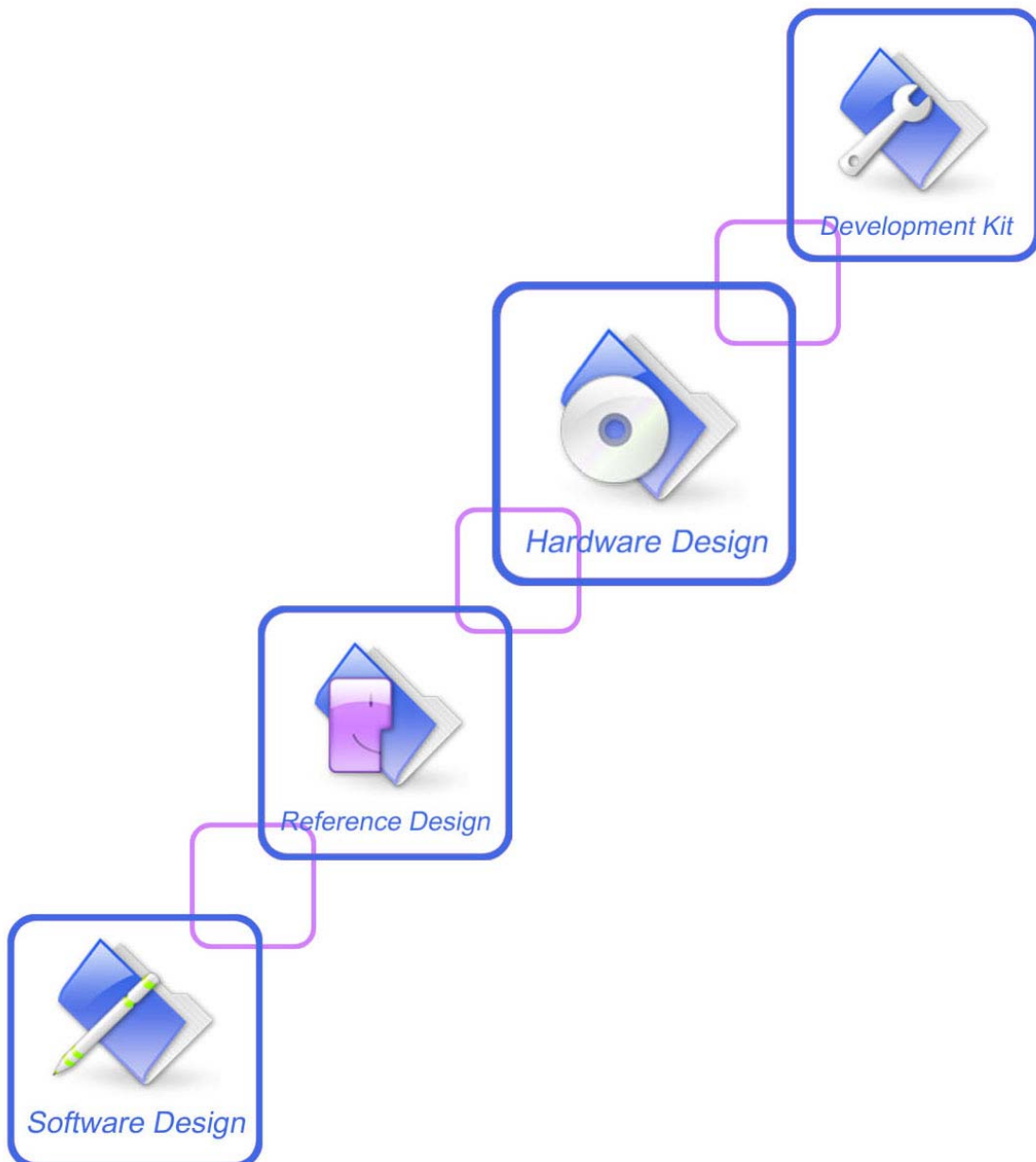




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SIM5215/SIM5216_Hardware Design_V2.00

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Revision History

Data	Version	Description of change	Author
2010-4-26	01.00	Origin	
2010-07-19	01.01	Add RESET timing and module is waked up by DTR signal description, modify the description of PCM interface	libing
2010-08-26	01.02	Add firmware update description	libing
2011-3-17	2.00	Arrange new structure	Xiaoyangyang

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1 Introduction

This document describes electronic specifications, RF specifications, function interface, mechanical characteristic and testing conclusions of the SIMCom SIM5215/SIM5216 module. With the help of this document and other SIM5215/SIM5216 software application notes, user guides, users can quickly understand and use SIM5215/SIM5216 module to design and develop applications quickly.

1.1 Product Outline

Designed for global market, SIM5215/SIM5216 is a GSM/GPRS/EDGE and UMTS /HSDPA that works on frequencies of GSM 850MHz, EGSM 900 MHz, DCS 1800 MHz, PCS 1900MHz and WCDMA 2100/900MHz, 2100/850 MHz or 1900/850MHz. User can choose the module based on the wireless network configuration. In this document, the entire radio band configuration of SIM5215/SIM5216 series is described in the following table.

Table 1: SIM5215/SIM5216 series frequency bands

Standard	Frequency	SIM5215/6E	SIM5215/6J	SIM5215/6A
GSM	GSM 850MHz	✓	✓	✓
	EGSM 900MHz	✓	✓	✓
	DCS1800MHz	✓	✓	✓
	PCS1900MHz		✓	✓
WCDMA	850MHz		✓	✓
	900MHz	✓		
	1900MHz			✓
	2100MHz	✓	✓	
HSPA	HSDPA (only SIM5216)	✓	✓	✓
	HSUPA			

With a tiny configuration of 36*26*4.5 mm and integrated functions, SIM5215/SIM5216 can meet almost any space requirement in users' application, such as Smart phone, PDA phone, industrial handhelds, machine-to-machine, vehicle applications, etc..

There is a 70 pins B2B connector on SIM5215/SIM5216, 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
- Analog Audio Interfaces
- SIM Interface
- GPIO
- ADC
- LDO Power Output
- Camera Interface
- PCM Interface
- SDIO Interface
- RTC
- I2C Interface

1.3 Hardware Diagram

The global architecture of the SIM5215/SIM5216 Embedded module is described in the figure below.

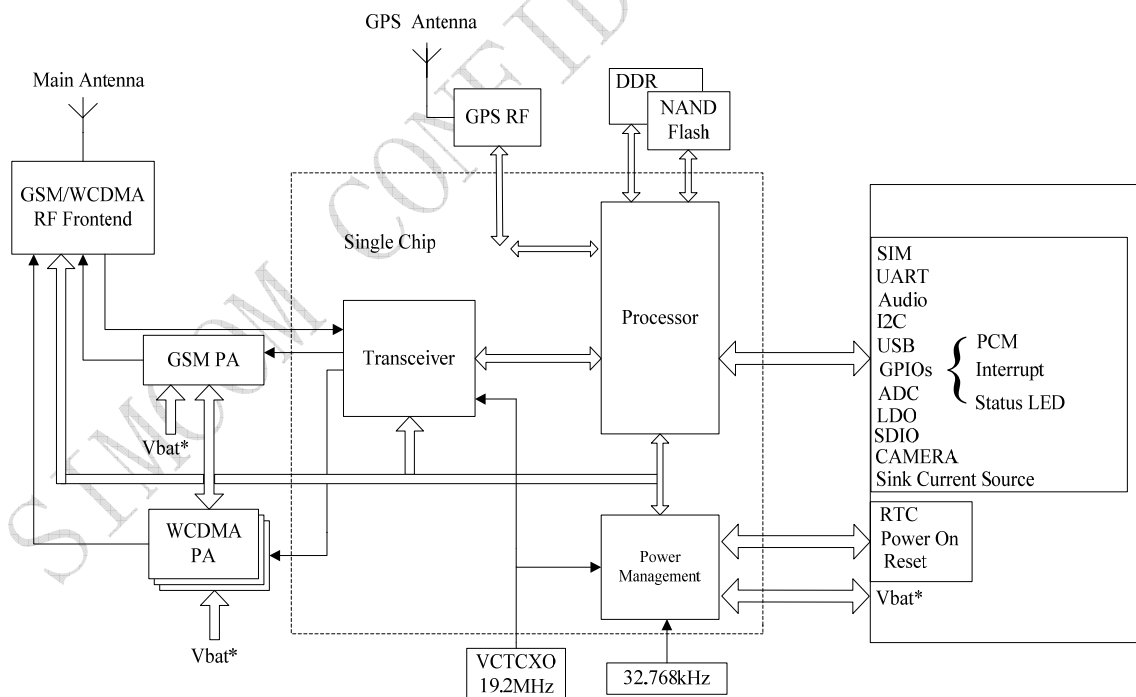


Figure 1: SIM5215/SIM5216 functional architecture

1.4 Functional Overview

Table 2: General Feature

Feature	Implementation
Power supply	Single supply voltage 3.3~4.2V
Transmission data	<ul style="list-style-type: none"> ● 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
SMS	<ul style="list-style-type: none"> ● 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.
Audio features(optional)	Speech codec modes: <ul style="list-style-type: none"> ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● AMR (WCDMA) ● AMR+QCP (GSM) ● A5/1, A5/2, and A5/3 ciphering
Serial interface	<ul style="list-style-type: none"> ● 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:36*26*4.5mm Weight:7g
Firmware upgrade	Firmware upgrade over USB interface
PCM	Multiplex on GPIOs. 3 kinds of coding formats: 8 bit (u-law or A-law) and 16 bit (linear).
Temperature range	<ul style="list-style-type: none"> ● 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 SIM5215/SIM5216 to customers' application platform are through a 70 pins B2B connector. Figure 2 is SIM5215/SIM5216 outline diagram.

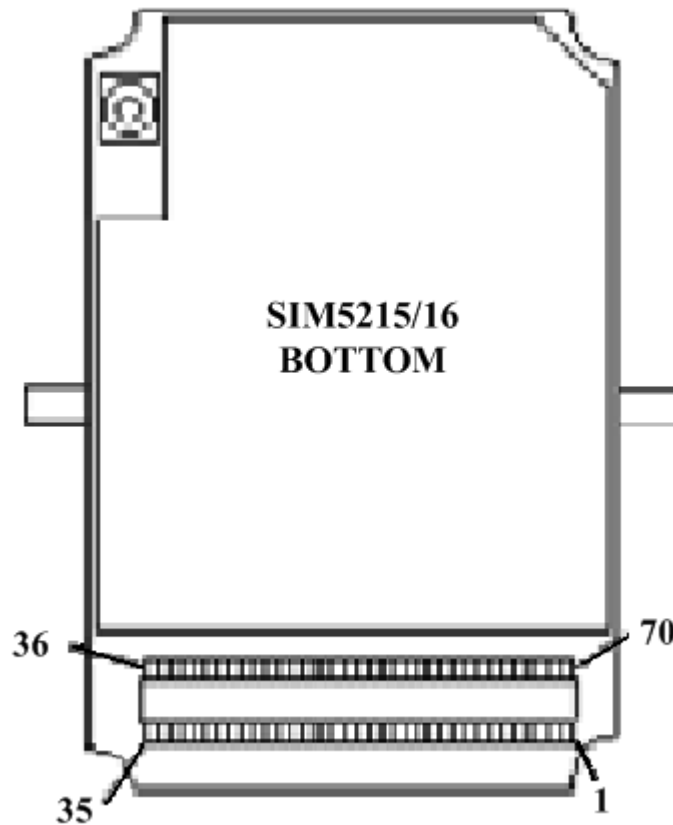


Figure 2: Pin view

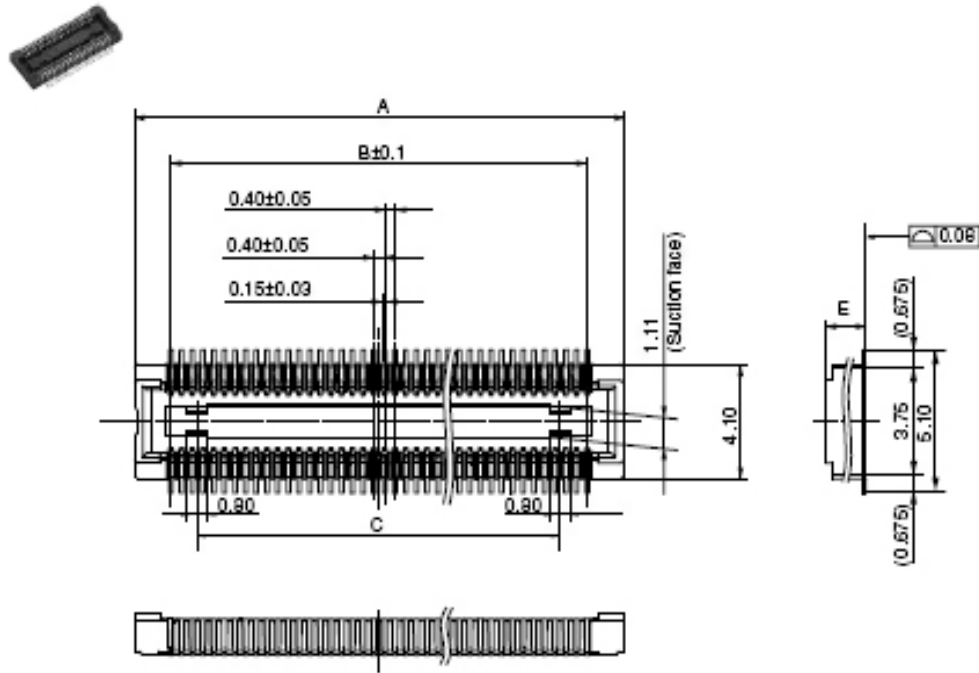


Figure: Board to Board connector jack (NAIS AXK770247G)

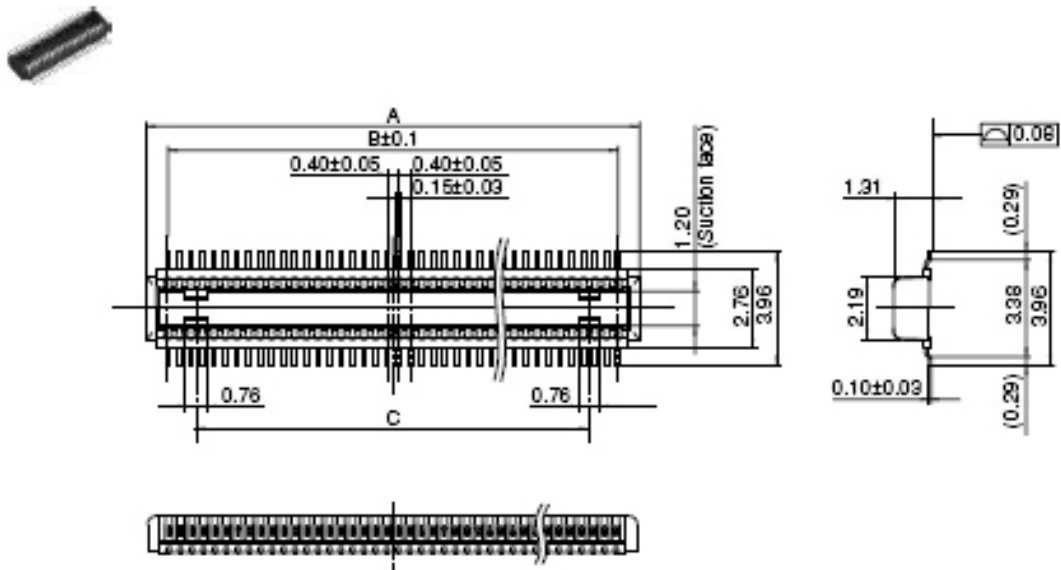


Figure: Board to Board connector pin (NAIS AXK870145W)

Note: We recommend users to adopt the board to board connector jack (NAIS AXK770247G) to connect with SIM5215/SIM5216 (NAIS AXK870145W).

Table 3: Pin definition

Pin No.	Define	Pin No.	Define
1	VBAT	70	VBAT
2	VBAT	69	VBAT
3	VBAT	68	VBAT
4	GND	67	GND
5	GND	66	GND
6	UART_TXD	65	GPIO0
7	UART_CTS	64	UART_RXD
8	UART_DCD	63	UART_RTS
9	USB_VBUS	62	UART_DTR
10	GPIO1	61	UART_RI
11	VRTC	60	USB_D_P
12	USIM_CLK	59	USB_D_M
13	USIM_RESET	58	GND
14	Reserved	57	V_USIM
15	CAM_D2	56	USIM_DATA
16	CAM_D4	55	Reserved
17	CAM_D6	54	CAM_D3
18	CAM_D8	53	CAM_D5
19	CAM_HSYNC	52	CAM_D7
20	GND	51	CAM_D9
21	CAM_CLK	50	CAM_VSYNC
22	CAM_STANDBY	49	CAM_PCLK
23	SPK_P	48	CAM_RESET
24	SPK_N	47	IIC_SDA
25	EAR_P	46	IIC_SCL
26	EAR_N	45	POWER_ON
27	HPR	44	MIC_N
28	HPL	43	MIC_P
29	RESET	42	HP_MICP
30	GPIO2	41	HKADC
31	GPIO3	40	VREG_AUX
32	GPIO4	39	SD_DATA3
33	GPIO5	38	SD_DATA2

34	SD_CLK	37	SD_DATA1
35	SD_CMD	36	SD_DATA0

2.2 Pin description

Table 4: Pin description

Pin name	I/O	Description	Comment
Power Supply			
VBAT		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.	
Audio interface			
MIC_P	I	Differential audio input	If it is unused, connect to ground through a 100N capacitor.
MIC_N			
HP_MICP	I	Single audio input	
EAR_P	O	Differential audio output	If these pins are unused, keep open.
EAR_N			
HPR	O		
HPL			
SPK_P	O		
SPK_N			
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	
SDIO interface			
SD_CLK	O	SDIO clock	If it is unused, keep open.
SD_CMD	I/O	SDIO command	
SD_DATA0	I/O	SDIO data	
SD_DATA1	I/O	SDIO data	
SD_DATA2	I/O	SDIO data	

SD_DATA3	I/O	SDIO data	
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 22kR 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	
Camera interface			
CAM_CLK	O	Camera clock	All camera pins can be configured as GPIOs. If it is unused, keep open.
CAM_PCLK	I	Camera pixel clock	
CAM_VSYNC	I	Horizontal synchronization	
CAM_HSYNC	I	Vertical synchronization	
CAM_STANDBY	O	Power down control	
CAM_RESET	O	Reset control	
CAM_D2	I	Data bit 0 (YUV or RGB)	
CAM_D3	I	Data bit 1 (YUV or RGB)	
CAM_D4	I	Data bit 2 (YUV or RGB)	
CAM_D5	I	Data bit 3 (YUV or RGB)	
CAM_D6	I	Data bit 4 (YUV or RGB)	
CAM_D7	I	Data bit 5 (YUV or RGB)	
CAM_D8	I	Data bit 6 (YUV or RGB)	
CAM_D9	I	Data bit 7 (YUV or RGB)	
PCM interface			
PCM_DIN/GPIO0	I	General Input PIN with module wake/interrupt. It also can be multiplexed as the PCM_DIN pin.	If it is unused, keep open.
PCM_SYNC/GPIO2	I	General Input PIN. It also can be multiplexed as the PCM_SYNC pin.	
PCM_CLK/GPIO3	O	General Output PIN. It also can be multiplexed as the PCM_CLK pin.	

PCM_DOUT/GPIO5	O	General Output PIN. It also can be multiplexed as the PCM_DOUT pin.	
GPIO			
GPIO1	O	Output PIN as LED control for network status.	If it is unused, keep open.
Other interface			
RESET	I	System reset in, active low.	Refer to 3.13
HKADC	I	Analog Digital Converter Input	Refer to 3.13
VREG_AUX	O	LDO output	

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2.3 Package Dimensions

The following figure shows mechanical dimensions of SIM5215/SIM5216.

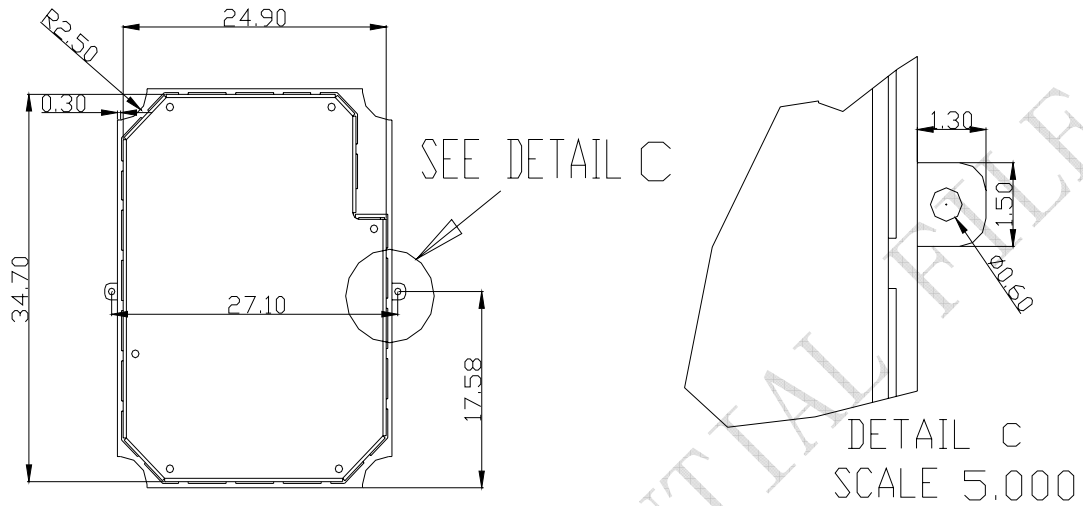


Figure 3: Top dimensions (Unit: mm)

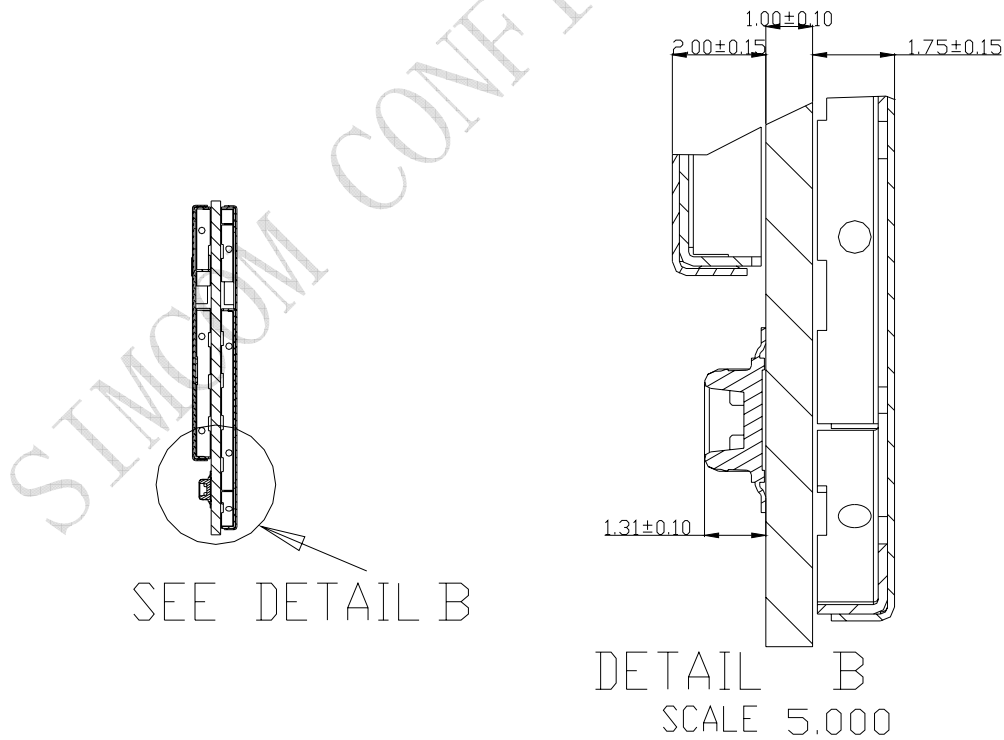


Figure 4: Side dimensions (Unit: mm)

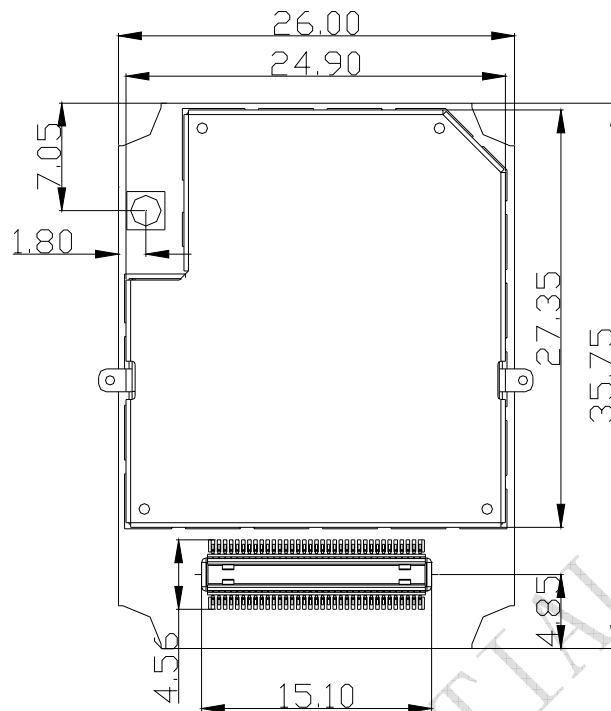


Figure 5: Bottom dimensions (Unit: mm)

3 Application Interface Specification

3.1 Power Supply

The power supply pins of SIM5215/SIM5216 include six VBAT pins. VBAT directly supplies the power to RF PA and baseband system. For the VBAT, 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 voltage ripple wave at the maximum power transmit phase.

The test condition: VBAT =4.0V, VBAT maximum output current =2A, $C_A=100 \mu\text{F}$ tantalum capacitor (ESR=0.7 Ω) and $C_B=1\mu\text{F}$ (Please refer to Figure 8—Application circuit).

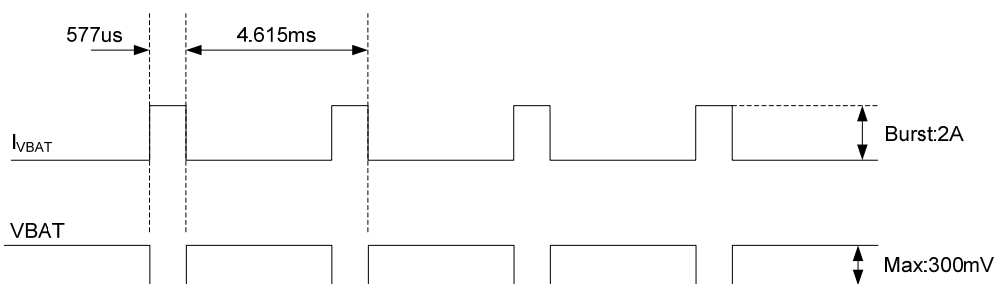


Figure 6: VBAT voltage drop during burst emission (GSM/GPRS)

3.1.1 Power Supply Pin

Six VBAT pins are dedicated to connect the supply voltage.

Table 5: Pin description

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

Note: 1. 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

Make sure that the input voltage at the VBAT 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 large tantalum capacitors (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, some multi-layer ceramic chip (MLCC) capacitors (0.1/1uF) 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 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.

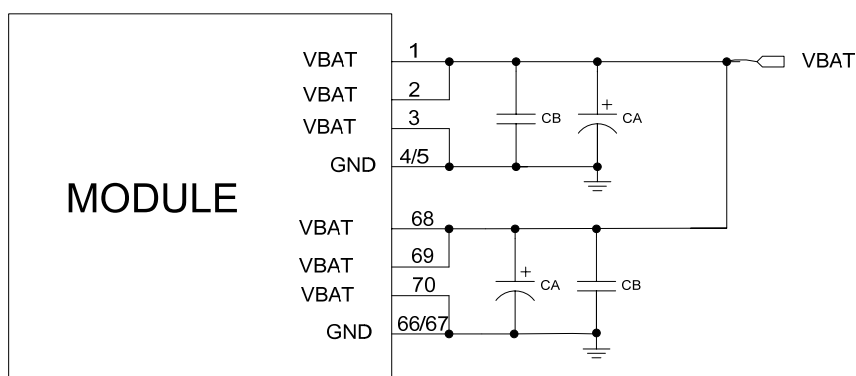


Figure 7: VBAT input application circuit

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.

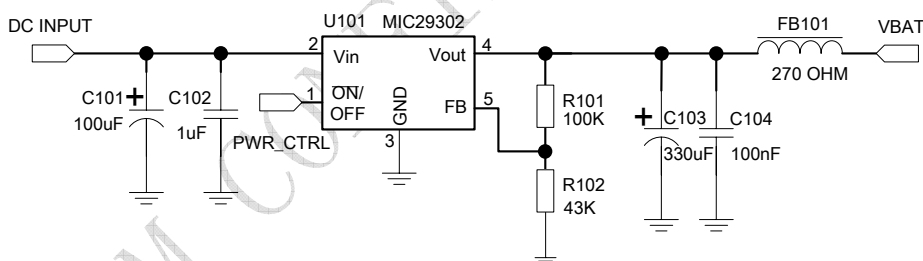


Figure 8: Reference circuit of the LDO power supply

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.

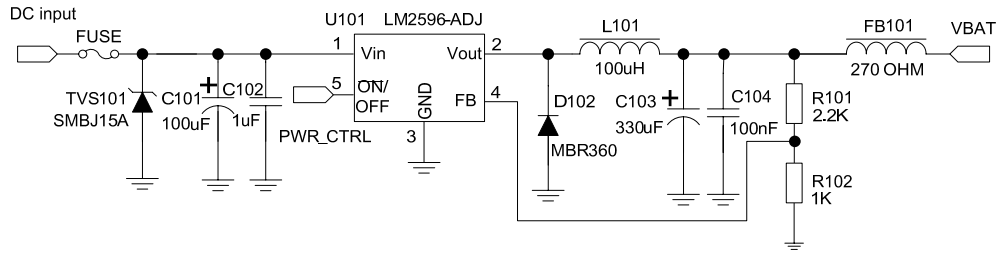


Figure 9: Reference circuit of the DCDC power supply

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 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**

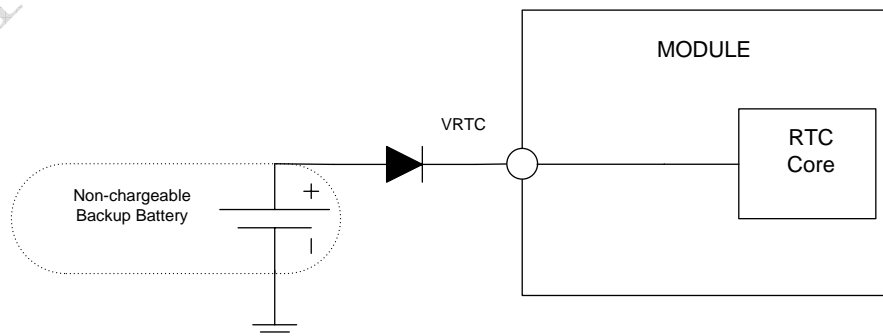


Figure 10: RTC supply from capacitor

- **Non-chargeable battery backup**

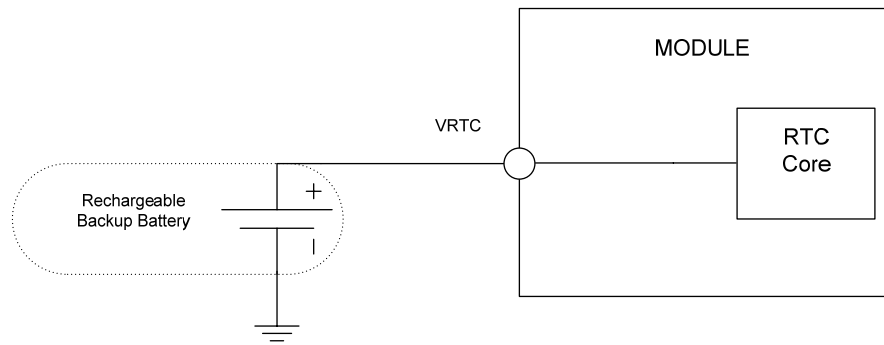


Figure 11: RTC supply from non-chargeable battery

- **Rechargeable battery backup**

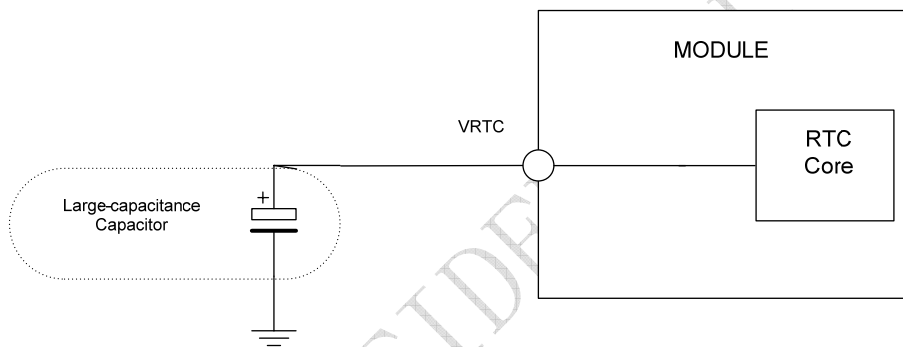


Figure 12: RTC supply from rechargeable battery

Note: The VRTC can be disabled, just 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.

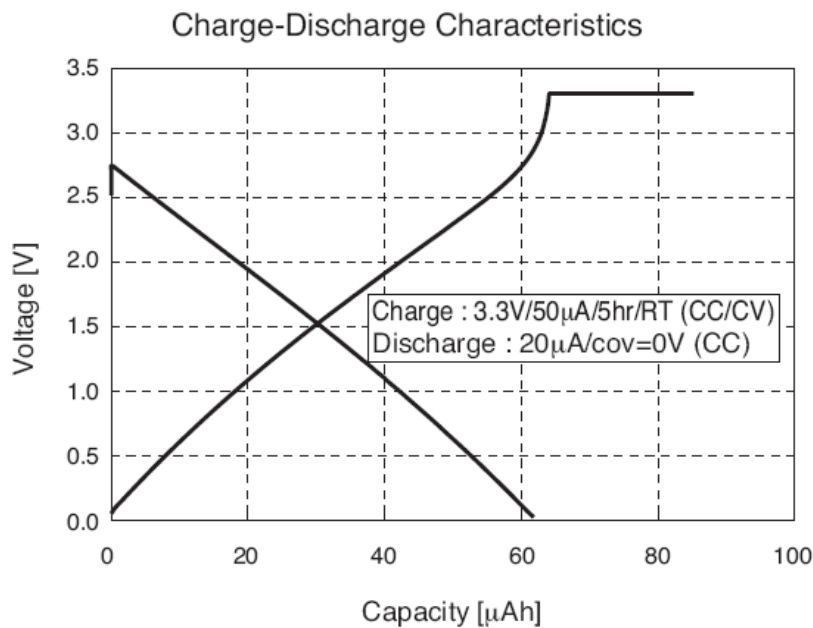


Figure 13: Seiko XH414H-IV01E Charge-Discharge characteristic

3.2 Power on/off Time Sequence

3.2.1 Power on Sequence

SIM5215/SIM5216 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 SIM5215/SIM5216 by pulling the POWER_ON pin down for a short time. The power-on scenarios are illustrated in the following figures.

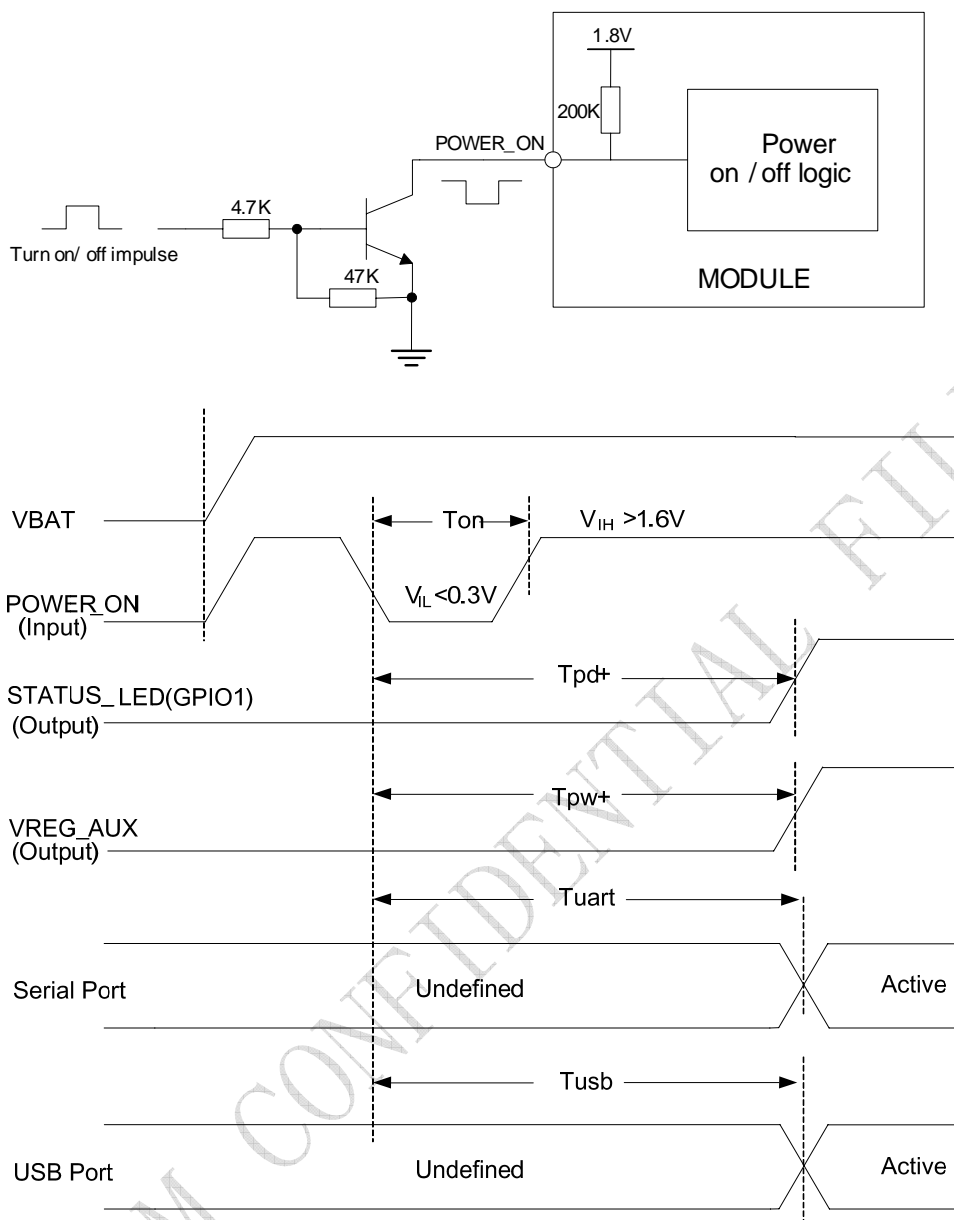


Figure 14: Power on Timing Sequence

Table 6: 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 SIM5215/SIM5216 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.

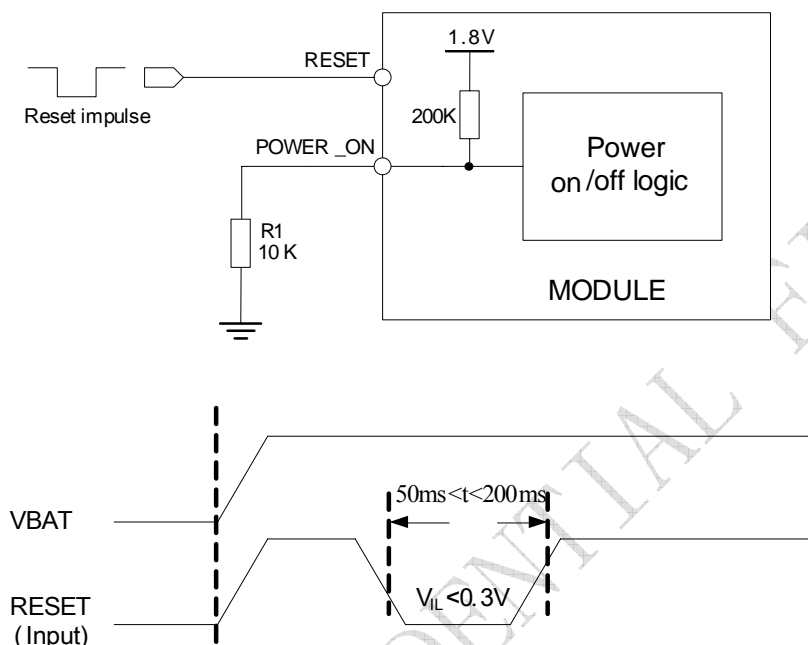


Figure 15: Application circuit

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 SIM5215/SIM5216 should be reset by RESET pin.

3.2.2 Power off Sequence

The following methods can be used to power down SIM5215/SIM5216. 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 SIM5215/SIM5216 by pulling the POWER_ON pin down
- Method 2: Power off SIM5215/SIM5216 by AT command

User can power off the SIM5215/SIM5216 by pulling POWER_ON down for a specific time. The power off scenario is illustrated in the following figure.

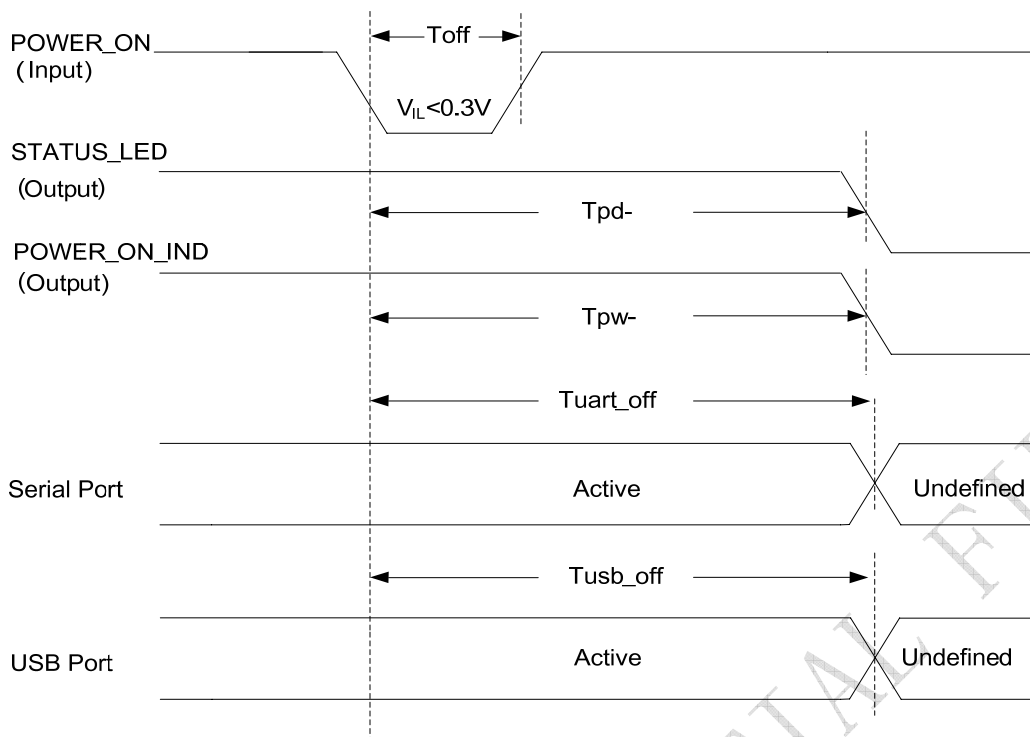


Figure 16: Power off timing sequence

Table 7: Power off timing

Parameter	Description	Time value	Unit
T_{off}	The time pulling POWER_ON down to power off	$0.5 < T_{off} < 5$	s
T_{pd-}	The time to indicate disconnecting from the network	> 7	s
T_{pw-}	The time to indicate the module power off completely	> 7.5	s
T_{uart_off}	The time to disable UART	> 6	s
T_{usb_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

SIM5215/SIM5216 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.

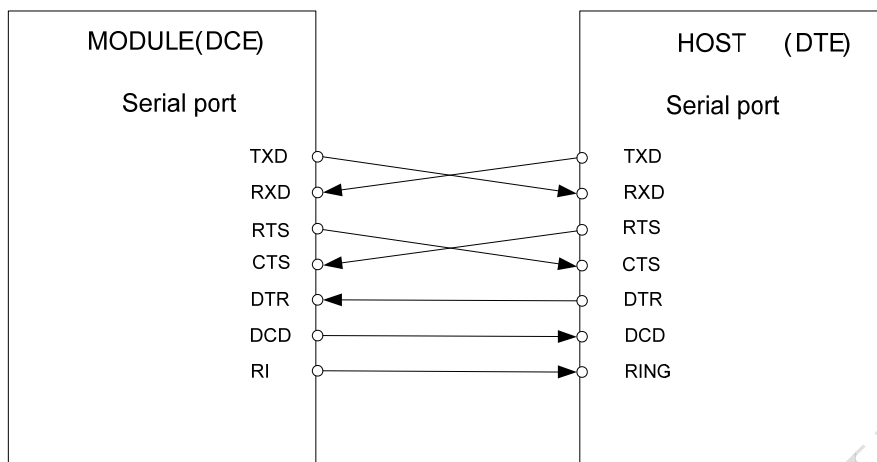


Figure 17: Full modem

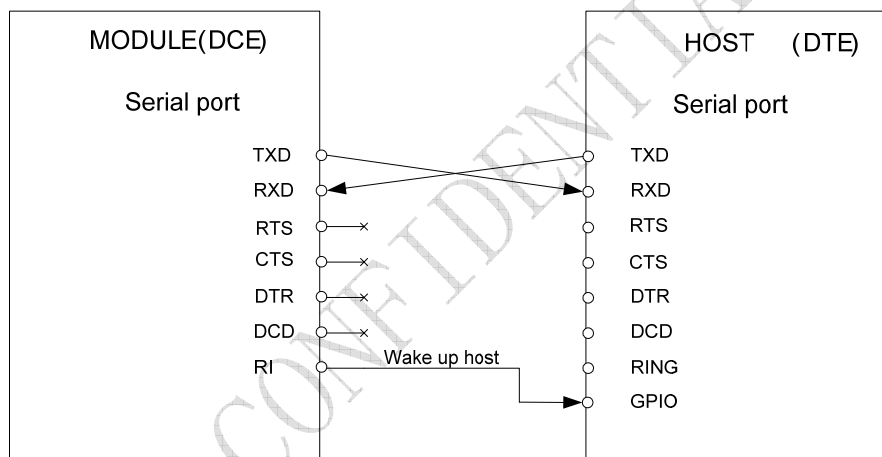


Figure 18: Null modem

3.3.1 Pin Description

Table 8: Pin description

Pin type	Pin name	Pin No.	I/O	Active voltage	Default Status
UART	UART_RXD	64	I	H	Pull-Down
	UART_TXD	6	O	H	Pull-Up
	UART_RTS	63	O	H	
	UART_CTS	7	I	H	Pull-Up

UART_DTR	62	I	H	Pull-Up
UART_DCD	8	O	H	
UART_RI	61	O	H	

More pin information refers to chapter 2.2.

Table 9: 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.

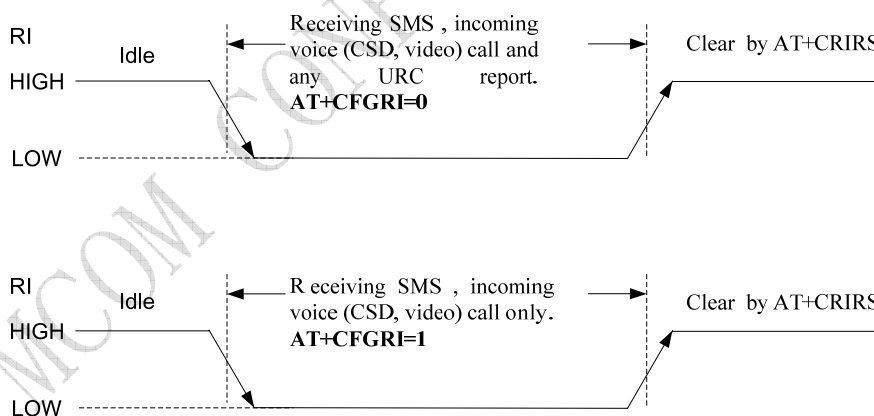


Figure 19: RI behaviour in NULL Modem

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.

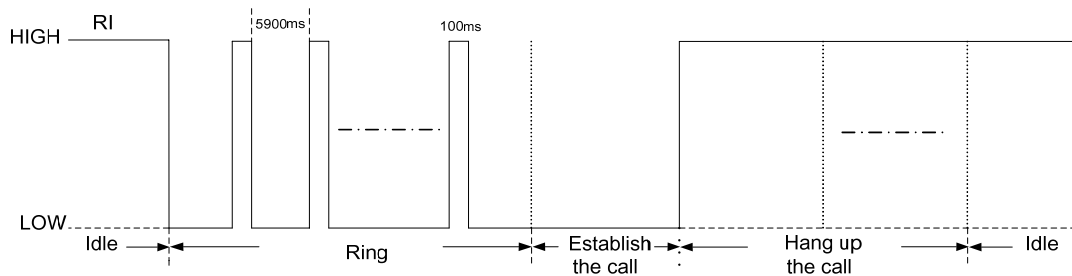


Figure 20: RI behaviour in FULL Modem

To comply with RS-232 protocol, the RS-232 level shifter chip should be used to connect SIM5215/SIM5216 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: SIM5215/SIM5216 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 Audio Interfaces

SIM5215/SIM5216 provides three analog signal outputs and two analog input. MIC1P/N and HP_MICP is used as microphone, HPL/R, EAR1P/N and SPK_P/N are used as audio output. Regarding audio parameters configuration, please refer to the ATC manual.

3.4.1 Pin Description

Table 10: Pin description

Audio channel	Pin name	Pin No.	Function
Normal	MIC_P	43	MIC positive input
	MIC_N	44	MIC negative input
	EAR_P	25	Receiver positive output
	EAR_N	26	Receiver negative output
Hand-free	MIC_P	43	MIC positive input
	MIC_N	44	MIC negative input
	SPK_P	23	Loudspeaker positive output
	SPK_N	24	Loudspeaker negative output
Headset	HP_MICP	42	Headset MIC positive input
	HPR	27	Headset right channel
	HPL	28	Headset left channel

Table 11: MIC input characteristics

Parameter	Min	Typ	Max	Unit
Working Voltage	-	1.8	-	V
Working Current	0.07	0.4	1	mA
External Microphone Load Resistance	1.2	2.2		k Ohms

Table 12: Audio output characteristics

Parameter			Min	Typ	Max	Unit
Normal (EAR_P,EAR_N)	Differential	Load resistance	27	32	-	Ohm
		Output power	-	50	-	mW
Headset (HPR,HPL)	Single ended	load Resistance	12	16	-	Ohm
	Differential	load Resistance	27	32	-	Ohm
	Single Ended	Output power	-	21.6	-	mW

Table 13: Speaker output characteristics

Parameter	Min	Typ	Max	Unit
Quiescent Current	-	2.5	4	mA
Output power(1KHz)	-	500	-	mW

3.4.2 Design Guide

There are three audio channels in SIM5215/SIM5216, including speaker output, receiver output and microphone input.

SPEAKER circuit in SIM5215/SIM5216 is a Class-D amplifier, optional EMI filter is shown in the following figure; these components (two ferrite beads and two capacitors) can reduce electromagnetic interference. If used, they should be located beside SPK_P and SPK_N pins. Considerable current flows in the channels, so wider PCB traces are recommended (~ 20 mils).

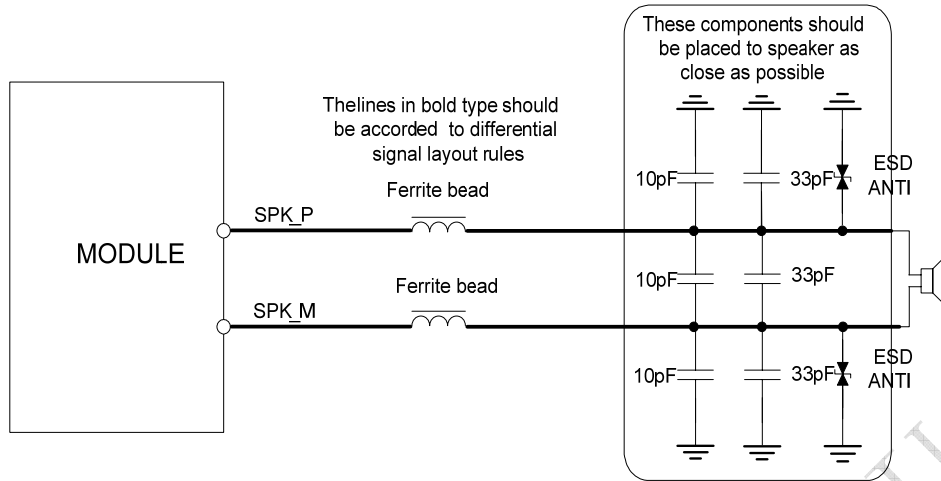


Figure 21: Speaker interface configuration

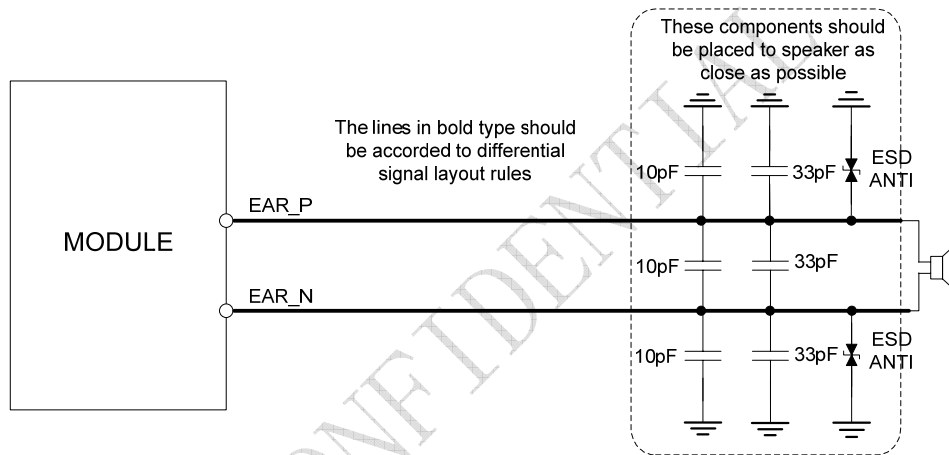


Figure 22: Receiver interface configuration

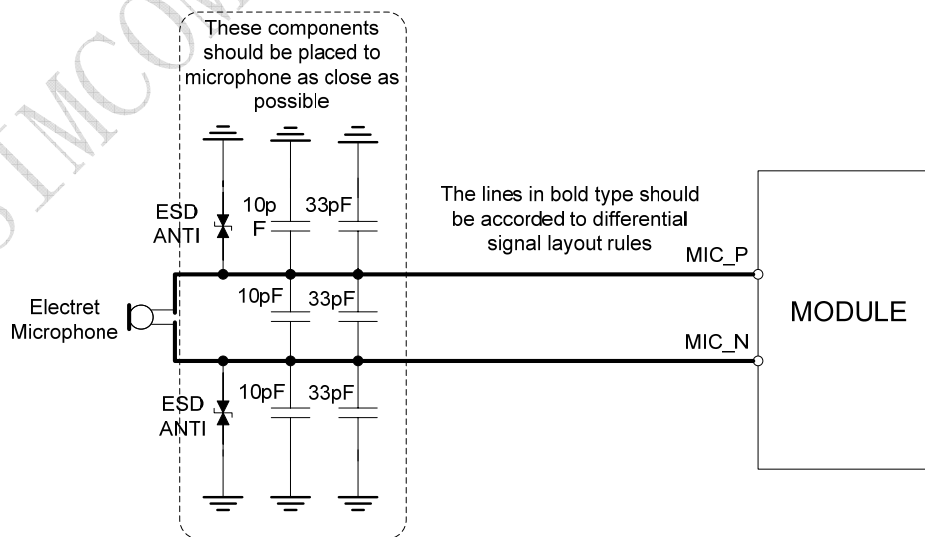


Figure 23: Microphone interface configuration

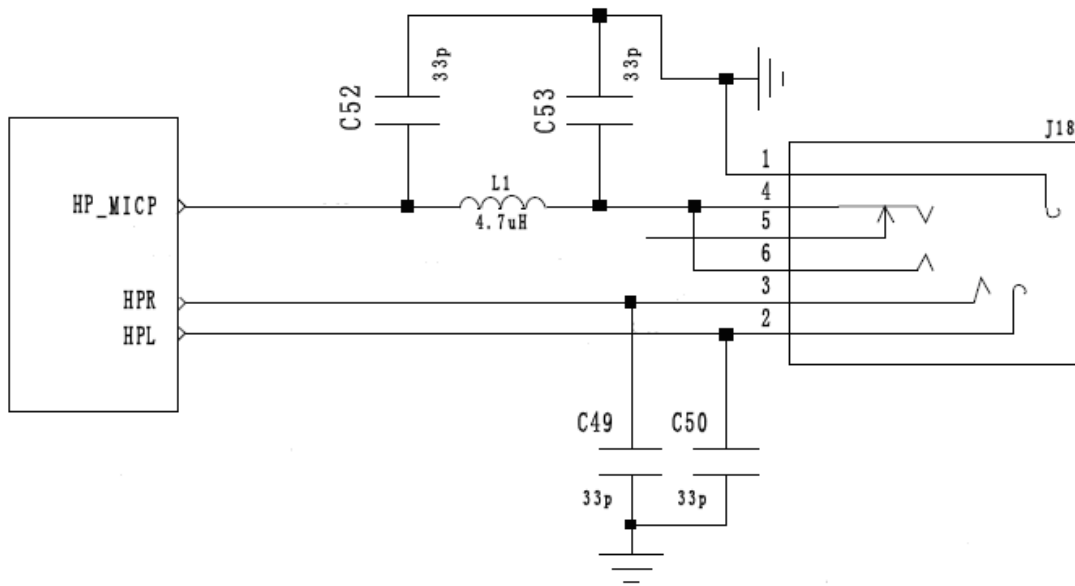


Figure 18: Headphone Microphone interface configuration

Note: SIM5215/SIM5216 has integrated MIC bias circuit. There is no need to pull the MIC_P and MIC_N up to the external power, just connect it to microphone. MIC_P and MIC_N must be differential lines.

3.4.3 Audio Parameter Characteristic

Main audio parameters can be changed to satisfy users' requirement. Here primary register parameters and related description are listed. User can adjust them through AT command. For more detail please refers to Audio Application Document.

Table 14: Audio parameter

Parameter	Influence to	Range	Gain range	Calculation	AT command
micAmp1	MICP/MICN analogue amplifier gain before ADC	0...1	0...24dB	2 steps	AT+CMICAMP1
txVol	Digital gain of input signal after ADC	0, 1...65535	Mute, -84...+12dB	$20 * \log(\text{txVol}/16384)$	AT+CTXVOL
txGain	Digital gain of input signal after summation of sidetone	0, 1...65535	Mute, -84...+12dB	$20 * \log(\text{txGain}/16384)$	AT+CTXGAIN
txFilter	Input PCM 13-tap filter parameters, 7	0...65535	---	MATLAB calculate	AT+CTXFTR

	values				
rxGain	Digital gain of output signal after summation of sidetone	0, 1...65535	Mute, -84...+12dB	$20 * \log(\text{rxGain}/16384)$	AT+CRXGAIN
rxVol	Digital Volume of output signal after speech decoder, before summation of sidetone and DAC	-300...300	dbm	-300...300dbm	AT+CLVL AT+CVLVL AT+CRXVOL
stGain	Digital attenuation of sidetone	0, 1...65535	Mute, -96...0dB	$20 * \log(\text{stGain}/16384) - 12$	AT+SIDET
rxFilter	Output PCM 13-tap filter parameters, 7 values	0...65535	---	MATLAB calculate	AT+CRXFTR

Note: If users require better experience on audio, users should modify these parameters according to their own electronic and mechanical design.

3.5 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.

3.5.1 Pin description

Table 15: 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 16: Pin description

Pin name	Pin	Description
USIM_CLK	12	USIM Card Clock
USIM_RESET	13	USIM Card Reset
USIM_DATA	56	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	57	USIM Card Power output depends automatically on USIM mode, one is 3.0V±10%, another is 1.8V±10%. Current is less than 50mA.

3.5.2 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.

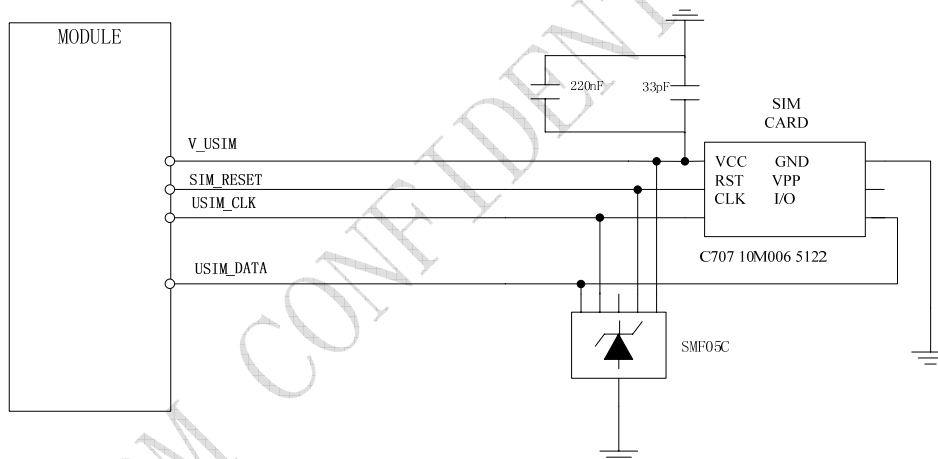


Figure 24: USIM interface reference circuit

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].

3.5.3 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.

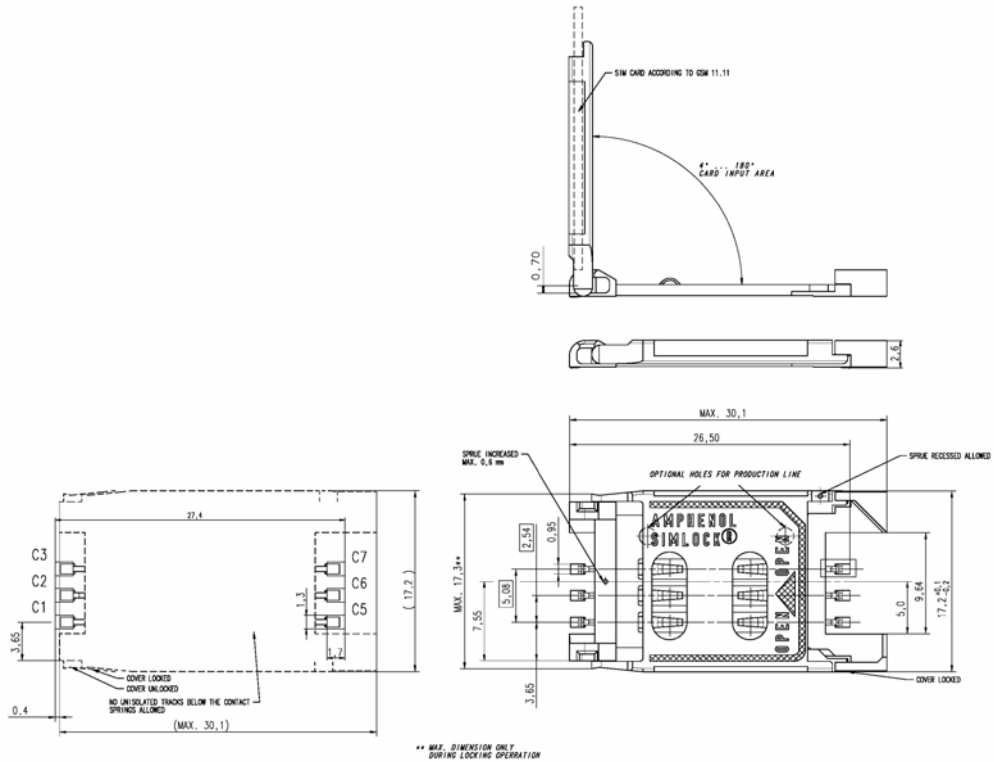


Figure 25: Amphenol SIM card socket

Table 19: 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.

3.6 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+CRIC and AT+CWIC” to read/write register values of related peripheral equipments connected with I2C interface.

3.6.1 Pin Description

Table 17: Pin description

Pin name	Pin No.	Function
I2C_SDA	47	Serial interface data input and output
I2C_SCL	46	Serial interface clock input

3.6.2 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.

3.6.3 Design Guide

For SIM5215/SIM5216, 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.

3.7 Camera Interface

SIM5215/SIM5216 module provides a Camera interface that supports camera and video phone functions. SIM5215/SIM5216 support both digital and analog (NTSC or PAL signal) sensor.

3.7.1 Pin Description

Table 18: Electronic characteristic

Pin name	Min	Typ	Max
CAM_D2	2.5	2.6	2.7
CAM_D3	2.5	2.6	2.7
CAM_D4	2.5	2.6	2.7
CAM_D5	2.5	2.6	2.7
CAM_D6	2.5	2.6	2.7

CAM_D7	2.5	2.6	2.7
CAM_D8	2.5	2.6	2.7
CAM_D9	2.5	2.6	2.7
CAM_HSYNC	2.5	2.6	2.7
CAM_VSYNC	2.5	2.6	2.7
CAM_CLK	2.5	2.6	2.7
CAM_PCLK	2.5	2.6	2.7
CAM_RESET	2.5	2.6	2.7
CAM_STANDBY	2.5	2.6	2.7

Table 19: Pin description

Pin name	Pin No.	Function
CAM_D2	15	Data bit 0 (YUV or RGB)
CAM_D3	54	Data bit 1 (YUV or RGB)
CAM_D4	16	Data bit 2 (YUV or RGB)
CAM_D5	53	Data bit 3 (YUV or RGB)
CAM_D6	17	Data bit 4 (YUV or RGB)
CAM_D7	52	Data bit 5 (YUV or RGB)
CAM_D8	18	Data bit 6 (YUV or RGB)
CAM_D9	51	Data bit 7 (YUV or RGB)
CAM_HSYNC	19	Horizontal synchronization
CAM_VSYNC	50	Vertical synchronization
CAM_CLK	21	Camera clock
CAM_PCLK	49	Camera pixel clock
CAM_RESET	48	Reset control
CAM_STANDBY	22	Power down control

3.7.2 Application Guide

When using a YUV sensor, users must connect the sensor data pin (OV7670: data0~data7; OV2640 and OV7725: data2~data9) to the module CAM_D2~CAM_D9 orderly. A typical circuit about the camera is shown in the following figure.

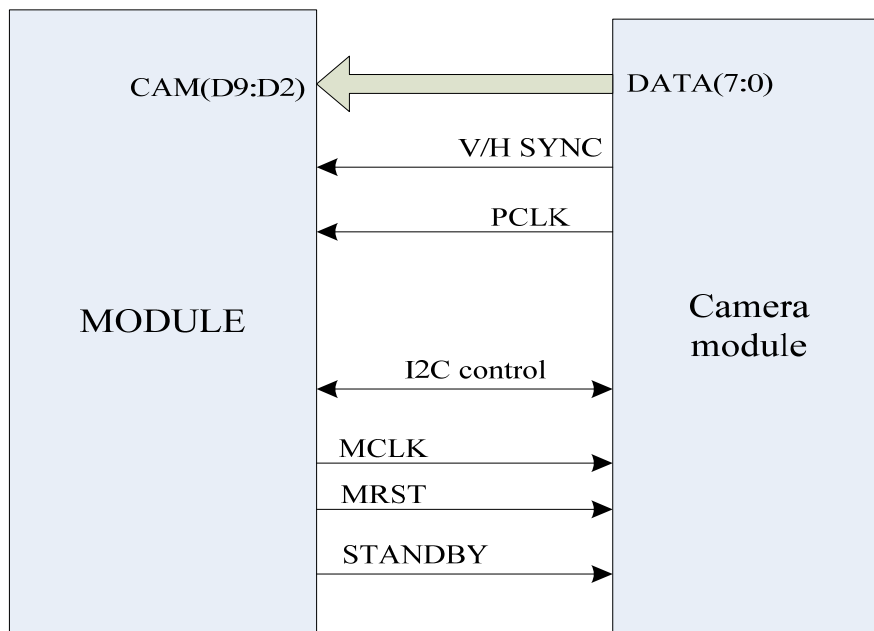


Figure 26: Reference circuit

When using analog sensor, you need to use AK8856 to decode NTSC or PAL signal to digital signal firstly, and then AK8856 transmits the digital data into the camera interface. Refer to the following figure.

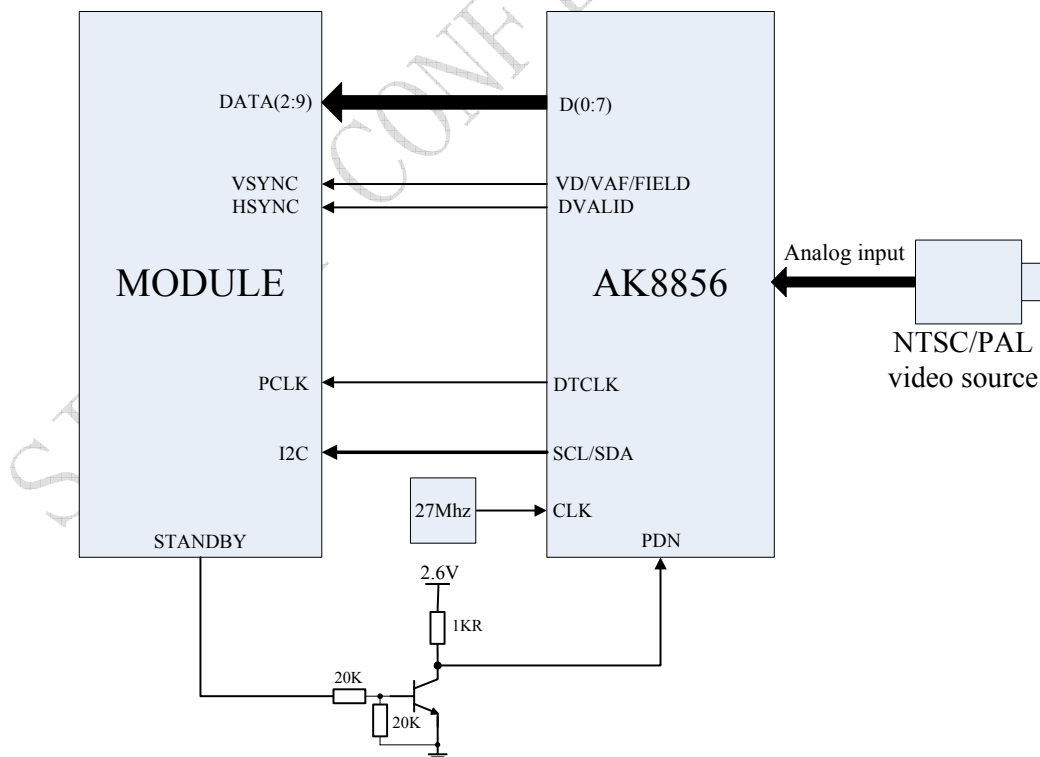


Figure 27: Analog sensor circuit reference

All camera pins can be configured for GPIOs by the AT command “AT+CCGSWT”. These GPIOs also support interruption operation if used as input pins. If these pins are configured for GPIOs, the sequence is listed in the following table.

Table 20: GPIO configuration

Pin name	GPIO No.
CAM_D2	GPIO6
CAM_D3	GPIO7
CAM_D4	GPIO8
CAM_D5	GPIO9
CAM_D6	GPIO10
CAM_D7	GPIO11
CAM_D8	GPIO12
CAM_D9	GPIO13
CAM_HSYNC	GPIO14
CAM_VSYNC	GPIO15
CAM_CLK	GPIO16
CAM_PCLK	GPIO17
CAM_RESET	GPIO18
CAM_STANDBY	GPIO19

Note: 1. We have tested several kinds of digital sensors, such as OV2640, OV7670, OV7725 and a NTSC/PAL digital video decoder named AK8856. Software must be adjusted before users adopt other kinds of sensors.

2. Because of high bit rate on camera bus, pay attention to influence of junction capacitance of ESD component on clock and data lines. Typically, the capacitance should be less than 10pF.

3. Pay attention to the polarity of power down pin in users’ sensor before designing. Default polarity of SIM5215/SIM5216 is shown: LOW: normal operation HIGH: power-down.

3.8 USB Interface

SIM5215/SIM5216 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 21: Electronic characteristic

Pin name	Pin No.	Input voltage scope(V)		
		Min	Typ	Max

USB_VBUS	9	4.4	5.0	5.25
USB_DP	60	They are compliant with the USB 2.0 specification.		
USB_DM	59			

3.8.1 Application Guide

Currently SIM5215/SIM5216 supports the USB suspend and resume mechanism which can help to save power. If no transaction is on USB bus, SIM5215/SIM5216 will enter suspend mode. When some events such as voice call or receiving SMS happen, SIM5215/SIM5216 will resume normal mode automatically.

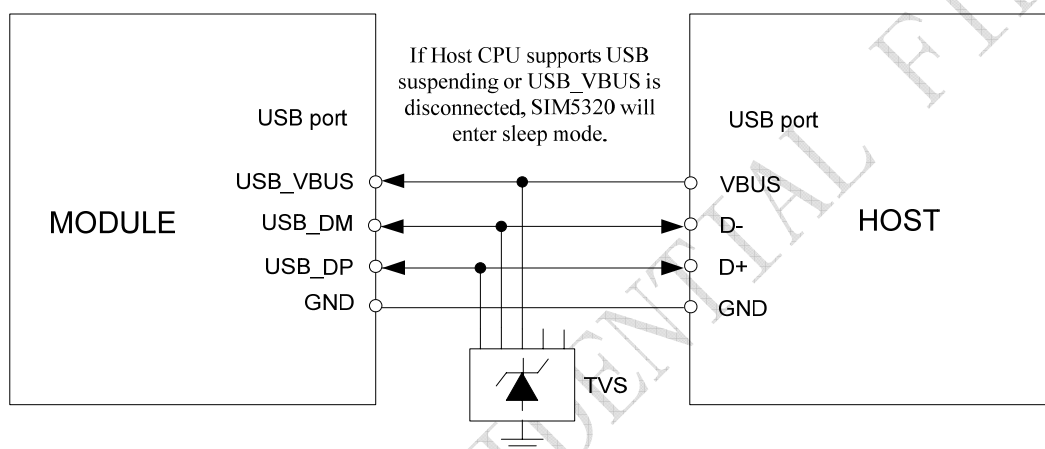


Figure 28: USB interface

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 SIM5215/SIM5216 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”.

3.9 SDIO Interface

SIM5215/SIM5216 provides one 4-bit SDIO interface. Its operation voltage is 2.85V, with clock rates up to 52 MHz. It supports 1-bit SD/MMC or 4-bit SD data transmission mode. Though the same hardware controller is used, the initialization procession for SD or MMC cards is different. SIM5215A&SIM5216A will detect which card is inserted automatically.

3.9.1 Pin Description

Table 22: Electronic characteristic

Pin name	2.85V mode		
	Min	Typ	Max
SD_DATA0	2.7	2.85	3.0
SD_DATA1	2.7	2.85	3.0
SD_DATA2	2.7	2.85	3.0
SD_DATA3	2.7	2.85	3.0
SD_CLK	2.7	2.85	3.0
SD_CMD	2.7	2.85	3.0
VREG_AUX	2.7	2.85	3.0

Table 23: Pin description

Pin name	Pin No.	Function
SD_DATA0	36	SD/MMC card data0
SD_DATA1	37	SD card data1
SD_DATA2	38	SD card data2
SD_DATA3	39	SD card data3
SD_CLK	34	SD card clock
SD_CMD	35	SD card command
VREG_AUX	40	SD card power

3.9.2 Design guide

The module provides a LDO named VREG_AUX for SD card power supply. The LDO is 2.85V by default, capable of 250mA. Data lines should be pulled up to VREG_AUX by 10K resistors. ESD/EMI components should be arranged beside SD card socket. Refer to the following application circuit.

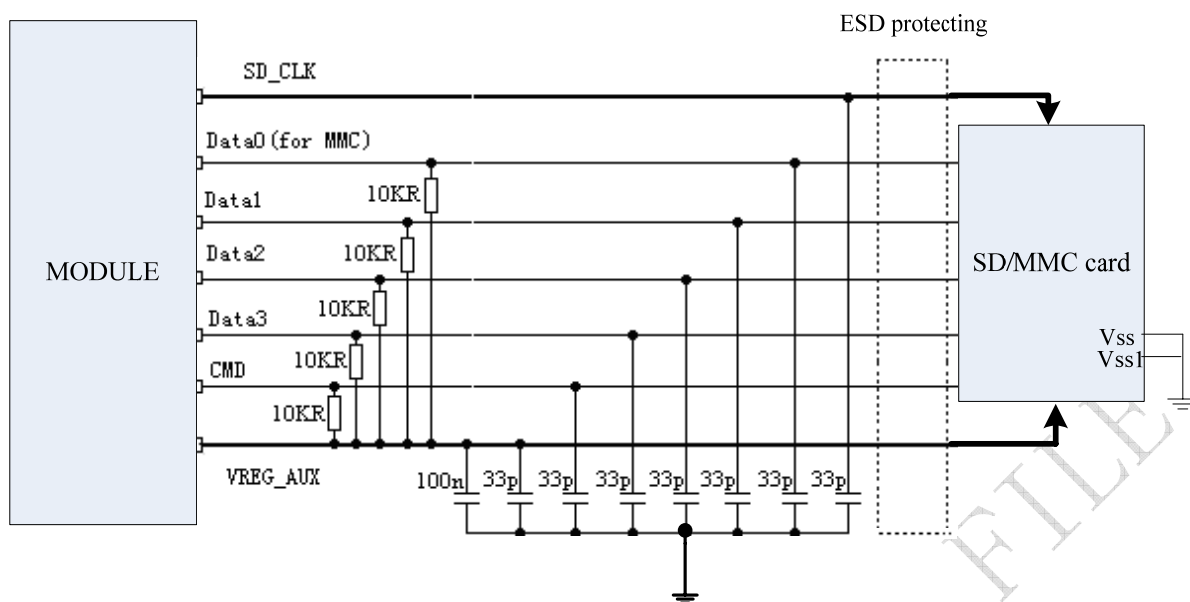


Figure 29: SDIO interface circuit

3.10 GPIO Interface

SIM5215/SIM5216 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.

3.10.1 Pin Description

Table 24: Electronic characteristic

Pin name	2.6V mode		
	Min	Typ	Max
GPIO1	2.5	2.6	2.7
GPIO4	2.5	2.6	2.7

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

Table 25: Pin description

GPIO4	32	I	Input PIN as RF operating control. H: Normal Mode L:Flight Mode If it is unused, left open. unused, left open.
-------	----	---	---

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

3.10.2 Application Guide

Network status

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

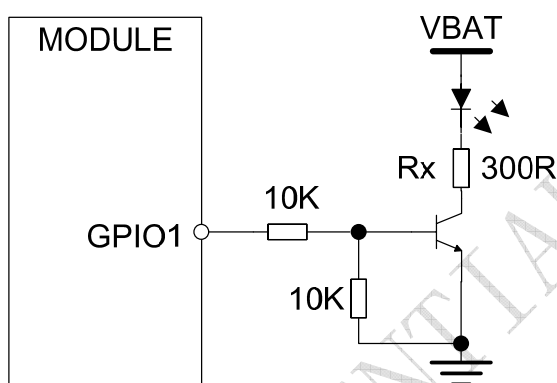


Figure 30: Application circuit

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

Table 26: 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 SIM5215/SIM5216 module to enter or exit the Flight mode. In Flight mode, SIM5215/SIM5216 closes RF function to prevent interference with other equipments or minimize current consumption. Bidirectional ESD protection component is suggested to add on GPIO4.

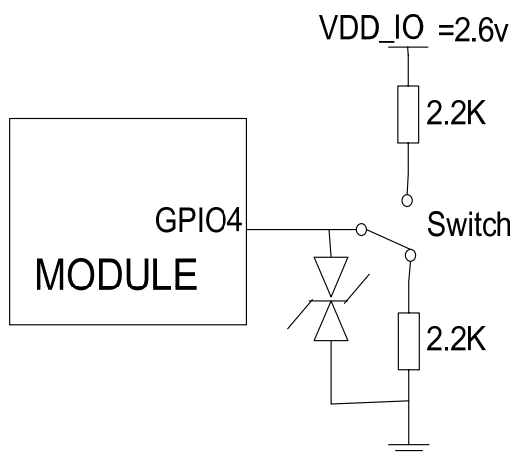


Figure 31: Flight mode switch

Table 27: Control status

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

Note: 1. For SIM5215/SIM5216, GPIO0, GPIO2, GPIO3 and GPIO5 have multiplex function, user can use them as PCM interface to connect extend codec. Refer to section 3.10 and document [1] for details.

2. When the module is powered off, make sure all digital interfaces (PCM 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.

3.11 PCM Interface

SIM5215/SIM5216 provides hardware PCM interface for external codec. The PCM interface enables communication with an external codec to support hands-free applications. SIM5215/SIM5216 PCM interface can be used in two modes: the default mode is auxiliary PCM (8 KHz long sync mode at 128 KHz PCM CLK); the other mode is primary PCM (8 KHz short sync mode at 2048 KHz PCM CLK). In short-sync (primary PCM) mode, SIM5215/SIM5216 can be a master or a slave. In long-sync (auxiliary PCM) mode, SIM5215/SIM5216 is always a master. SIM5215/SIM5216 also supports 3 kinds of coding formats: 8 bits (u-law or A-law) and 16 bits (linear).

Note: PCM interface is multiplexed from GPIO (default setting). The AT command "AT+CPCM" is used to switch between PCM and GPIO functions. Please refer to document [22] and document [1] for details.

3.11.1 Pin Description

Table 28: Electronic characteristic

Pin name	2.6V mode		
	Min	Typ	Max
PCM_CLK	2.5	2.6	2.7
PCM_SYNC	2.5	2.6	2.7
PCM_DOUT	2.5	2.6	2.7
PCM_DIN	2.5	2.6	2.7

Table 29: Pin description

Pins	Pin No.	AUX_PCM functionality	Primary PCM functionality	Description
PCM_DIN/GPIO0	74	AUX_PCM_DIN	PCM_DIN	PCM data input
PCM_SYNC/GPIO2	75	AUX_PCM_SYNC	PCM_SYNC	PCM data synchrony
PCM_DOUT/GPIO5	73	AUX_PCM_DOUT	PCM_DOUT	PCM data output
PCM_CLK/GPIO3	76	AUX_PCM_CLK	PCM_CLK	PCM data clock

3.11.2 Signal Description

The default PCM interface in SIM5215/SIM5216 is the auxiliary PCM interface. The data changes on the high level of PCM_CLK and is sampled at the falling edge of PCM_CLK in one period. Primary PCM is disabled after every power-on or every reset event. So user must use AT command to enable the primary PCM mode after powering on or resetting the module every time if user wants to use Primary PCM. SIM5215/SIM5216 PCM Interface can be operated in Master or Slave mode if it is configured to primary PCM. In Master Mode, the Module drives the clock and sync signals that are sent to the external codec. When it is in Slave Mode, the external codec drives the clock and sync signals which are sent to the module. Both PCM modes are discussed in this section followed by additional PCM topics.

Auxiliary PCM (128 KHz PCM clock)

u-law coding is supported by the auxiliary PCM. The auxiliary codec port operates with standard long-sync timing and a 128 KHz clock. The AUX_PCM_SYNC runs at 8 KHz with 50% duty cycle. Most u-law codec support the 128 KHz clock.

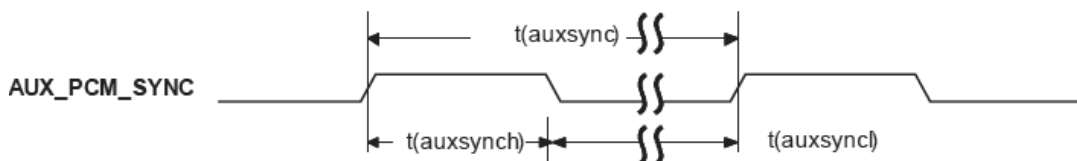


Figure 32: Synchrony timing

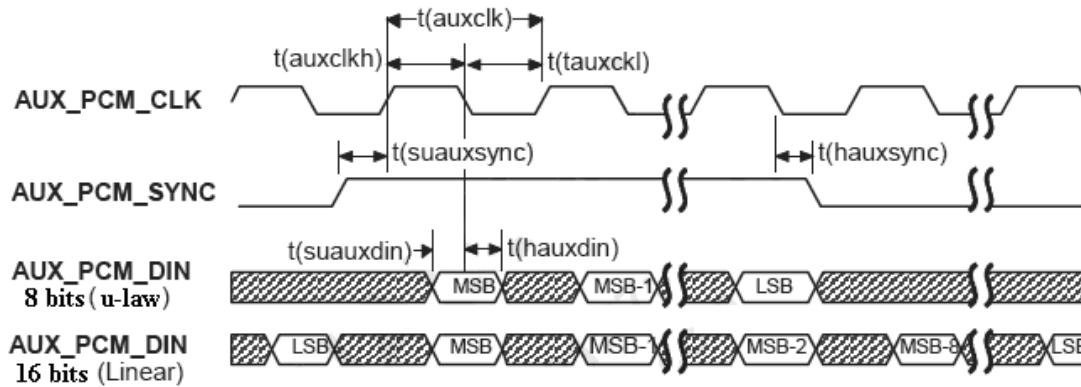


Figure 33: EXT CODEC to MODULE timing

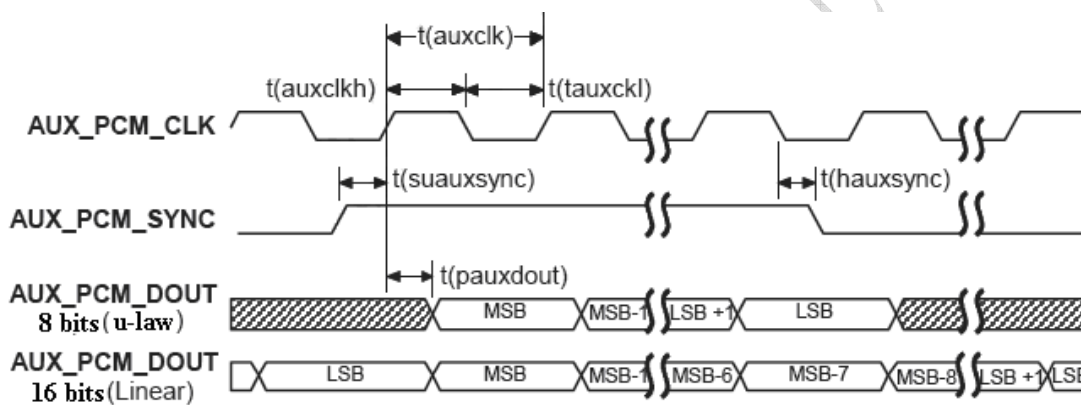


Figure 34: MODULE to EXT CODEC timing

Table 30: Timing parameters

Parameter	Description	Min	Typ	Max	Unit
T(auxsync)	AUX_PCM_SYNC cycle time	-	125	-	μs
T(auxsynch)	AUX_PCM_SYNC high time	62.4	62.5	-	μs
T(auxsyncl)	AUX_PCM_SYNC low time	62.4	62.5	-	μs
T(auxclk)*	AUX_PCM_CLK cycle time	-	7.8	-	μs
T(auxclkh)	AUX_PCM_CLK high time	3.8	3.9	-	μs
T(auxckl)	AUX_PCM_CLK low time	3.8	3.9	-	μs
T(suauxsync)	AUX_PCM_SYNC setup time high before falling edge of PCM_CLK	1.95	-	-	μs
T(hauxsync)	AUX_PCM SYNC hold time after falling edge of PCM_CLK	1.95	-	-	μs

T(suauxdin)	AUX_PCM_DIN setup time before falling edge of AUX_PCM_CLK	70	-	-	ns
T(hauxdin)	AUX_PCM_DIN hold time after falling edge of AUX_PCM_CLK	20	-	-	ns
T(pauxdout)	Delay from AUX_PCM_CLK rising to AUX_PCM_DOUT valid	-	-	50	ns

*Note: $T(\text{auxclk}) = 1/(128 \text{ KHz})$.

Primary PCM (2048 KHz PCM clock)

SIM5215/SIM5216 also supports 2.048 MHz PCM data and sync timing for u-law codec. This is called the primary PCM interface. User can use AT command to take the mode you want as discussed above.

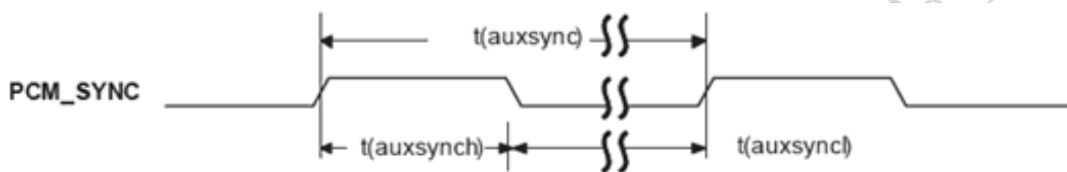


Figure 35: Synchrony timing

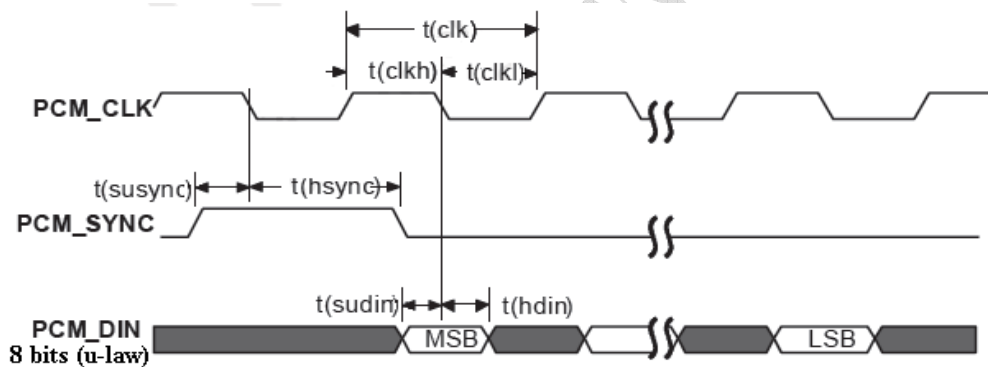


Figure 36: EXT CODEC to MODULE timing

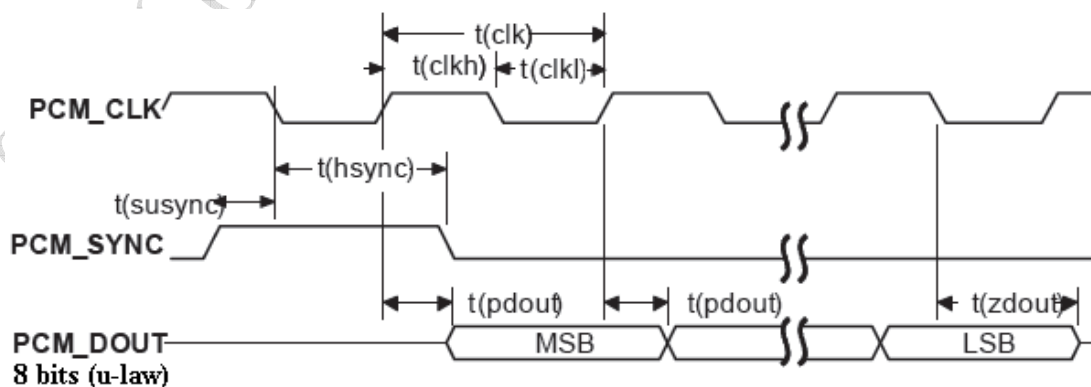


Figure 37: MODULE to EXT CODEC timing

Table 31: Timing parameters

Parameter	Description	Min	Typ	Max	Unit
T(sync)	PCM_SYNC cycle time	–	125	–	μs
T(synch)	PCM_SYNC high time	400	500	–	ns
T(sync _l)	PCM_SYNC low time	–	124.5	–	μs
T(clk)	PCM_CLK cycle time	–	488	–	ns
T(clk _h)	PCM_CLK high time	–	244	–	ns
T(clk _l)	PCM_CLK low time	–	244	–	ns
T(susync)	PCM_SYNC setup time high before falling edge of PCM_CLK	60	–	–	ns
T(hsync)	PCM_SYNC hold time after falling edge of PCM_CLK	60	–	–	ns
T(sudin)	PCM_DIN setup time before falling edge of PCM_CLK	50	–	–	ns
T(hdin)	PCM_DIN hold time after falling edge of PCM_CLK	10	–	–	ns
T(pdout)	Delay from PCM_CLK rising to PCM_DOUT valid	–	–	350	ns
T(zdout)	Delay from PCM_CLK falling to PCM_DOUT HIGH-Z	–	160	–	ns

Note: SIM5215/SIM5216 can transmit PCM data by USB except for PCM interface. Please refer to document [22] for more information of PCM Application Note.

3.12 Multi-functional interface

SIM5215/SIM5216 merges functions for various applications. It can enrich users' design and lower the cost of users' hardware.

3.12.1 Reset Function

SIM5215/SIM5216 also has a RESET pin (PIN29) 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.

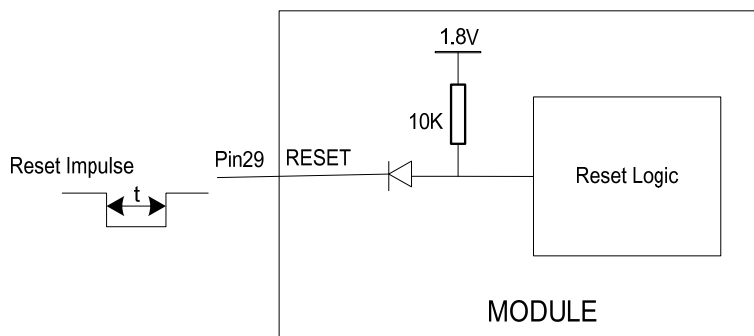


Figure 38: Reset circuit

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

3.12.2 ADC

SIM5215/SIM5216 has a dedicated ADC that is available for digitizing analog signals such as battery voltage and so on; it is on PIN 41, namely HKADC. This HKADC is 8 bit successive-approximation circuit, and electronic specification is shown in the following table.

Table 32: Electronic Characteristics

Specification	Min	Typ	Max	Unit	Comments/Conditions
Resolution		8		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].

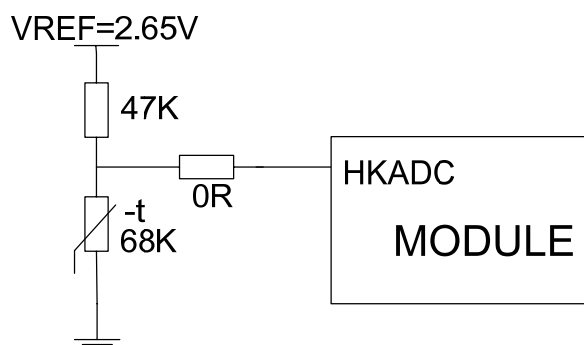


Figure 39: Reference circuit

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

3.12.3 LDO

SIM5215/SIM5216 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 33: 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 34: 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 2100	24dBm +1/-3dB	-56dBm ±5dB
WCDMA 1900	24dBm +1/-3dB	-56dBm ±5dB
WCDMA 850	24dBm +1/-3dB	-56dBm ±5dB
WCDMA 900	24dBm + 1/-3dB	-56dBm ±5dB

Table 35: 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
WCDMA 2100	2110~2170 MHz	1920~1980 MHz
WCDMA1900	1930~1990 MHz	1850~1910 MHz
WCDMA 850	869 ~894 MHz	824 ~849 MHz
WCDMA 900	925 ~960 MHz	880 ~915 MHz

Table 36: Conducted receive sensitivity

Frequency	Receive sensitivity
GSM850	< -106dBm
E-GSM900	< -106dBm
DCS1800	< -106dBm
DCS1800	< -106dBm
WCDMA 2100	< -108dBm
WCDMA 1900	< -108dBm
WCDMA 850	< -106dBm
WCDMA 900	< -106dBm

4.2 Operating Specification

SIM5215/SIM5216 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 37: GPRS/EDGE data throughput

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 38: HSDPA throughput

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 throughput rates depend on network configuration, network loading, signal condition and so on.

4.3 Antenna Design Guide

SIM5215/SIM5216 provides a RF antenna connector and a antenna pad. Customer's antenna can be soldered to the module antenna pad or connected to module's antenna connector through a 50Ω RF cable. SIMCom recommends that the total insertion loss of RF cable should meet the following requirements:

- GSM900/GSM850 <1dB
- DCS1800/PCS1900 <1.5dB
- WCDMA 2100/1900 <1.5dB
- WCDMA 900/850 <1dB

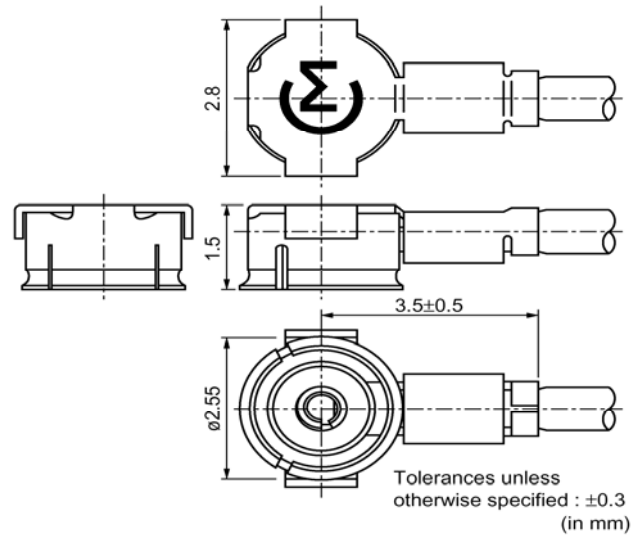


Figure: RF adapter cable MXTK88TK2000

4.3.1 Antenna connector

SIM5215/SIM5216 uses MURATA MM9329-2700 RF connector. MURATA MXTK88XXXXX as matching connector is recommended to use in the host board. Refer to the following figure for details.

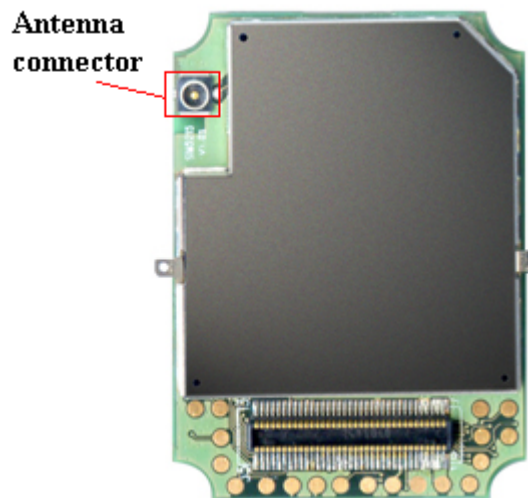


Figure: Module antenna connector

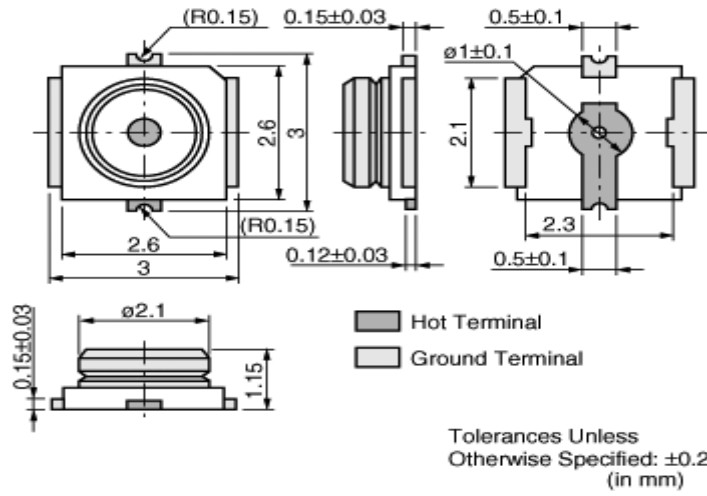


Figure: RF connector MM9329-2700

Note: For more information about the connector, visit <http://www.murata.com/>

4.3.2 Antenna pad

The antenna can be soldered to RF pad or attached through contacting springs. The reference ground pad is located nearby.

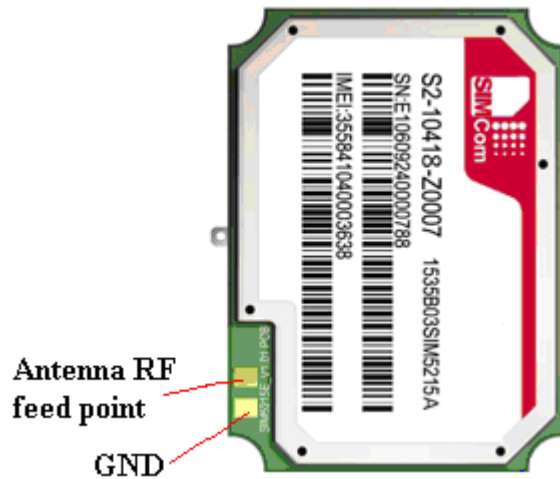


Figure: Module antenna pad

5 Reliability and Operating Characteristics

5.1 Electronic Characteristics

Absolute maximum rating for digital and analog pins of SIM5215/SIM5216 are listed in the following table:

Table 39: 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 40: 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 41: Operating temperature

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

Note: SIMCom recommends user to install a heat sink on the module shielding case if SIM5215/SIM5216 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 42: 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.
	GSM TALK	Connection between two subscribers is in progress. In this case, the power consumption depends on network settings (DTX off/on, FR/EFR/HR, hopping sequences, etc.) and antenna.
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.
	WCDMA TALK	Module is active in WCDMA mode. The power consumption depends on network settings.
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 SIM5215/SIM5216 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), SIM5215/SIM5216 will enter sleep mode automatically. In this mode, SIM5215/SIM5216 can still receive paging, voice call or SMS from network. If USB interface of SIM5215/SIM5216 is connected to host CPU, but host CPU does not support USB suspending, then SIM5215/SIM5216 will not enter sleep mode. After USB is disconnected, SIM5215/SIM5216 will enter sleep mode.

Note: When UART interface is connected with host CPU, SIM5215/SIM5216 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 UART_DTR to wake up the module from host CPU and to use 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 SIM5215/SIM5216 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 SIM5215/SIM5216 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 Chapter 3.10.2.

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 SIM5215/SIM5216 is connected to USB bus, but it does not transfer data.

Table 43: Current consumption

GSM Sleep mode (without USB connection)	
GSM850	Sleep @DRX=2 3.0mA
	Sleep @DRX=5 1.8mA
	Sleep @DRX=9 1.4mA
GSM900	Sleep @DRX=2 3.0mA
	Sleep @DRX=5 1.86mA
	Sleep @DRX=9 1.4mA
DCS1800	Sleep @DRX=2 3.1mA
	Sleep @DRX=5 1.7mA
	Sleep @DRX=9 1.4mA
PCS1900	Sleep @DRX=2 3.1mA
	Sleep @DRX=5 1.6mA
	Sleep @DRX=9 1.5mA
GSM Sleep Mode (with USB suspended)	
GSM850	Sleep @DRX=2 4.3mA
	Sleep @DRX=5 2.8mA
	Sleep @DRX=9 2.2mA
GSM900	Sleep @DRX=2 4.3mA
	Sleep @DRX=5 2.7mA
	Sleep @DRX=9 2.1mA
DCS1800	Sleep @DRX=2 4.4mA
	Sleep @DRX=5 2.8mA
	Sleep @DRX=9 2.3mA
PCS1900	Sleep @DRX=2 4.4mA
	Sleep @DRX=5 2.7mA
	Sleep @DRX=9 2.2mA
Voice Call	
GSM850	@power level #5 <300mA, Typical 305mA
GSM 900	@power level #5 <300mA, Typical 305mA
DCS1800	@power level #0 <250mA, Typical 237mA
PCS1900	@power level #0 <250mA, Typical 237mA
GPRS Data	
DATA mode, GPRS (1 Rx,4 Tx) CLASS 12	
GSM 850	@power level #5 <540mA
GSM 900	@power level #5 <500mA
DCS1800	@power level #0 <380mA
PCS1900	@power level #0 <380mA
DATA mode, GPRS (3Rx, 2 Tx) CLASS 12	
GSM 850	@power level #5 <390mA
GSM 900	@power level #5 <380mA
DCS1800	@power level #0 <300mA
PCS1900	@power level #0 <250mA
EDGE Data	

DATA mode, EDGE(1 Rx,4 Tx) CLASS 12	
GSM 850	@power level #8 <350mA
GSM 900	@power level #8 <340mA
DCS1800	@power level #2 <325mA
PCS1900	@power level #2 <290mA
DATA mode, EDGE(3Rx, 2 Tx) CLASS 12	
GSM 850	@power level #8 <250mA
GSM 900	@power level #8 <240mA
DCS1800	@power level #2 <230mA
PCS1900	@power level #2 <210mA
UMTS Sleep Mode (without USB connection)	
WCDMA 1900	Sleep @DRX=9 1.2mA
	Sleep @DRX=8 2.1mA
	Sleep @DRX=6 4.2mA
WCDMA 850	Sleep @DRX=9 1.2mA
	Sleep @DRX=8 2.0mA
	Sleep @DRX=6 4.4mA
UMTS Sleep Mode (with USB suspended)	
WCDMA 1900	Sleep @DRX=9 1.9mA
	Sleep @DRX=8 2.6mA
	Sleep @DRX=6 4.6mA
WCDMA 850	Sleep @DRX=9 1.9mA
	Sleep @DRX=8 2.7mA
	Sleep @DRX=6 4.8mA
UMTS Talk	
WCDMA 1900	@Power 23dBm Typical 580mA
	@Power 10dBm Typical 205mA
	@Power-55dBm Typical 174mA
WCDMA 850	@Power 23dBm Typical 510mA
	@Power 10dBm Typical 195mA
	@Power-55dBm Typical 131mA
HSDPA Data(Only 5216A)	
WCDMA 1900	@Power 23dBm Typical 584mA
	@Power 10dBm Typical 331mA
	@Power-55dBm Typical 179mA
WCDMA 850	@Power 23dBm Typical 536mA
	@Power 10dBm Typical 231mA
	@Power-55dBm Typical 165mA

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. RF emissions interfere with audio input/output. It is recommended to shield the sensitive components and trace with common ground and user can add beads where necessary.

Normally SIM5215/SIM5216 is mounted on customer host board. Although some ESD components have been added in SIM5215/SIM5216, 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, audio jacks, switches, keys, etc. The following table is the SIM5215/SIM5216 ESD measurement performance; the results are from SIMCom EVB test.

Table 44: The ESD performance measurement table (Temperature: 25°C, 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 SIM5215/SIM5216



Figure 40: Top and bottom view of SIM5215/SIM5216

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

application.

6.2 Moisture Sensitivity Level (MSL)

SIM5215/SIM5216 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.

6.3 Firmware Update

When SIM5215/SIM5216 modules are embed into users' equipment, there are two methods to update firmware easily, which are called SD card and USB update.

6.3.1 SD Card Update

SD card update means that user can use SD card to update the firmware into the module. The realization process is described in following figures.

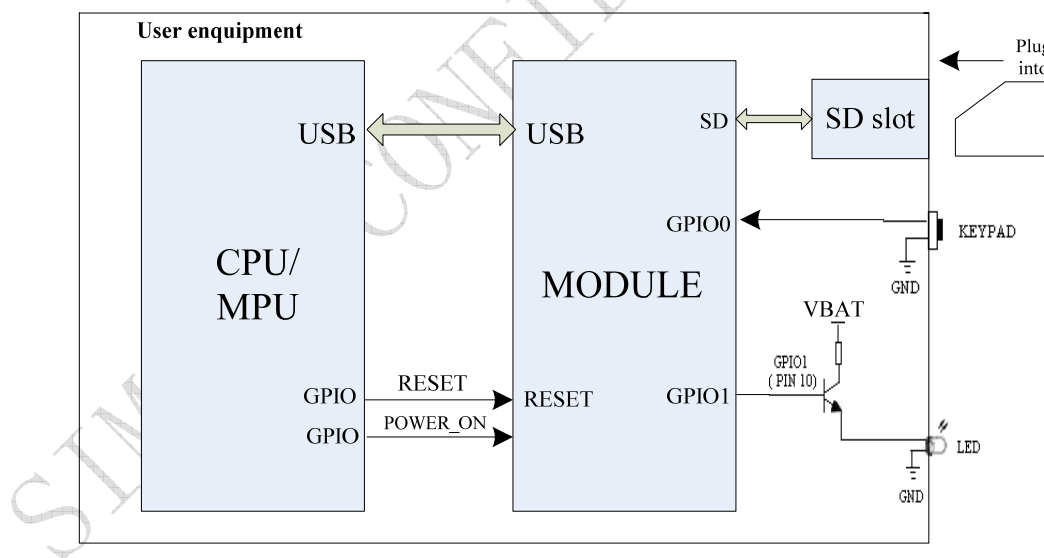


Figure: Reference circuit for SD card update

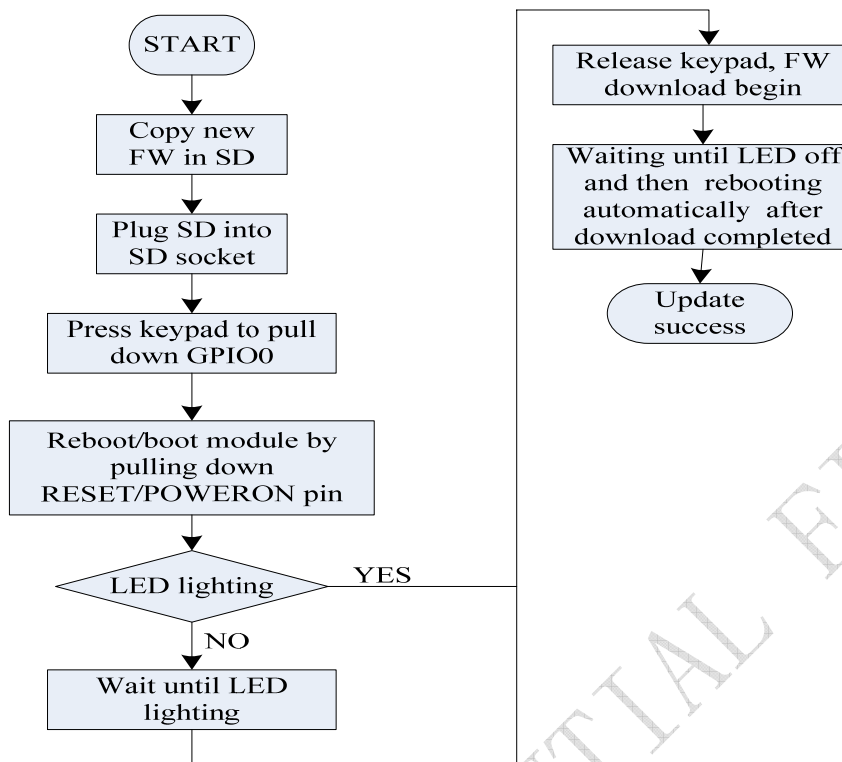


Figure: SD card update procedure

Note: QCN will be erased after SD card update, so users must backup QCN files before downloading the new firmware.

6.3.2 USB Update

Users can use USB interface to download the new firmware. The realization process is described in following figures.

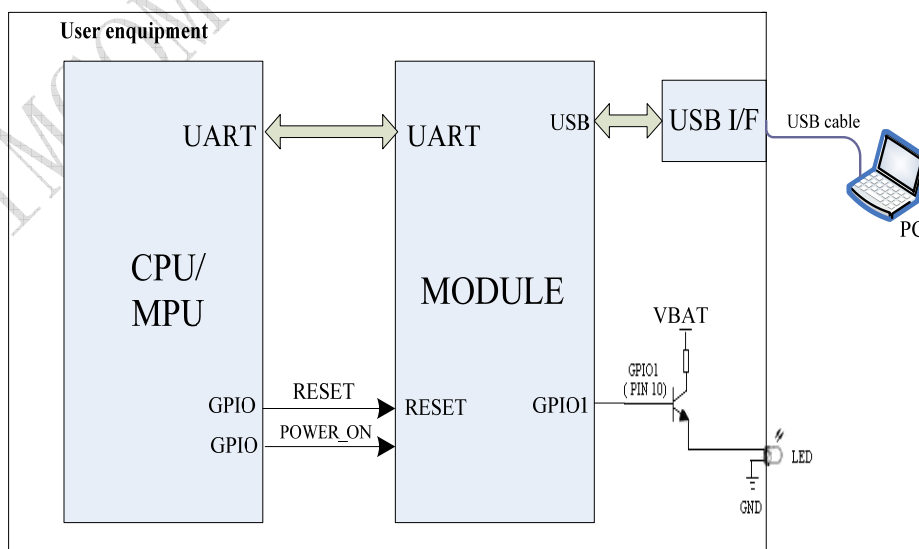


Figure: Reference circuit for USB update (UART communication)

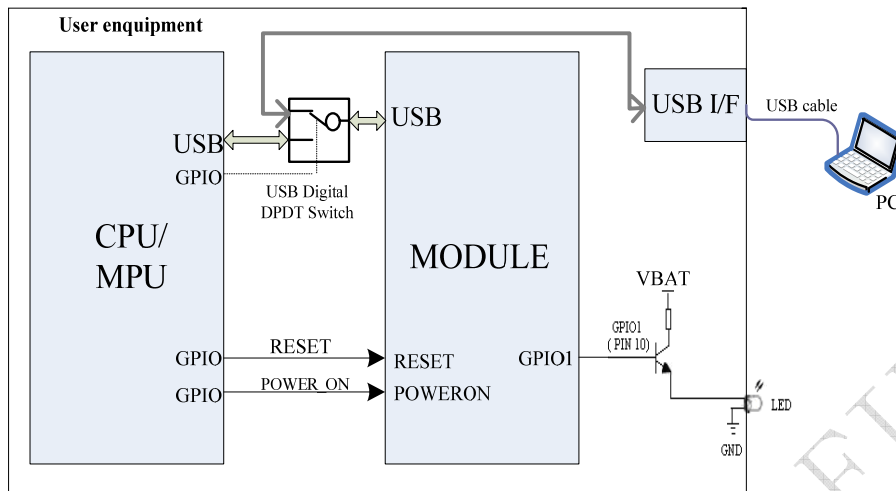


Figure: Reference circuit for USB update (USB communication)

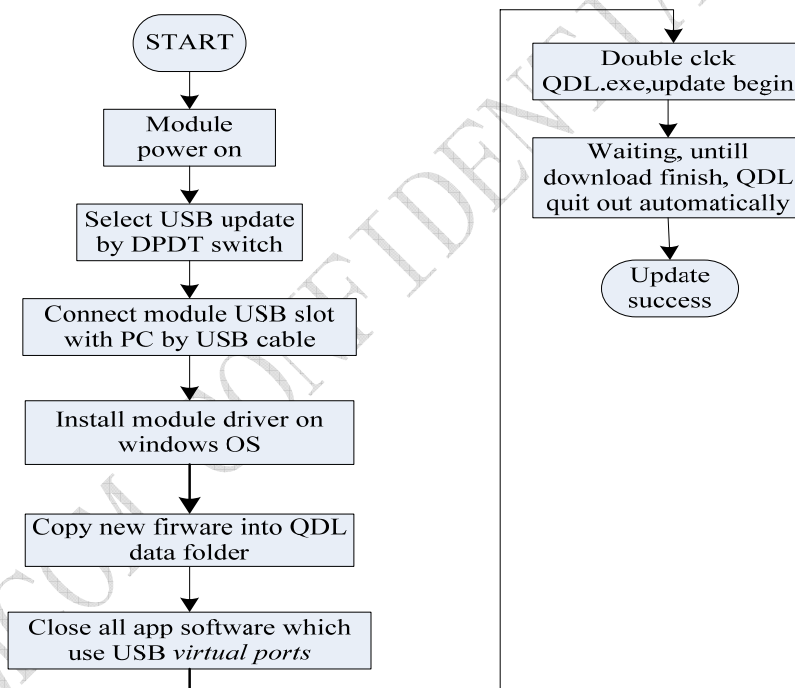


Figure: SD card update procedure

Note: We recommend using SD card update when users adopt USB to communicate with the module.

Appendix

A. SIM5215/SIM5216 GPIOs List

Table 45: SIM5215/SIM5216 GPIOs list

Name	GPIO Index	Default Function	Alternate Function
PCM_DIN	0	GPIO Interrupt [LEVEL/LOW]	PCM_DIN
GPIO1	1	Status led	GPIO
PCM_SYNC	2	GPIO [IN]	PCM_SYNC
PCM_CLK	3	GPIO [OUT/LOW]	PCM_CLK
GPIO4	4	RF Switch	Enable/Disable RF subsystem
PCM_DOUT	5	GPIO [OUT/LOW]	PCM_OUT
CAM_D2	6	Data bit 0 (YUV or RGB)	GPIO
CAM_D3	7	Data bit 1 (YUV or RGB)	GPIO
CAM_D4	8	Data bit 2 (YUV or RGB)	GPIO
CAM_D5	9	Data bit 3 (YUV or RGB)	GPIO
CAM_D6	10	Data bit 4 (YUV or RGB)	GPIO
CAM_D7	11	Data bit 5 (YUV or RGB)	GPIO
CAM_D8	12	Data bit 6 (YUV or RGB)	GPIO
CAM_D9	13	Data bit 7 (YUV or RGB)	GPIO
CAM_HSYNC	14	Horizontal synchronization	GPIO
CAM_VSYNC	15	Vertical synchronization	GPIO
CAM_CLK	16	Camera clock	GPIO
CAM_PCLK	17	Camera pixel clock	GPIO
CAM_RESET	18	Reset control	GPIO
CAM_STANDBY	19	Power down control	GPIO
UART1_CTS	20	CTS	GPIO
UART1_RFR	21	RTS	GPIO
UART1_DTR	22	DTR wake up module	GPIO
UART_DCD	23	DCD	GPIO
UART_RI	24	RI wake up host	GPIO

B. Digital I/O Characteristics

Table 46: Digital I/O characteristics

Parameter	Description	2.6V Mode			Unit
		Min	Typ	Max	
VREG_AUX	LDO output	0	2.6	2.9	V
V _{IH}	High-level input voltage	1.69	2.6	2.9	V
V _{IL}	Low-level	-0.3	0	0.91	V

	input voltage				
V _{OH}	High-level output voltage	1.17	2.6	2.6	V
V _{OL}	Low-level output voltage	0	0	0.45	V
I _{IH}	Input high leakage current	-	-	1	uA
I _{IL}	Input low leakage current	-1	-	-	uA
C _{IN}	Input capacitance	-	-	7	pF

Note: These parameters are for digital interface pins, such as keypad, GPIO, I²C, UART, and DEBUG. The Digital I/O specifications under both conditions are presented in the above tables.

C. Related Documents

Table 47: Related documents

SN	Document name	Remark
[1]	SIM5215/SIM5216_AT C_V1.00	SIM5215/SIM5216_ATC_V1.00
[2]	ITU-T Draft new recommendation V.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]	Audio Application Note V1.01	Audio Application Note V1.01
[22]	PCM Application Note V1.02	PCM Application Note V1.02
[23]	Keypad Application Note V1.01	Keypad Application Note V1.01
[24]	<i>Sleep_Application_Note</i>	<i>Sleep_Application_Note</i>
[25]	<i>Waking_up_Application_Note</i>	<i>Waking_up_Application_Note</i>
[26]	Module secondary-SMT-UGD	SMT Note

D. Terms and Abbreviations

Table 48: 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

E. Safety Caution

Table 49: 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.

	<p>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.</p>
	<p>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.</p> <p>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.</p> <p>Also, some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.</p>

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