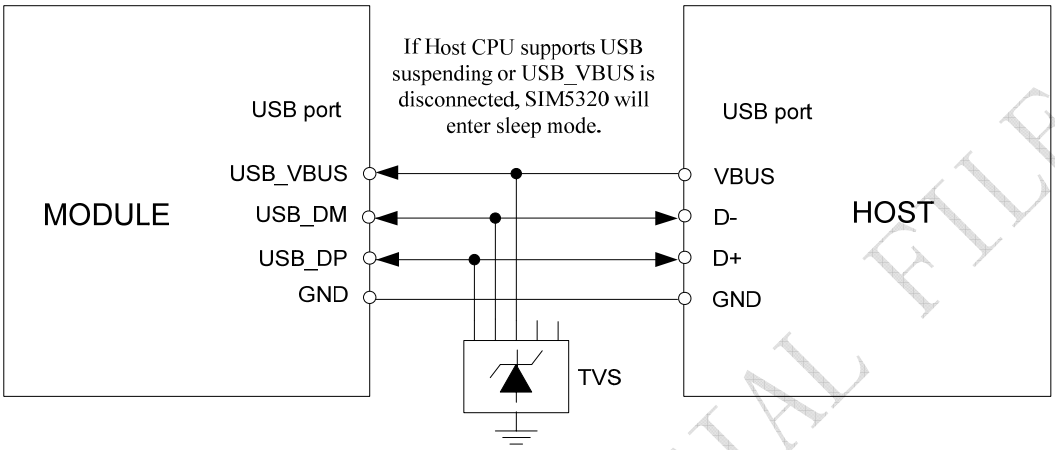


Figure 24: USB interface

Because of high bit rate on USB bus, pay attention to influence of junction capacitance of ESD component on USB data lines. Typically, the capacitance should be less than 4pF @1MHz.

Note：The SIM5320AD has two kinds of interface (UART and USB) to connect to host CPU. USB interface is mapped to five virtual ports: "SIMTECH USB Modem", "SIMTECH NMEA Device", "SIMTECH ATCOM Device", "SIMTECH Diagnostics interface" and "SIMTECH Wireless Ethernet Adapter".

3.7 SPI Interface

SPI interface of SIM5320AD is master only. It provides a duplex, synchronous, serial communication link with peripheral devices. Its operation voltage is 1.8V, with clock rates up to 26 MHz.

3.7.1 Pin Description

Table 14: Electronic characteristic

Pin name	1.8V mode		
	Min	Typ	Max
SPI_CLK	1.65	1.8	1.95
SPI_CS_N	1.65	1.8	1.95

SPI_MOMI_DATA	1.65	1.8	1.95
SPI_MIMO_DATA	1.65	1.8	1.95

Table 15: Pin description

Pin name	Pin No.	Function
SPI_CS	9	SPI chip-select; not mandatory in a point-to-point connection
SPI_MISO_DATA	7	SPI master in/slave out data
SPI_CLK	6	SPI clock
SPI_MOSI_DATA	8	SPI master out/slave in data

3.8 GPIO Interface

SIM5320AD 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.

3.8.1 Pin Description

Table 16: Electronic characteristic

Pin name	2.6V mode		
	Min	Typ	Max
GPIO1	2.5	2.6	2.7
GPIO4	2.5	2.6	2.7
GPIO40	2.5	2.6	2.7
GPIO41	2.5	2.6	2.7
GPIO43	2.5	2.6	2.7
GPIO44	2.5	2.6	2.7
GPIO42	2.5	2.6	2.7

Note: If more GPIOs need to be used, users can configure GPIO on other multiple function interfaces,. Please refer to GPIO list.

Table 17: Pin description

Pin name	Pin No.	I/O	Function
GPIO1	51	O	Output PIN as LED control for network status. If it is unused, left open.
GPIO4	54	I	Input PIN as RF operating control. H: Normal Mode L:Flight Mode If it is unused, left open.
GPIO40	49	O	Output PIN as operating status indicating of module. H: Power on L: Power off If it is unused, left open.
GPIO41	52	I/O	General input/output PIN. It can be used as wake/interrupt signal to host from module If it is unused, left open.
GPIO42	53	I/O	General Purpose Input/Output Port.
GPIO43	50	I/O	General Purpose Input/Output Port. It can be used as wake/interrupt signal to module from host. If it is unused, left open.
GPIO44	48	I/O	General Purpose Input/Output Port

Note: The output driver current of GPIOs is 1mA at the lower supply voltage and 2mA at the higher supply voltage.

3.8.2 Application Guide

Network status

GPIO1 is used to control Network Status LED; application circuit is shown below.

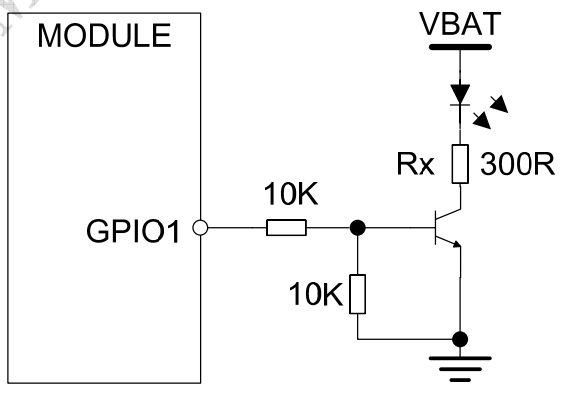


Figure 25: Application circuit

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

Table 18: LED status

LED Status	Module Status
Always On	Searching Network/Call Connect
200ms ON, 200ms OFF	Data Transmit
800ms ON, 800ms OFF	Registered network
Off	Power off / Sleep

Flight mode control

GPIO4 controls SIM5320AD module to enter or exit the Flight mode. In Flight mode, SIM5320AD closes RF function to prevent interference with other equipments or minimize current consumption. Bidirectional ESD protection component is suggested to add on GPIO4.

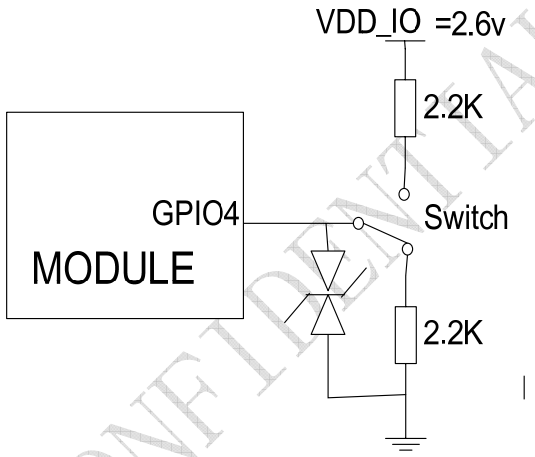


Figure 26: Flight mode switch

Table 19: Control status

GPIO4 Status	Module operation
Low Level	Flight Mode: RF is closed.
High Level	Normal Mode: RF is working.

Note：

1. When the module is powered off, make sure all digital interfaces (UART, etc) connected with peripheral devices have no voltage higher than 0.3V. If users' design cannot meet above conditions, high level voltages maybe occur in GPIO pins because current leakage from above digital interfaces may occur.

3.9 Global Positioning System

SIM5320AD merges GPS 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 GPS receivers fail, and provides a platform to enable wireless operators to address both location-based services and emergency mandates.

3.9.1 Technical specification

Tracking sensitivity	-157 dBm
Cold-start sensitivity	-144 dBm
Accuracy (Open Sky)	<2m (CEP50)
TTFF (Open Sky)	Hot start <1s Cold start 35s（good signal）/ 100s(weak signal)
Receiver Type	12-channel, GPS L1 Frequency (1575.42MHz), C/A Code
Update rate	Default 1 Hz
GPS data format	NMEA-0183
GPS Current consumption (WCDMA/GSM Sleep mode)	100mA (Total supply current)
GPS antenna	Passive/Active antenna

Note: Performance will vary depending on the environment, antenna type and signal conditions and so on.

3.9.2 Operate Mode

SIM5320AD 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 GPS observables and provides the GPS 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 GPS 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 GPS 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 GPS 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, GPS-only solutions typically perform poorly indoors. The SIM5320AD GPS solution provides optimal time to fix, accuracy, sensitivity, availability, and reduced network utilization in both of these environments, depending on the given condition.

3.9.3 Application Guide

Users can adopt an active antenna or a passive antenna as GPS signal transceiver. In this document, all GPS specification mentioned is from passive antenna. The following is the reference circuit.

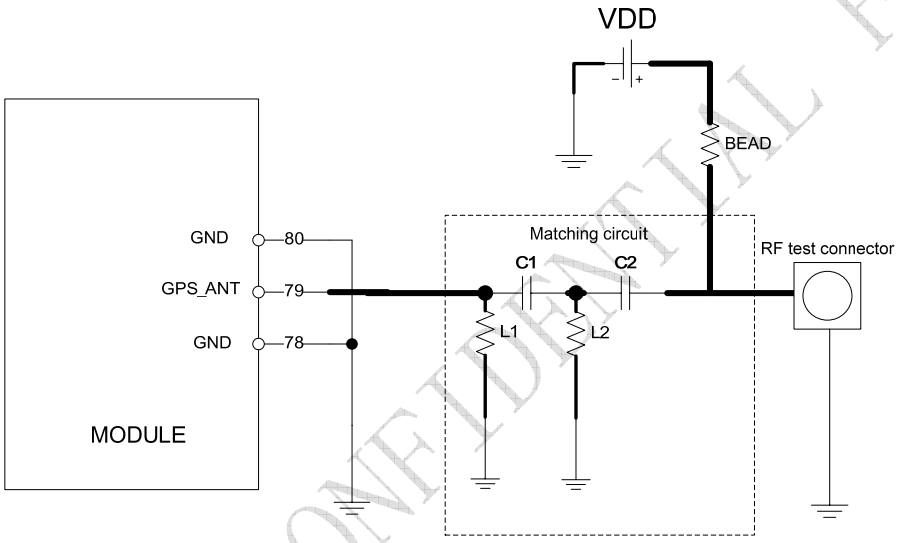


Figure 27: Active antenna circuit

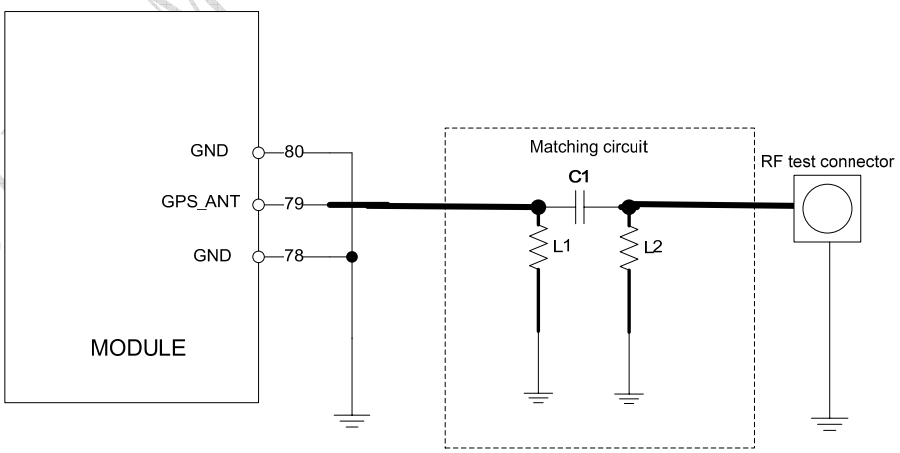


Figure 28：Passive antenna circuit (Default)

In above figures, the components C1 and L1, L2 are used for antenna matching, the values of the

components can only be obtained after the antenna tuning usually, and they are provided by antenna vendor.C2 in Figure 27 is used for DC isolation. In active antenna circuit, users must use an external LDO/DCDC to provide VDD voltage whose value should be taken according active antenna characteristic, and VDD can be shut down to avoid consuming additional current when not being used.

GPS 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 GPS, user should configure SIM5320AD in proper operating mode by AT command. Please refer to related document for details. SIM5320AD can also get position location information through AT directly.

Note:GPS 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 GPS mode. Default mode is standalone mode.
AGPS mode needs more support from the mobile telecommunication network. Refer to AGPS application document for details.

3.10 Multi-functional interface

SIM5320AD merges functions for various applications. It can enrich users' design and lower the cost of users' hardware.

3.10.1 Sink Current Source

The dedicated pin (CURRENT_SINK) is intended for driving passive devices，such as LCD backlight, this implementation is +5V tolerant and suitable for driving white LEDs. The high-current driver can maintain a constant current which is set by *the AT command "AT+ CLEDITST"*, capable of up to 150 mA.

Table 20: Electronic characteristic

Symbol	Description	Min	Typ	Max	Unit
CURRENT_SINK	Input voltage	0.5	VDD	5	V
I_O	Input current	-	-	150	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.

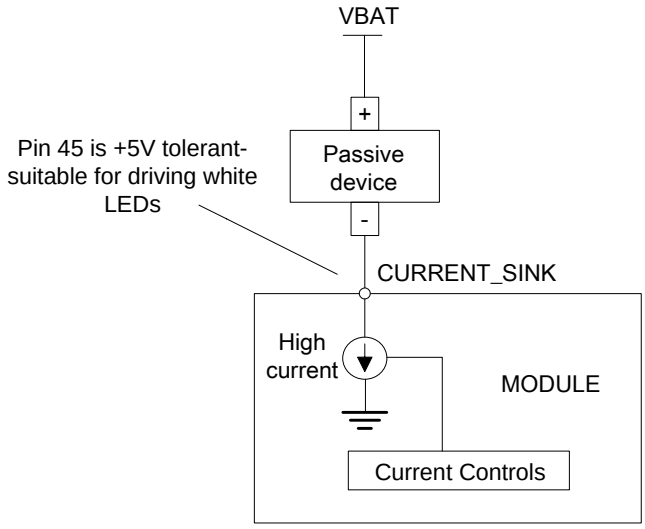


Figure 29: Current drive

Note: The sinking current can be adjusted to meet design requirement through the AT command "AT+ CLEDITST =<0>, <value>".The "value" ranges from 0 to 15,on behalf of the current changes from 0mA to 150mA in steps of 10mA.

3.10.2 Reset Function

SIM5320AD also have 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.

This pin is already pulled up in module, so the external pull-up resistor is not necessary. A 100nF capacitor close to the RESET pin is strongly recommended. A reference circuit is recommended in the following figure.

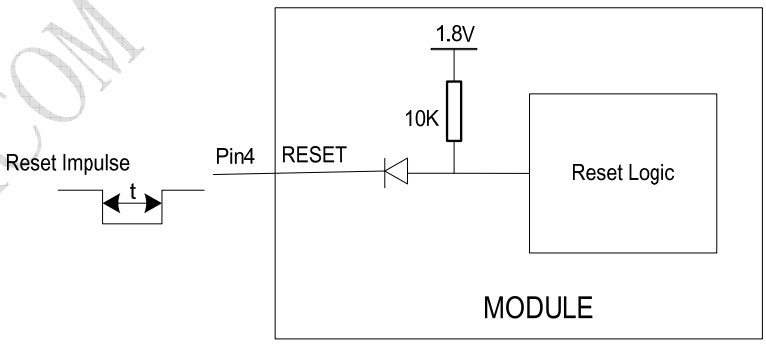


Figure 30: Reset circuit

Note：50ms<t<200ms. ESD components are suggested to be used on Reset pin.

3.10.3 ADC

SIM5320AD has a dedicated ADC that is available for digitizing analog signals such as battery voltage

and so on; it is on PIN 47 and PIN 46 , namely ADC1 and ADC2 . This ADC is 12 bit successive-approximation circuit, and electronic specification is shown in the following table.

Table 21: Electronic Characteristics

Specification	Min	Typ	Max	Unit	Comments/Conditions
Resolution		12		Bits	
Differential nonlinearity	-4		+4	LSB	Analog Vdd = ADC reference 2.4MHz sample rate
Integral nonlinearity	-8		+8	LSB	
Gain Error	-2.5		+2.5	%	
Offset Error	-4		+40	LSB	
Input Range	GND		2.2V	V	
Input serial resistance		2		kΩ	Sample and hold switch resistance
Input capacitance		53		pF	
Power-down to wakeup		9.6	19.2	μs	

User can introduce a signal in the ADC pin directly and use the AT command "AT+CADC" to get the raw data which is between 0 and 255. The data can be transformed to any type such as voltage, temperature etc. Please refer to Chapter 3.1.2 and *document [1]*.

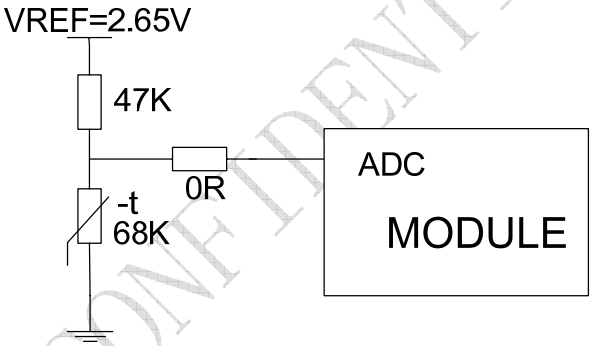


Figure 31: Reference circuit

Note: The input signal voltage value in ADC must not be higher than 2.2V.

3.10.4 LDO

SIM5320AD has a LDO power output, namely VREG_AUX. The LDO is available and output voltage is 2.85v by default, rated for 250mA. User can switch the LDO on or off by the AT command "AT+CVAUXS" and configure its output voltage by the AT command "AT+CVAUXV".

Table 22: Electronic characteristic

Symbol	Description	Min	Typ	Max	Unit
VREG_AUX	Output voltage	1.5	2.85	3.05	V
I_O	Output current	-	-	250	mA

4 RF Specification

4.1 RF Specification

Table 23: Conducted transmission power

Frequency	Max	Min
GSM850	33dBm ±2dB	5dBm ± 5dB
E-GSM900	33dBm ±2dB	5dBm ± 5dB
DCS1800	30dBm ±2dB	0dBm ± 5dB
PCS1900	30dBm ±2dB	0dBm ± 5dB
GSM850 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
E-GSM900 (8-PSK)	27dBm ±3dB	5dBm ± 5dB
DCS1800 (8-PSK)	26dBm +3/-4dB	0dBm ±5dB
PCS1900(8-PSK)	26dBm +3/-4dB	0dBm ±5dB
WCDMA 1900	24dBm +1/-3dB	-56dBm ±5dB
WCDMA 850	24dBm +1/-3dB	-56dBm ±5dB

Table 24: Operating frequencies

Frequency	Receiving	Transmission
GSM850	869 ～894 MHz	824 ～849 MHz
E-GSM900	925 ～960 MHz	880 ～915 MHz
DCS1800	1805～1880 MHz	1710～1785 MHz
PCS1900	1930～1990 MHz	1850～1910 MHz
WCDMA1900	1930～1990 MHz	1850～1910 MHz
WCDMA 850	869 ～894 MHz	824 ～849 MHz

Table 25: Conducted receive sensitivity

Frequency	Receive sensitivity
GSM850	< -106dBm
E-GSM900	< -106dBm
DCS1800	< -106dBm
DCS1800	< -106dBm
WCDMA 1900	< -108dBm
WCDMA 850	< -106dBm

4.2 Operating Specification

SIM5320AD can support high rate data by GSM/WCDMA wireless network. In the different network environment, data transmission rate shifts depending on modulation and encoding.

Table 26: GPRS/EDGE data throughout

Function	Coding schemes	1 Timeslot	2 Timeslot	4 Timeslot
GPRS	CS-1	9.05kbps	18.1kbps	36.2kbps
	CS-2	13.4kbps	26.8kbps	53.6kbps
	CS-3	15.6kbps	31.2kbps	62.4kbps
	CS-4	21.4kbps	42.8kbps	85.6kbps
EDGE	MCS-1	8.80kbps	17.6kbps	35.20kbps
	MCS-2	11.2kbps	22.4kbps	44.8kbps
	MCS-3	14.8kbps	29.6kbps	59.2kbps
	MCS-4	17.6kbps	35.2kbps	70.4kbps
	MCS-5	22.4kbps	44.8kbps	89.6kbps
	MCS-6	29.6kbps	59.2kbps	118.4kbps
	MCS-7	44.8kbps	89.6kbps	179.2kbps
	MCS-8	54.4kbps	108.8kbps	217.6kbps
	MCS-9	59.2kbps	118.4kbps	236.8kbps

Table 27: HSDPA throughout

Category	Supported	Max supported HS-DSCH codes	Theoretical max peak rate(Mbps)	Modulation
Category1		5	1.2	16QAM,QPSK
Category2		5	1.2	16QAM,QPSK
Category3		5	1.8	16QAM,QPSK
Category4		5	1.8	16QAM,QPSK
Category5	✓	5	3.6	16QAM,QPSK
Category6	✓	5	3.6	16QAM,QPSK
Category7		10	7.2	16QAM,QPSK
Category8		10	7.2	16QAM,QPSK
Category9		15	10.0	16QAM,QPSK
Category10		15	14.0	16QAM,QPSK
Category11		5	0.9	QPSK
Category12	✓	5	1.8	QPSK

Note: Actual throughout rates depend on network configuration, network loading, signal condition and so on.

4.3 Antenna Design Guide

SIM5320AD provides RF antenna interface. Customer's antenna should be located in the host board and connected to module's antenna pad through micro-strip line or other types of RF trace and the trace impedance must be controlled in 50Ω. SIMCom recommends that the total insertion loss between the antenna pad and antenna should meet the following requirements:

- GSM900/GSM850<0.5dB
- DCS1800/PCS1900 <0.9dB
- WCDMA 1900<0.9dB
- WCDMA 850<0.5dB

To facilitate the antenna tuning and certification test, a RF connector and an antenna matching circuit should be added. The following figure is the recommended circuit.

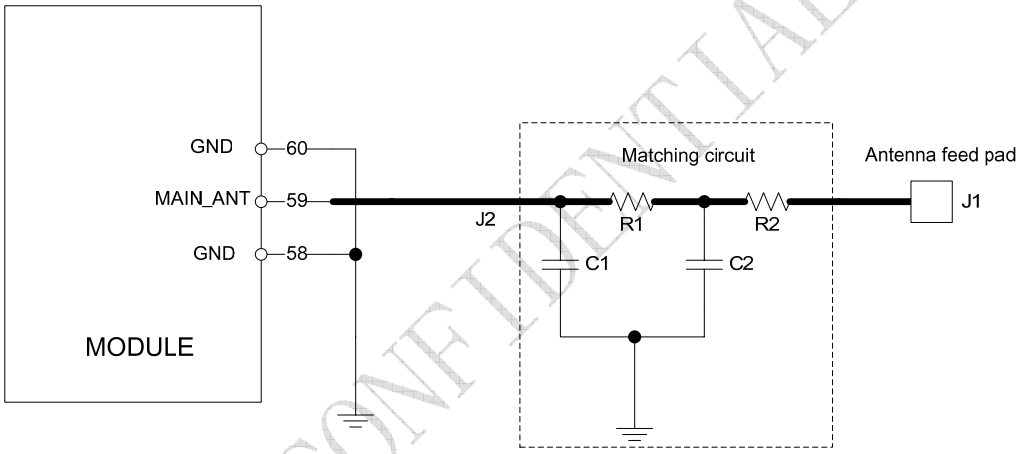


Figure 32: Antenna matching circuit

In this figure, the components R1,C1,C2 and R2 is used for antenna matching, the value of components can only be got after the antenna tuning, usually, they are provided by antenna vendor. By default, the R1, R2 are 0 ohm resistors, and the C1, C2 are reserved for tuning.

The RF test connector in the figure is used for the conducted RF performance test, and should be placed as close as to the module's antenna pin. The traces impedance between components must be controlled in 50ohm.

5 Reliability and Operating Characteristics

5.1 Electronic Characteristics

Absolute maximum rating for digital and analog pins of SIM5320AD are listed in the following table:

Table 28: Absolute maximum ratings

Parameter	Min	Max	Unit
Voltage at digital pins (1.8v mode)	-0.3	1.8+0.3	V
Voltage at digital pins (2.6v mode)	-0.3	2.6+0.3	V
Voltage at VBAT	-0.5	6.0	V
Voltage at VRTC	1.5	3.2	V
Voltage at USB_VBUS	-0.5	6.0	V

Table 29: Recommended operating ratings

Parameter	Min	Typ	Max	Unit
Voltage at digital pins (1.8v mode)	1.65	1.8	1.95	V
Voltage at digital pins (2.6v mode)	2.5	2.6	2.7	V
Voltage at VBAT	3.3	3.8	4.2	V
Voltage at VRTC	1.5	-	3.0	V
Voltage at USB_VBUS	4.75	5	5.25	V

The operating temperature and power specification is listed in the following table.

Table 30: Operating temperature

Parameter	Min	Typ	Max	Unit
Ambient temperature	-30	25	80	℃
Storage temperature	-40	25	+85	℃

Note: SIMCom recommends user to install a heat sink on the module shielding case if SIM5320AD operates in WCDMA band.

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	
Sleep mode	GSM/WCDMA SLEEP	Module will automatically enter SLEEP mode if DTR is set to high level and there is no on air or hardware interrupt (such as GPIO interrupt or data on serial port). In this case, the current consumption of module will be reduced to the minimal level. In SLEEP mode, the module can still receive paging message，voice call and SMS.
GSM	GSM IDLE	Software is active. Module has registered to the GSM network, and the module is ready to communicate.
GPRS	GPRS STANDBY	Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration.
	GPRS DATA	There is GPRS data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level), uplink/downlink data rates and GPRS configuration (e.g. used multi-slot settings).
EDGE	EDGE STANDBY	Module is ready for data transfer in EDGE mode, but no data is currently sent or received. In this case, power consumption depends on network settings and EDGE configuration
	EDGE DATA	There is EDGE data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level), uplink/downlink data rates and EDGE configuration.
WCDMA	WCDMA IDLE	Module has registered to the WCDMA network, and the module is ready to communicate.
HSDPA	HSDPA IDLE	Module is ready for data transmission, but no data is currently sent or received. Power consumption depends on network settings and HSDPA configuration
	HSDPA DATA	There is HSDPA data transfer (PPP or TCP or UDP) in progress. In this case, power consumption is related with network settings (e.g. power control level), uplink/downlink data rates and HSDPA configuration
Power down	Module can be powered down by the AT command “AT+CPOF” or the POWER_ON pin. The power management unit shuts down the power supply of the module, only the power supply of RTC is remained. The serial interface is not accessible. Operating voltage (connected to VBAT) remains applied.	
Minimum functionality mode	The AT command “AT+CFUN” 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 or the SIM card will not be accessible, or both will be closed, and the serial port is still accessible. The power consumption in this mode is very low.	

5.2.2 Minimize Power Consumption

There are two modes that SIM5320AD achieves low power consumption.

Sleep mode

If peripheral equipments stops working, and there is no on air or hardware interrupts (such as GPIO interrupts or data on UART), SIM5320AD will enter sleep mode automatically. In this mode, SIM5320AD can still receive paging，voice call or SMS from network. If USB interface of SIM5320AD is connected to host CPU, but host CPU does not support USB suspending, then SIM5320AD will not enter sleep mode. After USB is disconnected, SIM5320AD will enter sleep mode.

Note: When UART interface is connected with host CPU, SIM5320AD can not enter sleep mode until RXD is pulled down by the host CPU. If the module is in the idle mode, make sure to pull the RXD to low level by host CPU. SIMCom recommends using GPIO43 or UART_DTR to wake up the module from host CPU and to use GPIO41 or UART_RI to wake up the host CPU. Before designing, pay attention to how to realize waking function and refer to Document[24] and Document[25] for more detail.

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 SIM5320AD 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 SIM5320AD 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 Chapter3.9.2.

5.3 Current Consumption

The current consumption in suspended mode and without USB connection is listed in the table below. Here, “suspended mode” means that SIM5320AD is connected to USB bus, but it does not transfer data.

Table 32: Current consumption

GSM Sleep mode (without USB connection)	
GSM850	Sleep @DRX=2 4.5mA Sleep @DRX=5 2.7mA Sleep @DRX=9 2.3mA
GSM900	Sleep @DRX=2 4.5mA

	Sleep @DRX=5 2.7mA Sleep @DRX=9 2.3mA
DCS1800	Sleep @DRX=2 4.5mA Sleep @DRX=5 2.7mA Sleep @DRX=9 2.3mA
PCS1900	Sleep @DRX=2 4.5mA Sleep @DRX=5 2.7mA Sleep @DRX=9 2.3mA
GSM Sleep Mode (with USB suspended)	
GSM850	Sleep @DRX=2 4.6mA Sleep @DRX=5 2.8mA Sleep @DRX=9 2.5mA
GSM900	Sleep @DRX=2 4.6mA Sleep @DRX=5 2.8mA Sleep @DRX=9 2.5mA
DCS1800	Sleep @DRX=2 4.6mA Sleep @DRX=5 2.8mA Sleep @DRX=9 2.5mA
PCS1900	Sleep @DRX=2 4.6mA Sleep @DRX=5 2.8mA Sleep @DRX=9 2.5mA
DATA mode, GPRS (1 Rx,4 Tx) CLASS 12	
GSM 850	@power level #5 <660mA,Typical 488mA
GSM 900	@power level #5 <660mA,Typical 484mA
DCS1800	@power level #0 <530mA,Typical 346mA
PCS1900	@power level #0 <530mA,Typical 353mA
DATA mode, GPRS (3Rx, 2 Tx) CLASS 12	
GSM 850	@power level #5 <460mA,Typical 335mA
GSM 900	@power level #5 <440mA,Typical 332mA
DCS1800	@power level #0 <400mA,Typical 260mA
PCS1900	@power level #0 <300mA,Typical 263mA
EDGE Data	
DATA mode, EDGE(1 Rx,4 Tx) CLASS 12	
GSM 850	@power level #8 <500mA,Typical 335mA
GSM 900	@power level #8 <500mA,Typical 332mA
DCS1800	@power level #2 <450mA,Typical 291mA
PCS1900	@power level #2 <450mA,Typical 293mA
DATA mode, EDGE(3Rx, 2 Tx) CLASS 12	
GSM 850	@power level #8 <330mA,Typical 235mA
GSM 900	@power level #8 <330mA,Typical 231mA
DCS1800	@power level #2 <300mA,Typical 206mA
PCS1900	@power level #2 <300mA,Typical 209mA
UMTS Sleep Mode (without USB connection)	
WCDMA 1900	Sleep @DRX=9 2.2mA Sleep @DRX=8 2.7 mA

	Sleep @DRX=6 4.7mA
WCDMA 850	Sleep @DRX=9 2.2mA Sleep @DRX=8 2.7 mA Sleep @DRX=6 4.7mA
UMTS Sleep Mode (with USB suspended)	
WCDMA 1900	Sleep @DRX=9 2.4mA Sleep @DRX=8 2.8 mA Sleep @DRX=6 4.8mA
WCDMA 850	Sleep @DRX=9 2.4mA Sleep @DRX=8 2.8 mA Sleep @DRX=6 4.8mA
HSDPA Data	
WCDMA 1900	@Power 23dBm CQI=22 Typical 610mA @Power 21dBm CQI=5 Typical 540mA @Power -5dBm CQI=22 Typical 270mA
WCDMA 850	@Power 23dBm CQI=22 Typical 550mA @Power 21dBm CQI=5 Typical 490mA @Power -5dBm CQI=22 Typical 220mA

5.4 EMC and ESD Notes

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

Normally SIM5320AD is mounted on customer host board. Although some ESD components have been added in SIM5320AD, to prevent ESD, user 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, switches, keys, etc. The following table is the SIM5320AD ESD measurement performance; the results are from SIMCom EVB test.

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

Part	Contact discharge	Air discharge
VBAT,GND	±4KV	±6KV
UART,USB	±2KV	±6KV
Antenna port	±4KV	±6KV
Other ports	±2KV	±2KV

6 Guide for Production

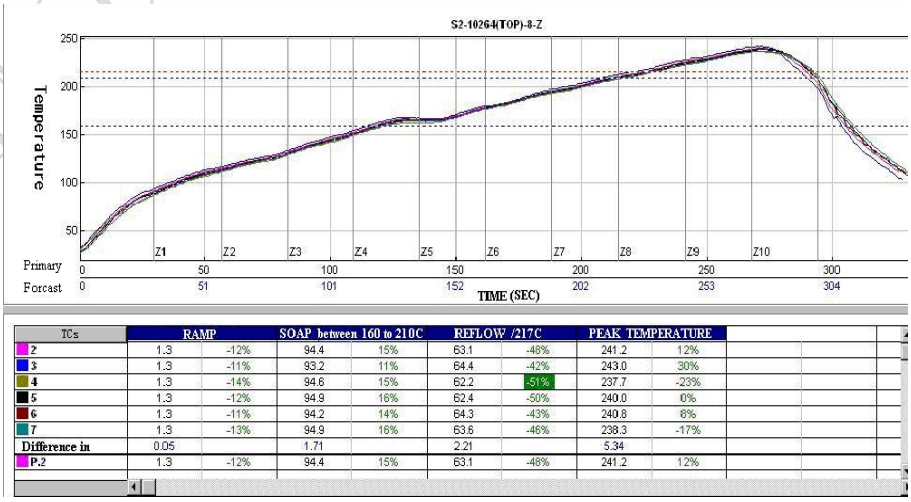
6.1 Top and Bottom View of SIM5320AD

Figure 33: Top and bottom view of SIM5320AD

These test points are only used for module manufacturing and testing. They are not for customer's application.

6.2 Typical Solder Reflow Profile

For customer convenience, SIMCom provides a typical example for a commonly used soldering profile. In final board assembly, the typical solder reflow profile will be determined by the largest component on the board, as well as the type of solder/flux used and PCB stack-up. Therefore the soldering profile shown below is only a generic recommendation and should be adjusted to the specific application and manufacturing constraints.



TCs	RAMP		SOAP between 160 to 210C		REFLOW /217C		PEAK TEMPERATURE	
2	1.3	-12%	94.4	15%	63.1	-48%	241.2	12%
3	1.3	-11%	93.2	11%	64.4	-42%	243.0	30%
4	1.3	-14%	94.6	15%	62.2	-51%	237.7	-23%
5	1.3	-12%	94.9	16%	62.4	-50%	240.0	0%
6	1.3	-11%	94.2	14%	64.3	-43%	240.8	8%
7	1.3	-13%	94.9	16%	63.6	-46%	238.3	-17%
Difference in	0.05		1.71		2.21		5.34	
P.2	1.3	-12%	94.4	15%	63.1	-48%	241.2	12%

Figure 34: The ramp-soak-spike reflow profile of SIM5320AD

For details about secondary SMT, please refer to *document [23]*.

6.3 Moisture Sensitivity Level (MSL)

SIM5320AD is qualified to Moisture Sensitivity Level (MSL) 5 in accordance with JEDEC J-STD-020. After the prescribed time limit exceeded, users should bake modules for 192 hours in drying equipment (<5% RH) at 40° C +5° C/-0° C, or 72 hours at 85° C +5° C/-5° C. Note that plastic tray is not heat-resistant, users must not use the tray to bake at 85° C or the tray may be damaged.

6.4 Stencil Foil Design Recommendation

The recommended thickness of stencil foil is more than 0.15mm.

6.5 Recommended Pad Design

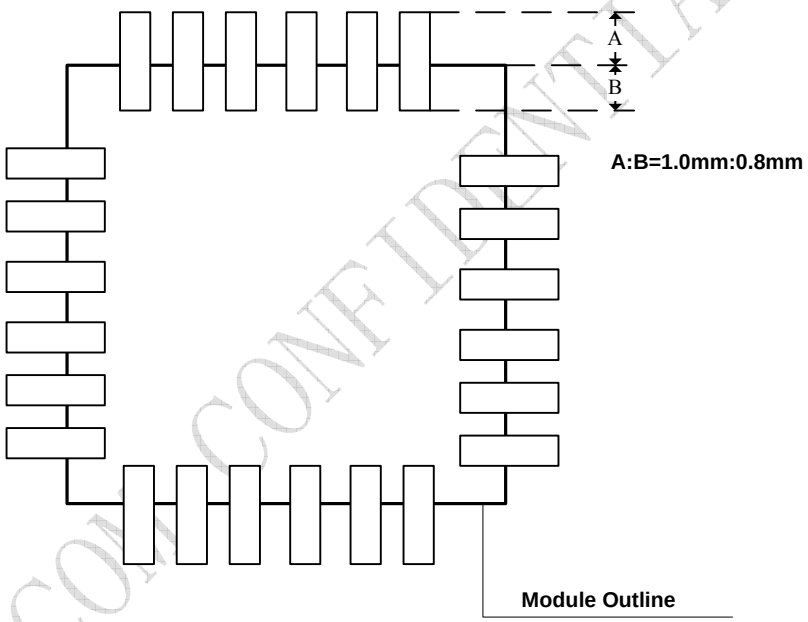


Figure 35: Recommended pad

Note: More designing details refer to Figure 6.

Appendix

A. System Design

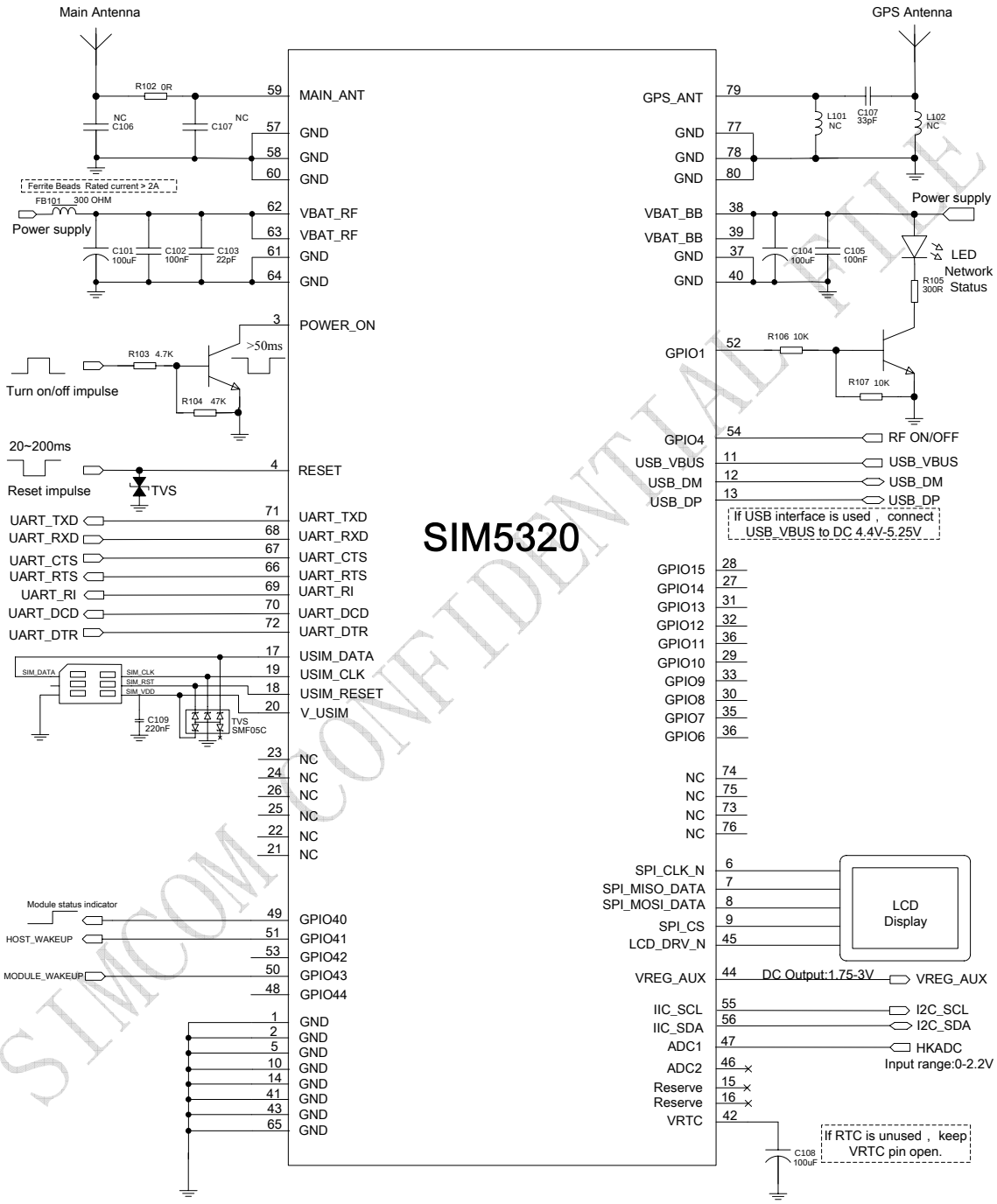


Figure 36: System design

B. SIM5320AD GPIOs List

Table 34: SIM5320AD GPIOs list

Name	GPIO Index	Default Function	Alternate Function
STATUS_LED	1	Status led	GPIO
RF_SWITCH	4	RF Switch	Enable/Disable RF subsystem
GPIO6	6	Keypad	GPIO
GPIO7	7	Keypad	GPIO
GPIO8	8	Keypad	GPIO
GPIO9	9	Keypad	GPIO
GPIO10	10	Keypad	GPIO
GPIO11	11	Keypad	GPIO
GPIO12	12	Keypad	GPIO
GPIO13	13	Keypad	GPIO
GPIO14	14	Keypad	GPIO
GPIO15	15	Keypad	GPIO
UART1_CTS	33	CTS	GPIO
UART1_RFR	34	RTS	GPIO
UART1_DTR	35	DTR wake up module	GPIO
UART_DCD	36	DCD	GPIO
UART_RI	37	RI wake up host	GPIO
GPIO40	40	Module power up status	GPIO
GPIO41	41	Wake up host	GPIO
GPIO42	42	GPIO	GPIO
GPIO43	43	Wake up module	GPIO
GPIO44	44	GPIO	GPIO

C. Digital I/O Characteristics

Table 35: Digital I/O characteristics

Parameter	Description	2.6V Mode			1.8V Mode			Unit
		Min	Typ	Max	Min	Typ	Max	
V_{IH}	High-level input voltage	1.69	2.6	2.9	1.17	1.8	2.1	V
V_{IL}	Low-level input voltage	-0.3	0	0.91	-0.3	0	0.63	V
V_{OH}	High-level output voltage	1.17	2.6	2.6	0.81	1.8	1.8	V
V_{OL}	Low-level output voltage	0	0	0.45	0	0	0.45	V

I_{IH}	Input high leakage current	-	-	1	-	-	1	uA
I_{IL}	Input low leakage current	-1	-	-	-1	-	-	uA
C_{IN}	Input capacitance	-	-	7	-	-	7	pF

Note: These parameters are for digital interface pins, such as keypad, GPIO, I²C, UART, SPI and DEBUG. The SIM5320AD includes two kinds of voltages: 1.8v and 2.6v. Digital I/O specifications under both conditions are presented in the above tables.

D. Related Documents

Table 36: Related documents

SN	Document name	Remark
[1]	SIM5320AD_ATC_V1.00	SIM5320AD_ATC_V1.00
[2]	ITU-T Draft new recommendationV.25ter	Serial asynchronous automatic dialing and control
[3]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[4]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[5]	GSM 07.05	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[6]	GSM 11.14	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[7]	GSM 11.11	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[8]	GSM 03.38	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[9]	GSM 11.10	Digital cellular telecommunications system (Phase 2)； Mobile Station (MS) conformance specification； Part 1: Conformance specification
[10]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[11]	3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
[12]	3GPP TS 34.121	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.

[13]	3GPP TS 34.123-1	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
[14]	3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
[15]	EN 301 908-02 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000. Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive
[16]	EN 301 489-24 V1.2.1	Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
[17]	IEC/EN60950-1(2001)	Safety of information technology equipment (2000)
[18]	3GPP TS 51.010-1	Digital cellular telecommunications system (Release 5); Mobile Station (MS) conformance specification
[19]	GCF-CC V3.23.1	Global Certification Forum - Certification Criteria
[20]	2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
[21]	*Sleep_Application_Note*	*Sleep_Application_Note*
[22]	*Waking_up_Application_Note*	*Waking_up_Application_Note*
[23]	Module secondary-SMT-UGD	SMT Note

E. Terms and Abbreviations

Table 37: 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

F. Safety Caution

Table 38: 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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